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Weight Status as a Mediator of the Association Between Preschool Extraversion and Adolescent Restrained Eating

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Abstract

Objectives

To determine the longitudinal association between preschool extraversion and weight/dieting outcomes in adolescence.

Methods

Children (*N* = 180) were recruited as part of a longitudinal study,

with child temperament assessed in preschool (age 5.25 years), weight assessed in 2nd grade and early adolescence, and eating outcomes assessed in early adolescence (*mean age* = 12.02 years).

Results

Preschoolers high in extraversion were significantly more likely to have higher body mass index z-scores (zBMI) and more restrained eating behaviors in adolescence. zBMI was found to mediate the relationship between extraversion and restrained eating, such that children with high levels of extraversion were more likely to have higher zBMI in adolescence and, owing to this higher weight status, to engage in more restrained eating.

Conclusions

Temperament is an important predictor of later maladaptive weight/dieting outcomes in adolescence, making it a potentially important early factor to consider in weight management interventions.

Research has demonstrated a complex constellation of risk factors for childhood obesity, including child characteristics (e.g., temperament, eating behaviors), parent characteristics (e.g., feeding behaviors, mental health), and community/school factors (e.g., park proximity, accessibility/affordability of healthy foods). One broad child characteristic, temperament, is becoming increasingly recognized as a factor that may influence why some children are at greater risk of obesity than others (Bergmeier, Skouteris, Horwood, Hooley, & Richardson, 2013; Harrison et al., 2011). Characterized by individual differences in a child's emotional, attentional, and physical behavior patterns, early child temperament is commonly grouped into three dimensions: negative affectivity (e.g., fear,

sadness), effortful control (e.g., self-regulation, inhibitory control), and surgency/extraversion (e.g., positive emotionality, impulsivity, risk-taking, high activity level) (Rothbart, 2012). Research shows that temperament may interact with other aspects of the broader constellation of ecological risk factors for childhood obesity, including child characteristics such as gender (Walther & Hilbert, 2016), parent-level characteristics such as personality (Achtergarde, Postert, Wessing, Romer, & Müller, 2015) and feeding practices (Hughes & Shewchuk, 2012; Larsen et al., 2015), and broader factors such as culture/ethnicity (Sutin & Terracciano, 2016).

A significant link has been found between temperament and weight-relevant outcomes over the course of childhood (Bergmeier et al., 2013). However, previous literature linking child temperament with weight outcomes has overwhelmingly focused on "negative" temperamental traits (i.e., negative affectivity and low effortful control) and their related constructs (e.g., high emotionality, low soothability, poor self-regulation) (Bergmeier et al., 2013). For example, infant soothability and negative food reactions are linked with increased risk for weight gain in preschool for females (Faith & Hittner, 2010). Similarly, toddlers with poor self-regulation skills are at greater risk of obesity in preschool (Graziano, Calkins, & Keane, 2010). In contrast, fewer studies have examined the so-called "positive" temperamental trait surgency/extraversion (hereafter referred to as extraversion) with regard to weight status. Extraversion is a broad construct referring to a range of traits including sociability, impulsivity, activity level, and pursuit of positive emotions such as pleasure (Costa & McCrae, 1992). Research examining extraversion and weight outcomes over the course of childhood is limited, but results suggest a link between early extraversion and obesity risk. Burton and colleagues (2011), for example, found an association between infant extraversion and rapid infant growth, a

risk factor for later overweight status. It has also been proposed that extraverted infants may demonstrate more openness to new foods, higher appetitive and caloric needs, and invite overfeeding in certain contexts, patterns that may continue later in life and lead to increased likelihood of excess weight gain (Vollrath, Tonstad, Rothbart, & Hampson, 2011). While few other studies have examined extraversion more broadly in the context of childhood obesity, multiple studies suggest an association between specific facets of extraversion and obesogenic eating behaviors. For example, pleasure-seeking and impulsivity are associated with higher appetitive drive (Leung et al., 2014), eating in response to external food cues such as smell and taste (Elfhag & Morey, 2008), and consumption of more palatable foods (Ouwens, van Strien, & van Leeuwe, 2009), all linked to later maladaptive weight outcomes.

Despite these links, research on the link between extraversion, eating, and weight-relevant outcomes is limited. Specifically, studies examining the association between the broader construct of extraversion and weight-related constructs in childhood are lacking, with most studies focusing only on specific traits related to extraversion such as impulsivity (Leung et al., 2014). This presents a significant deficit in the literature because, as highlighted by Gartstein, Potapova, and Hsu (2014), surgency may be linked with specific obesogenic eating and feeding patterns as early as infancy. Further, few studies have examined the role of extraversion in predicting later eating behaviors and weight outcomes. Further, most studies have focused on outcomes in early childhood, and little is known about how temperament may relate to eating behaviors and weight outcomes later in childhood and adolescence. This represents a significant gap in the literature, as adolescence is an important developmental period marked by increasing independence in food selection and intake (Bassett, Chapman, &

Beagan, 2008). Additionally, lower parental regulation of eating habits may reveal maladaptive patterns of food consumption previously obscured during childhood by high parental monitoring and control over the food environment. This premise is supported by findings that adolescents typically experience a decline in dietary quality and exhibit an increase in obesogenic eating behaviors (Neumark-Sztainer, Story, Hannan, & Croll, 2002). Disordered eating behaviors such as restriction and binging are also more likely to emerge during this period (Smolak & Levine, 2013), patterns that are likely to track into adulthood (Mikkilä, Räsänen, Raitakari, Pietinen, & Vikari, 2005). Additionally, adolescence is a period marked by increased social pressure to maintain a certain body weight (Halvarsson, Lunner, Westerberg, Anteson, & Sjödén, 2002), potentially leading to higher levels of dieting and weight management strategies. The current study sought to address this gap in the literature by exploring the impact of an understudied early childhood temperament factor—specifically extraversion—on later eating and weight outcomes in adolescence.

Little is known about specific mechanisms through which childhood extraversion may lead to increased risk for obesity in adolescence. Extraverted youth may be at increased risk for weight gain owing to proneness to obesogenic eating behaviors such as those reviewed above (e.g., food overconsumption, heightened responsivity to external food cues). Further, findings from Nederkoorn, Jansen, Mulkens, and Jansen (2007) suggest that impulsive children are not only at increased risk for obesity compared with their less impulsive peers, but also experience less success in losing excess weight. Speculatively, this increased risk for obesity and difficulty with weight loss may lead to the development of unhealthy dieting patterns in extraverted adolescents that, in turn, further increase risk for weight gain. Although no known studies have examined the relationship

between extraversion and dieting in adolescence, Elfhag and Morey (2008) found that extraverted adults engaged in more restrained eating, the dietary practice of restricting food/caloric intake in a conscious effort to control weight. While individuals who engage in restrained eating often perceive their food restriction as an adaptive pattern (Elfhag & Morey, 2008), according to Restraint Theory restrained eating leads to overeating owing to (1) the continued ignoring of internal cues of hunger and (2) the body's adaptive drive to avoid starvation by seeking calories under deprivation situations (Herman & Polivy, 1983). Over time, food restriction may thus produce loss of self-regulatory abilities in food consumption, resulting in overeating and subsequent weight gain (Herman & Polivy, 1980). This creates a vicious cycle between the ineffective weight management strategy of food restriction and subsequently higher body mass index (BMI). This pattern may emerge as early as adolescence, with research demonstrating that higher BMI predicted restrained eating in a sample of 13- to 16-year-olds (Snoek, van Strien, Janssens, & Engels, 2008). However, despite its relevance to both eating patterns and weight outcomes, no known research has examined the relationship between weight status and dietary patterns within the context of child temperament.

Theoretically, the design of the present study follows recommendations by Snoek and colleagues (2008), who have conducted multiple longitudinal studies on the relationship between restrained eating and BMI. They have proposed that higher BMI is a better predictor of restrained eating than restrained eating is of BMI. In other words, higher BMI leads to restrained eating more often than restrained eating leads to higher BMI. Following this model, the current study tested a mediation model in which early extraversion predicts later restrained eating in adolescence, with this relationship mediated by adolescent weight status. However, owing to the

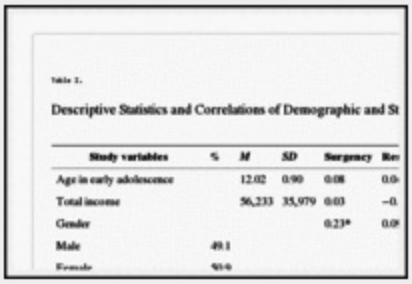
potential for a bidirectional relationship between restrained eating and BMI, supplementary analyses also tested a mediational model including restrained eating as the mediator and zBMI as the outcome. The current study sought to (1) explore the longitudinal associations between preschool extraversion and later dietary behaviors and weight outcomes and (2) examine potential mechanisms of these associations. Specifically, adolescent zBMI was tested as a mediator of the association between preschool extraversion and restrained eating in adolescence. First, it is hypothesized that extraversion in preschool will predict early adolescent zBMI. This hypothesis is based on findings that more extraverted children are higher in pleasure-seeking, impulsivity, and situational anticipation (Rothbart, Ahadi, Hershey, & Fisher, 2001), all characteristics hypothesized to be associated with weight gain. Consistent with findings by Snoek and colleagues (2008), it is expected that this model will be stronger than the alternative model testing zBMI as the outcome variable. Second, it is hypothesized that preschool extraversion will predict eating behaviors in early adolescence, particularly restrained eating. This hypothesis is supported by research showing that greater extraversion is related to more restrained eating in adults (Elfhag & Morey, 2008). Third, it is predicted that higher adolescent zBMI will be associated with higher levels of engagement in restrained eating based on research demonstrating that restrained eating is used as a weight management technique (Elfhag & Morey, 2008). Fourth, it is predicted that early adolescent zBMI will mediate the relationship between preschool extraversion and early adolescent restrained eating, such that extraverted youth will be more likely to have higher zBMIs, which will then lead to restrained eating to manage weight.

Method

Participants

Participants were 180 children recruited in preschool for a longitudinal study in a cohort sequential design from preschool to early adolescence. Participants were recruited at a Midwestern site through flyers distributed at local preschools and medical/health centers. Because the focus of the larger longitudinal study was to describe typical development, children with diagnosed developmental, behavioral, or language disorders at the time of preschool recruitment were excluded. To be eligible for the study, the primary language spoken at home had to be English.

In terms of race and ethnicity, 65.7% of children reported as European American, 17.8% as multiracial, 14.2% as Latino, 1.8% as African American, and 1.0% as Asian American. The original longitudinal study involved a lagged cohort design in which children participated at 5.25 years old. The follow-up study occurred at one time-point for all children who had previously participated in the preschool study and had reached 5th grade or beyond by the time of the follow-up. Data for the current analyses included measurement of temperament during their initial study visit in preschool (participating within 2 weeks of turning 5.25 years) and BMI and dietary patterns assessed during adolescence (age range 10.75–15.08 years, $m = 12.02$, $SD = 0.90$). Recruitment involved stratification by sex (50.9% female) and oversampling on sociodemographic risk (39.1% at-risk). Sociodemographic risk was defined as eligibility for public medical assistance based on federal poverty guideline of family income to size. See Table I for demographic information.


Descriptive Statistics and Correlations of Demographic and St

Study variables	%	*M*	*SD*	Surgency	Re
Age in early adolescence		12.02	0.90	0.08	0.0
Total income		56,233	35,979	0.03	−0.
Gender				0.23*	0.0
Male	49.1				

[See full table]

Table I. Descriptive Statistics and Correlations of Demographic and Study Variables

Of the 194 children who participated at age 5.25 years and were eligible for the follow-up, 180 participated in the follow-up study (92.8%). Of 180 participants who completed the study measures in early adolescence, 169 youth had complete data (93.9%). Children who did not participate in the follow-up study did not differ from children who participated on demographic or key study variables (i.e., gender, ethnicity, mothers' highest level of education, socioeconomic status, extraversion, zBMI in 2nd grade; ps > .05). In terms of missing data, nine children were missing the temperament measure at 5.25 years, and two children were missing BMI data in adolescence. Full information maximum likelihood (FIML) estimation was used for mediation analyses, and thus, the full sample of 180 participants was included in the analyses. FIML estimation is a preferred way to handle missing data to avoid introducing bias (Enders, 2010; Little, Jorgensen, Lang, & Moore, 2014).

Procedures

During the larger longitudinal preschool study, parents (almost always mothers) completed ratings of child temperament and behavior when children were 5.25 years. A follow-up data collection was conducted with the sample when participants were early adolescents. Families that had previously participated in a larger longitudinal study through preschool and

elementary school were contacted to participate in a follow-up study on health behaviors. During the follow-up study, adolescents provided data on restrained eating behaviors, and height/weight measurements for BMI calculations were collected by trained research assistants. Parents provided consent, and youth provided assent for participation. Parents and youth separately completed measures in quiet rooms as part of a laboratory visit. The University of Nebraska-Lincoln [redacted for blind review] institutional review board approved all procedures.

Measures

Surgency/Extraversion Temperament

Temperament was measured in preschool using the Children's Behavior Questionnaire (CBQ), a valid and reliable measure, at 5.25 years (Rothbart et al., 2001). The CBQ is appropriate for children between 3 and 7 years. Parents answered questions about how true a behavior is of their child and responded on a 7-point Likert scale ranging from extremely true to extremely untrue. The 36-item CBQ has a three-factor structure including extraversion, negative affectivity, and effortful control. To address gaps in the literature on "positive" temperamental traits and eating behaviors, extraversion was included as the independent variable. Extraversion is composed of questions on impulsivity, high intensity pleasure, activity level, and positive anticipation. Shyness inversely loads on the extraversion factor. The internal consistency in the current study is good ($\alpha = .72$).

Restrained Eating

Restrained eating in early adolescence was measured using the Dutch Eating Behaviors Questionnaire (DEBQ), a reliable 33-item questionnaire (van Strien, 2002; van Strien, Frijters, Bergers, & Defares, 1986). The DEBQ is a valid assessment of eating patterns, with evidence of sensitivity to

experimental manipulations of diet restriction (Williamson et al., 2007). Restrained eating assesses intentions to restrict food and actual control of eating. Early adolescents answered 10 questions about restrained eating patterns on a 5-point Likert-type scale. The restrained eating scale was included as an outcome measure. The internal consistency in the current study is good ($\alpha = .87$).

Body Mass Index z-Scores

Youth height and weight were objectively measured using a high-quality electronic scale and stadiometer during the same early adolescent laboratory visit in which the DEBQ was completed. Weight was recorded to the nearest 0.1 lb, and height to the nearest 0.1 inch. Child height and weight were converted to BMI (weight (lb)/[height (in)]$^2 \times 703$) and then to BMI z-scores (hereafter specified as zBMI) based on age and gender using the Center for Disease Control and Prevention (CDC) growth charts (Kuczmarski et al., 2000). Based on CDC guidelines, 4.1% youth were underweight, 62.7% were healthy weight, 19.5% were overweight, and 13.6% were obese in early adolescence. zBMI was included as a mediator variable.

Height and weight measurements were also available from a laboratory visit conducted with participants during 2nd grade. As with the early adolescent measurement point, these data were converted to zBMI and included as a distal mediator in analyses to examine change in zBMI from childhood to early adolescence.

Analysis Plan

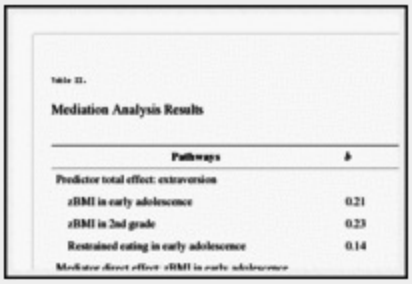
Mediation was estimated in Mplus version 6.12 to calculate the direct and indirect effects of the extraversion temperament trait on restrained eating with mediators of zBMI in early adolescence and zBMI in 2nd grade. The

mediation model controlled for gender, ethnicity/race, age in early adolescence, and total household income. See Table I for correlations of study variables. Bootstrapping methods were used to quantify the indirect pathway of extraversion on restrained eating through zBMI. Compared with other methods of testing mediation, bootstrapping is an often recommended approach that does not assume a normal distribution of the data and produces fewer Type I errors (Hayes, 2009). Supplementary analyses were conducted in Mplus to compare the model of zBMI predicting restrained eating with a model in which restrained eating predicts zBMI. AIC and BIC values were compared to determine the preferred model. The model with the smaller Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values is preferred. A post hoc power analysis revealed that a sample size of 180 provided ample power to find a medium effect.

Results

Mediation Analyses

Results for the mediator analysis are presented in Figure 1 and Table II. The mediator analysis controlled for age in early adolescence, gender, race, and total household income. None of the control variables significantly predicted restrained eating. zBMI in the 2nd grade was included as a distal mediator. The first path established that extraversion (independent variable) was associated with zBMI in the 2nd grade (mediator), $b = 0.23$, $SE = 0.09$, $ß = .19$, $t = 2.44$, $p = .015$. However, the second path testing the direct effect of zBMI in the 2nd grade (mediator) on restrained eating (dependent variable) indicated that zBMI in the 2nd grade was not associated with restrained eating in early adolescence, $b = 0.04$, $SE = 0.09$, $ß = .04$, $t = 0.41$, $p = .684$.



Mediation Analysis Results

Pathways	b
Predictor total effect: extraversion	
zBMI in early adolescence	0.21
zBMI in 2nd grade	0.23
Restrained eating in early adolescence	0.14

See full table

Table II. Mediation Analysis Results

View larger version

Figure 1. Standardized mediation results controlling for gender, age in early adolescence, race, and total household income.

*p < .05, **p < .01, ***p < .001

The primary question of interest in the analyses was whether zBMI in early adolescence mediated the association between extraversion and restrained eating in early adolescence. The first path established that extraversion (independent variable) was associated with zBMI in early adolescence (mediator), b = 0.21, SE = 0.09, ß = .17, t = 2.20, p = .028. Second, the direct effect of zBMI in early adolescence (mediator) predicting restrained eating (dependent variable) was estimated. zBMI in early adolescence was associated with restrained eating, b = 0.23, SE = 0.09, ß = .30, t = 2.65, p = .008. Third, the path estimating the total effect of extraversion (independent variable) predicting restrained eating (dependent variable) was estimated. Extraversion significantly predicted restrained eating, b = 0.14, SE = 0.07, ß = .15, t = 2.05, p = .041. Fourth, the direct effect of extraversion on restrained eating through zBMI in early adolescence (mediator) was estimated. With the inclusion of the mediators, the coefficient for extraversion was no longer significant and decreased to b =

0.11, SE = 0.07, ß = .11, t = 1.40, p = .161.

Nonparametric bootstrapping analyses were repeated 1,000 times to test the model of zBMI as a mediator of the relationship between extraversion and restrained eating. In these analyses, mediation is significant if the 95% Bias Corrected confidence intervals for the indirect effect do not include 0 (Hayes, 2009; Preacher & Hayes, 2008). Using bootstrapping procedures, zBMI in early adolescence was found to fully mediate the relationship between extraversion and restrained eating (95% CI = 0 .01–0.11), such that preschoolers with high levels of extraversion were more likely to have higher zBMI as early adolescents, and owing to high zBMIs, engaged in more restrained eating.

To calculate the percent mediated by zBMI, the following formula using the beta weights was used: 100 × [1 − (direct effect/total effect)]. Therefore, 26.67% of the total effect between extraversion and restrained eating was accounted for by the zBMI mediator [100 × (1 − (0.11/0.15) = 26.67%]. The total variance in restrained eating explained by the full model was 20.1%. Therefore, the zBMI mediator explained 5.36% of the total variance in restrained eating (0.2667 × 0.2010).

Supplementary Analyses

To supplement the main analyses, we compared the primary model described above (with zBMI predicting restrained eating; Model A) with an alternative model in which restrained eating predicted zBMI (Model B). In Model A, zBMI significantly predicted restrained eating, b = 0.24, ß = .31, p < .001. In Model B, restrained eating significantly predicted zBMI, b = 0.40, ß = .31, p < .001. When the fit statistics (AIC and BIC) were compared to determine the preferred model, Model A was statistically preferred

(Model A: AIC = 404.85, BIC = 414.35; Model B: AIC = 498.76, BIC = 508.25). The mediation model follows the same pattern of predictors as Model A.

Discussion

This study explores longitudinal associations between child extraversion in preschool and later eating practices and weight outcomes in adolescence, expanding on previous research by examining weight outcomes in early adolescence within a longitudinal design. In support of a priori hypotheses, findings suggest that the early temperamental trait extraversion has long-term effects on both eating patterns and subsequent weight outcomes into early adolescence. Consistent with the first hypothesis, preschool extraversion predicted higher early adolescent zBMI. In support of the second hypothesis, preschool extraversion predicted restrained eating behaviors in early adolescence. In line with the third hypothesis, early adolescent zBMI was a significant mediator of restrained eating, such that higher zBMI was associated with higher likelihood of restrained eating practices. Consistent with the fourth hypothesis, zBMI mediated the relationship between extraversion and restrained eating, such that children high in extraversion in preschool were more likely to have higher zBMIs in early adolescence, leading to restrained eating in early adolescence.

This research builds on previous literature examining the relationship between child temperament and weight status (Faith & Hittner, 2010; Graziano et al., 2010) by examining extraversion, an aspect of temperament subject to less research than negative temperamental traits (e.g., negative affect). Extraversion includes many traits that may be linked to obesogenic eating behaviors, including lower inhibitory control, higher reward

sensitivity, and higher pleasure-seeking behavior (Leung et al., 2014). For example, toddlers with lower inhibitory control and higher reward sensitivity are at greater risk for overweight in early childhood (Graziano et al., 2010). This study extends previous findings by demonstrating the continuation of the link between extraversion and weight status into adolescence.

While previous research has linked extraversion to increased likelihood of restrained eating practices in adults (Elfhag & Morey, 2008), no known studies have examined the relationship between extraversion and dietary behaviors in an adolescent sample. However, as previous research suggests that adolescents experience increased social pressure to maintain a certain body weight (Halvarsson et al., 2002) and that disordered eating is most likely to emerge during adolescence (Smolak & Levine, 2013), enhancing our understanding of the use of weight management strategies such as restrained eating in this population is important. Results of the current study suggest that youth higher in extraversion are particularly likely to use restrained eating practices. However, given the paucity of research on this topic, more research is necessary to elucidate the relationship between child temperament, risk for overweight, and possible compensatory weight management strategies in adolescence.

The finding that zBMI was a significant predictor of restrained eating is consistent with previous research demonstrating that overweight adolescents are likely to use restrained eating as a means of weight management (Snoek et al., 2008; Walther & Hilbert, 2016). This pattern is concerning because while adolescents may use restrained eating practices as a way to curb weight gain and/or promote weight loss, over time these eating patterns may lead to further weight gain (Braet et al., 2014). Thus, overweight adolescents

may be prone to select unhealthy and often ineffective compensatory weight management strategies. Future studies should examine this association further, including examination of the risk factors and potential long-term implications of unhealthy dieting patterns in adolescence.

Finally, results demonstrated that zBMI mediated the relationship between extraversion and restrained eating, such that children high in extraversion in preschool are more likely to have higher zBMIs, which then leads to engagement in restrained eating in early adolescence. Because extraverted youth may be more prone to episodes of food over-consumption (Rothbart et al., 2001), it may be that they then overcompensate by attempting to restrict food intake to curb weight gain, a weight management strategy demonstrated in both children (Braet et al., 2008) and adolescents (Snoek et al., 2008; Walther & Hilbert, 2016). According to Restraint Theory, restrained eating practices are often an ineffective weight management strategy as, over time, food restriction can lead to diminished levels of self-control and later overcompensation in food consumption (Herman & Polivy, 1980, 1983). This pattern is demonstrated in research by Rollins, Loken, Savage, and Birch (2013), who found that children restricted from consuming certain foods were more likely to overcompensate later on and consume high quantities of restricted foods when made available. Results of the current study suggest that extraverted children may be at higher risk of food overcompensation, increasing their risk for overweight status and subsequent maladaptive weight management strategies in adolescence.

Implications

Although the effect sizes were modest, this study has important clinical implications. This study identifies a temperament style (i.e., extraversion) that appears to be important for BMI and later eating behaviors. Results

indicate that pediatric psychologists may want to assess temperament in obesity prevention and treatment. It also follows that treatments could be tailored based on temperament. Pediatric psychologists who know that youth with extraverted temperaments may be more likely to engage in restrained eating and have higher BMIs can implement strategic interventions. For example, psychoeducation on mindful or intuitive eating can be provided as an alternative to restrained eating. Stimulus control can be used to design environments that discourage children with extraverted temperaments from overeating based on environmental cues, pleasure-seeking, and impulsivity.

This study also has important research implications. Past research has focused primarily on temperament styles that are viewed as more negative, such as negative affectivity. However, given that extraversion is characterized by pleasure-seeking behaviors and impulsivity, it makes intuitive and theoretical sense that extraversion would be implicated in unhealthy eating behaviors as well. The current study addresses this gap by examining the role of preschool extraversion in predicting early adolescent zBMI and restrained eating. This study also strengthens the literature by examining temperament and zBMI in a longitudinal framework that spanned an average of 7 years. The extended longitudinal nature of the study is a major contribution to this area of research.

This study has several limitations that should be noted. First, we could not control for zBMI at the preschool baseline because height and weight measurements were not taken at that time point. However, objectively measured zBMI was available early in elementary school (2nd grade), allowing us to include zBMI at this earlier age as a distal mediator and capture change in weight status from childhood to early adolescence.

Second, although the overall design of the current study is longitudinal, early adolescent zBMI and restrained eating were assessed at the same time point, which creates some uncertainty regarding the direction of associations between these variables. The main mediation model in the study was based on recommendations by Snoek and colleagues (2008) who proposed that higher BMI leads to restrained eating more often than the reverse. Thus, the main model tested included zBMI as the mediator and restrained eating as the outcome. However, it is likely that the relationship between restrained eating and BMI is a complex, cyclical process. For example, as emphasized in the Restraint Theory (Herman & Polivy, 1983), restrained eating may lead to obesogenic eating behaviors that result in higher BMI, which may further drive individuals to continue their use of restrictive eating practices as a means of curbing weight gain. Thus, it is possible that findings from the current study that higher adolescent zBMI resulted in the use of restrained eating practices is only one segment in this cycle. Multiple repeated measures of constructs across childhood and adolescence are recommended in future studies to explicate more sophisticated cyclical relationships between dietary practices and weight status over time. Despite the concurrent measurement of some constructs at the adolescent time point, the study's overall longitudinal design allows for stronger conclusions to be made about the predictive role of extraversion for both BMI and restrained eating. Future researchers would be advised to measure eating behaviors and BMI each at multiple time points to better explicate the direction of effects.

Third, the findings explained a relatively small portion of the variance in adolescent restrained eating and zBMI. This is not surprising, however, given that small effect sizes are common in research examining eating behavior and BMI, which are affected by a wide range of factors. Fourth, the

study is limited by the sample's racial/ethnic composition, which may limit generalization to more ethnically diverse samples. However, the sample was regionally representative for race/ethnicity and was oversampled for socioeconomic risk, a population at high risk for overweight and obesity later in life (Brisbois, Farmer, & McCargar, 2012), making results particularly relevant for economically vulnerable populations. Further, while the study design contributes to the literature by examining potential long-term weight implications of extraversion, a less-studied temperamental trait, it is recommended that future research examines the longitudinal association between temperament and weight outcomes within a broader ecological framework, including potential interactions between different facets of child temperament, eating behaviors, maternal feeding behaviors, gender differences, and cultural factors. Finally, this study focused solely on maladaptive eating behaviors, limiting understanding of the relationship between temperament and healthy dietary and weight management strategies. Future research may benefit from examining potential positive effects of temperamental traits on dietary patterns and weight status.

Despite the limitations noted, this study provides important and novel findings within a much-needed longitudinal framework. The current study builds on previous research on temperament, eating behaviors, and weight outcomes by focusing on an understudied aspect of temperament (extraversion), objectively measuring of BMI in childhood and adolescence, and using multiple informants on validated measures across development. To our knowledge, the extended longitudinal design spanning from preschool into early adolescence is a novel contribution to the field.

Conclusions

In conclusion, this study found that preschool extraversion predicts both zBMI and restrained eating in early adolescence. Moreover, zBMI acted as a mediator of the relationship between extraversion and restrained eating, such that overweight youth were more likely to engage in restrained eating. This may suggest that extraverted youth with higher BMIs engage in higher levels of restrained eating as a compensatory weight management strategy. Health-care practitioners are urged to consider the role of temperament and eating behaviors with adolescent populations.

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Conflicts of interest: None declared.

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Table I.

Descriptive Statistics and Correlations of Demographic and Study Variables

Study variables	%	M	SD	Surgency	Restrained eating	zBMI adoles
Age in early adolescence		12.02	0.90	0.08	0.04	0.04
Total income		56,233	35,979	0.03	−0.08	0.01
Gender				0.23*	0.09	0.13
Male	49.1					
Female	50.9					
Ethnicity				0.10	0.07	0.02
European American	67.5					
African American	1.8					
Hispanic	14.2					
Asian American	1.0					
Multiracial	17.8					
Socioeconomic status —at-risk				0.05	0.14	0.01

Yes	39.1					
No	60.9					
BMI in 2nd grade						
Underweight	3.1					
Healthy weight	71.3					
Overweight	13.8					
Obese	11.9					
BMI in early adolescence						
Underweight	4.1					
Healthy weight	62.7					
Overweight	19.5					
Obese	13.6					
zBMI 2nd grade		0.40	0.99	0.19*	0.22**	0.80[a]
Surgency/extraversion		4.57	0.84	–	0.16*	0.17[a]
Restrained eating		2.01	0.79	–	–	0.31[a]
zBMI early adolescence		0.51	1.04	–	–	–

*p < .05, **p < .01, ***p < .001

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Table II.

Mediation Analysis Results

Pathways	b	SE	β	T	p
Predictor total effect: extraversion					
zBMI in early adolescence	0.21	0.09	.17	2.20	.028
zBMI in 2nd grade	0.23	0.09	.19	2.44	.015
Restrained eating in early adolescence	0.14	0.07	.15	2.05	.041
Mediator direct effect: zBMI in early adolescence					
Restrained eating	0.23	0.09	.30	2.65	.008
Mediator direct effect: zBMI in second grade					
Restrained eating	0.04	0.09	.04	0.41	.684
Predictor direct effect: extraversion with mediators included					
Restrained eating	0.11	0.07	.11	1.40	.161

Control variables predicting restrained eating					
Gender	0.02	0.03	.04	0.55	.585
Age in early adolescence	0.32	0.66	.04	0.48	.63
Race/ethnicity	0.04	0.12	.03	0.33	.742
Total annual income	−4887.60	3055.65	−.15	−1.60	.110

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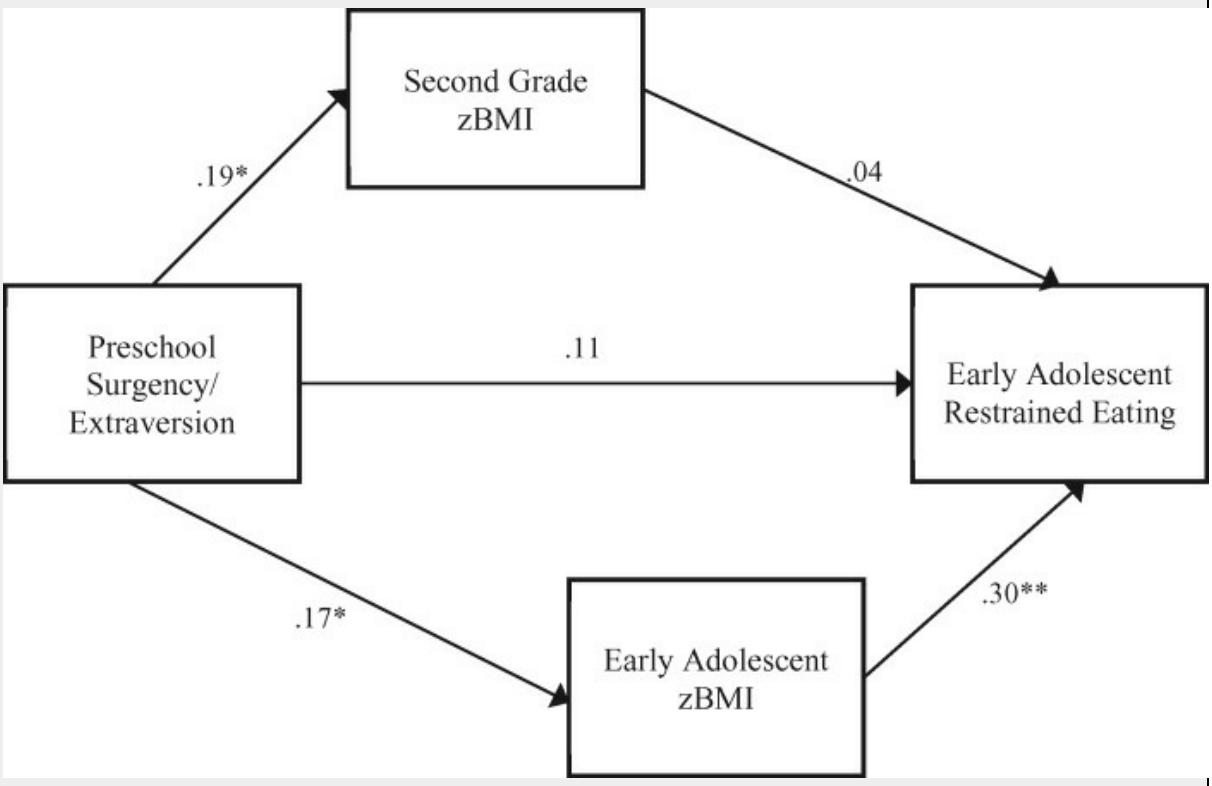

Figure 1.

Standardized mediation results controlling for gender, age in early adolescence, race, and total household income.

*p < .05, **p < .01, ***p < .001

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