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Positive parenting mitigates the effects of poor self-regulation on BMI trajectories from age 4 to 15 years

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Abstract

Objective—This study sought to determine whether parenting style moderated the effects of delay of gratification on BMI trajectories from age 4 to 15 years.

Methods—Longitudinal data were analyzed on 778 children drawn from the Study of Early Child Care and Youth Development. Parenting style (authoritative, authoritarian, permissive, neglectful) was created from measures of mothers' sensitivity and expectations for self-control when children were age 4 years. Self-regulation was also measured at 4 years using a well-known delay of gratification protocol. BMI was calculated from measured height and weight at each time point. Mixed modeling was used to test the interaction of parenting styles and ability to delay gratification on BMI trajectories from 4 to 15 years.

Results—There was a significant interaction effect of parenting and ability to delay on BMI growth from 4 to 15 years for boys. Boys who had authoritarian mothers and failed to delay gratification had a significantly steeper rate of growth in BMI from childhood through adolescence than children in any other parenting x delay group.

Conclusions—Authoritative and permissive parenting styles were protective against more rapid BMI gains for boys who could not delay gratification. Ability to delay gratification was protective against BMI gains for boys who had parents with authoritarian or neglectful parenting styles.

Keywords

Parenting; Self-Regulation; Obesity

The most recent prevalence statistics from 2009–2010 indicate that approximately 17% of children aged 2–19 in the United States were considered overweight or obese. More so, the prevalence of obesity is greater among boys (18.6%) than it is among girls (15%) (Ogden, Carroll, Kit, & Flegal, 2012). Though previously rising rates of childhood obesity have been flattening over the last decade, the existing rate of childhood obesity and overweight is alarmingly high and a definite cause for concern (Ogden et. al., 2012). There is a need to understand the factors that set certain children along a path to rapid weight gain in order to inform programs to prevent further weight gain and treat existing weight concerns. One

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factor that has been identified as setting children on this upward trajectory is self-regulation failure.

Results from several studies document a link between children's ability to self-regulate and obesity. Self-regulation is often defined as a purposeful process originating from within the person whereby one exerts control or makes an adjustment with the aim of replacing one response with another to either achieve a certain goal or conform to set rules or ideals (Vohs & Baumeister, 2010). Children with self-regulation in the eating domain are able to recognize satiety cues and stop eating when full (Birch & Fisher, 1997), which is an important protective factor for obesity. However many overweight and obese children tend to lack this ability and eat past the point of satiety (Faith, Berkowitz, Stallings, Kerns, Storey & Stunkard, 2006; Fisher & Birch, 2002; Hill, Llewellyn, Saxton, Webber, Semmler et al., 2008). Results from cross-sectional and longitudinal studies show that high levels of self-regulation even outside of the eating domain are protective against rapid weight gain in children and result in a lower incidence of obesity in childhood (Graziano, Calkins & Keane, 2010) and adolescence (Francis & Susman, 2009;; Seeyave, Coleman, Appugliese, Corwyn, Bradley et al., 2009; Tsukayama, Toomey, Faith & Duckworth, 2010). Two of these studies specifically looked at children's ability to delay gratification in order to delineate the effect of this aspect of low self-regulatory capacity on increased weight gain (Francis & Susman, 2009; Seeyave et al., 2009). Additional studies also provide evidence that difficulty delaying gratification is highly prevalent among obese children (Bonato & Boland, 1983; Bruce, Black, Bruce, Daldalian, Martin & Davis, 2011).

Delay of gratification refers to a child's ability to delay receiving an immediate reward in return for a larger, later reward (Mischel, Shoda & Rodriguez, 1989). This is thought to be related to self-regulation and self-regulation of energy intake; an important correlate of weight gain and obesity (Frankel, Hughes, O'Connor, Power, Fisher & Hazen, 2012). It is argued that delay of gratification translates to eating behavior and obesity with respect to food choices, portion control and food motivation (Bruce, Martin & Savage, 2011). While the ability to delay gratification is a risk factor for obesity in childhood, there are children who cannot delay but do not develop obesity. It follows then, that there are moderating factors that may distinguish between children who are most at risk for obesity, even when they fail to delay gratification and as such exhibit low levels of self-regulation. Parenting style is one such moderator that is examined in this paper.

Multiple studies confirm an association between parenting styles and overweight status in children (Rhee, Lumeng, Appugliese, Kaciroti & Bradley 2006; Olvera & Power, 2010; Hughes, Shewchuk, Baskin, Nicklas & Qu, 2008). In this paper parenting style was operationalized using Maccoby and Martin's (1983) expanded definition of parenting typologies which include: Authoritative, Authoritarian, Permissive (Indulgent) and Neglectful (Disengaged). These four parenting styles characterize parents based on their responsiveness and demandingness. Responsiveness reflects parental warmth, autonomy granting and emotional involvement with the child; while demandingness reflects disciplinary style and expectations for child self-control.

Some studies indicate that authoritarian parenting is related to pathological weight gain (Rhee et al., 2006); other studies with low-income and minority children indicate that authoritarian parenting did not have any impact on weight status, rather, permissive parenting was predictive of overweight and obesity (Olvera & Power, 2010, Hughes et al., 2008). These mixed findings suggest that there is a need to better understand which specific parenting styles confer either protection or risk, and if certain child characteristics may alter this risk/protection.

Parenting style is thought to moderate the link between parenting practices and child outcomes (Darling & Steinberg, 1993). Darling & Steinberg's contextual approach to parenting suggests that the effect of any given parenting practice on the socialization of the child is dependent upon the context in which it is delivered. While this study does not focus on any one specific parenting practice, it instead highlights the overall attitude toward and interaction of the parent with the child. The aim is to understand how parenting style interacts with delay of gratification to produce differential BMI growth patterns in childhood and adolescence. Several studies to date point to the idea that general parenting *style* moderates the effects of certain parenting *practices* on children's weight status (Wen & Hui, 2010); and that parenting plays a moderating role with respect to various child characteristics and the subsequent effects of those characteristics on weight status (Sleddens, Gerrards, Thijs, de Vries, & Kremers, 2011).

With respect to self-regulation, the limited resource theory posits that if constraints are placed on one's ability to self-regulate in a particular domain, the ability to self-regulate in other domains may be limited. Applying Maccoby and Martin's (1983) definition of parenting styles, the kind of constraints a parent might place on their child's ability to self-regulate could include: insufficient autonomy granting (i.e. low responsiveness) thus not giving the child the opportunity to exert self-regulation; and too many expectations for child self-control (i.e. unresponsive demandingness). The latter is important given that this theory suggests that self-regulation is a fixed resource affected by the existing demands on the person for self-control (Baumeister et al., 1998). Using the theory and the definitions of parenting style, it is expected that parenting styles characterized by high responsiveness (authoritative) would be optimal for the child in terms of how parenting might moderate existing child self-regulation. It is also anticipated that parenting characterized by demandingness with a lack of responsiveness to the child would be detrimental (authoritarian parenting).

At present, few studies examine the interaction of parenting and self-regulation in the context of obesity. There is evidence that insensitive parenting coupled with a child's difficult temperament results in a greater likelihood of obesity and overweight (Anderson, Gooze, Lemeshow & Whitaker, 2012; Wu, Dixon, Dalton, Tudiver & Liu, 2011; Zeller, Boles & Reiter-Purtill, 2008); yet very little is known about the interaction between parenting and objectively-measured indicators of self-regulation, such as the ability to delay gratification.

The purpose of this study was to examine how specific parenting styles moderate the effects of children's ability to delay gratification on BMI changes from early childhood through

adolescence. This paper specifically tested the hypothesis that there would be an interaction between parenting and delay of gratification, such that in children who fail to delay, authoritative parenting will confer protection against pathological BMI gains. Conversely, it was hypothesized that when more parent-centered parenting styles (authoritarian, neglectful) are coupled with children who fail to delay we will see the steepest BMI trajectories from age 4 to 15 years. Due to known gender differences in the prevalence of obesity, the rate at which children grow (Kuczmarski, Ogden, Grummer-Strawn, Flegal, Guo, Wei, Mei et al., 2000), patterns of weight gain with respect to body composition (boys gaining muscle and girls gaining fat) (Boot, Bouquet, de Ridder, Krenning & de Muinck Keizer-Schrama, 1997), ability to delay gratification (Silverman, 2003) and differences in the calculation of BMI (Kuczmarski et al., 2000) this interaction was also examined by gender.

Methods

Participants

Longitudinal data from the National Institutes of Child Health and Human Development's Study of Early Child Care and Youth Development (NICHD SECCYD) were used to examine the relations between parenting, self-regulation and changes in BMI. Data were collected from families at 10 sites across the United States from the birth of the child until age 15. Further details about the methods of data collection and the original cohort can be found in detail at the study website: <http://www.nichd.nih.gov/research/supported/Pages/seccyd.aspx>. There were 1,364 children in the original cohort, attrition throughout the course of the study resulted in a sample of 1,226 at age 4 and 1,009 by age 15. Missingness was primarily due to no data for the parenting variables at age 4.

Children with missing data for the following measures were excluded from the analyses: maternal sensitivity, expectations for self-control and anthropometrics at age 15 years. After excluding missing cases, there were 778 families in the final analytic sample. Attrition analyses were performed to examine whether families missing from the study at age 15 differed sociodemographically from families with complete data on several measures: maternal education, family income-to-needs ratio, initial BMI and parenting style.

Data collected when children were ages 4, 7, 9, 11, 12, 13, 14 and 15 were used for analysis. The final sample was 48% male, 83% White, 12% Black, 4% Other and 1% Asian. Data were collected in a series of telephone calls, home and laboratory visits. The Pennsylvania State University Institutional Review Board approved the study and the use of the data.

Measures

Parenting style—Parents were categorized into one of four groups: authoritative, permissive, neglectful, and authoritarian. Parenting styles were constructed to reflect the definitions outlined by Maccoby and Martin (1983) and were in keeping with the guidelines used by Rhee and colleagues (2006) in a previous study published on this sample. Two measures were used to classify parents into one of the four groups: maternal sensitivity and maternal expectations for child self-control. The measures used to classify parents into the four parenting styles were collected when children were age 4. Though parenting style was

only measured at age 4, in a previous study of the stability of observed parenting behavior from age 4 to age 13, maternal parenting was found to be relatively stable over time (Quest, Clark & Tresch, 2011).

Maternal sensitivity is a composite measure of three scales: (1) supportive presence, (2) respect for autonomy and (3) reflected hostility. Each scale was coded from videotapes of a series of behavioral interaction tasks between the mother and child. Two of the tasks were intended to be difficult for the child and required the mother's help. The first task required the child to complete a maze on an Etch-a-Sketch®. The second task required the child to put together a wooden tower out of irregularly shaped blocks, while the final portion of the interaction was a period of playtime between the mother and child with puppets. Trained observers who were blinded to the study hypotheses performed all of the videotaping and coding; coding was performed in teams of three or four coders. Coders were rigorously trained and supervised met either weekly or biweekly to recode the tapes during the scoring period. This task was validated for a number of child outcomes including children's behavior problems, academic achievement and social skills (Belsky et al., 2007). **Supportive presence** was scored on a scale from 1 to 7 with a 7 being the most optimal. The scale reflects emotional support, confidence in the child's efforts and appropriate redirection of the child's behaviors. Example behavior for a high score included, "You're really good at this;" "Wow! You got another one right!" A low score on this measure indicated a parent that was unavailable, passive, aloof or indignant. **Respect for autonomy** was also scored on a 7-point scale and reflected the mother's regard for the child's perspective and of the ability to show regard for the child while still giving instruction. A parent that scored high on this scale accepted the child's ideas and perspectives, encouraged the child to think as an individual and did not intrude on the child's differing opinions. A low score indicated a parent who exerted their expectations on the child in a demeaning way, forced the child to be submissive to the parent in a "win-lose" manner whereby the parent must win. Most importantly, parents who scored low on this scale did not accept the validity of the child's ideas, therefore it was better and safer for the child to do as the parent said. The third scale, **hostility**, was a reverse-coded 7-point scale reflecting the degree of maternal warmth displayed toward the child. A parent scoring high was characterized as blaming or rejecting the child, or trying to put the child down in addition to: not exhibiting any emotional support for the child, overtly rejecting the child and blaming them for their mistakes. Example behaviors include: telling the child they will be left behind if they cannot complete the task, or rejecting the child as a means to control their behavior. A very high score on this measure indicated the possibility of physical abuse or neglect of the child. The composite score for maternal sensitivity (the sum of supportive presence, respect for autonomy, and reversed hostility) was calculated by the NICHD SECCYD and had both good internal validity ($\alpha = 0.84$). and good inter-rater reliability (intra-class correlation = 0.88). Scores on the measure ranged from 4 to 21 where high scores represented increasing maternal sensitivity to the child's needs.

Maternal expectations for child self-control were measured using an 11-item self-report survey completed by the child's mother. The survey was developed by Greenberger and Goldberg (1989) and was further modified by the NICHD SECCYD for use in this sample.

Mothers were asked to rate how often they expected their child to behave in certain ways according to a 7-point Likert scale. Scores reflected the mother's expectation of self-control from the child and not actual control. Scores ranged from 7–77, and higher scores reflect higher expectations for self-control from the child. The measure had good internal validity ($\alpha = 0.82$).

Parenting Groups: Maternal sensitivity and maternal expectations for self-control were dichotomized according to the methods used by Rhee and colleagues (2006). Each variable was split at the median and scores at the median were included in either the low sensitivity or low expectations for self-control group. The parenting styles were created according to Maccoby and Martin's definitions for each parenting style depending on whether a mother was high or low on the scores of sensitivity and expectations for child self-control. Authoritative mothers scored high on both measures, while neglectful mothers scored low on both measures. Permissive mothers were classified as high sensitivity and low expectations for self-control while Authoritarian mothers were classified as low sensitivity and high expectations for self-control.

Self-Regulation—One aspect of children's self-regulation was measured at age 4 using the delay of gratification procedure (Mischel, Shoda & Rodriguez, 1989). Delay of gratification is thought to be a relatively stable construct at the behavioral and neurological level as demonstrated in a 40-year follow-up study after an initial delay of gratification task identical to the one used in this study (Casey, Somerville, Gotlib, Ayduk, Franklin et al., 2011). It is a videotaped behavioral procedure performed in the laboratory. This measure is designed to assess the child's ability to postpone the desire for immediate reward in order to obtain a larger reward. At the beginning of the procedure, children select their favorite of the following three foods: animal crackers, pretzels and M&M's. The selected food is then placed on a table in front of the child in the form of both a large and a small pile of food. The child is told that the research assistant is going to leave the room for a little while, and if the child can wait seven minutes until they return the child can have the large pile of food and passes the task. If not, the child is told that they can ring a bell at any time and the research assistant will return and then the child can have the small pile of food, which is considered failing the task. The continuous variable (number of minutes waited) ($M=4.48$, $SD = 3.01$) for this sample is very negatively skewed, therefore for this study, the dichotomy defined by this highly-validated task was used in that children either waited the full time for the larger reward (pass), or not (fail). Children who "pass" are considered to have better self-regulatory capacity and are able to delay gratification of an immediate reward for a larger, delayed reward.

Weight Status—At each time point, children had their standing height and weight measured by a trained research assistant in the laboratory. All measurements were taken in duplicate, with height measured in inches and weight measured in pounds. Age- and sex-specific Body Mass Index (BMI) was calculated as weight (kg) divided by squared height (m). National reference criteria were used to calculate age- and sex-specific BMI percentiles (Kuczmarski et al., 2000). According to the CDC, children are classified as overweight

when they are at or above the 85th percentile for BMI and obese at or above the 95th percentile (Kuczmarski et al., 2000).

Covariates—Family income-to-needs ratio at age 4 and mother's education (number of years of school completed) were measured at study entry, and were included as potential covariates. Pubertal status was also included as a covariate in the analyses. The Tanner staging criteria were used to assess pubertal status for both boys and girls. This measure assesses genital and pubic hair development in boys, and breast and pubic hair development in girls. The Tanner staging criteria use 5 stages to assess pubertal development. Precocious puberty is defined as a Tanner stage 4 or higher at age 9. Pubertal status was measured by a nurse or pediatric endocrinologist during their 9-year-old annual health and physical development visit.

Statistical Analyses

All analyses were performed using SAS version 9.2 (SAS, Cary Institute, NC). All variables of interest were assessed for normality and outliers. It was concluded that all continuous variables to be used in the mixed model analyses were normally distributed. No outliers were excluded from the analyses. Descriptive statistics were generated for all variables of interest and post hoc Duncan tests were used to assess differences between the groups of parenting styles. Mixed modeling (SAS Proc Mixed) was used to examine two separate models for boys and girls predicting BMI trajectories from age 4 to 15 years. In the models tested, a 3-way interaction of parenting x self-regulation x time was used to predict BMI trajectories from age 4 to 15. These models examined differences in BMI trajectories across 8 parenting x self-regulation groups. Examples of these groups include an authoritarian mother with a child who can delay gratification, and a neglectful mother with a child who cannot delay gratification. The model tested for main effects of time, self-regulation, parenting and the interaction of parenting x self-regulation x time. This model also controlled for mother's education, income and pubertal status. Pubertal status was included as a covariate in the final analyses due to previous results indicating that early puberty is predictive of later rapid weight gain (Francis & Susman, 2009).

Results

Maternal Characteristics by Parenting Style

Descriptive statistics by parenting style are presented in Table 1. In general, families in the sample were predominantly middle income (or not poor), with an average income-to-needs ratio of 3.63 ($\sigma = 3.26$). The income to needs ratio (INR) can be used to categorize families into the following groups: poor ($\text{INR} < 1$), near poor ($1 < \text{INR} \leq 2$) and not poor ($\text{INR} > 3$). Income-to-needs ratios were significantly lower for families with authoritarian and neglectful mothers. Authoritarian and neglectful mothers were also significantly younger when the study child was born, and reported lower education levels than authoritative and permissive mothers, on average.

Child Self-Regulation and Weight Status at 4 Years, by Parenting Style

Overall, 46% of children in the sample failed the delay of gratification task. Children of authoritative and permissive mothers waited significantly longer on the delay of gratification task than children of authoritarian and neglectful mothers. Of the children who could not delay gratification, 41% had neglectful mothers and 34% had authoritarian mothers compared with approximately 12% of permissive and authoritative mothers. There were no significant differences in children's BMI at age 4 by parenting style.

Parenting Styles, Self-Regulation and Children's BMI from 4 to 15 years

The models in this study were specified to examine how parenting interacted with children's ability to delay gratification to predict the rate of growth in BMI. This model tested differences in BMI growth by parenting x self-regulation groups. Overall, differences among 8 groups were tested, and the model was analyzed separately for boys and girls in order to examine differences by gender and to interpret the results in the context of the Center for Disease Control and Prevention's guidelines for BMI growth in youth (Kuczmarski et al., 2000). All models were adjusted for mother's education, income-to-needs ratio and pubertal status at age 9.

For girls, time was the only significant predictor of differences in the rate of growth in BMI from 4 to 15 years. There was no significant interaction effect of parenting x delay x time ($F = 1.28, p < 0.10$), however, the BMI trajectories for these groups can be seen in Figure 1. There was also no main effect of pubertal status at age 9 on the rate of BMI growth from 4 to 15 years. For boys, the results of the mixed modeling analysis revealed a significant interaction for parenting x self-regulation x time ($F = 1.54, p < 0.05$), as seen in Figure 2. Overall, the effect of parenting explained an added 4% of the variability in BMI, and delay of gratification explained an added 14% of the variability in BMI. The effect sizes of interaction terms tend to be relatively small however the effect size of the interaction was calculated as the R^2 improvement between models with and without the interaction term, resulting in an effect size of 0.041.

The results suggest that in boys, there is a moderated effect of parenting and ability to delay gratification on the rate of growth in BMI, independent of pubertal status, mother's education and the income-to-needs ratio. The effect of parenting on BMI gains is such that over time mothers who are neglectful or authoritarian have children who have higher gains in BMI than those who are permissive or authoritative. The effect of delay of gratification on BMI gains indicates that over time, children who fail to delay gratification have greater BMI Gains than those who can delay gratification. More so, when these terms are multiplied to produce a three way interaction effect with time, the results indicate that over time authoritative and permissive parents moderate the effects of failing to delay gratification. For these children, the mean growth in BMI is equivalent to the growth in BMI for children who can delay gratification but have mothers who are neglectful or authoritarian. In this instance, delay of gratification serves as a moderator for more negative parenting behavior patterns. Children with the most optimal BMI gains are those who can delay gratification with authoritative mothers; conversely children who have authoritarian and neglectful

mothers have consistently elevated growth in BMI that tracks near the 95th percentile, a cut-off determined by the CDC that classifies a child as obese.

Analysis of variance (ANOVA) was used to test for mean differences in BMI change from 4 to 15 years, by parenting and delay group. The results of the ANOVA demonstrated significant differences in BMI change across the 8 parenting x self-regulation groups ($F = 4.33$ $p < 0.001$). Post-hoc Duncan tests revealed that boys with authoritarian mothers, who could not delay gratification, had a significantly greater BMI change from 4 to 15 years than all other groups except for children with neglectful mothers who could not delay gratification. Children with authoritative mothers who were able to delay gratification, had a significantly smaller change in BMI from 4 to 15 years compared to all other groups. There were no significant differences in BMI change for all other combinations of parenting style and self-regulation.

Discussion

The present study identified factors that potentially confer both risk and protection for a rapid rate of BMI gains throughout childhood. These findings expand the existing literature by demonstrating that: (1) parenting styles characterized by maternal sensitivity may confer protection against obesity in boys, particularly for those who fail to delay gratification; and (2) parenting styles characterized by low levels of maternal sensitivity may pose a significant risk for obesity development in boys, especially for those who fail to delay gratification.

Throughout childhood and early adolescence, it is normative for BMI to increase gradually, however too steep of a BMI trajectory can be detrimental. Previous reports on this sample identified that children who fail to self-regulate at an early age, gain more weight throughout childhood (Francis & Susman, 2009; Tsukayama et al., 2010; Seeyave et al, 2009). Although more children of authoritarian and neglectful mothers failed to delay gratification, at age 4 there were no initial differences in children's BMI between the eight parenting x self-regulation groups. The pattern of growth in BMI was similar for boys and girls, yet the most notable differences were for boys of authoritarian mothers who failed to delay gratification. In this group, the mean BMI approached the 95th percentile cut-off point for being classified obese (according to the CDC's BMI-for-age-percentiles (Kuczmarski et al., 2000)) as early as age 7. At the other end of the spectrum were boys who were the least at risk; boys of authoritative mothers with the ability to delay gratification. There were no significant differences among the remaining parenting x delay of gratification groups. However, for boys who experience neglectful or authoritarian parenting and can delay gratification, the stress of harsh parenting does not necessarily triumph over the child's ability to self-regulate within the domain of BMI gains and obesity.

These results provide a substantial contribution to the literature in two ways. First, they identify a potentially critical intervention point for boys and their mothers. Initially there are no significant differences in weight status at age 4 across parenting x delay of gratification groups, however beyond this age, the combined effects of parenting and delay of gratification begin to emerge as important correlates of overweight status. This is a critical

period given that children who are obese in early and middle childhood tend to experience long-term levels of obesity and a multitude of obesity-related complications (Dietz, 1994); including experiencing hypertension as an adult (Sabo, Lu, Daniels & Sun, 2012). Of more alarm, men are significantly more likely to die as a result of ischemic heart disease and women of all-causes of death as a result of obesity incidence occurring as young as six-years old and in particular as a result of obesity incidence prior to puberty (Must, Phillips & Naumova, 2012). Therefore, interventions at this age, and in particular prior to puberty, may be able to capitalize on an important period for reversing the upward, accelerated trend in BMI growth for children at risk for obesity.

This is hopeful given that existing behavioral interventions aimed at bettering children's self-regulation skills show promise for both weight reduction and eating regulation (Israel et al., 1994; Riggs, Sakuma & Pentz, 2007). Second, these findings highlight the importance of examining interactions between parenting and self-regulation in general behavioral contexts, and show their relevance for obesity. This gives credence to future study of a general model of harsh family environments and their impact on dysregulation within the context of obesity risk.

The results revealed that the interaction of parenting x self-regulation was only significant for boys, although the ranking of the parenting x self-regulation groups was similar for boys and girls. While this does not necessarily mean that parenting and self-regulation do not play significant roles in the onset of obesity in girls, it does mean that it is possible that something else may explain why some girls gain weight faster relative to others. It is also possible that because parenting style was only assessed at age 4 for this study, that the effect of parenting may change for one gender more than the other. More so, it is possible that because we reduced the sample size approximately in half to test the model for girls, that we did not have adequate statistical power to detect an effect. Prior research has demonstrated significant gender differences in obesity-related behaviors, though the findings have historically highlighted notable differences for girls rather than for boys (Fisher & Birch, 1999; Jago, Fox, Page, Brockman & Thompson, 2010; Seabra, Mendonça, Maia, Welk, Brustad et al., 2012). While early-onset puberty is one factor that lends girls down a path of rapid weight gain in adolescence (Francis & Susman, 2009); it is also possible that there are not such dramatic effects for girls because mothers may parent their daughters differently, particularly as their daughters get older. For example as girls get older, mothers place greater emphasis on controlling their daughter's weight and eating habits and in particular play a role in the development of dieting behaviors in girls (Francis & Birch, 2005). Delay of gratification also may not play the same role in the development of obesity in young girls (Bourget & White, 2006).

Though self-regulation is an important indicator of developmental weight gain, it is possible that pressure from mothers who are overtly controlling and demanding plays a different role for girls in terms of how self-regulatory capacity might affect weight gain. Despite a well-known link between self-regulation and overeating (Czaja, Rief & Hilbert, 2009; Hartmann, Czaja, Rief & Hilbert, 2009), support for this notion was not found in this study. Adjusting for bulimic tendencies (a proxy measure for dysregulated eating) did not significantly affect any of the models tested in this analysis and eating behavior data was only available at age

15, thus, these results were not presented in this study. This analysis used a measure of self-regulation that required children to wait for a food reward, however, this is not a measure of eating regulation. A specific procedure exists that measures the extent to which children eat (or overeat) in the absence of hunger. This measure is considered a more reliable indicator of self-regulation in the eating domain (Fisher & Birch, 1999; Francis, Ventura, Marini & Birch, 2007). However, children's hunger levels were not measured prior to the procedure, therefore it is unclear what role hunger may have played in the child's ability to delay gratification.

Given that this was a longitudinal study spanning more 15 years of the child's life, attrition was to be expected which may limit our results despite the finding that there were no significant differences between families who remained in the study versus families who left. Also of note, though these findings are not from a nationally representative sample, they do represent a large sample of children from several sites across the country that have distinctly different geographic and demographic characteristics. Therefore, we are limited in our ability to generalize the findings to all children and families in the U.S. (more information on the study sites can be found at the study website: (<http://www.nichd.nih.gov/research/supported/Pages/seccyd.aspx>)).

The results suggest that although parenting and self-regulation are independent risk factors for obesity, the interaction between these two constructs may be important for understanding children's risk for obesity. Previous research has shown that harsh and chaotic family environments play a role in predicting childhood obesity and that the effect of the family children's weight status may be partially influenced by children's self-regulatory capacity (Evans, Fuller-Rowell & Doan, 2012); failure to delay gratification at age four has been shown to predict overweight and obesity three decades later (Schlam, Wilson, Shoda, Mischel & Ayduk, 2013). Future research is needed to examine additional correlates of parenting and self-regulation that may be predictive of obesity development. Efforts should also be focused on the development of efficacious programs that target parenting skills and improvement in children's ability to delay gratification in order to increase children's self-regulatory capacity and create family environments that have been shown to be protective against obesity.

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Figure 1.

Body mass index (BMI) trajectories for boys age 4 to 15 years grouped by parenting and ability to delay gratification. BMI trajectories are plotted against the Centers for Disease Control's (CDC) BMI-for-age-percentiles reference criteria for boys age 2–20 (e.g. 50th percentile, 85th percentile and 95th percentile). Superscript letters indicate significant differences in the rate of growth. The single letter 'b' refers to the following 4 lines: Permissive (No Delay), Authoritative (No Delay), Neglectful (Delay) and Authoritarian (Delay)

Table 1

Descriptive Statistics by Parenting Style

	Mean (SD)				
	Sample (n = 778)	Authoritative (n = 138)	Permissive (n = 138)	Authoritarian (n = 242)	Neglectful (n = 260)
Mother's Education (No. Years Complete)	14.47 (2.36)	15.28 (1.85) ^a	15.57 (2.35) ^a	13.94 (2.14) ^b	13.95 (2.48) ^b
Income/Needs Ratio	3.63 (3.26)	4.04 (2.33) ^a	40 (2.68) ^a	3.35 (4.39) ^b	3.21 (2.58) ^b
Mother's Age (years)	28.77 (5.52)	30.00 (4.6) ^a	30.56 (5.00) ^a	27.58 (5.44) ^b	28.28 (5.97) ^b
Delay of Gratification (Time Waited, Mins)	44 (2.99)	5.40 (2.65) ^a	5.30 (2.70) ^a	4.11 (3.08) ^b	4.04 (3.05) ^b
Girls BMI at 4 years	15.88 (1.56)	15.87 (1.48)	15.72 (1.15)	16.02 (1.82)	15.82 (1.51)
Boys BMI at 4 years	16.09 (1.48)	15.99 (1.19)	15.96 (1.32)	16.38 (1.89)	15.97 (1.23)
Girls BMI at 15 years	22.91 (4.92)	22.90 (4.96) ^{ab}	21.59 (3.39) ^b	23.22 (5.58) ^a	23.30 (4.85) ^a
Boys BMI at 15 years	23.06 (5.22)	21.39 (3.50) ^a	22.34 (4.96) ^{ab}	24.19 (5.91) ^c	23.30 (5.20) ^{bc}
Frequency (%)					
Delay of Gratification (Failed)	46.16	5.72	5.86	15.48	19.11

Note. BMI = Body Mass Index, an Income/Needs ratio <1 is considered to be "poor", > 1 but < 2 is considered "near poor" and > 3.00 is considered "not poor." Different superscript symbols denote significant differences between groups. For boys age 15, a BMI greater than 26.8 is considered obese (BMI percentile greater than 95%), a BMI greater than 23.5 is considered overweight (BMI percentile greater than 85%). For girls age 15, a BMI greater than 28.1 is considered obese, a BMI greater than 24 is considered overweight. For boys age 4, a BMI greater than 17.8 is considered obese and a BMI greater than 16.8 is considered overweight. For girls age 4 a BMI greater than 18.03 is considered obese and a BMI greater than 16.8 is considered overweight.