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Preventing Weight Gain and Obesity: Indirect Effects of the Family Check-Up in Early Childhood

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Abstract

The early signs of obesity are observable in early childhood. Although the most promising prevention approaches are family centered, few relevant early prevention programs exist. This study evaluated the effects of an evidence-based, home-visiting intervention, the Family Check-Up (FCU), on the trajectory of children's weight gain. The FCU was designed to prevent the development of behavior problems by improving family management practices; children's weight has not been an explicit target. On the basis of previous research and conceptual models, we hypothesized that intervention effects on parenting practices, specifically caregivers' use of positive behavior support (PBS) strategies in toddlerhood, would mediate improvements in children's weight trajectories. A total of 731 indigent caregiver-child dyads from a multisite randomized intervention trial were examined. Observational assessment of parenting and mealtime behaviors occurred from age 2 to 5. The child's body mass index (BMI) was assessed yearly from age 5 to 9.5. Path analysis with a latent growth model revealed a significant indirect effect of the FCU on the trajectory of BMI in later childhood. Improvements in caregivers' PBS in toddlerhood, which was related to the nutritional quality of the meals caregivers served to the child during the mealtime task, served as the intervening process. Further, findings indicate that the FCU prevents progression to overweight and obese status amongst at-risk children. These study results add to existing evidence that has demonstrated that family-based interventions aimed at improving general family management skills are effective at preventing weight gain. Future directions are discussed.

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Keywords

BMI; family intervention; latent growth model; pediatric obesity; translational research

Rates of overweight (BMI 85th percentile) and obese (BMI 95th percentile) adults, adolescents, and children in the United States are alarmingly high and represent one of the most deadly and costly public health concerns (IOM and National Academies, 2005; Ogden, Carroll, Kit, & Flegal, 2014). Although the overall rate of growth in obesity for preschoolers and school-age children has slowed, particularly for ethnic minority youths, the overall prevalence has increased threefold during the past three decades (Ogden et al., 2014). Epidemiologic studies indicate that the most significant jump in overweight status occurs between preschool (ages 2–5) and school age (ages 6–11; Ogden et al., 2006), which is highly predictive of progressing to obesity in subsequent developmental periods (e.g., Nader et al., 2006). These trends render early prevention efforts a public health imperative (IOM, 2011; IOM and National Academies, 2005).

Family-based approaches to obesity intervention in early childhood are generally considered best practices (August et al., 2008; Barlow, 2007; IOM, 2011; IOM and National Academies, 2005). Ecological models of child health (Kazak, Simms, & Rourke, 2002) and pediatric obesity (Fiese & Jones, 2012; Rhee, 2008) underscore caregivers' vital role in the development and maintenance of obesity: Parents establish and model healthy eating and physical activity habits, which influence the children's practices and long-term maintenance of a healthy weight. Existing obesity intervention programs that include a family component have been shown to be effective with respect to a variety of weight-related outcomes (Whitlock, O'Connor, Williams, Beil, & Lutz, 2010; Young, Northern, Lister, Drummond, & O'Brien, 2007), and have been found to be superior to programs that work solely with the child on behavior and dietary change (McGovern et al., 2008). However, intervention effects tend to be small, programs experience high rates of drop out, and the effects typically are not maintained long term (Ebbeling, Pawlak, & Ludwig, 2002).

There is a longstanding and growing recognition that parenting in general, specifically parent-child relationship quality and effective family management, is related to pediatric obesity. In general, maladaptive family management strategies have been associated with weight gain in pediatric populations (Kitzman-Ulrich et al., 2010; Zeller et al., 2007). Parenting styles have been associated with risk of obesity, with children of parents with authoritarian and permissive styles being at 3–5 times greater risk, respectively, than are children of parents with an authoritative style (Rhee, Lumeng, Appugliese, Kaciroti, & Bradley, 2006). An authoritarian style of parenting could include requiring the child to clean his or her plate, while a dismissive style leads to low expectations for self-control in terms of portion size and the nutritional quality of food the child consumes. By contrast, authoritative parenting has been linked to greater fruit and vegetable intake and physical activity (e.g., Schmitz et al., 2002). As noted by Rhee (2008) and others (e.g., Kitman-Ulrich et al., 2010), targeting the way parents interact with their children, particularly when it comes to eating behaviors and physical activity, may be instrumental to the success of family-based

obesity prevention. Despite the intuitive appeal of this idea, it has not been extensively tested and the mechanisms are currently not well understood.

Although empirical examinations of the influence of general parenting behaviors on children's weight status are limited, two conceptual models are useful in understanding the processes by which a relationship would exist. First, Rhee's (2008) conceptual model emphasizes the pervasive role of positive parenting behaviors on healthy dietary habits through availability of nutritious food. Within this model, parents' behaviors, attitudes, and interpersonal interactions with other family members exert an overarching influence on children's eating and activity behaviors and leisure-time activities through the creation of "a home environment that promotes certain behaviors, expectations, beliefs, and social norms" (Rhee, 2008, p. 13). Further, Rhee posits that parents' shaping of a positive home environment with regard to diet and physical activity early in the child's life presumably has lifelong effects on weight. At another level of Rhee's model is the availability of nutritious food to the developing child. Parents of young children have tremendous influence on a child's diet, and data show that exposing children to healthy foods and making them accessible to the child increases consumption of these foods (e.g., Cullen et al., 2003; Wardle et al., 2003). Thus, Rhee's proposed model links family functioning, parenting, and parents' feeding behaviors to child energy consumption, which in turn influences the child's weight status (see Rhee, 2008, Figure 4, p. 30).

Biglan and colleagues offer a broader conceptualization of the influence positive parenting exert on children's healthy development, which they refer to as the nurturing environment (Biglan, Flay, Embry, & Sandler, 2012; Komro, Flay, & Biglan, 2011). A nurturing environment is one that fosters successful development and curtails interrelated behavioral and emotional problems that can result in deleterious health outcomes (Biglan et al., 2012). Proponents of this idea cogently argue that preventive interventions should target the shared elements implicated in the development of common childhood problems, such as positive parenting, rather than focus on discrete problems and change mechanisms (Komro et al., 2011). Interventions that foster a nurturing environment have been found to affect multiple problems through a single intervention approach. For example, parenting interventions almost ubiquitously target parenting behaviors that promote the child's acquisition of prosociality, which affects numerous outcomes. The nurturing environments framework supports examination of intervention effects on positive parenting and their relation to child outcomes across various domains of child health and adaptation.

The primary intervention target of early and middle childhood programs designed to prevent problem behavior, particularly disruptive child behavior, are grounded in family management training principles that manipulate the family environment to support positive youth outcomes (e.g., Forgatch & Patterson, 2010; Webster-Stratton & Reid, 2010). Although family management interventions were primarily developed to prevent and treat youth conduct problems, recent findings indicate that some of these programs have an effect on weight-related outcomes, suggesting that foundational parenting skills are germane to preventing pediatric obesity. In a randomized trial of a parenting intervention for 4-year-old minority children at risk for behavior problems, Brotman and colleagues (2012) found lower rates of obesity at follow-up (3 to 5 years postintervention) for boys and girls in the

treatment group. These and other collateral benefits of parenting interventions with regard to obesity may be tied to the familial precursors common to the development of behavior problems and obesity in youth, such as family conflict and ineffective family management (e.g., Mamun et al., 2009). In the context of weight management, parenting behaviors are likely to influence the structuring of mealtimes (e.g., eating together, routine meal times), which has been linked to improved nutritional value of meals parents serve to their children (Schmitz et al., 2002).

Similarly, in our research with the Family Check-Up (FCU; Dishion & Stormshak, 2007) model, significant effects on obesity rates have been found for older adolescents (Van Ryzin & Nowicka, 2013). The FCU is a brief, three-session intervention that is tailored to the individual needs of each family. Typically, the three meetings include an initial contact session, a home-based multi-informant ecological assessment, and a feedback session. Feedback emphasizes parenting and family strengths, yet draws attention to possible areas of change. The FCU uses an ecological framework to intervene with families to improve children's adjustment by motivating positive behavior support (PBS) and other family management practices. PBS is a prevalent and effective behavior management principle that emphasizes the use of nonaversive, reinforcing caregiver-child interactions and involves the caregiver being proactive and structuring the home in ways that promote healthy development and adaptation (e.g., Carr et al., 2002). The assessment of PBS typically consists of observational ratings of caregivers' use of positive reinforcement strategies that included stating clear expectations for positive behaviors, structuring the child's environments to elicit positive behaviors, and interactively engaging with the child to provide a context for healthy development (Lunkenheimer et al., 2008). In previous studies of the FCU, PBS has been found to mediate a number of salient child outcomes, including early conduct problems (Dishion et al., 2008; Smith, Dishion, Shaw, & Wilson, 2013), school readiness (Lunkenheimer et al., 2008), academic achievement (Brennan et al., 2013), and behavioral control (Shelleby et al., 2012).

With respect to intervention effects of the FCU on weight gain and obesity, Van Ryzin and Nowicka (2013) evaluated data from a randomized trial of the FCU with high-risk middle school youths and found lower rates of obesity emerging in early adulthood for the intervention condition. The effects were the result of improving family relationships and the youth's eating attitudes. Second, Smith and colleagues (manuscript submitted for publication) evaluated the relation between engagement in the FCU over time and weight trajectories in early childhood by using data from the same trial as this study used. Because a health maintenance approach was used in which families randomized to the intervention were offered the FCU six times between child age 2 and 8.5, there was variability in rates of engagement in the intervention. Therefore, we used complier average causal effect (CACE) modeling to account for this variability while analyzing intervention effects on weight trajectories from age 5 to 9.5. In CACE modeling, characteristics of known engager families from the intervention condition are compared with families in the control condition that likely would also have participated had they been offered the intervention (Jo, 2002). Findings indicated that families participating in the FCU at every opportunity to do so had a significantly slower rate of growth (Cohen's $d = .81$) in body mass index (BMI) scores than

did latent engager families from the control condition. These findings are promising in terms of an overall effect for families that have high rates of engagement in the FCU over time but the mechanisms responsible for this effect cannot be elucidated as CACE modeling does not allow for tests of mediation. A second limitation of CACE modeling is that the full sample is not included when intervention effects are examined for a specific engagement status. Smith and colleagues' study included only 25% of the families in the FCU condition who elected to engage each time the FCU was offered from age 2 to 8.5. In that this pattern of engagement could be considered somewhat atypical, using an intention-to-treat analytic approach to evaluate intervention effects and potential mediating variables with the full sample is warranted.

This Study

We evaluated the indirect effects of the FCU on pediatric weight gain and obesity from toddlerhood to middle childhood. We hypothesized that parents' use of PBS strategies in toddlerhood, and their influence on the nutritional quality of meals served to the child, would serve as the intervening process between intervention and trajectory of BMI. Situating parenting and dietary practices in the causal chain is consistent with Rhee's (2008) model. In our evaluation of these relationships, we included salient ecological correlates of parenting, dietary practices, and weight as covariates. Previous research suggests that obesity is often associated with the economic situation of the family, which is related to the nutritional quality of the food items parents are able to provide their children, food insecurity, and low fruit and vegetable consumption (e.g., Casey, Szeto, Lensing, Bogle, & Weber, 2001; Drewnowski & Specter, 2004), as well as other factors that influence economic status, such as parent educational attainment and single-parent status (Schmitz et al., 2002). Effective parenting and management of mealtimes can also be influenced by child factors, including disruptive behaviors (Scaramella & Leve, 2004) and temperament (for a review, see Gallagher, 2002), caregiver factors (e.g., depression; Lovejoy, Graczyk, O'Hare, & Neuman, 2000), and household characteristics, such as chaos and disorganization (Bronfenbrenner & Evans, 2000). Higher obesity risk and poor dietary practices have been associated with household chaos (Chambers, Duarte, & Yang, 2009) and child temperament, such as behavioral and emotional control (e.g., Liang, Matheson, Kaye, & Boutelle, 2013). Prominent conceptual models of pediatric obesity also implicate these factors in children's weight gain (Fiese & Jones, 2012; Rhee, 2008). Reports of regional differences in obesity in the United States indicate inclusion of this variable as well (Ogden et al., 2014).

Methods

Participants

This study examined 731 caregiver-child dyads (49% female children) recruited from the Women, Infants, and Children Nutrition Program (WIC) in three geographically and culturally diverse U.S. regions near Charlottesville, VA (188 dyads); Eugene, OR (271); and Pittsburgh, PA (272). Families with children between ages 2 years 0 months and 2 years 11 months who indicated socioeconomic, family, and/or child risk factors on screening measures (on at least two of the three factors) were invited to participate in the study. If the child did not meet criteria for child problem behaviors, they were required to be above the

mean on national norms to increase the likelihood that the caregivers would be motivated to improve these behaviors by engaging in the intervention. The caregivers who participated in the assessment session at each age were predominantly biological mothers (average of 95% for ages 2–9.5). The sample was culturally diverse: European American (50.1%), African American (27.9%), Latino/Hispanic (13.4%), and American Indian, Asian American, Native Hawaiian, and multiple ethnicities (8.6%).

Procedures

Participants were randomly assigned to either the intervention (367 families) or the control (364 families) condition (WIC services as usual) after the first assessment at age 2. For these analyses, assignment was coded as 0 for the control condition and 1 for the intervention group. Caregivers and children who agreed to participate in the study were scheduled for a 2.5-hour home visit each year before being offered the FCU. In this trial, the FCU assessment occurred prior to being offered the service each year to obtain an assessment of functioning before additional intervention and thus determine effects of the previous year's intervention. Each year the home-based assessment began by introducing the child to an assortment of age-appropriate toys and having them play for 15 minutes while the caregiver completed questionnaires. For ages 2 and 3, free play was followed by a clean-up task (5 min). Beginning at age 3, a delay of gratification task followed (5 min). Next was a set of 3-minute teaching tasks. Afterward, children participated in an age-appropriate inhibition task (3–9 min). Last, dyads participated in a meal preparation and lunch task (20 min). Parenting was coded from these observational tasks. Beginning at age 5, each child was weighed and measured (height) during the home visit to calculate BMI. Families randomized to the intervention condition were offered the FCU following the home-based assessment each year. Engagement in the FCU at age 2 (defined as participation in the feedback session) was 75% (276 families).

Measures

BMI and body size—BMI was calculated from height (stadiometer) and weight (electronic scale) data collected yearly beginning at age 5 at the home visit. BMI was standardized (z -score) by sex and age according to the World Health Organization growth reference data for children ages 5 to 19 years (Onis et al., 2007). Because BMI was not available at baseline, coders rated body size on the basis of observations of the interaction tasks occurring at age 2. Body size was rated on a 1–9 scale (1 = *not at all overweight*, 5 = *somewhat overweight*, 9 = *overweight*). Percent interrater agreement for body size ratings was high (99%).

Positive behavior support (PBS)—Four observational measures of parenting were used to build the PBS construct at ages 2 and 3: (1) parent involvement, using the following items from the Home Observation for Measurement of the Environment (HOME; Bradley, Corwyn, McAdoo, & Garcia-Coll, 2001): “Parent keeps child in visual range, looks at often”; “Parent talks to child while doing household work”; “Parent structures child’s play periods” (Yes/No); (2) positive behavior support based on microcoding of caregivers prompting and reinforcing young children’s positive behavior as captured in the following Relationship Process Code (RPC; Jabson, Dishion, Gardner, & Burton, 2004) scores:

positive reinforcement (verbal and physical), prompts and suggestions of positive activities, and positive structure; (3) engaged parent–child interactions were assessed using RPC codes and represent the average duration of parent–child sequences that involve talking or physical interactions, such as turn taking or playing a game. Kappa coefficients were .86 for the RPC scores at both ages; (4) proactive parenting comprised six items from the Coder Impressions Inventory (COIMP; Dishion, Hogansen, Winter, & Jabson, 2004), such as the parent giving the child choices for behavior change; communicating with the child in calm, simple, and clear terms; and redirecting the child to more appropriate behavior if the child misbehaved (age 2: $\alpha = .84$; age 3: $\alpha = .87$).

Nutritional quality—Coders rated the nutritional quality of the meals served to the child during the family meal task at ages 2 to 5. Meals were rated on a 1–9 scale. Scores ranging from 1 to 3 indicated high-carb, high-fat meals with very few fruits and vegetables served. Scores of 4–6 were given for meals with multiple food groups represented and generally healthy options, and lower caloric density and fat content than the meals that received a 1–3 score. Scores of 7–9 indicated a greater variety of food groups represented, including fresh fruits and vegetables. We calculated a mean of available data across ages 2 to 5. Interrater agreement was high (83%).

Caregiver depression—Primary caregivers' initial level of depressive symptomatology was assessed at child age 2 with the 20-item Center for Epidemiological Studies on Depression Scale (Radloff, 1977). Ratings are provided on a scale ranging from 0 (*less than a day*) to 3 (*5–7 days*) and are summed. Internal consistency was acceptable ($\alpha = .74$).

Cumulative risk—An index of cumulative risk was generated from seven indicators reported at entry into the study: (a) single parenthood, (b) parent substance use problem, (c) low maternal education, (d) residence in a dangerous neighborhood, (e) residence in a densely populated neighborhood, (f) income below the national poverty line, and (g) parent with a felony conviction. Families received a score of 1 for each risk indicator if present or a 0 if the risk indicator was absent, and the scores were summed. Poverty levels were calculated by adjusting gross household income at age 2 for inflation using the U.S. Department of Labor Bureau of Labor Statistics Consumer Price Index to reflect 2010 levels; 76% were below the poverty line.

Chaotic home environment—We used the Confusion, Hubbub and Order Scale (Matheny, Wachs, Ludwig, & Phillips, 1995) to assess chaotic home environment at age 2. Caregivers answered 15 true or false to statements such as "*it's a real zoo in your home*" and "*your family almost always seems to be rushed*." The chaos items were summed and then reverse coded so that higher scores indicate higher levels of chaos ($\alpha = .74$).

Child noncompliance—During the home assessments, staff completed macro-level ratings of the child's compliance with caregiver directives using three items from the COIMP (Dishion et al., 2004): cooperation with the caregiver (reverse scored), dysregulation and difficulty controlling behavior and emotion, and overall compliance (reverse scored). Interrater agreement (88%) and internal consistency ($\alpha = .86$) were high at the age 2 assessment.

Inhibitory control—The 13-item Inhibitory Control subscale of the Children’s Behavior Questionnaire (Rothbart, Ahadi, Hershey, & Fisher, 2001) was used to measure children’s ability to suppress immediate behavioral reactions. Primary caregivers rated each item (e.g., “has difficulty waiting in line for something,” “can easily stop an activity when s/he is told ‘no’”) on a scale ranging from 1 (*extremely untrue of child*) to 7 (*extremely true of child*). Internal consistency was acceptable ($\alpha = .66$).

Data Analysis

To test our primary hypotheses, we used path modeling conducted in Mplus 7.1 (L. K. Muthén & Muthén, 2013) with maximum likelihood estimation with robust standard errors, which provides more valid estimates of standard errors when dependent variables are nonnormally distributed (e.g., BMI). First, we fit a latent growth curve (LGC) to the BMI z -scores at ages 5, 7.5, 8.5, and 9.5 with conceptually relevant covariates (child ethnicity/race, caregivers’ depressive symptomatology, cumulative risk, child noncompliance, inhibitory control, chaotic family environment, child body size at age 2, geographic region). After determining fit and significant variance in the LGC parameter(s), we added the hypothesized indirect pathway from intervention group assignment to the slope of BMI through PBS at age 3 and nutritional quality of the meals served. Inclusion of covariates of PBS and nutritional quality was determined using a conceptual and model-fitting approach. First, all covariates were included. Then nonsignificant predictors were removed one at a time and the resultant model fit was compared with that of the previous model. The path was retained if its removal resulted in a significant decrement in model fit. Next, we tested for moderation by child race/ethnicity and geographic region of the family by using a multiple-group analysis approach that compared fit indices of nested unconstrained and constrained models. Racial/ethnic minority status and region were tested as moderators because of the disproportionate rates of obesity among minority children (Wang & Beydoun, 2007) and regional differences in obesity rates (Ogden et al., 2014). Last, because poverty influences dietary quality and weight (Drewnowski & Specter, 2004; Wang & Beydoun, 2007), we examined poverty status independent of the remaining six-indicator cumulative risk score. Poverty status was also examined as a potential moderator of the indirect intervention effect. Fit of each path model was examined using the customary indices: Small chi-squares correspond to better fit to the data; comparative fit index (CFI) values greater than 0.95 indicate good fit to the data (Bentler, 1992); root mean square error of approximation (RMSEA) values less than 0.05 indicate good model fit (Browne & Cudeck, 1993); standardized root mean square residual (SRMR) values less than .08 are generally considered good fit (Hu & Bentler, 1999).

We also conducted a supplementary analysis to determine effects of the FCU on preventing children at risk for overweight (BMI 75th percentile) from progressing to overweight or obese status. We conducted a logistic regression that included data about children whose BMI placed them in the “at risk for overweight” range when assessed at age 5 ($n = 74$) compared with their age 9.5 status. Change scores were created to indicate categorical increase (1), decrease (−1), or no change (0). We used a Bayesian estimator in Mplus for this analysis because of its robust performance under conditions of smaller sample sizes (Lee & Song, 2004). Similar to maximum likelihood methods, the Bayesian estimator uses all

available data to estimate parameters (Asparouhov & Muthén, 2010). Fit indices of models using Bayesian estimation are determined by using the Bayesian posterior predictive checking (PPC) method (95% Confidence Interval [CI] in which a negative lower limit is an indicator of good model fit) and the posterior predictive *p*-value (PPP; low values indicate poor fit) (B. O. Muthén, 2010).

Results

We began by fitting an unconditional LGC of BMI from ages 5 to 9.5 with the a priori covariates. Table 1 contains the intercorrelations and descriptive statistics of the variables in this study, along with the valid number of participants available for each measure. The LGC model with covariates provided good fit to the data, $\chi^2(19) = 57.10$, CFI = .963, RMSEA = .052, SRMR = .029. BMI was found to increase over time during this period at a relatively slow rate (.018 standard deviations per year) with significant individual variation (.005, $p < .05$). Ratings of child body size at age 2 were significantly related to the intercept ($\beta = .39$, $SE = .08$, $p < .001$). The family's geographic region of residence was also significantly related to the intercept ($\beta = -.12$, $SE = .05$, $p < .05$). Children living near Charlottesville had a higher age 5 BMI than did children in Eugene or Pittsburgh. Higher cumulative risk was significantly related to steeper growth in BMI ($\beta = .17$, $SE = .09$, $p < .05$). We then added the PBS and nutritional quality variables to test the hypothesized indirect effect. Inhibitory control at age 2 was not related to PBS at age 3, nutritional quality, or the parameters of the BMI LGC. Thus, for parsimony it was not included in the final model. The remaining covariates were retained because they added variance to the BMI slope parameter. Covariates were allowed to intercorrelate. The final model (Figure 1) provided acceptable fit to the data, $\chi^2(60) = 121.55$, CFI = .956, RMSEA = .042, SRMR = .040. The results of the final path model are presented in Table 2. Paths are referenced in text with the corresponding path labels. Assignment to the FCU was significantly related to improved PBS at age 3 (Path A), controlling for baseline levels (B). PBS at age 3 was significantly associated with the nutritional quality of the meals served to the child from ages 2 to 5 (C), which was significantly associated with a less steep increase in BMI (D). The hypothesized indirect effect (A*C*D) was significant ($\beta = .012$, $p < .05$). Families' cumulative risk was significantly associated with the nutritional quality of the meals (T), such that greater risk was associated with less nutritious meals. The final model accounted for 12% of the variance in the slope ($R^2 = .12$, $SE = .095$) and 17% of the variance in the intercept ($R^2 = .17$, $SE = .069$).

Poverty status, examined independently from cumulative risk, was not related to PBS, nutritional quality, or the LGC. The model fit, although acceptable, was significantly worse compared with that of the model presented in Figure 1. This is likely because of high intercorrelations amongst the variables included in the cumulative risk score (Trentacosta et al., 2008), as well as evidence that the combination of poverty and low education is the strongest socioeconomic predictor of obesity (Drewnowski & Specter, 2004). We tested the model in Figure 1 for moderation by child race/ethnicity and poverty status by removing each variable as a covariate and conducting a multiple group analysis. No evidence of moderation was found.

Results of the logistic regression indicated a medium effect that approached significance ($d = .30$, $\beta = .30$, $SD = .125$, $p = .06$) in favor of the FCU for preventing children at risk for overweight at age 5 from progressing to overweight or obese status at age 9.5. The model provided good fit to the data: PPC 95% CI = $-4.42 | 1.20$; PPP = .667. Descriptive results illustrate the meaningfulness of this analysis: 39% of children in the control condition became overweight or obese compared with 20% in the FCU condition, and 44% (control) compared with 70% (FCU) were in the normal weight classification by age 9.5.

Discussion

Prevention of pediatric obesity is an area of significant emphasis around the world. There is consensus among the leading experts that prevention programs should begin early and involve the family to promote enduring behavioral change that leads to lifelong healthy weight (August et al., 2008; Barlow, 2007; IOM, 2011). Parenting and family management practices are instrumental to the development of obesity and, therefore, are a clear target for family-centered prevention efforts. Although it does not explicitly target children's weight, the FCU intervention focuses on improving the primary family-based protective and risk factors of pediatric obesity (PBS, family conflict, harsh parenting, coercive family processes, family relationship quality); as such, the FCU exerts a long-term influence on weight gain. Intervention effects on these family factors have been found across multiple trials of the FCU from early childhood through adolescence (e.g., Dishion et al., 2008; Smith et al., in press; Van Ryzin & Nowicka, 2013). The results of this study support the conceptual models of Rhee (2008), Fiese and Jones (2012), and others regarding the ways in which parents influence children's weight. That is, parents' use of positive, proactive family management strategies in early childhood is associated with feeding practices, specifically, serving more nutritious meals. The trajectory of BMI that follows is, not surprisingly, related. We found that participation in the FCU in toddlerhood increased caregivers' use of PBS, which in turn was related to serving more nutritious meals to their children and a less steep increase in BMI scores from middle to late childhood. Analyses also indicated that the FCU prevents at-risk children from progressing to overweight or obese status, which markedly increases the risk of serious medical complications and premature death (Ebbeling et al., 2002).

Future Directions

Basic developmental research supports obesity prevention strategies that focus on parenting and family management in early childhood. Because treatment targets and proposed change agents overlap significantly, family-based interventions for pediatric obesity can be built upon family-centered programs for the prevention of behavior problems. The findings of this study, and the results reported by Brotman and colleagues (2012), strongly indicate that foundational parenting skills are critical elements for the prevention of obesity and problem behaviors alike. Scientists are currently developing an adapted version of the FCU model that will focus on parents' efforts to change their children's dietary practices and physical activity levels in the service of preventing and treating obesity. Our study findings support this endeavor and elucidate aspects of family management and parenting that are likely to maximize the desired effects on weight and obesity.

Strengths and Limitations

Among this study's strengths are its large randomized multisite sample, inclusion of pertinent covariates, observational assessment of family interactions and mealtime, and a sophisticated analytic approach. However, four primary caveats should be mentioned. First, the assessed nutritional quality of meals was based on only four meals served during a 4-year span. The mean nutritional quality of the meals predicted a child's weight trajectory, but its measurement could be improved. Second, the measurement of feeding-specific parenting behaviors, as opposed to a broad construct such as PBS, would be a significant contribution to the literature. Relatedly, there is little empirical research concerning the relation between broad parenting behavior measures and feeding-specific parenting behaviors. Third, a temporal overlap occurred between two variables in the indirect intervention path of the model. We used available data from ages 2 to 5 to strengthen the measurement of nutritional quality, yet we assessed our intervening effect on PBS at age 3. Further, this measurement approach potentially strengthens the association of PBS and nutritional quality when a concurrent assessment is included. Of note, analyses conducted following the findings of our study evaluated a cross-lag panel model between PBS and nutritional quality from age 2 to 5 to determine the temporal relation. Montañó, Smith, Dishion, Shaw, and Wilson (manuscript submitted for publication) found concurrent and successive associations between these variables, which alleviates some of the concern regarding the measurement overlap of nutritional quality and PBS in this study. Studies of this kind, combined with the results of our study showing indirect effects of the FCU through these pathways, are critical for successful adaptations of family-centered interventions to more effectively prevent pediatric obesity. Assessing multiple meals each year or including multiple indices of nutritional quality, such as portion size and nutritional quality of the meal, would improve this line of inquiry. A similar temporal overlap occurs between nutritional quality and the first assessment of BMI included in the LGC (both at age 5); however, this issue is less problematic because of our primary interest in the slope rather than the intercept. Last, although our supplemental analysis supports our contention that the FCU prevents obesity for at-risk children, the test is underpowered to detect statistical significance because of the small sample size.

Concluding Remarks

Obesity is an international epidemic with few evidence-based and consistently effective approaches for early prevention. Increasing caregivers' capacity for effective family management that promotes a positive, nurturing home environment has wide-ranging benefits for children's health (Biglan et al., 2012). Adaptation of existing evidence-based programs that accomplish this task, with a more explicit emphasis on parent support of healthy dietary and physical activity habits, could increase their effectiveness in terms of reducing the prevalence of obesity compared to the effects shown by current programs. Adaptation of models that can be effectively implemented in community service delivery systems, such as the FCU (Smith, Stormshak, & Kavanagh, 2014; Stormshak, Margolis, Huang, & Dishion, 2012), offer significant promise in this regard. However, evidence-based adaptation and rigorous evaluation is needed. Further, adaptations of programs that explicitly target and have been shown to be successful at engaging high-risk families could

have an impact on the high rates of attrition the majority of obesity prevention and treatment programs currently experience. A focus on family management and changing the home environment in support of child behavior change, as opposed to a focus on weight, might also increase participant retention in the intervention because the stigma associated with participation in an obesity intervention is reduced and the child's self-esteem is protected (Barlow, 2007). Few effective remedies currently exist to address the issues of attrition and stigma. Last, the results of this study are consistent with leading expert opinion in the field and empirical studies that indicate the need to change the family environment. Without widespread change at various levels, including the family, obesity is likely to remain one of the gravest public health concerns (Institute of Medicine, 2011).

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References

- Asparouhov, T.; Muthén, BO. Bayesian analysis using Mplus: Technical implementation. Mplus Technical Report. 2010. Retrieved from <http://www.statmodel.com>
- August GP, Caprio S, Fennoy I, Freemark M, Kaufman FR, Lustig RH, Montori VM. Prevention and treatment of pediatric obesity: An endocrine society clinical practice guideline based on expert opinion. *Journal of Clinical Endocrinology & Metabolism*. 2008; 93(12):4576–4599. [PubMed: 18782869]
- Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: Summary report. *Pediatrics*. 2007; 120(Supplement 4):S164–S192. [PubMed: 18055651]
- Bentler PM. On the fit of models to covariances and methodology to the bulletin. *Psychological Bulletin*. 1992; 112(3):400–404. [PubMed: 1438635]
- Biglan A, Flay BR, Embry DD, Sandler IN. The critical role of nurturing environments for promoting human well-being. *American Psychologist*. 2012; 67(4):257–271. [PubMed: 22583340]
- Bradley RH, Corwyn RF, McAdoo HP, Garcia-Coll C. The home environments of children in the United States. Part I: Variations by age, ethnicity, and poverty status. *Child Development*. 2001; 72:1844–1867. [PubMed: 11768149]
- Brennan LM, Shelleby EC, Shaw DS, Gardner FEM, Dishion TJ, Wilson MN. Indirect effects of the family check-up on school-age academic achievement z through improvements in parenting in early childhood. *Journal of Educational Psychology*. 2013; 105(3):762–773.
- Bronfenbrenner U, Evans GW. Developmental Science in the 21st Century: Emerging Questions, Theoretical Models, Research Designs and Empirical Findings. *Social Development*. 2000; 9(1): 115–125.
- Brotman LM, Dawson-McClure S, Huang K-Y, Theise R, Kamboukos D, Wang J, Ogedegbe G. Early childhood family intervention and long-term obesity prevention among high-risk minority youth. *Pediatrics*. 2012; 129(3):e621–e628. [PubMed: 22311988]
- Browne, WM.; Cudeck, R. Alternative ways of assessing model fit. In: Bollen, KA.; Long, JS., editors. *Testing structural equation models*. Newbury Park, CA: Sage; 1993.
- Carr EG, Dunlap G, Horner RH, Koegel RL, Turnbull AP, Sailor W, Fox L. Positive Behavior Support: Evolution of an Applied Science. *Journal of Positive Behavior Interventions*. 2002; 4(1): 4–16.

- Casey PH, Szeto K, Lensing S, Bogle M, Weber J. Children in food-insufficient, low-income families: Prevalence, health, and nutrition status. *Archives of Pediatrics & Adolescent Medicine*. 2001; 155(4):508–514. [PubMed: 11296080]
- Chambers EC, Duarte CS, Yang FM. Household instability, area poverty, and obesity in urban mothers and their children. *Journal of health care for the poor and underserved*. 2009; 20(1):122–133. [PubMed: 19202252]
- Cullen KW, Baranowski T, Owens E, Marsh T, Rittenberry L, de Moor C. Availability, accessibility, and preferences for fruit, 100% fruit juice, and vegetables influence children's dietary behavior. *Health Education & Behavior*. 2003; 30(5):615–626. [PubMed: 14582601]
- Dishion TJ, Hogansen J, Winter C, Jabson JM. The Coder Impressions Inventory. 2004 Unpublished coding manual. Available from the Child and Family Center, 6217 University of Oregon, Eugene, OR 97403.
- Dishion TJ, Shaw DS, Connell A, Gardner FEM, Weaver C, Wilson M. The Family Check-Up with high-risk indigent families: Preventing problem behavior by increasing parents' positive behavior support in early childhood. *Child Development*. 2008; 79(5):1395–1414. [PubMed: 18826532]
- Dishion, TJ.; Stormshak, EA. *Intervening in children's lives: An ecological, family-centered approach to mental health care*. Washington, DC: American Psychological Association; 2007.
- Drewnowski A, Specter S. Poverty and obesity: The role of energy density and energy costs. *The American Journal of Clinical Nutrition*. 2004; 79(1):6–16. [PubMed: 14684391]
- Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: Public-health crisis, common sense cure. *The Lancet*. 2002; 360(9331):473–482.
- Fiese BH, Jones BL. Food and family: A socio-ecological perspective for child development. *Advances in child development and behavior*. 2012; 42:307–337. [PubMed: 22675910]
- Forgatch, MS.; Patterson, GR. Parent management training-Oregon model: An intervention for antisocial behavior in children and adolescents. In: Weisz, JR.; Kazdin, AE., editors. *Evidence-based psychotherapies for children and adolescents*. New York, NY: Guilford Press; 2010. p. 159-178.
- Gallagher KC. Does child temperament moderate the influence of parenting on adjustment? *Developmental Review*. 2002; 22(4):623–643.
- Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*. 1999; 6(1):1–55.
- Institute of Medicine. *Early childhood obesity prevention policies*. Washington, DC: The National Academies Press; 2011.
- Institute of Medicine and National Academies. *Preventing childhood obesity: Health in the balance*. National Academies Press; 2005.
- Jabson JM, Dishion TJ, Gardner FEM, Burton J. Relationship Process Code V-2.0 (RPC) training manual: A system for coding relationship interactions. 2004 Unpublished coding manual. Available from the Child and Family Center, 195 W. 12th Ave., Eugene, OR 97401-3408.
- Jo B. Statistical power in randomized intervention studies with noncompliance. *Psychological Methods*. 2002; 7(2):178–193. [PubMed: 12090409]
- Kazak AE, Simms S, Rourke MT. Family systems practice in pediatric psychology. *Journal of Pediatric Psychology*. 2002; 27(2):133–143. [PubMed: 11821497]
- Kitzman-Ulrich H, Wilson D, George S, Lawman H, Segal M, Fairchild A. The integration of a family systems approach for understanding youth obesity, physical activity, and dietary programs. *Clinical Child and Family Psychology Review*. 2010; 13(3):231–253. [PubMed: 20689989]
- Komro KA, Flay BR, Biglan A. Creating nurturing environments: A science-based framework for promoting child health and development within high-poverty neighborhoods. *Clinical Child and Family Psychology Review*. 2011; 14(2):111–134. [PubMed: 21468644]
- Lee S, Song X. Evaluation of the Bayesian and maximum likelihood approaches in analyzing structural equation models with small sample sizes. *Multivariate Behavioral Research*. 2004; 39(4):653–686.
- Liang J, Matheson B, Kaye W, Boutelle K. Neurocognitive correlates of obesity and obesity-related behaviors in children and adolescents. *International Journal of Obesity*. 2013:1–13.

- Lovejoy MC, Graczyk PA, O'Hare E, Neuman G. Maternal depression and parenting behavior: A meta-analytic review. *Clinical Psychology Review*. 2000; 20(5):561–592. [PubMed: 10860167]
- Lunkenheimer ES, Dishion TJ, Shaw DS, Connell AM, Gardner FEM, Wilson MN, Skuban EM. Collateral benefits of the Family Check-Up on early childhood school readiness: Indirect effects of parents' positive behavior support. *Developmental Psychology*. 2008; 44(6):1737–1752. [PubMed: 18999335]
- Mamun AA, O'Callaghan MJ, Cramb SM, Najman JM, Williams GM, Bor W. Childhood behavioral problems predict young adults' BMI and obesity: Evidence from a birth cohort study. *Obesity*. 2009; 17(4):761–766. [PubMed: 19148130]
- Matheny AP, Wachs TD, Ludwig JL, Phillips K. Bringing order out of chaos: Psychometric characteristics of the confusion, hubbub, and order scale. *Journal of Applied Developmental Psychology*. 1995; 16(3):429–444.
- McGovern L, Johnson JN, Paulo R, Hettinger A, Singhal V, Kamath C, Montori VM. Treatment of pediatric obesity: A systematic review and meta-analysis of randomized trials. *Journal of Clinical Endocrinology & Metabolism*. 2008; 93(12):4600–4605. [PubMed: 18782881]
- Montaño Z, Smith JD, Dishion TJ, Shaw DS, Wilson MN. Longitudinal cross-lagged associations between positive parenting and nutritional quality of meals served during early childhood. manuscript submitted for publication.
- Muthén, BO. Bayesian analysis in Mplus: A brief introduction. Technical Report. Los Angeles, CA: Muthén & Muthén; 2010.
- Muthén, LK.; Muthén, BO. Mplus (Version 7.1). Los Angeles, CA: Muthén & Muthén; 2013.
- Nader PR, O'Brien M, Houts R, Bradley R, Belsky J, Crosnoe R, Network HDECCR. Identifying risk for obesity in early childhood. *Pediatrics*. 2006; 118(3):e594–e601. [PubMed: 16950951]
- Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999–2004. *JAMA*. 2006; 295:1549–1555. [PubMed: 16595758]
- Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011–2012. *JAMA*. 2014; 311(8):806–814. [PubMed: 24570244]
- Onis, Md; Onyango, AW.; Borghi, E.; Siyam, A.; Nishida, C.; Siekmann, J. Development of a WHO growth reference for school-aged children and adolescents. *Bulletin of the World Health Organization*. 2007; 85(9):660–667. [PubMed: 18026621]
- Radloff LS. The CES-D scale. *Applied psychological measurement*. 1977; 1(3):385–401.
- Rhee KE. Childhood overweight and the relationship between parent behaviors, parenting style, and family functioning. *The ANNALS of the American Academy of Political and Social Science*. 2008; 615(1):11–37.
- Rhee KE, Lumeng JC, Appugliese DP, Kaciroti N, Bradley RH. Parenting styles and overweight status in first grade. *Pediatrics*. 2006; 117(6):2047–2054. [PubMed: 16740847]
- Rothbart MK, Ahadi SA, Hershey KL, Fisher P. Investigations of temperament at three to seven years: The Children's Behavior Questionnaire. *Child Development*. 2001; 72(5):1394–1408. [PubMed: 11699677]
- Scaramella LV, Leve LD. Clarifying parent-child reciprocities during early childhood: The early childhood coercion model. *Clinical Child and Family Psychology Review*. 2004; 7(2):89–107. [PubMed: 15255174]
- Schmitz KH, Lytle LA, Phillips GA, Murray DM, Birnbaum AS, Kubik MY. Psychosocial correlates of physical activity and sedentary leisure habits in young adolescents: The teens eating for energy and nutrition at school study. *Preventive Medicine*. 2002; 34(2):266–278. [PubMed: 11817924]
- Shelleby EC, Shaw DS, Cheong J, Chang H, Gardner FEM, Dishion TJ, Wilson MN. Behavioral control in at-risk toddlers: The influence of the Family Check-Up. *Journal of Clinical Child & Adolescent Psychology*. 2012; 41(3):288–301. [PubMed: 22494145]
- Smith JD, Dishion TJ, Shaw DS, Wilson C, Winter C, Patterson GR. Coercive family process and early-onset conduct problems from age 2 to school entry. *Development and Psychopathology*. in press
- Smith JD, Dishion TJ, Shaw DS, Wilson MN. Indirect effects of fidelity to the Family Check-Up on changes in parenting and early childhood problem behaviors. *Journal of Consulting and Clinical Psychology*. 2013; 81(6):962–974. [PubMed: 23895087]

- Smith JD, Montañó Z, Dishion TJ, Shaw DS, Wilson MN. Engagement in the Family Check-Up reduces children's weight gain from age 2 through 9. manuscript submitted for publication.
- Smith JD, Stormshak EA, Kavanagh K. Results of a pragmatic effectiveness-implementation hybrid trial of the Family Check-Up in community mental health agencies. *Administration and Policy in Mental Health and Mental Health Services Research*. 2014 Available ahead of print.
- Stormshak, EA.; Margolis, K.; Huang, CY.; Dishion, TJ. Implementation of a family-centered, school-based intervention to prevent student academic and behavioral problems. In: Kelly, B.; Perkins, DF., editors. *Handbook of implementation science for psychology in education*. New York, NY: Cambridge University Press; 2012. p. 264-276.
- Trentacosta CJ, Hyde LW, Shaw DS, Dishion TJ, Gardner FEM, Wilson MN. The relations among cumulative risk, parenting, and behavior problems during early childhood. *Journal of Child Psychology and Psychiatry*. 2008; 49(11):1211–1219. [PubMed: 18665880]
- Van Ryzin MJ, Nowicka P. Direct and indirect effects of a family-based intervention in early adolescence on parent-youth relationship quality, late adolescent health, and early adult obesity. *Journal of Family Psychology*. 2013; 27(1):106–116. [PubMed: 23421838]
- Wang Y, Beydoun MA. The obesity epidemic in the United States—gender, age, socioeconomic, racial/ethnic, and geographic characteristics: A systematic review and meta-regression analysis. *Epidemiologic Reviews*. 2007; 29(1):6–28. [PubMed: 17510091]
- Wardle J, Cooke LJ, Gibson EL, Sapochnik M, Sheiham A, Lawson M. Increasing children's acceptance of vegetables; A randomized trial of parent-led exposure. *Appetite*. 2003; 40(2):155–162. [PubMed: 12781165]
- Webster-Stratton, C.; Reid, MJ. The Incredible Years parents, teachers, and children training series: A multifaceted treatment approach for young children with conduct disorders. In: Weisz, JR.; Kazdin, AE., editors. *Evidence-based psychotherapies for children and adolescents*. 2nd ed.. New York, NY: Guilford Press; 2010. p. 194-210.
- Whitlock EP, O'Connor EA, Williams SB, Beil TL, Lutz KW. Effectiveness of weight management interventions in children: A targeted systematic review for the USPSTF. *Pediatrics*. 2010; 125(2):e396–e418. [PubMed: 20083531]
- Young KM, Northern JJ, Lister KM, Drummond JA, O'Brien WH. A meta-analysis of family-behavioral weight-loss treatments for children. *Clinical Psychology Review*. 2007; 27(2):240–249. [PubMed: 17070638]
- Zeller MH, Reiter-Purtill J, Modi AC, Gutzwiller J, Vannatta K, Davies WH. Controlled study of critical parent and family factors in the obesigenic environment. *Obesity*. 2007; 15(1):126–126. [PubMed: 17228040]

Figure 1.

Path model.

Note. Bold paths are significant. PBS = Positive behavior support. zBMI = Body mass index z-score by child age and gender. I = intercept of the latent growth curve. S = slope of the latent growth curve. Covariates at the bottom of the figure were assessed at age 2. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 1

Intercorrelations and Descriptive Statistics of Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. BMI z-score (age 5)	–	.77**	.70**	.66**	.60**	-.07	-.01	-.05	-.07	.01	-.00	.05	-.01	.05	.04
2. BMI z-score (age 7.5)		–	.91**	.88**	.62**	-.08	-.03	-.08	.00	.06	.08	.02	.02	-.02	.04
3. BMI z-score (age 8.5)			–	.88**	.58**	.01	.03	-.04	-.01	.06	.04	.00	-.01	.04	.00
4. BMI z-score (age 9.5)				–	.55**	.01	-.01	-.08	-.04	.07	.08	.01	-.03	-.01	.04
5. Body size rating (age 2)					–	.09	.03	-.03	-.06	-.03	-.04	-.02	-.01	-.01	-.03
6. Nutritional quality of meals						–	.31**	.28**	.04	-.02	-.22**	-.11*	-.02	.01	-.05
7. Positive behavior support (age 2)							–	.54**	-.04	-.04	-.19**	-.13**	.01	-.11**	.05
8. Positive behavior support (age 3)								–	.07	-.00	-.19**	-.13**	.00	-.11**	.01
9. Intervention condition									–	.07	-.04	-.01	.04	.02	-.01
10. Child race/ethnicity										–	.10**	-.07*	-.08*	-.01	.05
11. Cumulative risk											–	.02	.05	.19**	.04
12. Observed noncompliance (age 2)												–	.05	.02	-.18**
13. Chaotic family environment (age 2)													–	.26**	-.24**
14. Caregiver depression (age 2)														–	-.05
15. Child inhibitory control (age 2)															–
Mean	.81	.92	.90	1.08	1.43	17.26			.50	2.67	2.10		5.31	16.78	3.97
Standard deviation	1.38	1.35	1.42	1.37	.91	5.21			.50	2.28	1.25		3.56	10.66	.80
N	403	494	505	464	594	422	694	635	729	729	714	723	690	727	720

Table 2

Results of Path Analysis

Model path	<i>B</i>	<i>SE (B)</i>	β	95% Confidence interval
A Intervention group → positive behavior support (age 3)	.15***	.05	.23	.202 .377
B Positive behavior support (age 2) → positive behavior support (age 3)	.59***	.03	.56	.066 .244
C Positive behavior support (age 3) → nutritional quality	1.92***	.34	.25	.009 .208
D Nutritional quality → BMI LGC slope	-.003*	.00	-.22	.152 .337
E Intervention group → BMI LGC slope	.001	.01	.01	.086 .257
F Child race/ethnicity → BMI LGC slope	.004	.00	.12	.098 .272
G Cumulative risk (age 2) → BMI LGC slope	.01	.01	.19	-.143 .013
H Chaotic family environment (age 2) → BMI LGC slope	.00	.00	.07	-.039 .099
I Impression of child weight (age 2) → BMI LGC slope	-.01	.01	-.14	-.004 .118
J Caregiver depressive symptomatology (age 2) → BMI LGC slope	.00	.00	-.06	-.044 .101
K Observed child noncompliance (age 2) → BMI LGC slope	.01	.01	-.01	-.052 .106
L Geographic region of residence (age 2) → BMI LGC slope	-.01	.01	-.11	.003 .156
M Child race/ethnicity → BMI LGC intercept	-.02	.03	-.03	.027 .140
N Cumulative risk (age 2) → BMI LGC intercept	-.01	.05	-.01	-.030 .101
O Chaotic family environment (age 2) → BMI LGC intercept	.01	.02	.04	.072 .241
P Impression of child weight (age 2) → BMI LGC intercept	.54***	.12	.41	-.039 .117
Q Caregiver depressive symptomatology (age 2) → BMI LGC intercept	-.00	.01	-.01	-.143 .045
R Observed child noncompliance (age 2) → positive behavior support (age 3)	-.06	.03	-.07	-.054 .108
S Cumulative risk (age 2) → nutritional quality	-.79***	.18	-.19	.073 .283
T Observed child noncompliance (age 2) → nutritional quality	-.48	.30	-.08	.110 1.098
U Geographic region of residence (age 2) → nutritional quality	.23	.30	.03	-.138 .930
V Caregiver depressive symptomatology (age 2) → nutritional quality	.04	.02	.08	.082 .299
Indirect intervention effect				
Intervention group → PBS (age 3) → nutritional quality → BMI LGC slope	-.001*	.00	.012	.000 .023

Note.

*
 $p < .05$.

**
 $p < .01$.

 $p < .001$.