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Predictors of parental perceptions and concerns about child weight

Kathleen L. Keller, PhD[1,2], **Annemarie Olsen, PhD**[3], **Laura Kuilema, MS**[1], **Karol Meyermann, MS**[2], and **Christopher van Belle, MS**[2]

[1]Departments of Nutritional Sciences and Food Science, The Pennsylvania State University, University Park, PA, 16802, USA

[2]New York Obesity Nutrition Research Center, St. Luke's-Roosevelt Hospital Center, Columbia University College of Physicians and Surgeons, 1090 Amsterdam Avenue 14A, New York, NY 10025, USA

[3]Department of Food Science / Sensory Science, Faculty of Life Sciences, University of Copenhagen, Rolighedsvej 30, 1958 Frederiksberg C, Denmark

Abstract

Appropriate levels of parental perception and concern about child weight are important components of successful obesity treatment, but the factors that contribute to these attitudes need clarification. The aim of this study was to identify child and parent characteristics that best predict parental perceptions and concerns about child weight. A cross-sectional design was used to assess characteristics of parents (e.g. age, income, and feeding attitudes) and children (e.g. body composition, *ad libitum* intake, and reported physical activity). Results are reported for 75, 4–6 year-olds from diverse ethnicities. Perceived child weight and concern were measured with the Child Feeding Questionnaire (CFQ). Multiple linear regression was used to identify the best models for perceived child weight and concern. For perceived child weight, the best model included parent age, children's laboratory intake of sugar-sweetened beverages (SSB) and palatable buffet items, and two measures of child body composition (ratio of trunk fat-to-total fat and ratio of leg fat-to-total fat). For concern, child android/gynoid fat ratio explained the largest amount of variance, followed by restrictive feeding and SSB intake. Parental perceptions and concerns about child weight are best explained by models that account for children's eating behavior and body fat distribution.

Keywords

obesity; body weight; parental perceptions; eating behavior

Corresponding Author: Kathleen L. Keller, Ph.D., The Pennsylvania State University, Departments of Nutritional Science and Food Science, 321 Chandlee Laboratory, University Park, PA, 16802. Phone: 1-814-863-2915. Fax: 1-814-863-6103. klk37@psu.edu.

Conflict of Interest
The authors have no conflict of interest to report.

Introduction

Childhood obesity is one of the most serious public health problems faced by present society. It is associated with chronic disease (Pi-Sunyer, 1991), shortened lifespan (Olshansky, 2005), psychosocial implications (Davison & Birch, 2001; Janicke, Marciel, Ingerski, & Novoa, 2007; Janssen, Craig, Boyce, & Pickett, 2004; Latner & Stunkard, 2003), and significant health costs (Wang, McPherson, Marsh, Gortmaker, & Brown, 2011). If current trends in the prevalence of obesity continue, the costs related to the disease may reach $48 to $66 billion over the next 20 years (Wang et al., 2011). Effective strategies to prevent and treat obesity are needed to reduce these costs. Because of the high relapse rate associated with adult obesity (Jeffery et al., 2000), successful prevention of the disease during childhood is a high priority (Bouchard, 1996).

Parent involvement is critical for successful prevention of childhood obesity. Weight loss programs that include emphasis on the entire family have demonstrated greater success than those that target the individual child (Epstein, 1996; Leonard, Michelle, Hollie, & Brian E Saelens, 1998). Parents also have an important role in obesity prevention because they are in charge of bringing food into the home and modeling healthful eating behaviors for their children (Faith, 2012). Therefore, understanding the factors that contribute to parental perceptions and concerns about child weight may help health professionals more effectively work with families to prevent this disease.

Despite the well-established importance of parental involvement in managing childhood obesity, many parents do not seek treatment because they fail to recognize their child's weight status as a problem. Several studies have underscored the importance of parental awareness of child weight in successful obesity treatment (Adams, Quinn, & Prince, 2005b; Doolen, Alpert, & Miller, 2009; Golan, Weizman, Apter, & Fainaru, 1998; Golan & Crow, 2004). Yet, most parents do not accurately perceive their child's weight (Baughcum, Chamberlin, Deeks, Powers, & Whitaker, 2000; Carnell, 2005; Garrett-Wright, 2011; Hackie & Bowles, 2007), and as a consequence, they may not seek treatment or be concerned (Baughcum et al., 2000; Young-Hyman, Herman, Scott, & Schlundt, 2000). This is a challenge for obesity prevention because parental concern for child weight is positively associated with treatment outcomes (Epstein, Valoski, Wing, & McCurley, 1994; Golan et al., 1998).

Several previous studies have investigated characteristics that help to explain variability in parental perceptions and concerns about child weight. Baughcum *et al.*, (Baughcum et al., 2000) found that maternal education was an important predictor of perceptions of child body weight, with low maternal education being associated with a higher likelihood of misclassifying child weight status. Findings from Genovesi and colleagues (Genovesi et al., 2005) from an Italian cohort found similar results with respect to maternal education. In another study, Rhee and colleagues identified several factors associated with parental perceptions of child weight, including parent body mass index (BMI) and the belief that childhood obesity was a significant health problem (Rhee, De Lago, Arscott-Mills, Mehta, & Davis, 2005). In this study, parents reported higher readiness to change their child's eating behaviors if they also believed themselves to be overweight. Carnell and colleagues reported similar findings in regards to concern for child weight; parents who perceived themselves to be heavier were more concerned for their child's weight (Carnell, 2005). Although clinicians commonly use BMI growth charts to communicate information about weight status to parents, studies indicate that this may not be the best predictor of perceived child weight (Wake, Canterford, Hardy, & Ukoumunne, 2011; Jain et al., 2001; Wake et al., 2011), and low-income parents report a distrust of this measure (Jain et al., 2001). While most studies have used relatively insensitive measures of body fat assessment, Parkinson *et*

al measured waist circumference and skinfolds and found them to be better predictors of parental perceptions of child weight status than child BMI (Parkinson, 2011). However, additional studies are needed to clarify the characteristics that contribute to inaccurate perceptions and concerns about child weight status in order to develop interventions that can effectively reach the broadest audience.

The purpose of this study was to identify predictors of parents' perceptions and concerns about child weight. Previous studies have not assessed body fat distribution, nor have they included measures of child eating behavior or physical activity, both of which can influence parental perceptions of children's health status (Gopinath, 2012; MacFarlane, 2010). In the present study, we used dual X-ray absorptiometry (DXA) to assess the relationship between body fat distribution and perceived child weight and concern. In addition, we assessed child eating behavior across 4 single-meals and estimated physical activity via a questionnaire completed by parents on behalf of their children. We hypothesized that measures obtained from DXA would be better predictors of perceived child weight and concern than child BMI z-score. We also hypothesized that higher consumption of energy-dense, nutrient poor food and beverages options in the laboratory would contribute to parents' perceptions and concerns about child weight.

Methods

Participants

Children (n=79) enrolled in this study were between 4–6 years-old (mean ± SD = 5.04 ± 0.78). Out of 79 children enrolled, complete meal and DXA data are reported for 75. Parents, 90% of whom were mothers, self-reported the ethnicity of their children as African-American (42.5%), Hispanic (31.3%), Caucasian (12.5%), Asian (2.5%) or "other" (11.3%). Approximately 40% of the children were boys. BMI z-score for children was on average 1.00 ± 1.02 kg/m^2, corresponding to the 85th BMI-for-age percentile. Mean BMI of the parent completing the questionnaire was 29.0 ± 7.73 kg/m^2. Characteristics of children and families are found in Table 1. This study was approved by the Institutional Review Board of St. Luke's Roosevelt Hospital Center. Parents consented to allow children to participate.

Study Design

This was a cross-sectional study consisting of four, one-hour sessions that took place between 4:00 pm – 6:00 pm, and a fifth session where body composition was measured. Test sessions took place over a one month period to avoid long lag times between visits. Parents were recruited from the community by placing advertisements on popular websites and around the hospital community where the study took place. Interested parents were screened on the phone prior to the first test session to ensure that the child was healthy, not on any prescription medications, and did not have any food allergies. After meeting the inclusion criteria, children attended the laboratory two hours fasted, with a parent.

Questionnaires

On the first visit, a parent completed questionnaires to assess demographics, income, feeding attitudes, and physical activity. The CFQ from Birch and colleagues (Birch et al., 2001) was used to assess perceived child weight and concern. This self-report instrument assesses four feeding attitudes (perceived parent weight, perceived child weight, perceived responsibility, and concern) and three feeding practices (restriction, monitoring, and pressure). We have previously reported on the relationship between other CFQ subscales and *ad libitum* intake in children (Sud, Tamayo, Faith, & Keller K.L., 2011).

Perceived child weight was assessed by three questions that ask parents to classify children's weight across developmental periods that included the first year of life, as a toddler, and as a preschooler. Parents rated perceived child weight on a 5-point categorical scale ranging from "markedly underweight" to "markedly overweight." Concern for child weight was assessed with three questions about parental concerns for children eating too much and attaining a desirable body weight. For each subscale, responses were quantified by converting to numbers 1–5, with higher scores indicating greater perceived weight and concern. The mean response across all question items for each sub-scale was used for all analyses. In addition to perceived child weight and concern, the other CFQ subscales were computed and added to the initial regression models.

Parents estimated physical activity for their children using the International Physical Activity Questionnaire (IPAQ). This questionnaire assesses frequency and amount of vigorous activity, walking, and sedentary time. It has been validated in a number of populations, including adolescents (Hagstrmer, Bergman, De Bourdeaudhuij, & Ortega, 2008; Wolin, Heil, Askew, Matthews, & Bennett, 2008), but not in young children. Parental responses were coded continuously as estimated number of minutes children spent per day on vigorous activity, walking, and sedentary time, for a total of 3 physical activity related variables that were included in regression models.

Body Composition

Anthropometric measures (weight and height) were performed by a trained researcher. Children were weighed and measured in stocking feet and light clothing on a standard balance scale (Detecto ®, Model 437, Webb City, MO) and stadiometer (Seca ®, Model 202, Chino, CA), respectively. Height and weight were converted to BMI kg/m^2 and BMI z-scores were calculated using the Centers for Disease Control and Prevention conversion program (Cole, Bellizzi, Flegal, & Dietz, 2000).

Body composition was assessed using whole body DXA (DPX, Lunar Corp., Madison, WI) using Pediatric Software Version 3.8G (Lunar Corp., Madison, WI). The following measures were extracted from the whole body scan and tested in regression models: trunk percent fat, android percent fat, gynoid percent fat, and android-to-gynoid fat ratio, trunk fat-to-total fat ratio, and leg fat-to-total fat ratio, as well as total body measures of percent fat, percent lean mass, fat mass, lean mass, bone mineral, and fat free mass. The rationale for using these measures was to capture variables that might be associated with children's body size and fat distribution.

Test-Meal Procedures

All foods and beverages at the meals were served without brand packaging, in plain plastic containers, and were prepared prior to the visit. Children were allowed 30 minutes to eat as much as they wanted. A researcher was seated at the table to assist the child and provide additional servings if needed, and read aloud a story to serve as a neutral distraction. Parents were seated in an adjacent waiting room, unable to hear or see the child.

Test-meal One

At the end of the first visit, children were provided a multi-item meal, similar to that used in other studies (Fisher & Birch, 1995; Keller et al., 2010; Spill, Birch, Roe, & Rolls, 2010), to establish baseline intake. Children were provided with standard serving sizes for each foo d ascertained from the Continuing Survey of Food Intake by Individuals, 1994–1996 (Smiciklas-Wright, Mitchell, Mickle, Cook, & Goldman, 2002). Foods served were macaroni and cheese, sandwiches (cheese, peanut butter), broccoli, grapes, graham crackers, baby carrots, strawberry yogurt, whole milk, and a SSB (fruit punch).

Test-meals Two & Three

At the end of sessions two and three, children received a low-fat or a high-fat meal, delivered in a randomized order The objective was to assess children's susceptibility to overeating foods that were high-fat and energy-dense. The same foods were served at both meals, but the recipes manipulated to produce differences in fat content that ranged from 0–11% fat content-by-weight in the low-fat meal and 34–48% fat content-by-weight in the high-fat meal. The foods served were macaroni and cheese, vanilla pudding, and chocolate and plain milk. Additional details about these recipe manipulations can be found in our previously published study (Olsen, van Belle, Meyermann, & Keller, 2011).

Test-meal Four

At the end of the fourth session, children received a highly palatable buffet of sweet (e.g. red licorice, gummies, SSB), sweet-fat (e.g. cookies, brownies, doughnuts), and savory-fat (e.g. pizza, mozzarella sticks, chips) items. The purpose of this meal was to assess children's susceptibility to overeating highly palatable foods.

Test-meal Nutrient Analysis

Total energy for each of the meals was computed as the difference between the pre- and post-weights of all items. Food label information was used to calculate total calories. Energy intakes from selected individual items (e.g. SSBs, main entrées, and sweets) were retained for analyses. Because of the interest in SSBs and childhood obesity, we created a mean score SSB intake across meals one and four to assess children's intake of this item in the laboratory.

Statistical Analysis

Descriptive statistics were performed to determine means and standard deviations for continuous variables and frequencies for categorical variables. Pearson's correlations were also computed between continuous variables and nonparametric correlations between categorical variables.

The primary study aims were tested with multiple linear regression analysis. Dependent variables were perceived child weight and concern. Independent variables were selected by identifying covariates that were theoretically associated with the dependent variables in one of four categories: demographics (e.g. ethnicity and age), parental characteristics (e.g. marital status and feeding styles), child behaviors (e.g. food intake and physical activity), and child body composition. All independent variables were included in the same model and stepwise regression used to identify the final predictors. Categorical variables (e.g. ethnicity, gender) were dummy coded before adding to the models. Based on suggested methods for building regression models with small sample sizes (<100) (McDonald, 2009), we limited the final regression model to no more than 6 independent variables that were either significant predictors, or associated with the dependent variable at a p-value ≤ 0.10. Multicollinearity was checked by examining the variance inflation factors for each independent variable to ensure they were ≤ 5 (Allison, 1999). SPSS version 20.0 (SPSS, Inc, Chicago, IL) was used for all analyses, all t-tests were two-tailed, and the cut-off for statistical significance for all analyses was $p<0.05$. The term predictor is used to describe statistical relationships, and is not meant to imply causality. All continuous variables are reported as means ± standard deviations (SD), unless otherwise noted.

Results

Descriptive Analyses

Out of 75 children, 40 (53.2%) were overweight. Higher perceived child weight was associated with child BMI z-score ($r=0.50$; $p<0.001$), but not parent BMI ($p=0.14$), child age ($p=0.50$), or parent age ($p=0.94$). Parental concern was also associated with higher child BMI z-scores ($r=0.60$; $p<0.001$), higher parent BMI ($r=0.36$; $p<0.005$), but not parent age ($p=0.31$) or child age ($p=0.24$).

Descriptive values for body composition measures obtained from DXA are listed in Table 2. Values are listed for all children, and broken down separately by weight status. Children who were overweight had higher measures of body fat than non-overweight children on all measures except the ratio of leg fat to total fat ($p=0.38$; unpaired t-tests). [Table 2]

Test-meal intake

Children consumed an average of 477.9 ± 244.8 kcals at the baseline meal, 495.4 ± 335.3 kcals at the high-fat meal, 312.7 ± 220.5 kcals at the low-fat meal, and 668.7 ± 354.1 at the highly palatable buffet. Energy intake at the low-fat meal was lower than intake at all the other meals ($p<0.05$ for all comparisons), while intake at the palatable buffet was higher than intake at the other three test-meals ($p<0.05$ for all paired t-test comparisons). There were no differences in the baseline meal ($p=0.62$) or the high-fat ($p=0.49$) and low-fat ($p=0.98$) meals as a function of child gender, but at the palatable buffet, boys ate more than girls ($t=1.98$; $p\leq0.05$). Intake at the test-meals did not differ by ethnicity (p-values from 0.24 – 0.65) or parental income (p-values from 0.15 – 0.69). Pearson's correlations between test-meal intake, parental feeding attitudes, and body composition are reported in Table 3.

Predictors of perceived child weight

The linear regression model that predicted the most variance in perceived child weight included parent age, children's intake of SSBs at the test-meals, calorie intake at the palatable buffet, the ratio of trunk fat to total fat, and the ratio of leg fat to total fat (adjusted $R\text{-sq}=0.41$; $F=9.03$, $p<0.001$). The highest amount of variance in this model was attributed to the two measures obtained from DXA, trunk fat-to-total fat (Beta=0.59) and leg fat-to-total fat (Beta=0.68). [Table 4]

Predictors of concern

The regression model that explained the most variance in parental concern included restriction of child feeding, children's intake of SSBs and intake at the palatable buffet, and android-to-gynoid ratio from DXA (adjusted $R\text{-sq}=0.59$; $F=26.53$, $p<0.001$). The highest amount of variance in this model was attributed to android-to-gynoid ratio, which explained approximately 47% of variance in the model [Table 5]. The relationship between android-to-gynoid ratio and parental concern about child weight was highly significant after holding other variables in the model constant (restriction of feeding, SSB intake and intake at the palatable buffet) ($t=7.21$; $p<0.001$). [Figure 1]

Discussion

The purpose of this study was to identify predictors of parents' perceptions and concerns about child weight in a cohort of 4–6 year-old children who participated in an eating behavior study that occurred across 5 study visits. Predictors tested were related to three categories: parental characteristics, child body composition, and child eating/activity behaviors. The best models for both included variables from all three of these categories, indicating that parental perceptions and concerns about child weight are complex and multi-

determined. There are two key findings from this study that are novel. First, children's eating behavior in the laboratory, in particular intake of sugar-sweetened fruit punch and total energy intake at a highly palatable buffet meal, were predictors of parental perceptions and concerns for child weight. Second, measures of child body fat obtained from DXA, a highly sensitive method for measuring body composition, were better predictors of perceived child weight and concern than child BMI or BMI z-score. Each model is discussed independently below.

Perceived child weight

With respect to perceived child weight, the final model included parent age, children's intake of SSBs and total energy at the palatable buffet, and ratios of trunk fat-to-total fat and leg fat-to-total fat. Parent age was negatively associated with perceived child weight in the final model, suggesting that older parents perceived their children to have lower body weights than younger parents. While the majority of parents completing the questionnaires in our study were mothers, we did have 8 fathers who participated. Adams *et al.,* studied the perceptions of overweight among Native American children of similar age children and found that fathers were less likely to recognize overweight in their children than mothers or grandmothers (Adams, Quinn, & Prince, 2005a). In our study, fathers were on average 6 years older than mothers. This might partially explain the effects of age we observed. However, when parent gender was added to the regression models in place of parent age its effect was not significant ($p=0.25$) likely due to the small sample size of fathers represented. Additional explanation of this finding will require follow-up investigations on the differences in child weight perceptions among mothers and fathers.

Children's mean intake of SSBs across two test-meals and intake at the highly palatable buffet were also positively associated with perceived child weight. If children exhibit similar dietary tendencies at home, these findings may suggest that parents perceive these dietary patterns as potential contributors to obesity. Sweetened beverages (Ebbeling et al., 2006) and 'junk foods' that have poor nutritional quality (Bittman, 2011) have received significant media attention because of purported relationships to obesity. Parents may be particularly aware of these behaviors in their children, and this may impact their perceptions of child body weight. Other findings support the notion that childhood eating behaviors contribute to perceptions about body weight status. Jain *et al.,* (Jain et al., 2001) conducted focus groups with low-income women and found that parents were not concerned about child weight status if they perceived the child's eating habits as healthy, but if children ate "junk food," parents were more likely to report concern. This may reflect the fact that parents are more concerned about children becoming obese in the future than they are about present risks of the disease (Carnell, 2005). Many parents may believe that children will "grow out" of weight problems (Lee et al., 2010), and perhaps unhealthful eating behaviors in children influence parent's beliefs about whether this will actually happen or not.

While child BMI was not a predictor of perceived child weight, other measures of child body composition were, in particular, ratios of trunk and leg fat to total fat. These findings add to those from Parkinson and colleagues (Parkinson, 2011) who found that other body composition measures such as waist circumference and skinfolds were better predictors of perceived child weight than BMI. In the present study, we used DXA, a highly sensitive measure of assessing body composition, and identified the ratios of trunk and leg fat-to-total fat as positively associated with perceived child weight. In both cases, parents tended to perceive children as more obese if they were carrying a higher proportion of body fat in the trunk or legs compared to the rest of the body. In the focus group study mentioned previously (Jain et al., 2001), parents emphasized that children who are just large, or "big boned," are not perceived as overweight, particularly if they carry their weight well and are strong. However, parents reported that signs such as a child being unable to button their

pants signals that the child may be overweight. This suggests that parents may be particularly sensitive to fat carried in areas like the trunk or legs that are visible and can affect the fit of clothing. Several studies have also reported that parents mistrust the information on growth charts (Jain et al., 2001) and have a poor understanding of what BMI-for-age percentiles mean (Sullivan, 2011). When taken into consideration with the findings presented in this paper, one can hypothesize that body fat distribution is a more important determinant of parental weight perceptions than total body size. Body symmetry has long been recognized as an important contributor of overall attractiveness (Wade, 2010). Our findings suggest that perceptions of child weight status may also be influenced by body symmetry, particularly if excess fat is carried in visible places such as the trunk or legs. If these studies are confirmed, it may be possible to use this information to establish clinical practices to help parents better recognize overweight in their children.

Concern for child weight

The regression model that best predicted concern for child weight included restrictive feeding practices, children's intake of SSBs and palatable buffet items, and android-to-gynoid fat ratio. Nearly half of the variance in this model was explained by android-to-gynoid, a comparison of upper body to lower body fat, with greater levels of upper compared to lower body fat associated with greater parent concern. Similar to the regression model that best predicted perceived child weight, parental concern showed a strong, positive association with android-to-gynoid fat ratio when children's intake of SSBs and palatable foods and parental use of restrictive feeding were held constant. This suggests that overall body proportions are also an important consideration in determining levels of parental concern for childhood weight status. Because carrying upper body fat is associated with greater health risks than lower body fat (Lee, 2012; Lubrano, 2012), it is possible that parental concerns are motivated by perceived health risks for their children. Previous research has suggested that parents exhibit greater concern about future health risks related to obesity than present health risks (Carnell, 2005). If, in fact, parents in the present study perceived upper body fat as a potential risk for future chronic disease, this may partly explain the strong correlation between these two variables. Pediatricians and health professionals may find it helpful to educate parents about other patterns of fat distribution in children that may be cause for concern.

Children's intake of SSBs and energy at the palatable buffet meal were also predictors of parent concern for child weight, although the latter variable did not reach statistical significance. However, laboratory eating behavior is only a proxy for what children might do at home, under free living conditions. That said, both SSBs and energy consumed at the palatable buffet were significantly associated with children's BMI z-score, suggesting that these methods were successful at promoting hyperphagia in children who are susceptible to overeating. This further supports the notion that parents perceive SSBs and the sweet, energy-dense options served at the buffet as carrying potentially negative consequences for child weight. Out of 15 total meal-related variables that were included in the initial models, including percentage of total fat and total calories consumed across the 4 test-meals, these were the only eating variables that were significantly associated with perceived parental weight and concerns.

Use of restrictive feeding practices was also a significant predictor of parent concern, and this agrees with several recent studies (Gray, 2010; May et al., 2007). Parents likely use restrictive feeding practices to a greater extent when they are concerned about children's weight. While some studies have found that high levels of restriction may be associated with greater likelihood of children to binge when they are given the opportunity (Fisher & Birch, 1999a; Fisher & Birch, 1999b), not all studies support this (Querido, Warner, & Eyberg, 2002; Sud et al., 2011). However, it is important for health professionals to understand that

parents who have high levels of concern for child weight may use restrictive feeding practices that could have unintended consequences if taken to an extreme.

This study has several limitations. Even though other studies have found children's physical activity to be an important predictor of parent's perceptions of child health risks (Adamo, 2010; Young-Hyman et al., 2000), our findings did not support this. Several issues with our design may have contributed to these null findings. Our cohort was small, particularly in relation to studies that have used multiple linear regression analysis. Variables that contributed a small amount of variance to perceived child weight or concern may have been undetectable due to the sample size. In addition, the questionnaire used to assess physical activity, the IPAQ, has previously been validated for use with adolescents (Hagstramer et al., 2008; Wolin et al., 2008) but has not been validated for use with young children. Despite this, we were able to predict over twice as much variance in perceived child weight and concern when compared to other studies that have used larger cohorts (Young-Hyman et al., 2000). We attribute this to the use of DXA, a highly sensitive measure of body fat composition. There were additional limitations, as well. Several key variables were assessed using questionnaires. Additionally, although the CFQ is a validated measure (Birch et al., 2001), the perceived child weight subscale asks questions in a manner that could be subject to recall bias. Further, the relationships reported in this study are cross-sectional. Longitudinal studies that examine the causal relationships between children's eating behaviors, body composition, and parental perceptions of overweight are needed. Moreover, laboratory measures of eating behavior were included as predictors of perceived child weight and concern, but it is unclear how well laboratory meals reflect children's behavior under free living conditions. Finally, the age group we examined was limited to pre-pubertal children, a time when concerns about future health may be limited and excess weight may not be noticeable. It is not possible to generalize these findings to other age groups.

Conclusions

We identified several novel predictors of parents' perceived child weight and concern. Measures of child body composition, including ratios of trunk and leg fat-to-total fat, and upper body-to-lower body fat, were better predictors of perceived child weight and concern than child BMI, body weight, or total body fat. In addition, children's intake of SSBs and highly palatable, energy dense foods at a buffet may be other behaviors by which parents are making these assessments. Upon confirmation from future studies, pediatricians and other clinicians may wish to include such assessments when working with children and their families.

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Reference List

Adamo KB, Papadakis S, Dojeiji L, Turnau M, Simmons L, Parameswaran M, et al. Using path analysis to understand parents' perceptions of their children's weight, physical activity and eating habits in the Champlain region of Ontario. Paediatr Child Health. 2010; 15(9):e33–e41. [PubMed: 22043145]

Adams AK, Quinn RA, Prince RJ. Low Recognition of childhood overweight and disease risk among Native-American caregivers. Obesity Res. 2005a; 13:146–152.

Allison, PD. Multiple Regression: a primer. Thousand Oaks, CA: Pine Forge Press; 1999.

Baughcum AE, Chamberlin LA, Deeks CM, Powers SW, Whitaker RC. Maternal perceptions of overweight preschool children. Pediatrics. 2000; 106:1380–1386. [PubMed: 11099592]

Birch LL, Fisher JO, Grimm-Thomas K, Markey CN, Sawyer R, Johnson SL. Confirmatory factor analysis of the Child Feeding Questionnaire: a measure of parental attitudes, beliefs and practices about child feeding and obesity proneness. Appetite. 2001; 36:201–210. [PubMed: 11358344]

Bittman M. Bad foods? Tax it, subsidize vegetables. New York Times. 2011

Bouchard C. Can obesity be prevented? Nutr Rev. 1996; 54:s125–S2130. [PubMed: 8700439]

Carnell S, Edwards C, Croker H, Boniface D, Wardle J. Parental perceptions of overweight in 3–5 y olds. Int J Obes. 2005; 29:353–355.

Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ. 2000; 320:1240–1243. [PubMed: 10797032]

Davison KK, Birch LL. Weight status, parent reaction, and self-concept in five-year-old girls. Pediatrics. 2001; 107:46–53. [PubMed: 11134433]

Doolen J, Alpert PT, Miller SK. Parental disconnect between perceived and actual weight status of children: A metasynthesis of the current research. J Am Acad Nurse Pract. 2009; 21:160–166. [PubMed: 19302692]

Ebbeling CB, Feldman HA, Osganian SK, Chomitz VR, Ellenbogen SJ, Ludwig DS. Effects of decreasing sugar-sweetened beverage consumption on body weight in adolescents: a randomized, controlled pilot study. Pediatrics. 2006; 117:673–680. [PubMed: 16510646]

Epstein LH. Family-based behavioural intervention for obese children. Int J Obes Rel Met Dis. 1996; 20(Suppl 1):S14–S21.

Epstein LH, Valoski A, Wing RR, McCurley J. Ten-Year Outcomes of Behavioral Family-Based Treatment for Childhood Obesity. Health Psych. 1994; 13:373.

Faith MS, Van Horn L, Appel LJ, Burke LE, Carson SA, French HA, et al. Evaluating parents and adult caregivers as "agents of change" for treating obese children: evidence for parent behavior change strategies and research gaps: a scientific statement from the American Heart Association. Circulation. 2012; 125:1186–1207. [PubMed: 22271754]

Fisher JO, Birch LL. Fat preferences and fat consumption of 3- to 5-year- old children are related to parental adiposity. J Am Diet Assoc. 1995; 95:759–764. [PubMed: 7797805]

Fisher JO, Birch LL. Restricting access to foods and children's eating. Appetite. 1999a; 32:405–419. [PubMed: 10336797]

Fisher JO, Birch LL. Restricting access to palatable foods affects children's behavioral response, food selection, and intake. Am J Clin Nutr. 1999b; 69:1264–1272. [PubMed: 10357749]

Garrett-Wright D. Parental perception of preschool child body weight. J Pediatr Nurs. 2011; 26:435–445. [PubMed: 21930030]

Genovesi S, Giussani M, Faini A, Vigorita F, Vigorita F, Pieruzzi F, et al. Maternal perception of excess weight in children: A survey conducted by paediatricians in the provence of Milan. Acta Paediatrica. 2005; 94:747–752. [PubMed: 16188779]

Golan M, Weizman A, Apter A, Fainaru M. Parents as the exclusive agents of change in the treatment of childhood obesity. Am J Clin Nutr. 1998; 67:1130–1135. [PubMed: 9625084]

Golan M, Crow S. Targeting parents exclusively in the treatment of childhood obesity: long-term results. Obesity. 2004; 12:357–361.

Gopinath B, Hardy LL, Bauer LA, Burlutsky G, Mitchell P. Physical activity and sedentary behaviors and health-related quality of life in adolescents. Pediatrics . 2012; 130:e167–e174. [PubMed: 22689863]

Gray WN, Janicke DM, Wistedt KM, Dumon-Driscoll MC. Factors associated with parental use of restrictive feeding practices to control their children's food intake. Appetite. 2010; 55:332–337. [PubMed: 20633586]

Hackie M, Bowles CL. Maternal Perception of Their Overweight Children. Public Health Nurs. 2007; 24:538–546. [PubMed: 17973731]

Hagstramer M, Bergman P, De Bourdeaudhuij I, Ortega FB. Concurrent validity of a modified version of the International Physical Activity Questionnaire (IPAQ-A) in European adolescents: The HELENA Study. Int J Obes. 2008; 32:S42–S48.

Jain A, Sherman SN, Chamberlin DPA, Carter Y, Powers SW, Whitaker RC. Why Don't Low-Income Mothers Worry About Their Preschoolers Being Overweight? Pediatrics. 2001; 107:1138–1146. [PubMed: 11331699]

Janicke DM, Marciel KK, Ingerski LM, Novoa W. Impact of Psychosocial Factors on Quality of Life in Overweight Youth. Obesity. 2007; 15:1799–1807. [PubMed: 17636099]

Janssen I, Craig WM, Boyce WF, Pickett W. Associations Between Overweight and Obesity With Bullying Behaviors in School-Aged Children. Pediatrics. 2004; 113:1187–1194. [PubMed: 15121928]

Jeffery RW, Drewnowski A, Epstein LH, Stunkard AJ, Wilson GT, Wing RR, et al. Long-term maintenance of weight loss: current status. Health Psych. 2000; 19:5–16.

Keller KL, Reid AR, MacDougall M, Cassano H, Song JL, Deng L, et al. Sex differences in the effects of bitter thiourea sensitivity on body weight in 4–6 year-old children. Obesity. 2010; 18:1194–1200. [PubMed: 19779476]

Latner JD, Stunkard AJ. Getting worse: The stigmatization of obese children. Obesity Res. 2003; 11:452–456.

Lee JM, Lim S, Zoellner J, Burt BA, Sandretto AM, Sohn W, et al. Don't Children Grow Out of Their Obesity? Weight Transitions in Early Childhood. Clin Ped. 2010; 49:466–469.

Lee MJ, Wu Y, Fried SK. Adipose tissue heterogeneity: implication of depot differences in adipose tissue for obesity complications. Mol Aspects Med. 2012

Epstein LH, Myers MD, Raynor HA, Saelens BE. Treatment of pediatric obesity. Pediatrics. 1998; 101:554. [PubMed: 12224662]

Lubrano C. Relationships between body fat distribution, epicardial fat and obstructive sleep apnea in obese patients with and without metabolic syndrome. PloS One. 2012; 7:e47–e59.

MacFarlane A, Crawford D, Worsley A. Associations between parental concern for adolescent weight and the home food environment and dietary intake. J Nutr Educ Behav. 2010; 42:152–160. [PubMed: 20097613]

May AL, Donohue M, Scanlon KS, Sherry B, Dalenius K, Faulkner P, et al. Child-Feeding Strategies Are Associated with Maternal Concern about Children Becoming Overweight, but not ChildrenGÇÖs Weight Status. J Am Diet Assoc. 2007; 107:1167–1174. [PubMed: 17604746]

McDonald, JH. Handbook of Biological Statistics. 2nd ed. Baltimore, MD: 2009.

Olsen A, van Belle C, Meyermann K, Keller KL. Manipulating fat content of familiar foods at test-meals does not affect intake and liking of these foods among children. Appetite. 2011; 57:573–577. [PubMed: 21801772]

Olshansky SJ, Passaro DJ, Hershow RC, Layden J, Carnes BA, Brody J, et al. A potential decline in life expectancy in the United States in the 21st century. New Engl J Med. 2005; 352:1138–1145. [PubMed: 15784668]

Parkinson KN, Drewett RF, Jones AR, Dale H, Pearce MS, Wright CM, et al. When do mothers think their child is overweight? Int J Obes. 2011; 35:510–516.

Pi-Sunyer FX. Health implications of obesity. Am J Clin Nutr. 1991; 53(Suppl-1603S)

Querido JG, Warner TD, Eyberg SM. Parenting styles and child behavior in African American families of preschool children. J Clin Child & Adolesc Psych. 2002; 31(2):272–277.

Rhee KE, De Lago CW, Arscott-Mills T, Mehta SD, Davis RK. Factors associated with parental readiness to make changes for overweight children. Pediatrics. 2005; 116:e94–e101. [PubMed: 15995022]

Smiciklas-Wright, H.; Mitchell, D.; Mickle, S.; Cook, A.; Goldman, J. Foods commonly eaten in the United States: Quantities consumed per eating occasion and in a day. Beltsville, MD: US Department of Agriculture; 2002. p. 1994-1996.

Spill MK, Birch LL, Roe LS, Rolls BJ. Eating vegetables first: the use of portion size to increase vegetable intake in preschool children. Am J Clin Nutr. 2010; 91:1237–1243. [PubMed: 20219955]

Sud S, Tamayo NC, Faith MS, Keller KL. Increased restrictive feeding practices are associated with reduced energy density in 4–6 year-old multi-ethnic children at *ad libitum* laboratory test meals. Appetite. 2011; 55:201–207. [PubMed: 20594990]

Sullivan SA. Urban parents' perceptions of healthy infant growth. Clinical Pediatr. 2011; 50:698–703.

Wade TJ. The relationships between symmetry and attractiveness and mating relevant decisions and behavior: a review. Symmetry. 2010; 2:1081–1098.

Wake M, Canterford L, Hardy P, Ukoumunne OC. At what BMI are parents of pre-schoolers concerned? National cross-sectional study. Int J Pediatr Obes. 2011; 6:499–501. [PubMed: 21679015]

Wang CY, McPherson K, Marsh T, Gortmaker SL, Brown M. Health and economic burden of the projected obesity trends in the USA and the UK. The Lancet. 2011; 378:815–825.

Wolin KY, Heil DP, Askew S, Matthews CE, Bennett GG. Validation of the International Physical Activity Questionnaire-Short among Blacks. J Phys Act Health. 2008; 5:746–760. [PubMed: 18820348]

Young-Hyman D, Herman LJ, Scott DL, Schlundt DG. Care giver perception of children's obesity-related health risk: a study of African American families. Obesity Res. 2000; 8:241–248.

Highlights

Body fat distribution from DXA was a predictor of parental perceived child weight.

Upper body to lower body fat ratio was the best predictor of parent weight concern.

Children's intake of sugar-sweetened beverages may influence parental weight concern.

Table 1

Characteristics of families enrolled in study

***Characteristic* (n=79 unless otherwise noted)**	***Mean***	***Standard Deviation (SD)***
Child Age (years)	5.04	0.78
Child BMI z-score	1.00	1.02
Parent Age (years)[a,b]	33.22	6.85
BMI of parent (kg/m^2)[c]	28.63	7.73
Perceived Child Weight (range 1–5)	3.02	0.43
Weight Concern (range 1–5)	2.42	1.32
	%	
Child gender		
% boys	39.5	N/A
% girls	60.5	N/A
Ethnicity		
% African-American	42.5	N/A
% Caucasian	12.5	N/A
% Asian	2.5	N/A
% Hispanic	31.3	N/A
% “other”	11.3	N/A
Child weight status		
% BMI < 85th %	46.8	N/A
% BMI ≥ 85th %	53.2	N/A
Income		
% < $20,000 per year	38.0	N/A
% ≥ $20,000 per year	62.0	N/A

[a]Due to missing data (a refusal of parents to report), parent age was collected for 76 parents.

[b]The parent that completed the questionnaires on behalf of their families ranged in age from 20 – 58 years.

[c]The BMI for the parent that completed the questionnaire on behalf of their families ranged in BMI from 17.1 – 53.2 kg/m^2

Table 2

Descriptive statistics for children's body composition variables obtained from DXA for all children, and broken down by weight status

Variable	All (n=75) - mean ± SD	BMI-for-age < 85th % - mean ± SD	BMI-for-age ≥ 85th % - mean ± SD	p-value (unpaired T-tests)
Trunk Tissue Fat (%)	19.76 ± 9.90	14.40 ± 5.52	25.00 ±10.62	< 0.001
Android Tissue Fat (%)	22.34 ± 11.77	15.78 ± 5.54	28.81 ± 12.81	< 0.001
Gynoid Tissue Fat (%)	35.47 ± 8.86	31.25 ± 7.02	39.66 ± 8.71	< 0.001
Total Tissue Fat (%)	21.98 ± 8.92	16.94 ± 4.78	26.72 ± 9.54	< 0.001
Trunk Fat / Total Fat (ratio)	0.37 ± 0.04	0.35 ± 0.03	0.39 ± 0.04	< 0.001
Leg Fat / Total Fat (ratio)	0.44 ± 0.04	0.45 ± 0.04	0.44 ± 0.04	0.38
Android Fat / Gynoid Fat (ratio)	0.60 ± 0.17	0.50 ± 0.09	0.69 ± 0.17	< 0.001

Table 3

Pearson's correlations between test-meal intake, parental feeding attitudes, and BMI z-score

Variable	**Baseline *ad libitum* meal**	**High-fat meal**	**Low-fat meal**	**Palatable buffet**
Perceived child weight	0.28 *	0.30 **	0.31 **	0.33 **
Concern	0.29 **	0.31 **	0.22	0.40 ***
BMI z-score	0.33 **	0.26 *	0.24 *	0.40 ***
Baseline *ad libitum* meal	--	0.60 ***	0.56 ***	0.40 ***
High-fat meal	0.60 ***	--	0.80 ***	0.39 **
Low-fat meal	0.57 ***	0.80 ***	--	0.51 ***
Palatable buffet meal	0.40 ***	0.39 **	0.51 ***	--

* Correlation is significant at $p<0.05$.

** Correlation is significant at $p<0.01$.

*** Correlation is significant at $p<0.001$.

Table 4

Multiple linear regression model predicting perceived child weight[a]

Variable	Standardized Beta Coefficient	t-value	p - value
Parent Age (yrs)	−0.25	−2.62	0.01
Children's Sweetened Beverage Intake (kcals)	0.28	2.75	0.008
Children's Intake at the Palatable Buffet (kcals)	0.30	3.12	0.003
Trunk Fat / Total Fat	0.59	3.99	<0.001
Leg Fat / Total Fat	0.68	4.94	<0.001

[a]Adjusted R-sq for the model = 0.41; F=9.03, p<0.001

Table 5

Multiple linear regression model predicting perceived parent concern[a]

Variable	Standardized Beta Coefficient	t-value	p - value
Restriction of Feeding	0.26	3.24	0.002
Children's Sweetened Beverage Intake (kcals)	0.24	2.98	0.004
Children's Intake at the Palatable Buffet (kcals)	0.16	1.87	0.07
Android % Fat / Gynoid % Fat	0.47	5.18	< 0.001

[a]Adjusted R-sq for the model = 0.59; F=26.53, p<0.001