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Child Body Fat and Body Mass Index: Which Determinants are Most Important?

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Abstract
The purpose of this study was to examine child and parent determinants of children's body fat percentage (BF%) along with their body mass index percentile (BMIp). Children's BF% and BMIp auger lifelong health risks when elevated, and one in five children are affected. Participants (*N* = 135) included 62% female children; 50.7% Caucasian, 31.7% Hispanic, and 8.5% African American. Children were aged 9–15 years (2% underweight, 47.9% normal weight, 19.7% overweight, and 24.6% obese).

Parent BMI average was 30.67 (1.4% underweight, 20.4% normal weight, 23.9% overweight, 40% obese, and 7% extreme obesity); 77.5% of the participating parents were mothers. Following multiple imputations, path analyses were conducted of child and parent determinants of children's BF% and BMIp. Children's BF% and BMIp were related to parents' concern about overweight and children's perception of that concern. For children of overweight or obese parents, who are at highest risk for obesity, assessing the parents' concern is the highest priority.

Keywords

child body fat percentage, child body mass percentile, parent concern

High body fat percentage (BF%) and body mass index percentile (BMIp) are growing issues (Skinner, Ravanbakht, Skelton, Perrin, & Armstrong, 2018) affecting 13.7 million children and adolescents (Centers for Disease Control and Prevention [CDC], 2019). Because the most salient determinants have not been identified (Butler, Derraik, Taylor, & Cutfield, 2018), the consequences of high BF% and high BMIp continue. BMIp ranges for underweight, normal, overweight, and obesity in children are provided by the CDC (2018a). The most recent published bioelectric impedance BF% ranges for children are provided by McCarthy, Cole, Fry, Jebb, and Prentice (2006).

High BF% was associated with lower reading fluency and comprehension in 6- to 8-year-old children (Haapala et al., 2018), as well as femoral intima media thickness and high-density lipoprotein-cholesterol in adolescents (Cayres et al., 2017). As children transition into adulthood, BF% is a risk factor for left atrial enlargement, stroke, poor survivability after myocardial infarction, and atrial fibrillation (Katulska et al., 2013). Body fat is linked with cancer (Song et al., 2015), inflammation and cognitive deficits (Erion et al., 2014), asthma (Forno et al., 2014), and periodontal disease (Irigoyen-Camacho et al., 2014).

Children of overweight or obese parents have a higher risk for adiposity (Steffen et al., 2013). The assessment of BF% has been recommended as a better index of health risk in children, than only using BMIp (Craig, Reilly, & Bland, 2013). Accordingly, similarities and differences in parent and child determinants of BF% and BMIp were examined in the current study.

Determinants of Child BF% and BMIp

As shown in Figure 1, parent and child determinants of child BF% or BMIp were examined in the present study. Parent determinants included: authoritative parenting, parent body mass index (BMI), diet, eating behaviors, self-efficacy, and stress. Child determinants included: their intake, physical activity, perceptions of parenting practices, and their perceptions of support related to food and activity.

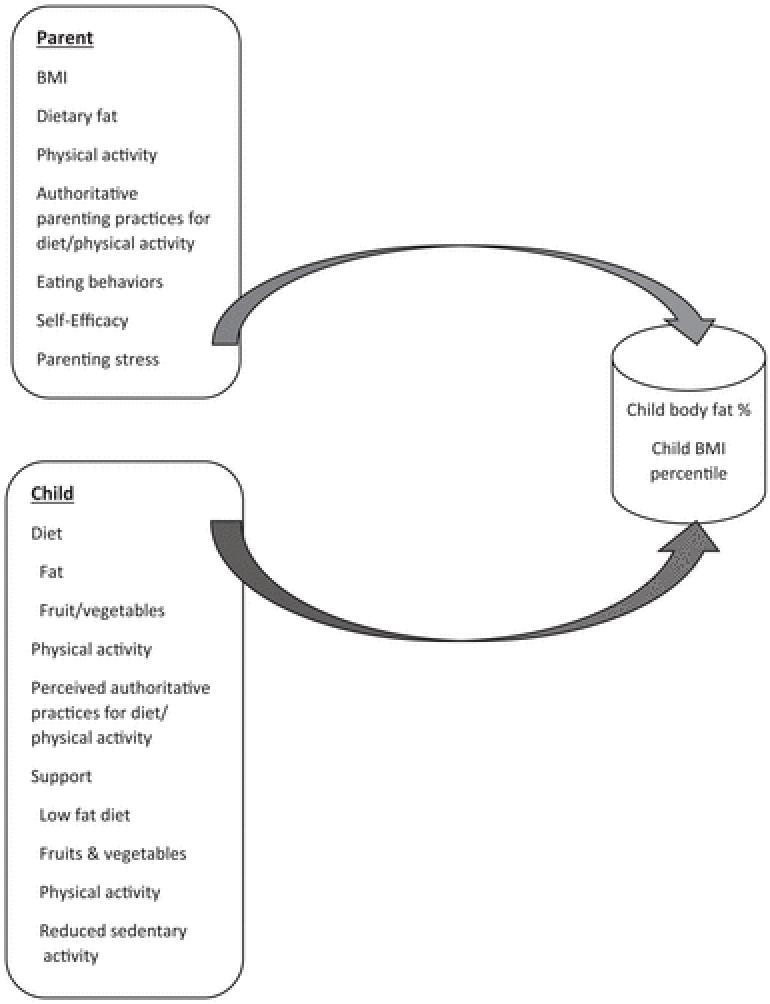

Figure 1. Conceptual framework: Do parent and/or child antecedents relate to child body fat percentage?

Authoritative parenting has been found to be associated with smaller gains in BMI and lower likelihood of overweight/obesity (Sokol, Qin, & Poti, 2017). Yet among parents with lower income and of historically disenfranchised racial/cultural groups, the use of authoritarian or permissive parenting strategies was associated with higher child body mass percentile (Loth, MacLehose, Fulkerson, Crow, & Neumark-Sztainer, 2013). The relationships of children's BF% and parenting variables as perceived by parents and children have not been reported, nor have they been examined along with children's BMIp.

Other parental variables that have been associated with children's weight-related behaviors include the parent's body mass index (BMI), diet (Santiago-Torres, Adams, Carrel, LaRowe, & Schoeller, 2014), eating behaviors, self-efficacy (Jago, Wood, Zahra, Thompson, & Sebire, 2015), and stress (Hughes, Power, Liu, Sharp, & Nicklas, 2015), but relationships to child BF% and BMIp have not been examined.

Thus, it was important to examine these variables, along with children's intake (Liu, 2013), physical activity (Brewer, Olson, & Sunehag, 2017), perceptions of parenting practices (Kim et al., 2008), and support related to food and activity (Williamson et al., 2012). Since lower physical activity increased BF% more in girls (Majid et al., 2016), examining possible gender differences in determinants also was necessary.

Purpose

Accordingly, the purpose of this study was to examine child and parent determinants of children's BF% along with their BMIp. Specifically, the research questions were:

1. Do children's dietary fat, fruit and vegetable intake, physical activity, perceptions of authoritative parenting, or support have a significant ($p < .05$) relationship with their BF% or BMIp?
2. Do parents' BMI, dietary fat, physical activity, authoritative parenting, eating behaviors, self-efficacy, or parenting stress have a significant ($p < .05$) relationship with their child's BF% or BMIp?
3. When combined, what child and parent determinants have a significant relationship with children's BF% or BMIp?
4. What child and parent determinants have a significant relationship with boys' BF% or BMIp?
5. What child and parent determinants have a significant relationship with girls' BF% or BMIp?
6. For parents who are overweight or obese, what child and parent determinants have a significant relationship with children's BF% or BMIp?

Methods

A correlational design was used to examine the research questions.

Study Sample

A convenience sample of 135 4th to 8th grade children and a parent was recruited by trained research personnel at multiple sites while completing paperwork prior to the start of school, by flyers sent home with students, posters at area YMCAs, and workplace health fairs. Those agreeing to participate were predominately from nine public and private schools or after school programs serving low- and middle-income culturally diverse families. Following review for protection of human subjects, parents providing consent and children providing assent completed measures.

The minimum sample size for power of .80, type I error of .05, and a medium effect size of .15 with 14 predictors in a multiple regression model was determined to be 135 (Buchner, Erdfelder, Faul, & Lang, 2017). This allowed for parent and child data to be analyzed separately, combining data from both in a subsequent regression. This power analysis is equivalent to the power for a single outcome in the posterior method use of path analysis, including multiple outcomes in the same model. Participant characteristics are presented in Table 1.

Table 1. Child and Parent Demographic Characteristics.

	n (%)	*M* (*SD*)
Child gender (female)	88 (62.0%)	
Child age (years)		10.8 (1.6)
Child's race/ethnicity		
White	72 (50.7%)	
Hispanic	45 (31.7%)	
African-American	12 (8.5%)	
Other	7 (4.9%)	

Child weight status Underweight (BMIp < 5)	3 (2.1%)	
Normal weight (BMIp 5–84.99)	68 (47.9%)	
Overweight (BMIp 85–94.99)	28 (19.7%)	
Obese (BMIp > 95)	35 (24.6%)	
Parent age (years)		38.94 (6.64)
Parent BMI		30.67 (6.63)
Parent weight status		
Underweight (BMI <18.49)	2 (1.4%)	
Normal weight (BMI 18.5–24.99)	29 (20.4%)	
Overweight (BMI 25–29.99)	34 (23.9%)	
Obese (BMI 30–39.99)	57 (40.0%)	
Extremely Obese (BMI >40)	10 (7%)	

Measures

Research assistants were trained on data collection procedures for all measures and monitored by the principal investigator throughout data collection. BMI for parents and percentile (BMIp) for children as well as BF% (measured with the Omron HBF-306C hand-held bioimpedance monitor) were measured in privacy without shoes or jackets. Weights to the nearest tenth of a pound were collected using a Seca model 8761321004 scale. Heights in stocking feet were measured to the nearest hundredth of an inch with a stadiometer (Seca Model 213, Hanover, MD, USA). BMI for adults was categorized using the CDC (2018b). BMIp for children was calculated using the school algorithm including birth date, measurement date, height, and weight (CDC, 2018a).

Percentage Energy from Fat Screener

Parents completed this 15-item scale (Thompson et al., 2007) with eight response options “Never” to “Twice or more per day” regarding the frequency for 13 types of foods eaten over the last year and to characterize their diet as high, medium, or low in fat. Percentage of dietary fat intake was calculated with an algorithm as a summated score that has correlated consistently with a 24-hour diet history (Williams et al., 2008). The algorithm was based on portion size estimates and regression coefficients from the US Department of Agriculture’s 1994–96 Continuing Survey of Food Intakes by Individuals. Dietary fat percentage, along with fruits and vegetables consumed, were used as indicators of diet quality. In a 12-month study no difference was found for reduced fat or carbohydrate diets relative to body weight (Gardner et al., 2018).

International Physical Activity Questionnaire (IPAQ)

Parents completed the International Physical Activity Questionnaires’ (IPAQ) 7-item questionnaire regarding the number of days and minutes spent in vigorous or moderate intensity activity in the past seven days. Among adults, the IPAQ demonstrated good repeatability, high content validity, and fair to moderate criterion validity with an accelerometer (Craig et al., 2013).

Parenting Stress Index/Short Form PSI

The Short Form-SF (Lee, Gopalan, & Harrington, 2016) assesses parents’ perceptions of stress. Respondents answer each of 36 items by indicating one of the following responses: Strongly Agree, Agree, Not Sure, Disagree, or Strongly Disagree. Higher scores represent higher levels of parenting stress. The three-factor structure has been confirmed with predominately African-American and Latino parents of children with behavior problems (Lee et al., 2016). Internal consistency for the total score in the current study was α = .92.

Multicultural Inventory of Parenting Self-Efficacy (MIPSE)

Consistent with previously published research (Mauricio et al., 2014), 10 items from the original 17-item MIPSE assessed perceived parenting self-efficacy. Parents indicated their perceived competence at each task by responding to a 5-point Likert scale ranging from 1 (not good at all) to 5 (very good). Three parenting dimensions were assessed: warmth (3 items), teaching/providing guidance (4 items), and positive control (3 items). Higher scores indicate greater overall parenting self-efficacy. Internal consistency for a total score was .87 in the current study.

Parental Confidence

Parent confidence in making obesity-related changes for their child or family was assessed with six questions (Taveras, Mitchell, & Gortmaker, 2009). Parents were asked to respond to the following prompt, "Please tell me how confident you are that you can do the following things," for six items: change family eating patterns, change family activity patterns, limit child's television viewing, reduce child's intake of sweetened drinks, remove the television from the child's room, and reduce child's intake of fast food. Respondents indicated their answers on a 4-point Likert scale (i.e., "not confident" to "extremely confident"). A total score was calculated (ranging from 0 to 24) with higher scores indicating a higher level of parental confidence. Internal consistency for the total score in the current study was .82.

Eating Inventory (formerly the Three Factor Eating Questionnaire)

The TFEQ-R18V2 (Cappelleri et al., 2009) assessed three domains of parent eating behavior: cognitive restraint, uncontrolled eating, and emotional eating. Respondents answered each of 18 items on a 4-point Likert scale. Reliability and validity have been previously reported for the TFEQ-R18V2 (Goldstein et al., 2014). In this study, subscale internal consistencies were as follows: α = .88 for the 9-item Uncontrolled Eating subscale or α = .57 if the reverse coding specified by Capelleri et al. (2009) was used; α = .77 for the 5-item Emotional Eating subscale; and α = .73 for the 3-item Cognitive Restraint subscale.

Food/Activity Parenting Practices Questionnaire (FAPPQ): Parent and child versions

This 45-item instrument has a Likert five-response format including 10 subscales (Frenn, Heinrich, Dohmen, & Pruszynski, 2011). Confirmatory factor analysis has been demonstrated with parents of adolescents (Kaur et al., 2006). In this study, reliability coefficients for the parent scale included their perceived Concern about Child Overweight α = .85; Responsibility for Child Feeding α = .77; Pressuring Child to Eat α = .74; Monitoring of Child Food α = .75;

Encouragement to Exercise α = .61; Control of Child Exercise α = .69; Own Weight Concern α = .87; and Own Weight Control α = .80. Parent Perceived Restriction of Sweets, High Fat, or Favorite Foods had low internal consistency (α = .33) as did Control of Child Eating α = .45, so these were not included in analyses.

In this study, reliability coefficients for the child scale included their perceived Concern About Own Weight α = .84; Control of Weight and Eating α = .71; Responsibility for Eating α = .57; Parent Concern

About Their Eating and Weight α = .89; Parent Responsibility for Child Eating α = .62; Parent Food Monitoring α = .81; Parent Food Guidance α = .81; Parent Pressure to eat α = .59; Parent Food Control α = .65; Parent Exercise Monitoring and Support α = .67; and Parent Exercise Control α = .71. Child Perceived Parental Encouragement to Exercise had a low internal consistency α = .44, so it was not included in analyses.

PACE Dietary Fat, Physical Activity, and Family Support scales

Children completed the 21-item (Prochaska, Sallis, & Rupp, 2001) recall of foods eaten in the last week that correlated significantly with percentage of calories from fat ($r = 0.36$, $p < .01$) in a sample similar to the current study. Internal consistency in this study for the total score was α = .71. The average of two items completed by the child assessing seven-day physical activity (Prochaska, Sallis, & Long, 2001) was used. A moderate correlation with an accelerometer ($r = .44$, $p < .001$) was reported for a sample similar to the current study.

Children also completed the 16-item PACE Family Support scale that had five option response choices regarding how often during a typical week a member of their household (e.g., father, mother, brother, sister, grandparent, or other relatives) provided support for reducing dietary fat, eating fruits and vegetables, engaging in physical activity, and reducing sedentary activity (Sallis, Grossman, Pinski, Patterson, & Nader, 1987). The scales were shown by Sallis et al. (1987) to correlate with physical activity and diet and to have acceptable test-retest and internal consistency. Subscale reliability coefficients in the current study were Dietary Fat Reduction α = .71; Fruit and Vegetable Consumption α = .78; Physical Activity α = .76; and Sedentary Activity Reduction α = .79. The mean of all the subscales was used for analyses.

Analysis

Cronbach's alpha was computed for survey measures. Measures and subscales with acceptable levels of internal consistency (as reported above with each instrument) were included in regression analyses. Child BF% and BMIp were the dependent variables.

Analyses were completed using multiple imputation (Harel et al., 2018; van Buuren, 2012). One hundred imputations were done with chained equations following the Fully Conditional Specification (FCS), which allows imputation of multivariate data without the assumption of multivariate normality (van Buuren, 2012). The percentage of missing data had a median of 17% and ranged from 0 to 86% across the full data set. To evaluate the effect of missing data in the analysis, Fraction of Missing Information (FMI) was evaluated as well, which represents the proportion of loss of information in the analysis due to missing data (Enders, 2010). The highest FMI present in the analysis was 30%, meaning that in the worst-case scenario, 30% of the information for one parameter is lost due to missing data, also indicating that the FMI process recovers at least 70% of the information.

Imputations were done with R (R Core Team, 2018) package mice (van Buuren & Groothis-Oudshoorn, 2011). Path analysis was used to analyze the data (Kline, 2016), which allowed for inclusion of multiple predictors and multiple outcomes in the same comprehensive model. Path analysis increases the power for testing relations to multiple outcomes, as well as accounts for the conditional relations between them. A build-up approach was used for each outcome variable. As an exploratory process, predictors were added one at a time, and decisions were made to either keep or exclude each predictor for each of the 20 possible predictors. This way the model never included all the predictors at once, and only the predictors that were evaluated as relevant were kept in the final model that is presented.

Path analysis was done with the R packages lavaan (Rosseel, 2012) and semTools (Jorgensen, Pornprasertmanit, Schoemann, & Rosseel, 2018). The standardized regression slope is presented as a measure of effect size. When testing for an interaction between predictors, once we established that the interaction was different from 0 ($p < .05$) we tested for simple slopes, looking at the relation between the focal predictor and the outcome at different levels of the moderator predictor. These slopes were also plotted (Darlington & Hayes, 2017).

Results

Sample demographics (Table 1) were representative of the city and county where data were collected in terms of race/ethnicity. Instrument means and standard deviations are shown in Table 2 and results for research questions (RQ) in Table 3.

Table 2. Child and parent descriptive information.

	Minimum	Maximum	Mean	Std. Deviation
Child				
Body fat percentage	5.00	48.80	28.87	8.55
Physical activity (days of 60 minutes or more)	0	7	3.87	2.09
Dietary fat percentage	3.00	58.00	18.134	8.50
Fruit per day	0	>4	2.36	1.06
Vegetables per day	0	>4	2.08	1.10
Pace family support				
Dietary fat reduction	1.00	5.00	2.71	1.00
Vegetables and fruit	1.25	5.00	3.69	1.02
Physical activity	1.25	5.00	2.88	.94
Reduce sedentary activity	1.00	5.00	3.21	1.13
Food/Activity Parenting Practices Questionnaire (FAPPQ)				
Child concern about own weight	1.00	5.00	2.67	1.22
Child perceived control of weight	1.00	4.33	3.08	.77
Child perceived parent concern	1.00	5.00	2.67	1.37
Child perceived parent monitoring	1.63	5.00	3.57	.82
Child perceived parent food responsibility	1.40	5.00	3.48	.79
Child perception of parent pressure to eat	1.00	5.00	2.95	.95
Child perceived parent control of child eating	2.00	5.00	3.56	.87
Child perceived parent exercise monitoring and support	1.00	5.00	3.66	.91
Child perceived parent exercise control	1.00	5.00	3.26	1.05
Parent				
Body fat percentage	12.70	48.90	34.10	7.59
Physical activity average daily minutes	0	150.00	34.75	37.71
Dietary fat percentage	21.35	34.94	29.25	2.34
Fruit per day	0	>4	1.74	1.04
Vegetables per day	0	>4	1.99	.936
Food/Activity Parenting Practices Questionnaire (FAPPQ)				
Parent concern child overweight	1.00	5.00	2.65	1.35
Parent responsibility for child feeding	2.00	5.00	3.86	.66
Parent pressuring child to eat	1.00	5.00	2.49	.98
Parent monitoring child food	1.00	5.00	3.53	.91
Parent perceived encouragement of child exercise	1.00	5.00	3.467	.91
Parent control child exercise	1.00	5.00	2.94	.87
Parent own weight concern	1.00	5.00	3.19	1.21
Parent own weight control	2.00	4.75	3.27	.461
Parenting stress	95.00	178.00	146.86	17.88

Eating inventory				
Uncontrolled eating	13	34	26.09	4.30
Cognitive restraint	3	12	7.81	2.06
Emotional eating	6	24	18.48	4.66
Multicultural Inventory of Parenting Self-Efficacy	3.10	5.00	4.11	.499
Parent confidence	1.00	4.00	3.29	.59

Table 3. Results.

RQ1. Children's antecedents with a significant (*p* < .05) relationship to their body fat percentage (BF%) or BMIp			
	Estimate (SE)	*p*-value	standardized
Child BF% R^2 = 0.188			
Child perceived control of weight and eating	–0.672 (0.337)	0.047	–0.181
Child perceived parent concern about their eating and weight	0.736 (0.198)	< .001	0.336
Child BMIp R^2 = 0.229			
Child perceived control of weight and eating	–3.048 (1.167)	0.009	–0.231
Child perceived parent concern about their eating and weight	2.708 (0.686)	< .001	0.348
RQ2. Parents' antecedents with a significant (*p* < .05) relationship to their child's BF% or BMIp			
	Estimate (SE)	*p*-value	standardized
Child BF% R^2 = 0.190 Parent concern about child overweight	2.421 (0.548)	< .001	0.363
Parent pressuring child to eat	–1.665 (0.753)	0.027	–0.182
Child BMIp, R^2 = 0.295 Parent concern about child overweight	9.555 (1.814)	< .001	0.404
Parent pressuring child to eat	–7.720 (2.492)	0.002	–0.237
Parent perceived own weight	12.903 (4.743)	0.007	0.193
RQ3. Child and parent antecedents with a significant relationship to children's BF% or BMIp			
	Estimate (SE)	*p*-value	standardized
Child BF%, R^2 = 0.262 Child perceived parent concern about their eating and weight	0.734 (0.176)	< .001	0.336

Child physical activity (days of 60 minutes or more)	–0.816 (0.323)	0.012	–0.197
Parent pressuring child to eat	–1.599 (0.728)	0.028	–0.175
Parent control child exercise	1.941 (0.795)	0.015	0.188
Child BMIp, R^2 = 0.355			
Child perceived parent concern about their eating and weight	1.780 (0.651)	0.006	0.232
Child perceived control of weight and eating	–1.978 (1.005)	0.049	–0.153
Parent concern about child overweight	5.136 (1.928)	0.008	0.220
Parent pressuring child to eat	–7.842 (2.399)	0.001	–0.244
Parent perceived own weight	11.085 (4.689)	0.018	0.168
RQ4. Child and parent antecedents with a significant relationship with boys' BF% or BMIp			
	Estimate (SE)	*p*-value	standardized
Child BF% R^2 = 0.251			
Child perceived parent concern about their eating and weight	1.018 (0.374)	0.007	0.390
Parent control child exercise	2.884 (1.583)	0.069	0.255
Child BMIp R^2 = 0.322			
Child perceived parent concern about their eating and weight	2.449 (1.218)	0.044	0.304
Parent concern about child overweight	8.230 (3.383)	0.015	0.360
RQ5. Child and parent antecedents with a significant relationship to girls' BF% or BMIp			
	Estimate (SE)	*p*-value	standardized
Child BF% R^2 = 0.216			
Child perceived parent concern about their eating and weight	0.501 (0.234)	0.032	0.254
Parent concern about child overweight	1.812 (0739)	0.014	0.291
Child BMIp R^2 = 0.321			
Child perceived parent concern about their eating and weight	1.882 (0.866)	0.030	0.249
Child perceived control of weight and eating	–2.778 (1.427)	0.052	–0.203
Parent concern about child overweight	5.473 (2.704)	0.043	0.230
Parent pressuring child to eat	–6.648 (3.022)	0.028	–0.207

RQ6. For parents who are overweight or obese: The slope of parent concern about child eating and weight on child BF% at different levels of parent BMI		
Parent BMI	Slope (SE)	*p*
Below 18.5 Underweight	1.568 (1.249)	0.245
18.5–24.9 Normal or Healthy Weight	2 0.220 (0.928)	0.812

25.0–29.9 Overweight	3 2.008 (0.861	0.020
30.0 and Above Obese	4 3.796 (1.207)	0.002

RQ1. Does children's dietary fat, fruit and vegetable intake, physical activity, perceptions of authoritative parenting, or support have a significant ($p < .05$) relationship with their BF% or BMIp?

Children's dietary fat, fruit and vegetable intake, physical activity, nor social support were significantly related to their BF% or BMIp. Child perceived control of their weight and eating was associated with lower BF% and BMIp. The child's perceived parental concern about the child's weight was associated with higher BF% and higher BMIp; as children's perceived parental concern increased by one standard deviation, BF% increased by 0.336 standard deviations, and BMIp increased by 0.349 standard deviations (Table 3).

RQ 2. Does parents' BMI, dietary fat, physical activity, authoritative parenting, eating behaviors, self-efficacy, or parenting stress have a significant ($p < .05$) relationship with their child's BF% or BMIp?

Parent BMI, BF%, dietary fat, average daily physical activity, fruit and vegetable intake, parental stress, eating behaviors, nor confidence were related to the child's BF% or BMIp. More concern about the child's weight and less pressuring of the child to eat were related to higher BF% and BMIp. The parent's perceived own weight was correlated with the child's BMIp.

RQ 3. When combined, what child and parent determinants have a significant relationship with children's BF% or BMIp?

The child's perceived parent concern about their weight and eating as well as the child's fewer days of 60 minutes or more of physical activity were associated with higher BF%. Greater parent control of the child's physical activity and less pressuring to eat were also associated with higher BF%.

The child's perceived control of their weight and eating was associated with lower BMIp, while perceiving their parent concern about their weight and eating was associated with higher BMIp. Higher parent concern about their child's weight and eating, the parent's own perceived weight, and less pressure on the child to eat were associated with higher child BMIp.

RQ 4. What child and parent determinants have a significant relationship with boys' BF%?

Perceived parental concern about boys' eating and overweight as well as the parents' control of the boys' physical activity were both associated with higher BF% in boys. Perceived parental concern about boys' overweight and the parents' concern about his weight were both associated with higher BMIp in boys.

RQ5. What child and parent determinants have a significant relationship with girls' BF% or BMIp?

Perceived parental concern about girls' overweight and parents' concern about girls' weight were both associated with higher BF% in girls. Perceived parental concern about girls' overweight and parents' concern about girls' weight also were both associated with higher BMIp in girls, along with less child perceived control of weight and eating and less parent pressure to eat.

RQ6. For parents who are overweight or obese, what child and parent determinants have a significant relationship with children's BF%?

Only one interaction presented as relevant, with an increase in explained variance and change in slopes by simple slopes testing. Parents' concern about child overweight in interaction with parents' BMI category was the only significant predictor of child BF% for overweight and obese parents. There were no significant relationships for child BMIp.

Discussion

Children's perceived control of their weight and eating was associated with lower BF% and BMIp, while perceiving parental concern about their eating and weight was associated with higher BF% and BMIp. It is important to examine child perspectives of parenting approaches, since those have been found to differ from and be more important than parent perspectives, but they have seldom been studied (Taylor, Wilson, Slater, & Mohr, 2011).

More days of 60 minutes or more physical activity for children was additionally associated with lower child BF% when parent perspectives were included, while greater parent control of children's physical activity was linked to higher child BF%. Physical activity has many benefits for youth (Tsiros, Samaras, Coates, & Olds, 2017). Replacing sedentary time with moderate–vigorous physical activity reduces BF% (García-Hermoso, Saavedra, Ramírez-Vélez, Ekelund, & Pozo-Cruz, 2017). The findings of the current study indicate that boys controlling their physical activity is an important consideration in reducing BF%, while girls' control of eating and weight is an important consideration for reducing their BMIp. Child self-control has been associated with less increase in BMI as children grow into adolescence (Datar & Chung, 2018).

Less parent pressure to eat was associated with higher child BF% and BMIp, particularly related to girls' BMIp. The finding that less pressure to eat was associated with higher child BF% and BMIp was contrary to other reported findings, where higher pressure has been associated with higher child BMIp (Gemmill, Worotniuk, Holt, Skouteris, & Milgrom, 2013). Much of the child feeding literature has been with parents of younger children, which may explain the difference.

Parents' perceptions of their own body weight also were significantly related to children's BMIp. Perceiving children as overweight was associated with a higher child weight, regardless of the child's actual weight, which is similar to findings that perceiving oneself as overweight results in more weight gain (Robinson & Sutin, 2016).

It was surprising that child variables including dietary fat, fruit and vegetable intake, and social support were not significant predictors of BF% or BMIp. Other research with older girls found social support was important in losing weight (Kulik, Valle, & Tate, 2015). In the current study, parents' eating style (as measured by the Eating Inventory), parental stress, and parenting self-efficacy had no relationship to children's body fat. General stressors, rather than stress specific to parenting, may be more influential in predicting children's weight status (Walton, Randall Simpson, Darlington, & Haines, 2014). Anxiety/stress was predictive of restrictive feeding practices in younger children, which is associated with higher child body weight (Swyden et al., 2017). In future research, another measure of parent self-efficacy may capture this construct better (Grossklaus & Marvicsin, 2014).

Both child and parent concern about overweight were associated with higher child body fat in the current study and with higher BMIp, similar to previous research findings (Kral, Moore, & Compher, 2015). Since parental concern was the only significant interaction for children of obese or overweight parents, these findings are particularly salient, given these children have the highest risk for overweight and obesity later in life. For parents who are concerned about their children's weight, better outcomes have been found when parents avoid criticizing their child's weight or avoid encouraging child weight loss while encouraging healthy diet and exercise (Gillison, Lorenc, Sleddens, Williams, & Atkinson, 2016). The language parents use is also important, with adolescents preferring the words "unhealthy weight" or "weight problem", instead of "heavy", "large," or "big" (Puhl & Himmelstein, 2018). The approach and language parents use is especially important since they overestimate overweight and obesity in their children (He & Fan, 2018) and girls labeled 'fat' were found to be overweight nine years later (Hunger & Tomiyama, 2014).

Body fat differs by gender, race/ethnicity, and age (Heo et al., 2014), so findings need to be interpreted with those considerations, though the purpose of this study was to examine modifiable determinants of body fat percentage and BMI percentile. Most of the parents in the current study were mothers. In terms of authoritative parenting variables, the child's perception of their mother's (as compared to father's) parenting has previously been found most related to their body fatness (Kim et al., 2008), so results could differ in a sample with more fathers. This was a cross-sectional study with a convenience sample, thus further research is needed with longitudinal designs. Notably, the sample characteristics were similar to those where data were collected. For example, the rate of overweight and obesity for the sample was similar for adults (74%) in the county where data were collected. The obesity rates where available for children (23.4%) were congruent with the zip codes from which data were collected, including a culturally diverse sample at high risk for obesity.

For children of overweight or obese parents, who are at highest risk for obesity, assessing parents' concern is the highest priority. Parents can also be helped to channel their concern authoritatively, encouraging physical activity by involving their child in making healthy choices. Parents, particularly those from historically under-represented minority groups, have reported interest in meeting with school nurses to address weight concern (Kubik & Lee, 2014). This study included children in 4th to 8th grade, but addressing weight concern with parents is important even with younger children, assuring that parents have an accurate understanding about healthy weight (Harrison, Brodribb, Davies, & Hepworth, 2018).

Children's BF% and BMIp were related to parents' concern about overweight and their children's perception of that concern. Providing options for 60 minutes or more a day while fostering boys' control of their physical activity was associated with lower BF%, while fostering girls' perceived control of their weight and eating was associated with lower BMIp. As many child and parent variables are considered, these offer the greatest relationship to children's BF% and BMIp.

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