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Factors Related to Weight Perception Accuracy among Obese Children and Adolescents at-Risk for Cardiovascular Disease

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Abstract

***Background:** Pediatric obesity has become a public health epidemic, but many overweight and obese children consider their weight normal. While having overweight or obese peers and family members further reduces the likelihood of children correctly self-identifying as overweight or obese, accurate identification of current body weight status is necessary in order to initiate behavior change and reduce risk of cardiovascular disease.*

***Objective:** The objective of this study was to explore factors related to children's and adolescents' perceptions of current body weight status.*

***Design and Participants:** This cross-sectional study included data from 117 obese children and adolescents (n=76 female, 41 male) ages 4-17 years, attending the Medical University of South Carolina's Heart Health Program.*

***Results:** Thirty-seven percent of the sample accurately categorized their weight status; accuracy did not differ by race. Older children (>11.9 y) were more likely to accurately perceive their weight than younger children (p=0.02), and older girls were more likely to be accurate than older boys (p=0.03). Relatively larger children were also more likely to accurately perceive their weight (p=0.01). Logistic regression analyses revealed that after controlling for BMI-for-age percentile, older girls had a 1.4 times higher likelihood of accurately perceiving their weight status compared to all other children (p=0.12 for the gender-by-age interaction).*

***Conclusions:** In a cohort of obese children and adolescents at-risk for cardiovascular disease, boys and younger girls were less likely to correctly identify their current body weight status. An individualized, family-centered approach should be taken during clinic visits to address children's weight status, and patient education should be focused on encouraging gradual behavior change strategies in order to improve self-efficacy, preserve health-related quality of life, and reduce cardiovascular disease risk in this population.*

Keywords: obesity, weight perception, overweight, children, adolescent, cardiovascular disease risk

Introduction

Pediatric obesity has remained a public health crisis over the past decade in the US, with 16.9% of children aged 2 to 19 years considered obese and 31.8% either overweight or obese (1). Despite obesity's prevalence and negative health consequences, previous studies have demonstrated that up to 86.3% of overweight and 62.3% of obese children believe that they are a healthy weight (2), and many obese children perceive themselves as being as healthy or healthier than normal weight children (3).

While most children seem to underestimate their

weight (4), overweight and obese children, appear to be more prone to size underestimation compared to normal weight children (4-6). Children appear to be worse at verbal interpretation of size compared to pictorial, with a demonstrated preference for describing themselves as "just right" rather than too big or too small (4). Several studies among children and adolescents have further demonstrated that overweight and obese males have lower accuracy in recognizing their own overweight status than do females (7-10). Whereas it has been reported that African American girls, as well as overweight and obese girls, tend to choose larger ideal body images (6,11), no cultural or ethnic differences have been reported in children's accuracy of weight perception (10). The objectives of the current study were to 1) examine children's perceptions of their current body weight status, 2) assess the accuracy of those perceptions, and 3) explore differences in perceptions and accuracy by demographic characteristics. Understanding these relationships could help improve upon existing or develop new clinical strategies for weight management and cardiovascular disease prevention in children and adolescents.

Methods

Study Design and Participants

This cross-sectional analysis included 117 obese children between the ages of 4 and 17 years attending the Medical University of South Carolina's Heart Health Program. Children were recruited from the Heart Health Program into the Pediatric Metabolic Syndrome Study (PMSS) from 2009-2014, which has been previously described (12). This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human patients were approved by the Institutional Review Board of the Medical University of South Carolina. Written, informed parental consent and subject assent (based on child age, <18y) were obtained from all participants at the first study visit.

Demographic characteristics including child age, self-reported race, and self-reported ethnicity were documented at an initial visit. A Registered Dietitian-Nutritionist (RDN) or trained research assistant administered a Lifestyle Questionnaire that included questions about feeding history, current health behaviors, eating habits, and activity patterns. Both the child and the parent were present during the consent and administration of the Lifestyle Questionnaire for all children <18y. While all questions were directed towards the child, the parent was allowed to answer if the child was unable or unwilling to do so. All answers were recorded by the RDN verbatim in the electronic medical record.

Child perceptions of current body weight status and other questions about body size, food intake and physical activity **relative to their peers** were asked as part of the Lifestyle Questionnaire and are shown in **Table 1**.

Table 1. *Categorical data collected about child and adolescent perceptions as part of Lifestyle Questionnaire during initial visit*

	Variable
"Do you think you weigh the right amount, are somewhat overweight, or are very overweight?"	Current weight perception accuracy
"Compared to your friends, are you about the same size, a little heavier, or a lot heavier?"	Relative body size perception
"Compared to your friends, do you usually eat less, about the same, or more?"	Relative food intake
"Compared to your friends, are you usually less active, about the same, or more active?"	Relative physical activity

Energy Intake and Expenditure Data

Dietary intake was also assessed within one month of the initial visit using the *Block Kids 2004 Food Frequency Questionnaire* (FFQ). Children and adolescents self-reported their dietary intake using the semi-quantified FFQ adapted for children, as previously described (12,13). Macronutrient and energy intakes were obtained from the FFQs. Resting energy expenditure was estimated using the Harris-Benedict equation, which takes into account height, weight, age, and gender (14).

Anthropometric Measurements

Within 28.0±35.7d of the initial visit, anthropometric measurements were taken by trained clinical staff, including height and weight measured in street clothes and stocking feet, using a wall-mounted stadiometer and a medical grade digital scale, respectively (both Seca, Hamburg, Germany) (15). BMI was calculated and used to determine the patient's percent of the 95th percentile for BMI-for-age and gender, per CDC growth charts (16). The subjects were grouped by the median of 134.0% of 95th percentile BMI-for-age. Children's severity of obesity index (SOI) was calculated as BMI (kg/m^2) at the time of the survey divided by the corresponding BMI at the 95th percentile, which has been described previously (17-19). Waist and hip circumference measurements were also taken using standardized methods, and waist:hip ratio (WHR) was calculated for all participants (15).

Statistical Analysis

Descriptive analyses were performed to summarize child demographic information. Continuous variables were normally distributed, and differences in continuous variables were examined using ANOVA, and in categorical variables using χ-square tests and logistic regression models. We used Pearson's correlations to examine associations between continuous variables and Spearman's *rho* correlations to examine associations between categorical variables. Significant relationships were controlled for in all future analyses. In addition to gender, subjects were grouped by the median age of 11.9 years. This was considered a suitable age of division based on both the demographics of the sample, as well as the age characteristics proposed by Piaget's theory of psychosocial development (20).

To examine the relationship between current body weight status perceptions and other main variables, child weight perception accuracy was coded as "accurate" or "inaccurate". Those who reported their perceived weight category as "a lot overweight" were coded as "accurate," and those who reported their perceived weight category as "weigh the right amount" or "somewhat overweight" were coded as "inaccurate", as all children in this study were at or above the 95th percentile BMI-for-age (equivalent to adult BMI $\geq$30 kg/m^2, or obese). T-tests were conducted between "accurate" and "inaccurate" perceivers in terms of all variables measured.

All analyses were conducted using SPSS statistical software version 24 (IBM, Armonk, NY). For main effects, a p-value <0.05 was considered statistically significant, and for interaction effects, $p<0.20$ was considered statistically significant. The PMSS was originally-powered to detect differences in fasting insulin levels between black and white subjects, as previously described (12), however, the current study is a descriptive analysis of baseline data.

Results

Characteristics of our participants are presented by gender and median age group in **Table 2**. The majority of the total sample (n=117) was non-Hispanic (93.2%), black (61.2%) and female (65%). Both waist circumference and WHR were larger in boys compared to girls (p=0.01 and 0.001, respectively). There were no significant differences between girls and boys in age, SOI, race, or ethnicity.

Table 2. *Demographic and anthropometric characteristics of a cohort of 117 obese children and adolescents at-risk for cardiovascular disease, mean ± SD or %*

	Girls N=76		**Boys N=41**		**Total Sample N=117**
	<11.9 y N= 39	**>11.9 y** N= 37	**<11.9 y** N= 19	**>11.9 y** N=22	---
Race (%) *Black*	50.0	62.0	63.2	67.0	62.0
White	50.0	38.0	37.0	33.0	38.0
Ethnicity(%)*Hispanic*	5.2	2.7	10.5	13.6	6.8
Non-Hispanic	95.8	97.3	89.5	86.4	93.2
Age (y)	9.0±1.7	14.7 ± 1.8	10.0±1.2	14.4 ± 1.7	12.0 ±3.1
BMI-for-age (% of 95th percentile)	134.0±25.1	139.8±22.3	136.5 ±15.5	141.5 ± 22.5	137.6 ±22.4
Severity of Obesity Index (SOI)	1.34±0.25	1.40±0.22	1.37±0.16	1.42±0.23	1.38±0.22
Waist circumference (cm)	82.5±10.4	101.7±20.4	91.8±10.0	107.6±13.0	94.8±17.6
Hip circumference (cm)	95.3±12.5	122.512.5	99.8±9.9	118.3±11.2	108.9±17.0
Waist: Hip Ratio (WHR)	0.87±0.05	0.83±0.15	0.92±0.09	0.91±0.07	0.87±0.10
Est. resting energy expenditure (REE, kcal)	1445±205	1856±203	1672±235	2210±330	1756±362
Energy intake(kcal, from FFQ)	1401±488	1304±459	1342±492	1377±632	1356±505
Total Physical Activity (minutes/day)	169±123	103±70	177±120	170±134	152±116

There were no differences between boys and girls in estimated energy or macronutrient intakes, or self-reported total physical activity time. Boys reported significantly more "outside" activity time compared to girls (93.2±100.8 vs 87.7±55.6 min/d, p=0.03). There were no significant differences between older and younger children in SOI, waist: hip ratio, energy or macronutrient intakes, total physical activity time. Younger children reported less "exercise" time compared to older children (36.1±35.3 vs 57.2±44.4 min/d, p=0.01).

Table 3 shows the distribution of current weight perception and accuracy by gender and median age group. Thirty-seven percent of the sample accurately categorized their weight status as "very overweight." Accuracy did not significantly differ by race or ethnicity. Older children (>11.9 y) were more likely to perceive their weight status accurately (p<0.001), and older girls were more likely to be accurate than older boys (p=0.03). Accurate children (n=43) had larger waist (p=0.003) and hip (p<0.001) circumferences, and tended to have higher SOI (p=0.14) compared to inaccurate children (n=73). There were no significant differences in WHR, estimated energy or macronutrient intakes, or reported physical activity time between accurate and inaccurate children.

Table 3. *Current weight perception (% response) in a cohort of obese children and teens at-risk of cardiovascular disease*

	Girls N=75		**Boys N=41**		**Total Sample N=116**
	<11.9 y N=38	**>11.9 y** N= 37	**<11.9 y** N= 19	**>11.9 y** N= 22	
Perception of current weight status (% response)					
Weight is the right amount	5.3	4.5	15.8	0	5.2
Somewhat overweight	68.4	68.2	57.9	40.5	57.8
Very overweight (ACCURATE weight status perception)	**26.3**	**27.3**	**26.3**	**59.5**	**37.1**

Weight perception accuracy was correlated with several markers of cardiovascular disease risk. Absolute body size (% 95th percentile BMI-for-age, r=0.23, p=0.01), SOI (r=0.19, p=0.04), measured hip (r=0.34, p<0.001) and waist circumferences (r=0.26, p=0.004) were each positively related to weight perception accuracy, as larger children were more likely to accurately perceive their weight as "very overweight".

Additionally, relative body size perception was correlated with accuracy (r=0.96, p <0.001), as those who identified themselves as "a lot heavier" than their peers were more likely to correctly identify themselves as "very overweight." While estimated caloric intake was not correlated with weight perception accuracy, relative body size perception was positively correlated with relative food intake (r=0.22, p=0.02), regardless of accuracy. While relative physical activity relative was not related to relative food intake, total physical activity time was correlated with absolute body size (r=0.30, p=0.002), as heavier children reported more total physical activity time.

Using logistic regression analyses, belonging to the higher BMI-for-age percentile category (>134.0%, β=1.04, p=0.02) significantly increased the log odds of accurately perceiving current body weight status. As shown in **Figure 1**, final logistic regression analyses revealed that after controlling for BMI-for-age percentile, older girls had a 1.4 times higher likelihood of accurately perceiving their current weight status, compared to all other children (p=0.12 for the gender-by-age interaction).

Given the prevalence of pediatric obesity in the United States, as well as its long-term effects on cardiovascular and other health outcomes, it is imperative that new and targeted strategies are developed in order to prevent and reverse this epidemic (21). A logical first step is to help obese individuals recognize their negative health status in order to motivate behavior change, as it has been previously shown that children who underestimate their weight were about three times less likely to attempt weight control methods compared to those who had accurately perceived their weight (22,23).

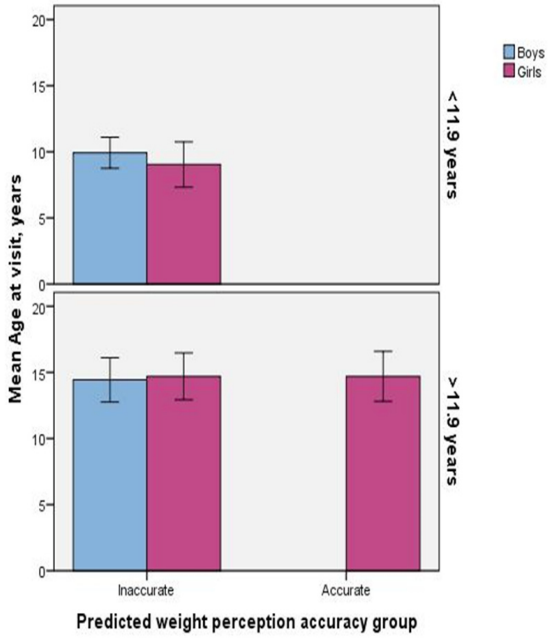

Figure 1. *Predicted accuracy of current body weight status perception (adjusted for gender, age, BMI-for-age percentile) in a cohort of obese children and teens at-risk for cardiovascular disease*

Discussion

In the current study, we found that 63% of obese children and adolescents incorrectly perceived their own weight status as "soewhat overweight" or "the right amount", which is similar to a recent estimate of 68% in a nationally-representative sample of 14y olds (24). The trends of underestimation and the tendency for girls to be more accurate in their perceptions has been well-documented (2,5-8,10,23,25,26). In our study, 43% of girls accurately perceived their weight compared to 27% of boys (Chi-square = 0.09 between genders), which is similar to observations in adults (27), and suggests that girls are more aware of their body shape, size and weight, likely because of social and cultural cues.

We did find that older girls in our study demonstrated a better recognition of their own weight status than any other subgroup, with 59.5% of girls over 11.9y correctly describing themselves as "very overweight." This concurs with a nationally-representative study reporting that 33% of children ages 8-11y were significantly more likely to misperceive their own weight status compared to 27% of teens (12-15y)

(25). These findings correspond with Piaget's theory of psychosocial development, in which children enter the formal operational stage of development around 11-12 years of age, during which they become able to think abstractly. This ability could be significant in children's ability to recognize their own body shape/size *relative* to a norm or their peers (who may or may not have been obese). Our younger, "inaccurate" group, 73.7% of children <11.9y, illustrate this theory.

Despite McHiza's finding that African American girls have a larger ideal body image compared to other ethnic groups (11), and that the prevalence of weight status misperception has been shown to be lower among white compared to black children (25), we did not find any such differences in perceptions between races or ethnicities, which is similar to the findings of Viner et al (10). We did find, however, that while SOI was similar for blacks and whites (1.38±0.22), WHR was significantly greater in white compared to black children (0.90±0.08 vs. 0.85±0.11, p=0.007).

These findings could be due to our smaller sample size, and the fact that we had more girls than boys in our sample. Furthermore, while research has indicated that obese girls have larger ideal body images compared to normal weight girls (7), we found that relatively larger children were more accurate compared to relatively smaller children, suggesting that ideal body image (which was not assessed in this study) does not affect accuracy of current body image perception. This dynamic could also be due to our relatively homogeneous sample. Since we had no normal weight children in this cohort, the only comparisons that can be drawn exist between relatively more or less obese children. This finding may also be the result of the medical intervention program in which the children were participating (Heart Health Program), or simply the nature of weight-related bullying. More severely-obese children may have been repeatedly told of their obesity status compared to less obese children, either by medical professionals, their family, or peers.

An interesting finding was that heavier children reported greater total physical activity time. Relative to their peers, 69% of girls and 43% of boys reported being as physically active as their peers, and 5% of girls and 17% of boys reported being more physically active compared to their peers. These children also reported their usual physical activity levels as being low, medium or high, and 73% of girls and 78% of boys reported their usual physical activity levels as medium or high (Chi-square = 0.06 between genders). In a similar cohort of children participating in a weight management program (17) we found that many obese children were participating in group sports / physical activities, but it was higher amounts of *family*-centered physical activities and lower amounts of screen time (<2h/d) that were related to lower SOI (better weight status). Sixty-two percent of our accurate children reported being as or more active than their peers, compared to 74% of our inaccurate children (Chi-square = 0.24), and 60% of the accurate children reported medium to high usual physical activity levels compared to 83% of the inaccurate children (Chi-square = 0.02), which could be due to over-reporting of physical activity in the inaccurate group.

We did find that relative body size perception was positively correlated with estimated caloric intake (13), and that estimated caloric intake was positively correlated with relative food intake. These findings suggest that obese children who tend to eat more may recognize the fact that they *do* eat more relative to their peers, and they also perceive themselves as larger in body size relative to their peers. Although we do not have information about our participants' peer groups' food intakes and body sizes at the time of the study, it does suggest that obese children may be able to *relatively* accurately assess their food intakes.

Given previous findings that overweight and obese youths who think their weight is "about right" have a higher health-related quality of life (HRQoL) compared to those who know or were told their weight is abnormal (5), weight management strategies related to behavior change (e.g. decreasing the portion sizes of foods and drinks; increasing physical activity time) rather than absolute body size (e.g. pounds and inches lost) may be more effective strategies that preserve HRQoL.

Strengths of this study include our use of measured height and weight, and our racially diverse, yet anthropometrically and metabolically homogeneous

sample that is representative of children and teens at-risk for cardiovascular disease and / or being treated for overweight and obesity in the US and worldwide. It is likely that relative perceptions of body weight and size, food intake, and physical activity of other populations of obese children and teens would be similar.

Limitations of this study include the nature of secondary data analyses, social desirability bias, and selection bias. The initial study was designed to collect dietary and lifestyle information from children with a diagnosis of *abnormal weight gain* and who were subsequently enrolled in our Heart Health Program, which included weight management components designed to modify diet and physical activity. Although the questionnaires were administered at the initial study visit, the children were still aware of the fact that they were enrolled in a weight management program, which could have impacted their answers regarding food intake, weight status and size perception. This factor may impact the generalizability for those children and teens *not* enrolled in similar programs, as these families were demonstrating a form of commitment to behavior change by being enrolled in MUSC's Heart Health Program.

Our use of a FFQ may also have significantly overestimated habitual energy intake, and we have discussed the biases inherent in this method (12). While another dietary assessment method such as multiple 24-h recalls would have been preferable, in this clinical setting the FFQ was chosen due to its being validated in the target population, ease of use, and low cost of implementation for the clinical staff.

Additionally, the weight perception questions on which we focused were worded in such a way that they may have biased the children's answers (see Table 1). Although improbable, it is possible that some of the children could have perceived themselves as slightly underweight, but were influenced by the wording of this question. Further, respondents' individual perceptions of the words themselves were not explored prior to assessing their perceptions about their own body weight, which may limit interpretation.

Although all questions were directed towards the child, parents were allowed to answer if the child did not (more likely with children <8y), particularly in the younger group. Since there is a well-established trend of parents under-reporting their children's weight and food intake-related behaviors, this may have biased the results to make the older children appear more accurate than the younger children (28,29). Further, this analysis did not include information about the participants' socioeconomic status or parental health factors that could have influenced the children's eating attitudes or perceptions, such as parental BMI (6,17).

Conclusion

In summary, in a cohort of obese children and adolescents at-risk for cardiovascular disease, only 37% of the sample was able to accurately categorize their weight status. Relatively larger children were more likely to accurately perceive their weight, and older children were more likely to accurately perceive their weight compared to younger children. Older girls were more likely to be accurate compared to other children. An individualized, family-based approach should be taken during all well-child and clinic visits with a multi-disciplinary health care team to address children's weight status. Behavior change strategies for weight loss and maintenance (e.g. decreasing portion sizes of foods and drinks; increasing physical activity) rather than absolute body size (e.g. pounds and inches lost) should be the focus of patient education in order to improve self-efficacy, preserve HRQoL and prevent cardiovascular disease in this population at risk.

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