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DIFFERENCES IN HOW BMI AND BODY FAT DISTRIBUTION INFLUENCE BODY
DISSATISFACTION AND SELF-ESTEEM IN CAUCASIAN AND AFRICAN AMERICAN
EARLY PUBERTAL GIRLS

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A THESIS

Submitted to the graduate faculty of The University of Alabama at Birmingham,
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Master of Arts

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2014

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Danielle Lorch

LIFESPAN DEVELOPMENTAL PSYCHOLOGY

ABSTRACT

Body dissatisfaction is among many psychological concerns related to obesity, particularly among pre-adolescent females. Though obesity prevalence estimates are higher among African American (AA) adolescent females, the limited data available suggests that they are less susceptible to weight-related body dissatisfaction than Caucasians. The purpose of the current study was to evaluate the relationship between BMI and body dissatisfaction and the relationship between BMI and self-esteem in obese AA and Caucasian girls, aged 7-11 years, and determine if these relationships are moderated by race. Furthermore, an examination of how total body fat and body fat distribution before and after a dietary intervention influence body dissatisfaction and self-esteem was conducted. The intervention consisted of two phases: a 6-week eucloric and a 12-week hypocaloric phase, in which all food was provided. The Contour Drawing Rating Scale assessed body dissatisfaction and Rosenberg's Self-Esteem Scale evaluated global self-esteem. Body fat was assessed by DXA. Limiting analyses to participants with complete data sets, 46 participants were included at baseline, 25 at 6-weeks, and 23 at 18-weeks. BMI, total body fat, trunk fat, gynoid fat, body dissatisfaction, and self-esteem improved at various time-points over the course of the study ($p < 0.03$). Results did not show a significant moderating effect of race on the

BODY COMPOSITION, DISSATISFACTION, AND SELF-ESTEEM

relationships between BMI, body dissatisfaction, and self-esteem. Findings indicated that body dissatisfaction was positively associated with BMI ($p=0.02$), though this association varied over the course of the study. Further, for AA girls, the trunk-to-gynoid fat ratio was negatively associated with self-esteem ($p=0.005$). Findings suggest that a structured dietary intervention in a free-living setting may be an effective strategy to improve both the physiological and psychological in AA and Caucasian pre-pubertal girls.

Keywords: Body image, self-esteem, dietary intervention, racial differences, BMI, body fat

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INTRODUCTION

Overweight/obesity (BMI %tile \geq 85) is positively associated with body dissatisfaction and poor self-esteem, generally becoming apparent in pre-adolescent girls, with the strength of these effects increasing with age (Granberg, Simons, & Simons, 2009; Nowicka et al., 2009; Sonnevile et al., 2012). Furthermore, mental health ramifications of body dissatisfaction and poor self-esteem may be equally as important in identifying physiological health concerns (Muennig, Jia, Lee, & Lubetkin, 2008). For example, dissatisfaction and concern with weight is positively associated with depressive symptoms (Paxton, Neumark-Sztainer, Hannan, & Eisenberg, 2006; Rierdan & Koff, 1997; Sowislo & Orth, 2013). Childhood obesity predicts a decline in psychological health (e.g., increased depression and anxiety, decreased quality of life), and understanding risk factors and predictors of body dissatisfaction in young girls may offer insight into subsequent improvements in both psychological and physiological health. Therefore, the goal of the present study was to evaluate how BMI and body fat distribution are related to body dissatisfaction and self-esteem in African American (AA) and Caucasian pre-pubertal girls.

Body Dissatisfaction

A positive relationship between BMI and body dissatisfaction has been well documented for child and adolescent girls (Paxton et al., 2006; Tanofsky-Kraff et al., 2004; Taylor, Wilson, Slater, & Mohr, 2012). The magnitude of dissatisfaction based on

BMI appears stronger for Caucasian than for AA girls (Brown et al., 1998). It is often accepted that the difference resides in larger ideal body sizes (i.e., the body size one would like to have) in AA relative to Caucasian girls (Chen & Wang, 2012). However, one report indicated that while Caucasians generally have increased overall feelings of body dissatisfaction, differences in ideal body size are reduced when controlling for BMI (Gluck & Geliebter, 2002), suggesting that these differences that are often reported may be confounded by BMI. BMI does not account for body composition and therefore may limit efforts to improve obesity-related health. Further, the prevalence and severity of obesity continues to increase and disproportionately affect AA girls relative to other groups. The psychological concerns associated with increased BMI and body dissatisfaction warrant attention to these matters in both races.

Self-Esteem

Body dissatisfaction also contributes to decreased self-esteem (Tiggemann, 2005). In adolescence, decreased self-esteem in addition to body dissatisfaction is associated with the presence of anxiety, depression, and unhealthy dieting behaviors (French et al., 1997; Paxton et al., 2006; Sowislo & Orth, 2013). In addition, BMI is negatively associated with self-esteem, and increased BMI has been associated with and shown to precede low self-esteem in children and adolescents (Hesketh, Wake, & Waters, 2004). This suggests that a girl's self-esteem and psychological health are highly dependent on her ability to be comfortable with her body (Cox et al., 2011).

As age increases self-esteem decreases (Nowicka et al., 2009), and this decrease in self-esteem is more prominent among Caucasian than AA youth (Brown et al., 1998).

Further, for both AA and Caucasian girls, it has been reported that a larger BMI is associated with a lower self-esteem (Biro, Striegel-Moore, Franko, Padgett, & Bean, 2006; Brown et al., 1998). However, it has been suggested that self-esteem is greater in AA than Caucasian girls (Biro et al., 2006), but the existing literature is unequivocal about racial differences in self-esteem in overweight/obese girls. While it is established that BMI is negatively associated with self-esteem, racial differences in self-esteem at these larger BMI's have not been satisfactorily established.

Fat Distribution, Body Dissatisfaction, and Self-Esteem

The majority of studies evaluating the relationship between overweight/obesity, body dissatisfaction, and self-esteem have used BMI. BMI, while widely used as a proxy for obesity, does not provide information on adipose tissue accumulation or distribution and racial variations in adipose tissue accumulation and distribution at similar BMI's have been reported in AA and Caucasian girls (Maligie, Crume, Scherzinger, Stamm, & Dabelea, 2012; Staiano, Broyles, Gupta, & Katzmarzyk, 2013). Research examining the specific influence of adipose tissue accumulation and/or its distribution is limited. It has been suggested that the increased acceptability of larger body sizes in AA girls may be attributable to accumulation of body fat (based on skinfold and body circumference measurements) (Halpern, Udry, Campbell, & Suchindran, 1999). Therefore, a more robust measurement of body fat, such as Dual-Energy X-Ray Absorptiometry (DXA), which allows for overall and regional quantification of body fat through the use of x-ray, may provide further insight into the relationship between obesity and its psychological effects in both races.

The existing literature assessing how fat distribution influences body dissatisfaction utilizes samples of adult women and provides conflicting results. Specifically, one study found that Caucasian women with gluteal-femoral obesity perceive themselves as smaller than women with abdominal obesity or a combination of both gluteal-femoral and abdominal obesity (Rhodes & O'Neil, 1997). Conversely, another study found that women with greater gynoid adiposity are more eating disordered and dissatisfied with their weight than women with greater adiposity in the abdomen (Radke-Sharpe, Whitney-Saltiel, & Rodin, 1990). To our knowledge, no study has investigated how adiposity impacts the body dissatisfaction and self-esteem of overweight and obese AA and Caucasian early-pubertal girls. Assessment of body fat distribution through the use of DXA while also measuring body dissatisfaction and self-esteem at the same time-points can allow for the investigation of which regions of body fat are associated with increased body dissatisfaction and decreased self-esteem.

Dietary Interventions

It is fairly well accepted that body dissatisfaction is positively associated with unhealthy dietary behaviors (French et al., 1997; Kelly, Wall, Eisenberg, Story, & Neumark-Sztainer, 2005; Neumark-Sztainer, Paxton, Hannan, Haines, & Story, 2006). While the literature suggests racial differences and potential cultural explanations, no study has evaluated the capacity to decrease body dissatisfaction, increase self-esteem, and decrease adiposity, thereby influencing the interrelationships among these variables in AA and Caucasian girls. Previous interventions among AA youth and adolescents have focused primarily on weight-loss via behavioral, educational, and physical activity

programs and have not attained improvements in psychological health (Huang, Norman, Zabinski, Calfas, & Patrick, 2007; Klesges et al., 2010; Resnicow et al., 2000). Dietary interventions that have had success in reducing body dissatisfaction and eating pathology (Stice, Rohde, Shaw, & Marti, 2013) as well as feelings of anxiety and depression (Lavigne et al., 1999) have been conducted in mostly Caucasian populations and suggest that a structured dietary intervention may be more effective in promoting physical and psychosocial changes among this population.

To that end, research examining the effect of a structured dietary intervention (i.e. weight loss camp) on psychological health has only been done in confined settings and with Caucasian children. While one study found that improvements in body dissatisfaction and self-esteem were positively associated with BMI change scores (Walker, Gately, Bewick, & Hill, 2003), another study found that it is perceived physical changes, rather than actual changes in BMI and body composition, that are associated with body dissatisfaction (Quinlan, Kolotkin, Fuemmeler, & Costanzo, 2009). A free-living, structured dietary intervention needs to be studied as a means of successfully promoting improvements in psychological health among overweight and obese children.

STATEMENT OF THE PROBLEM

There is paucity in the literature examining the relationship between BMI, body dissatisfaction, and self-esteem in preadolescent girls and with race as a moderating factor. Furthermore, the existing literature reveals conflicting results about the ability to improve body image in both races. While previous dietary interventions have been successful at improving self-image (i.e., body dissatisfaction and self-esteem) in

Caucasian girls, behavioral, educational, and physical activity interventions have not shown significant intervention effects in either race. Dietary interventions examining the effects of changes in body composition on self-image have, to our knowledge, not been done in AA girls.

The overall objective of this study is to evaluate the relationship between BMI and body dissatisfaction and the relationship between BMI and self-esteem in overweight/obese AA and Caucasian girls, aged 7-11 years, and determine if these relationships are moderated by race. Additionally, this study aims to determine how body fat distribution measured by DXA, namely trunk and gynoid fat, contributes to these relationships. The girls participated in a dietary intervention, which aimed to maintain and subsequently induce weight loss. Accordingly, the relationships between BMI and self-image were evaluated pre- and post- intervention.

Specific Aim 1

To examine the relationship between BMI and body dissatisfaction in overweight/obese girls and determine if the relationship is moderated by race both pre- and post- dietary intervention.

Due to the literature suggesting a positive relationship between BMI and body dissatisfaction that is stronger for Caucasian than AA girls (Brown et al., 1998), it was hypothesized that the positive relationship between BMI and body dissatisfaction would be moderated by race such that at a higher BMI AA girls would experience less body dissatisfaction than their Caucasian counterparts, while at a lower BMI these differences would be reduced (Hypothesis 1.1).

Further, previous studies have found that a structured dietary intervention may be effective at improving body dissatisfaction (Quinlan et al., 2009; Stice et al., 2013; Walker et al., 2003). Therefore, it was also hypothesized that a dietary intervention would result in decreases in body dissatisfaction (Hypothesis 1.2).

Specific Aim 2

To examine the relationship between BMI and self-esteem in overweight/obese girls and determine if the relationship is moderated by race both pre- and post- dietary intervention.

Existing literature suggests that racial differences in self-esteem are prominent at more average BMIs and are reduced as BMI increases (Biro et al., 2006; Brown et al., 1998). Therefore, it was hypothesized that the negative relationship between BMI and self-esteem would be moderated by race such that at a lower BMI AA girls would have more self-esteem than their Caucasian counterparts, while at a higher BMI these differences would be reduced and both races would experience decreased self-esteem (Hypothesis 2.1).

Although previous dietary interventions have not found significant intervention effects for self-esteem, the negative relationship between both body dissatisfaction and BMI with self-esteem (Hesketh et al., 2004; Tiggemann, 2005) suggests that decreases in body dissatisfaction and BMI would result in increased self-esteem. Consequently, it was hypothesized that a dietary intervention would result in increases in self-esteem (Hypothesis 2.2).

Specific Aim 3

To evaluate how body fat distribution influences body dissatisfaction and self-esteem among Caucasian and AA early-pubertal girls both pre- and post- dietary intervention.

Previous literature has suggested that there is a positive association between total body fat and body dissatisfaction (Halpern et al., 1999). It was hypothesized that more total body fat will be associated with increased body dissatisfaction and reduced self-esteem (Hypothesis 3.1).

The existing and limited literature examining how body fat distribution is associated with psychological health report conflicting results on whether it is trunk fat or gynoid fat that has a greater influence on body dissatisfaction (Radke-Sharpe et al., 1990; Rhodes & O'Neil, 1997). However, it was hypothesized that greater trunk fat and a lower trunk-to-gynoid fat ratio would be associated with increased body dissatisfaction and decreased self-esteem (Hypothesis 3.2).

METHODS

Participants

Participants were 52 Caucasian (n=23) and AA (n=29) overweight (BMI %tile \geq 85 or $<$ 95) and obese (BMI %tile \geq 95) early-pubertal girls (Tanner $<$ 3), aged 7 to 11 years, based on parental-report. They were recruited from the Birmingham-Hoover Metropolitan Area through newspaper and radio advertisement, distribution of flyers, and word of mouth. Participants were excluded if: they had attained menarche; had medical diagnoses and/or were taking medications known to affect body composition, the lipid

profile, insulin sensitivity, or blood pressure; participated in greater than 60 minutes per day of exercise; were currently on a modified diet; and/or had plans to move from the Birmingham area during the study period. The research was conducted at the University of Alabama at Birmingham (UAB) from 2010 - 2014, and the university's Institutional Review Board for human subjects approved the study. All participants' parents provided informed consent and participants provided assent when appropriate.

Procedures

Data from this analysis is part of a larger study (Puberty Related Intervention to Improve Metabolic Outcomes; NIH/NIDDK 083333, PI Casazza) in which the main objective was to evaluate the metabolic effects of a dietary intervention on overweight and obese Caucasian and AA girls, ages 7-11 years (Casazza et al., 2012). The intervention consisted of two phases: a 6-week eucaloric phase, which was designed for weight stability, and a 12-week hypocaloric, weight loss phase. Inclusion of the eucaloric phase of the dietary intervention allows for the examination of the effect of changing dietary habits without caloric deficiency on body dissatisfaction and self-esteem.

At baseline, guardians filled out demographic questionnaires and questionnaires assessing regular diet and physical activity of their daughters, while participants had their heights and weights measured and completed a DXA scan. Participants subsequently attended an initial outpatient visit to the university's Clinical Research Unit (CRU) in which the study pediatrician assessed pubertal status and participants completed psychosocial questionnaires assessing their body dissatisfaction and self-esteem. After the initial study visit, participants and their guardians returned to the CRU to receive the

pre-prepared and packaged meals that they would be directed to eat for the first week of the intervention. The meals consisted of 1600 kcal, and 100 kcal snacks were added to each package to reach the required daily kcal for weight maintenance.

Any weight change greater than 2 kg from baseline resulted in caloric modification to achieve weight maintenance. All food was provided for both phases of the study, and participants returned each week to receive their meals for the remainder of that week. Outcome measures including height, weight, body fat, body dissatisfaction, and self-esteem, were assessed by study personnel of White ethnicity at baseline and at the conclusion of each of the 6-week eucaloric and 12-week hypocaloric phases.

Outcome Variables

Body Dissatisfaction

Body dissatisfaction was assessed by the Contour Drawing Rating Scale (Thompson & Gray, 1995), a questionnaire consisting of nine female front-view contour drawings that gradually increase in size, with larger drawings being rated as a greater weight status. The purpose of this questionnaire is to determine an individual's perceived and desired body size. While perceived body size measures how participants currently view their body, ideal body size measures the body size that they wish to have. When completing this questionnaire, participants circle both their perceived and ideal body sizes, and scores for perceived body size and ideal body size range from 1 to 9. Body dissatisfaction is calculated subtracting the ideal body figure score from the perceived body figure score (Thompson & Gray, 1995). Any score that is not "0" is considered to be dissatisfied. A larger score (both in the positive and negative direction) indicates a higher level of dissatisfaction. A positive score would indicate that an individual is

dissatisfied because they want to be thinner, while a negative score would indicate that an individual feels too thin and would like to gain weight. Reliability and validity of the Contour Drawing Scale for use in early adolescent girls has been established (Wertheim, Paxton, & Tilgner, 2004).

Self-Esteem

Rosenberg's Self-Esteem Scale was used to assess global self-esteem (Rosenberg, 1989). This 10-item, 4-point Likert scale (ranging from "strongly disagree" to "strongly agree") evaluates positive and negative feelings about the self. Sample items from this questionnaire include, "I feel like I am not worthy of anything at times" and "Overall, I like myself." Higher scores on this scale indicate higher self-esteem and feeling more positive about one's own self. This scale has been validated as a unidimensional scale and has established high reliability and internal consistency among college students (Gray-Little, Williams, & Hancock, 1997).

Total Body Fat and Fat Distribution

Whole-body composition for the assessment of total body fat, trunk fat, and gynoid fat were measured by DXA using a GE Lunar Prodigy densitometer (GE LUNAR Radiation, Madison, WI). Girls were scanned in light clothing while lying flat on their backs with their arms at their sides.

BMI

The same registered dietitian measured the height and weight of all study participants. Participants were weighed to the nearest 0.1kg, in minimal clothing and without shoes, using a Scaletronix (Wheaton, IL) digital scale. Height was measured to the nearest inch, without shoes, using the Digi-kit stadiometer (Measurement Concepts and Quick Medical, North Bend, WA). BMI percentile was calculated using the Centers for Disease Control and Prevention age- and sex- specific BMI percentile calculator (Centers for Disease Control and Prevention: Division of Nutrition).

Covariates

Pubertal Status

To control for body composition differences related to variation in reproductive maturation timing, pubertal status was evaluated according to the criteria of Marshall and Tanner. Tanner staging was conducted by direct observation according to breast development and appearance of pubic hair, with a single composite number representing the higher of the two values assigned (Marshall & Tanner, 1969, 1970).

Statistical Analyses

Paired samples t-tests were used to assess time-effects for each variable, such that for both body dissatisfaction and self-esteem three separate t-tests were conducted – one assessing the change from baseline to 6-weeks, one from 6-weeks to 18-weeks, and one from baseline to 18-weeks. One-way ANOVAs were used to determine if body dissatisfaction and self-esteem differed by race. Controlling for tanner stage and race,

Pearson partial correlations were used to examine associations between BMI %tile, body fat distribution, body dissatisfaction, and self-esteem. These Pearson partial correlations were ran again, only controlling for tanner stage, and significant correlations were stratified by race.

Hierarchical regression was conducted at each time-point and for each outcome variable to determine if tanner stage, race, BMI, and the BMI x race interaction are significant predictors of body dissatisfaction and self-esteem. The interaction term was used to test the moderating effect of BMI and race on body dissatisfaction and self-esteem. Continuous predictors were centered to reduce intercorrelation among main effects and the interaction term. In step one, all predictors were entered into the model (tanner, race, and BMI). In step two, the two-way BMI x race interaction was entered. No follow-up analyses were conducted because none of the interaction terms reached statistical significance.

All analyses were conducted using IBM SPSS Statistics software (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.), and statistical significance was defined as $p \leq 0.05$ (two-tailed).

Limiting analyses to participants with complete data sets, 46 participants were included at baseline, 25 at 6-weeks, and 23 at 18-weeks.

RESULTS

Sample characteristics at baseline are shown in Table 1. Sixty-one percent of participants were AA and 39% were Caucasian. Girls (M age 9.75 ± 1.28) were

approaching reproductive maturity (mean tanner stage 2.33 ± 0.84), and the average BMI %tile was 98.00 ± 1.48 .

Table 1

Sample characteristics at baseline

	<i>M</i>	<i>SD</i>
Age (years)	9.75	1.28
Tanner	2.35	0.84
BMI %tile	98.00	1.48
Trunk Fat Mass (kg)	12131.26	3667.44
Gynoid Fat Mass (kg)	4465.70	1127.00
Trunk-to-Gynoid Fat Ratio	2.73	0.51
Total Fat Mass (kg)	25772.29	7153.42

Table 2 shows differences in outcome variables between completers and non-completers. There were no racial differences between participants who completed the intervention and those who dropped out. Among AA girls, there were no differences in outcome variables between completers and non-completers. For Caucasian girls, completers had a higher self-esteem at baseline than non-completers (M completers = 35.67 ± 1.32 , M non-completers = 33.00 ± 7.95).

There were no racial differences in total body fat, trunk fat, or gynoid fat. However, at baseline and 6-weeks Caucasian girls had a larger trunk-to-gynoid fat ratio

than AA girls (M Caucasian = $3.02 \pm .48$, M AA = $2.58 \pm .45$; M Caucasian = $2.97 \pm .51$, M AA = $2.60 \pm .68$, respectively). At 18-weeks BMI %tile also differed by race (M Caucasian = $92.58\% \pm 5.28$, M AA = $96.28\% \pm 2.89$).

Table 2

Baseline characteristics of completers and non-completers

	Completers AA ($M \pm SD$)	Non- Completers AA ($M \pm SD$)	Completers Caucasian (M $\pm SD$)	Non- Completers Caucasian (M $\pm SD$)
BMI %tile	97.77 \pm 1.09	98.68 \pm 1.08	98.00 \pm 0.82	97.85 \pm 2.23
Trunk Fat Mass (kg)	10575.77 \pm 2998.84	13035.13 \pm 3863.83	13462.70 \pm 4727.37	12914.00 \pm 3601.56
Gynoid Fat Mass (kg)	4452.23 \pm 1089.79	4713.88 \pm 1002.84	4641.40 \pm 1351.68	4223.23 \pm 1310.72
Trunk-to-Gynoid Fat Ratio	2.36 \pm 0.27	2.75 \pm 0.49	2.89 \pm 0.47	3.12 \pm 0.47
Total Fat Mass (kg)	27118.46 \pm 7575.57	26570.94 \pm 6904.08	27507.30 \pm 6148.42	23833.42 \pm 7256.21
Body Dissatisfaction	2.81 \pm 1.38	2.47 \pm 1.25	2.50 \pm 1.07	2.17 \pm 1.47
Self-Esteem	32.00 \pm 8.04	30.07 \pm 10.26	35.67 \pm 1.32	33.00 \pm 7.95

Table 3 presents changes in BMI %tile, body fat distribution, and psychosocial variables over the 18-week dietary intervention. BMI %tile, total body fat, trunk fat, and gynoid fat decreased after both phases at 6- and 18- weeks ($p < 0.03$). Mean body dissatisfaction did not change after the eucaloric, weight maintenance phase, but did

decrease after the hypocaloric phase ($p = 0.001$). In addition, self-esteem significantly increased from baseline to 18-weeks ($p = 0.002$).

Table 3

Time-effects of outcome variables

	Baseline (n=46)	6-Weeks (n=25)	18-Weeks (n=23)
Age (years)	9.75 ± 1.28	-	-
Tanner	2.33 ± 0.84	-	-
BMI %tile	98.00 ± 1.48	96.60 ± 3.11 ^a	94.35 ± 4.01 ^a
Trunk Fat Mass (kg)	12131.26 ± 3667.44	10739.80 ± 3959.62 ^a	9287.13 ± 3613.91 ^a
Gynoid Fat Mass (kg)	4465.70 ± 1127.00	3966.68 ± 1112.80 ^a	3693.04 ± 1298.99 ^a
Trunk-to-Gynoid Fat Ratio	2.73 ± 0.51	2.72 ± 0.65	2.54 ± 0.50
Total Fat Mass (kg)	25772.29 ± 7153.42	23129.40 ± 6518.36 ^c	20506.96 ± 7063.47 ^c
Body Dissatisfaction	2.51 ± 1.25	2.34 ± 1.07	1.48 ± 1.08 ^b
Self-Esteem	31.96 ± 8.20	34.13 ± 6.41	37.14 ± 3.83 ^b

Note: Significant time-effects from baseline to 6-weeks and baseline to 18-weeks; ^a $p \leq .001$, ^b $p \leq .01$, ^c $p \leq .05$

Table 4 shows average weight- and fat-loss at 6- and 18-weeks, stratified by race. The average amount of weight- and fat-loss and each time-point did not differ between AA and Caucasian girls. However, for AA girls body dissatisfaction at 6-weeks was

positively associated with gynoid fat-loss ($r = 0.55, p = 0.05$). At 18-weeks, self-esteem was negatively associated with fat-loss among Caucasian girls ($r = -0.79, p = 0.01$).

Table 4

Average weight- and fat-loss at 6- and 18-weeks, stratified by race

	AA ($M \pm SD$)	Caucasian ($M \pm SD$)
Weight-Loss 6-weeks (lbs)	-2.45 ± 5.45	-5.51 ± 5.47
Weight-Loss 18-weeks (lbs)	-5.12 ± 7.58	-13.45 ± 8.44
Trunk Fat-Loss 6-weeks (kg)	-658.04 ± 1137.50	-1426.13 ± 1249.10
Trunk Fat-Loss 18-weeks (kg)	-1594.69 ± 1305.18	-3570.92 ± 1881.44
Gynoid Fat-Loss 6-weeks (kg)	-350.13 ± 369.09	-557.07 ± 454.21
Gynoid Fat-Loss 18-weeks (kg)	-639.19 ± 460.08	-1082.67 ± 642.48
Trunk-to-Gynoid Fat Ratio Loss 6-weeks	0.05 ± 0.29	0.07 ± 0.26
Trunk-to-Gynoid Fat Ratio Loss 18-weeks	0.03 ± 0.27	-0.09 ± 0.38
Total Fat-Loss 6-weeks (kg)	-2807.65 ± 8201.06	-3704.57 ± 8851.13
Total Fat-Loss 18-weeks (kg)	-5654.44 ± 9369.67	-8289.92 ± 10744.47

Pearson partial correlations, controlling for tanner stage and race, are shown in Table 5. A positive association between BMI %tile and body dissatisfaction was observed at baseline and 6-weeks, such that girls with a higher BMI reported greater body dissatisfaction relative to those with a lower BMI ($r = 0.71, p = 0.007$; $r = 0.63, p =$

0.02, respectively). Total body fat, trunk fat, and gynoid fat were not significantly associated with body dissatisfaction or self-esteem at any time-point. However, an inverse relationship between trunk-to-gynoid ratio and self-esteem was observed at baseline and 6-weeks ($r = -0.46, p = 0.05$; $r = -0.70, p = 0.005$, respectively), suggesting that girls with greater trunk fat, relative to gynoid fat, had lower self-esteem than girls with a lower proportion of trunk-to-gynoid fat. Controlling only for tanner stage and stratifying significant correlations by race, the negative relationship between self-esteem and the trunk-to-gynoid fat ratio at baseline and 6-weeks only remained significant for AA girls ($r = -0.42, p = 0.03$; $r = -.65, p = 0.005$, respectively) (Figures 1-3).

Table 5

Pearson partial correlations between BMI, body composition, and psychosocial measures, controlling for tanner stage and race

	Body Dissatisfaction Baseline	Body Dissatisfaction 6-Weeks	Body Dissatisfaction 18-Weeks	Self- Esteem Baseline	Self- Esteem 6-Weeks	Self- Esteem 18- Weeks
BMI %tile	.71**	.63*	.33	-.15	-.51	-.74**
Trunk Fat	.27	.27	.41	-.42	-.31	-.27
Gynoid Fat	.16	.12	.31	-.26	-.11	-.15
Trunk- to- Gynoid Fat Ratio	.30	.37	.28	-.46*	-.70**	-.23
Total Fat	.37	.28	.40	-.34	-.26	-.25

Note: * $p < .05$, ** $p < .01$

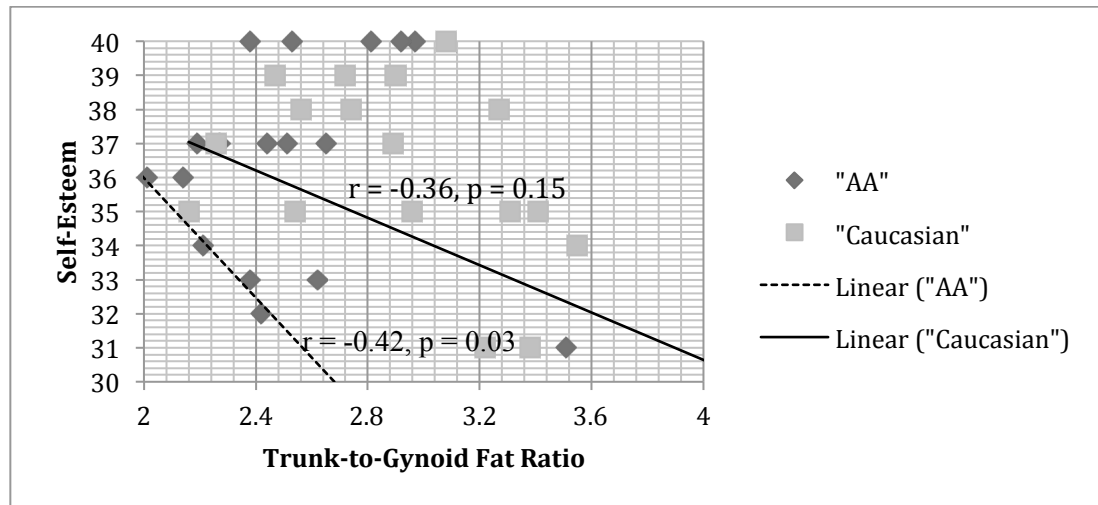


Figure 1. The relationship between trunk-to-gynoid fat ratio and self-esteem at baseline stratified by race. Pearson partial correlations showed a significant negative correlation between trunk-to-gynoid fat ratio and self-esteem in AA girls, but not Caucasian girls at baseline.

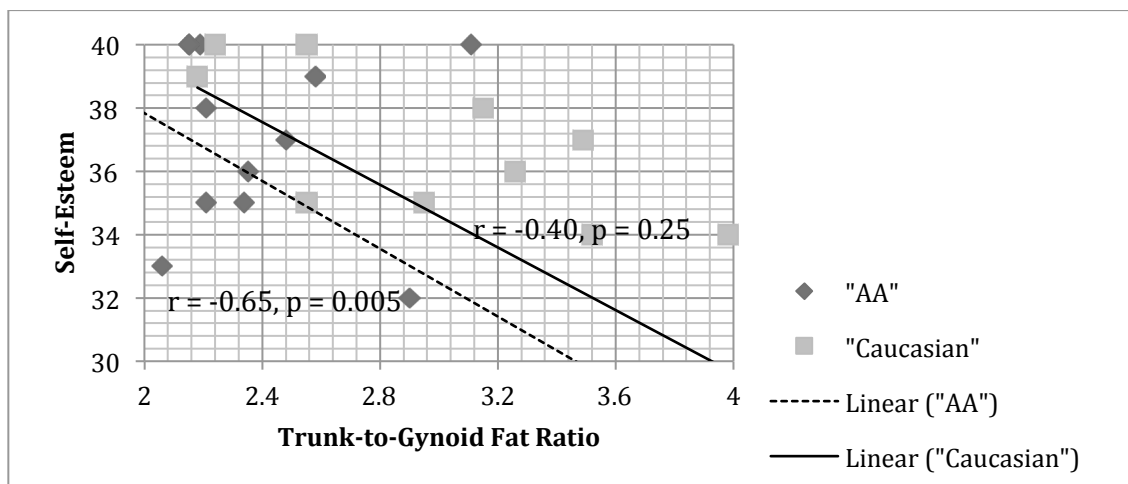


Figure 2. The relationship between trunk-to-gynoid fat ratio and self-esteem at 6-weeks stratified by race. Pearson partial correlations showed a significant negative correlation between trunk-to-gynoid fat ratio and self-esteem in AA girls, but not Caucasian girls at 6-weeks.

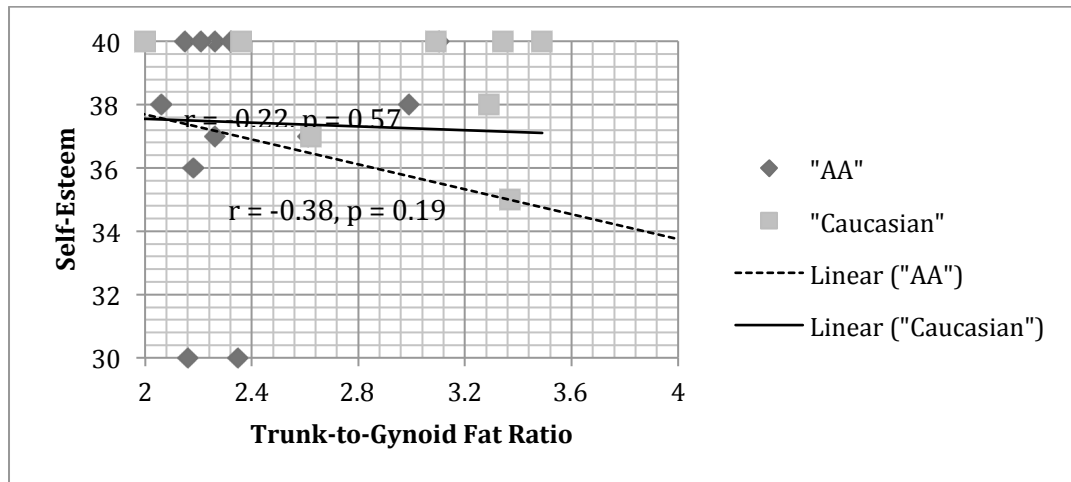


Figure 3. The relationship between trunk-to-gynoid fat ratio and self-esteem at 18-weeks stratified by race. Pearson partial correlations did not show a significant correlation between trunk-to-gynoid fat ratio and self-esteem in either AA or Caucasian girls at 18-weeks.

Hierarchical regression analyses did not reveal a significant effect for the BMI x race interaction on body dissatisfaction or self-esteem. Further analyses showed that the only outcome variable that differed by race was body dissatisfaction at 18-weeks ($p = 0.008$), with body dissatisfaction being greater for Caucasian ($M = 2.00$) than AA girls ($M = 0.92$).

DISCUSSION

The effects of obesity on psychological health are arguably as detrimental to long-term quality of life as those associated with metabolic health (Delfabbro, Winefield, Anderson, Hammarstrom, & Winefield, 2011; Walders-Abramson et al., 2013). To our knowledge, this is the first study to examine racial differences in psychosocial outcomes

of a structured dietary intervention in a population of early pubertal girls as young as 7 years of age. Most weight-loss interventions in young girls have utilized educational, behavioral, and/or physical activity interventions and have not shown significant improvements in most physiological and psychological outcomes, including BMI, body composition, body dissatisfaction, and self-esteem (Huang et al., 2007; Klesges et al., 2010; Resnicow et al., 2000). While BMI %tile, total body fat, trunk fat, and gynoid fat reduced after each phase of this intervention, a decline in body dissatisfaction was only apparent after the hypocaloric, weight-loss phase. Self-esteem increased over the course of the study, and body dissatisfaction was positively associated with BMI %tile prior to the hypocaloric phase. Furthermore, there was a negative relationship between the trunk-to-gynoid fat ratio and self-esteem for AA girls, but not Caucasian girls. Race was not a moderator of the relationship between BMI and body dissatisfaction or the relationship between BMI and self-esteem. However, at the end of the intervention, Caucasian girls had higher body dissatisfaction than their AA counterparts. Although Caucasian girls had greater body dissatisfaction, their body dissatisfaction improved from baseline to the end of the study. These results suggest that a structured dietary intervention may be an effective strategy to improve both the physiological and psychological health in both AA and Caucasian girls.

The reductions in anthropometric and body composition variables over the course of the study suggest that a free-living structured dietary intervention, as opposed to a confined setting or an educational, behavioral, or physical activity intervention, can significantly improve variables associated with the physiological health of obese early pubertal girls of both Caucasian and AA race. The current intervention may have been

more effective in AA girls than other interventions because of the provision of food. Previous research has shown that weight-related self-efficacy with respect to total energy, snack, and dessert intake is linked to availability of food (Glasofer et al., 2013). Among AA girls of low socioeconomic status, and therefore a limited food budget, the food that is affordable, available, and purchased is often less healthy (Surkan et al., 2011). Further, it has been noted that AA adolescents of low socioeconomic status have a reduced ability to alter dietary habits (i.e., consume less empty calories, meats, and fried foods and consume more fruits, vegetables, grains, and dairy) (Fahlman, McCaughtry, Martin, & Bo, 2010). The provision of food in the current study not only offers healthy food choices at no cost, but it also reduces availability of energy-dense and empty-calorie food choices, thus improving consumption of healthy foods and dietary adherence.

The improvement in body dissatisfaction that is only present after the hypocaloric, weight-loss phase, as well as the positive correlation between body dissatisfaction and BMI %tile that dissipated after this phase presents an interesting paradox. Intuitively, reductions in body dissatisfaction would be expected with weight-loss that occurred after the eucaloric phase, as well. It would also be expected that the relationship between body dissatisfaction and BMI %tile would remain significant at all time points. Speculatively, these results are due to participants' subjective perceptions of their weight status and body composition rather than the objective, actual changes that occurred (Martin Ginis, McEwan, Josse, & Phillips, 2012). Although participants lost weight and were at a lower BMI %tile after the first 6-weeks, they may not have perceived that weight-loss was successful, as they may have wanted to lose more weight or notice more significant changes in their body sizes and shapes. Some results show that among adolescents

attending a weight-loss camp, when significant reductions in body dissatisfaction occur there is an inverse association between changes in BMI and body dissatisfaction (Walker et al., 2003). Conversely, no associations between changes in BMI and these decreases in body dissatisfaction have been reported (Quinlan et al., 2009). While reasons for the discordant results are not known, our results provide further evidence that among pre-pubertal girls perceived physical changes may influence body dissatisfaction more than objective measures of weight- or fat- loss.

Over the course of the intervention self-esteem increased, but this increase was not negatively associated with BMI as previous literature has found (Biro et al., 2006; Brown et al., 1998; Hesketh et al., 2004). There is paucity in the literature regarding the extent to which fat distribution, and not just overall fat accumulation, may influence body image and self-esteem in early pubertal and adolescent girls. Despite Caucasian girls having a larger trunk-to-gynoid fat ratio than their AA counterparts, a negative relationship between trunk-to-gynoid fat ratio and self-esteem was only observed among AA girls. These results are consistent with previous studies suggesting that AA women idealize significantly lower waist-to-hip ratios than Caucasians (Freedman, Carter, Sbrocco, & Gray, 2004) and provides support for the notion that AA girls idealize a “curvaceous” shape whereas Caucasian girls prefer a more “slender” shape (Overstreet, Quinn, & Agocha, 2010). However, further research is needed to determine how body size ratios and body fat ratios differently influence self-esteem among AA youth.

The finding that race did not moderate the relationship between either BMI and body dissatisfaction or BMI and self-esteem suggests that associations between BMI to body dissatisfaction and low self-esteem are as salient for AA girls as their Caucasian

counterparts. Further, because body dissatisfaction only differed by race post-intervention, it does not provide support for studies purporting that body dissatisfaction is more of a concern for Caucasian than AA girls (Brown et al., 1998; Chen & Wang, 2012; Rucker & Cash, 1992). This racial difference in body dissatisfaction may be more prominent in adolescence rather than childhood as differences in body image perception become more apparent with the onset of puberty (Siegel, Yancey, Aneshensel, & Schuler, 1999). These results suggest that a structured dietary intervention is equally important for improving body dissatisfaction and self-esteem in AA as Caucasian youth and may foster greater improvements in body dissatisfaction in AA girls through the alternation of nutrient intake that has been associated with body dissatisfaction in this population (Sharma, Ikeda, & Fleming, 2013).

This study has several strengths including relatively strict inclusion criteria, repeated measurements of weight and body composition via DXA, the provision of meals to promote dietary adherence, the use of well-validated measures of body image and self-esteem, and statistically controlling for pubertal status. However, this study also has limitations. There were a relatively small number of participants who provided complete data over the three assessments, resulting in decreased statistical power. Further, the absence of a control group makes it impossible to make definitive causal statements. As such, future studies, ideally randomized control trials, are necessary to clarify the extent to which the relationship between BMI and body dissatisfaction as well as the relationship between self-esteem and fat distribution are causal. Nonetheless, the results of this study suggest that a structured dietary intervention may be an effective strategy to

improve the physiological and psychological ramifications, including body dissatisfaction and self-esteem, associated with obesity.

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