Testing Accuracy of Body Size Estimation Among Boys

by

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Abstract

The current study utilized this sample to explore a very different question: the associations between boys' estimates of their body size/shape and potential biasing factors such as the boys' preferred size, parents' perceptions and boys' physical dimensions derived from 3D body scans. The sample used for this study consisted of 119 mother-son pairs, who participated in a study of attitudes and practices related to the purchase of boys clothing. The boys were between the ages of 8 and 14. During data collection, the boys were body scanned using a $[TC]^2$ NX 12 Body Scanner and both boys and their mothers answered questions pertaining to body image including the Stunkard silhouettes (Stunkard, et al., 1983), which were used to measure estimated body size. We treated BMI as the operational definition of accuracy and found that BMI explained 41% of the variance in boys' size estimates. The inclusion of five potential biasing factors and three control variables added an additional 27% to the variance accounted for. Since nearly two-thirds of the total variance explained was linked to our accuracy indicator, it appears that boys in the current study were relatively accurate. However, significant biases were also noted. Boys' estimates of their own size, reflected in their selection of Stunkard silhouette was biased toward their preferred size, with boys wishing they were bigger selecting larger silhouettes than would be expected from their BMI and with boys wishing they were smaller selecting smaller ones. Boys' size estimates were also biased in the direction of their mothers' perceptions of their size. When their mothers viewed them as bigger (smaller), the boys selected a larger (smaller) silhouette than would be expected based only on BMI. We also looked at biasing effects for

mothers' size from the perspective of self-reports and sons' reports. When sons viewed mothers as larger (smaller), they tended to select a larger (smaller) silhouette for themselves, as if identifying with mothers' size. However, when mothers described themselves as larger, the biasing effect on the boys' size estimates was in the opposite direction. Controlling for boys' perceptions of mothers' size, boys whose mothers said they were larger (smaller) estimated their own size to be smaller (larger) than would be expected on the basis of BMI. The final potential biasing factor examined was a factor score created from actual the body scans which provided objective measures of various parts of the body (chest, hips, waist, bicep, thigh, and distance from floor to waist on the back side). Although the factor score did not uniquely contribute to boys' size estimates, when we included the three control variables, income, ethnicity (white versus other), and age, in the model the association between the factor score and the boys' size estimates neared significance even controlling for BMI, suggesting that the a combined measure of objectively assessed body parts could be a better measure of accuracy than BMI. Additional analysis revealed that two body parts (waist and hips) seem to be more meaningful to boys as they estimate their body sizes. Boys for whom these parts were larger (smaller) described themselves as larger (smaller) than would be expected from their BMI alone. Given the mothers' role in biasing their sons' size estimates, we looked to see if sons' discrepancies from the BMI norm in BMI affected mothers' size estimates for sons. We expected that larger discrepancies in the overweight direction would lead mothers to more seriously underestimate their son's size, but actually found the opposite. Mothers revealed a significant bias in their estimates only when sons were below the BMI norm and under those circumstances they selected a smaller size than would be expected.

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INTRODUCTION

Adolescence is a period that begins prior to the teenage years and involves important physical and social changes. Both physical and sexual maturity take shape, and adolescents progressing through these changes develop important self-views including views about how their body appears and how they would like it to appear. During this time, their body shape and appearance matter to their social standing and relationships due to an emphasis placed on physical attractiveness (Shulman & Kipnis, 2001). These views of the body are called "body image." Body image is the subjective perception of one's physical appearance based in part on how a person sees him or herself but also how the adolescent believes s/he is perceived by others (Martin, 2010). For adolescents, an important part of development involves gaining a healthy and normal viewpoint of their own body, which will equip them with an ability to view themselves in a more satisfied manner (Friestad & Rise, 2004). Adolescents' ability to view themselves accurately could affect whether they gain this empowered viewpoint or not.

Body image results from many influences, including parents (Rodgers & Chabrol, 2009), health concerns (Daniels, 2009), peers (Keery, van den Berg, & Thompson, 2004), romantic relationships (Sanchez, Good, Kwang, & Saltzman, 2008) and ethnicity (Schooler, 2008). Considering the importance of adolescent body image and the many factors influencing it, considerable research has addressed this topic. Since body image is a subjective perception, however, the adolescent's ability to accurately describe objective aspects of their body, such as his or her body shape and weight, may be as important to understanding body image as these other social factors. Therefore, we must understand accuracy and the biases that lead to inaccuracy. This will be the driving question behind the current investigation.

A review of the literature reveals that a focus on accuracy of body size, body weight and body image requires attention to the strategies by which they are assessed. Several methods have been used to measure individual's estimates of their own body size and weight, including self-report and various strategies whereby images of the body are intentionally distorted so that the subject can readjust the image to represent his/her estimated true size and weight. These techniques become assessments of accuracy in estimation when self-reports are compared to direct measurements and when distorted or adjusted images are compared to the adolescent's true (photographic) image. Self-report measures include estimated Body Mass Index (BMI), which is based on self-reported height and weight, and identification with one of Stunkard's figural stimuli, which consist of nine silhouettes ranging from extremely thin to extremely heavy (Stunkard, Sørensen, & Schulsinger, 1983). Image distortion techniques use video and digital cameras that manipulate the size and shape of an image of one's own or another person's body that research participants then readjust to restore the dimensions of the pre-distorted image. Other techniques for assessing accuracy focus on specific body parts. Here subjects cast light beams onto a surface intended to approximate the true width of these body parts.

Accuracy in estimation of weight, size, and body shape varies by the type of measure used, as well as by the attributes of the individual making the estimates. Attributes of the individual that may affect accuracy include being underweight or being overweight/obese. For example, using self-report or the distorted image technique, obese girls tend to under report their weight (Collins, 1987; Rasmussen, Eriksson, & Nordquist, 2007), but girls classified as abdominally obese tend to overestimate it (Rhodes & O'Neil, 1997). Most objectively obese adolescents do not self-report being obese and consider themselves normal (Al-Sendi, Shetty, & Musaiger, 2004; Conley & Boardman, 2007; Rasmussen et al.). Similarly, undergraduates who estimate the weight and size of target individuals tend to underestimate the target's weight, and they become more inaccurate when the target is heavier (Vartanian, Herman, & Polivy, 2004). Research shows that young women prefer their weight to be described by others as even lighter than they consider themselves to be (Leary & Quinlivan, 2005). A different pattern is found for individuals adjusting a mirror-sized image of themselves. Obese and normal weight participants do not differ in inaccuracy. Both groups tend to overestimate (Gardner, Gallegos, Martinez, & Espinoza, 1989). These studies show a tendency for obesity to inject bias into self-assessments of weight and body size. Also, obesity injects different directions to that bias depending on the method used.

Comparisons between those who are actively trying to lose weight (dieters) versus those who are not actively trying to lose weight (non-dieters) reveal inconsistent results across studies. Dieters versus non-dieters do not differ in their ability to estimate a target's body weight (Vartanian et al., 2004), suggesting that active dieting does not affect judgments of other people's weight. Even though clinical descriptions of anorexic individuals indicate that they overestimate their own body size and weight (Slade & Russell, 1973), in one study, anorexic participants and normal weight participants did not differ in their ability to accurately assess their body shape when using a video distortion procedure (Collins, 1987). In similar studies, findings suggest that anorexic participants judge their bodies as accurately as the control group (Fernández, Probst, Meermann, & Vandereycken, 1994; Probst, Vandereycken, van Coppenolle, & Pieters, 1995). In contrast, in a study that used a modification of the distortion procedure whereby participants could see themselves in a mirror while adjusting their pre-distorted image, there is a statistically significant difference between participants with clinical eating disorders and non-eating disordered control participants (Shafran & Fairburn, 2002). Participants with eating disorders overestimated their weight and body size more than those without eating disorders.

Although obese European, African American, and European Americans do not tend to perceive themselves as obese (Al-Sendi et al., 2004; Rasmussen et al., 2007; Skelton, Busey, & Havens, 2006), they are also not completely happy with their body size. European girls from Sweden and Finland underreport their weight more than boys; however, studies show that when compared to boys, European girls from other countries more often over- report their weight (Rasmussen et al.; Van Vliet, Kjölhede, Duchén, Räsänen, & Nelson, 2009). African American women compared to European American women tend to overestimate the size of a target figure; however, neither group of women tends to be more inaccurate than the other or less happy with their own body size, since they all prefer to be smaller than they are (Schuler, Vinci, Isosaari, Philipp, Todorovich, Roy et al., 2008; Docle, Kevin, Register, & Spana, 1987). It appears that across ethnicities, most girls tend to be similarly inaccurate as well as unhappy with their perceived body size. It appears that ethnicity does not matter when looking across samples of women. However, research has not shown generalizable trends for boys. I hope to contribute to this literature by studying a sample of male adolescents.

Not only are characteristics of the evaluator important to biased estimates, but the assessment procedure itself may contribute to bias. For example, although self-reports are generally accurate on average (Bulik et al., 2001), when self-reporting their weight, girls tend to underestimate more than boys do (Conley, & Boardman, 2007; Elgar, Roberts, Tudor-Smith, & Moore, 2005; Rasmussen et al., 2007). Using the adjustable light beam assessment procedure to estimate the size (width) of specific body parts, a significant overestimation is found everyone, but females overestimate significantly more than males do (Thompson & Thompson, 1986). The

BMI assessment, which is based on the ratio of weight and height, has a built-in bias because muscularity is not taken into account when BMI is calculated. More muscular individuals have a larger BMI than would be expected because they are heavier than a less muscular person of equal size. This assessment bias can cause great inaccuracy (Jones, Bain, & King, 2008). Finally, bias can be introduced into estimates of body weight and size when eating disordered patients are compared with non-eating disordered patients. Eating disordered participants tend to overestimate their body size more compared to those without an eating disorder using the image distortion procedure when a mirror image is available to compare to the distorted image (Shafran & Fairburn, 2002). However, in other studies that use video distortion techniques, but without the mirror, (Collins, 1987; Fernandez, et al., 1994; Probst, et al., 1995), anorexic patients judge their bodies as accurately as the control group. These findings are unexpected considering researchers such as Schneider, Frieler, Pfeiffer, Lehmkuhl, and Salbach-Andrae (2009) point out participants with an eating disorder tend to overestimate more than those without an eating disorder.

Weight distribution also appears to play a role in estimation accuracy. Abdominally obese women were more likely to overestimate their body size compared to gluteal-femorally obese women when using the video distortion technique and the adjustable light beam methods, and all women were more likely to overestimate the size of their thighs than other areas of their body (McCabe, Ricciardelli, Sitaram, & Mikhail, 2006; Rhodes & O'Neil, 1997; Thompson & Thompson, 1986). It is possible that there is a relation between actual measured size (controlling for height) of a number of body components and inaccuracy. The sensitivity to certain body dimensions may cause more bias in reporting. Body parts that are typically included in the estimation tasks are cheeks, waist, hips, and thighs because participants tend to overestimate these parts (McCabe et al.; Thompson & Thompson). If people are sensitive to the size of these parts, then including their actual size as predictors may help to explain variation in bias.

Not only are adolescents and young adults often biased in the estimation of their body size and weight, their parents are too. On average, parents tend to underreport their children's weight (see also, Van Vliet et al., 2009). In fact, parents of overweight children tend to report their child's weight as healthy (Eckstein, Mikhail, Ariza, Thomson, Millard, & Binns, 2006; Skelton et al., 2006). Although Goodman, Hinden, and Khandelwal (2000) found that parents were more likely to report a problem with obesity for daughters than sons most objectively obese teens were not considered obese by parents. Not all mothers are equally biased. Inaccurate mothers tend to have a higher BMI than those who were accurate (Jackson, Strauss, Lee, & Hunter, 1990).

Interestingly, the research on parent reports of their children's weight or body size is independent of research on their adolescents' body image. Van Vliet et al., (2009) have found that mother perceptions of the body weight of their daughters often agree with the BMI of the daughter. However, parents tend to be more worried about girls compared to boys. A contribution of the current study will be that this examination of adolescent bias in self-reports of body size will explicitly account for the views of the adolescent's mother.

Although considerable research is focused on understanding the accuracy of body image among adolescents, there are still gaps in the literature. Most of the previous research (Collins, 1987; Farrell, Shafran, & Fairburn, 2003; Fernández et al., 1994; Geller, Srikameswaran, Zaitsoff, Cockell, & Poole, 2003; Probst et al., 1995; Van Vliet et al., 2009;) focuses on small samples consisting primarily of girls. A smaller sample has less statistical power; therefore, the results must be interpreted with caution. Studies of girls may not generalize to boys. Much previous work (Bulik, Wade, Heath, Martin, Stunkard, & Eaves, 2001; Collins, 1987; Farrell et al., 2003; Fernández et al., 1994; Gardner & Brown, 2010; Kaufer-Horwitz, Martínez, Goti-Rodríguez, & Ávila-Rosas, 2006; Leary & Quinlivan, 2005; McCabe et al., 2006; Probst et al., 1995; Rhodes & O'Neil, 1997; Thompson & Thompson, 1986; Vartanian et al., 2004) studied individuals from college age to middle age and would not necessarily generalize to early adolescents or preadolescents. Some of these studies also examined people with diagnosed eating disorders and may not generalize to normally developing people.

For the current study, I plan to contribute to the literature by focusing on a sample of 135 adolescent boys with no present or prior history of eating disorders. Self-report data provided by the boys and by their mothers will be used, as well as body measures objectively taken with three dimensional (3D) body scans. The aim will be to evaluate biases in the boy's estimates of their body size. It is expected that there will be an association between the boy's self-reported body size and (a) his preferred (ideal) body size, (b) his mothers' Stunkard estimate of his body size, (c) her self-reported body size, (d) the boy's estimate of his mother's body size and (e) the objectively measured size of six body parts (hips, waist, thighs, full chest, bicep, and distance from the floor to mid-back) controlling for the boy's objectively measured BMI. It is also expected that when boys are more out of the norm (overweight or underweight) mothers' estimates will be less accurate.

II. REVIEW OF THE LITERATURE

In this chapter, I will address in detail the different methods for measuring body size and weight as well as findings pertaining to research subjects' accuracy when making these estimates. Although some studies were conducted with eating disordered participants, the focus I will take is not about eating disorders but rather how the method was used to measure participants' estimates of body size and weight and factors that may bias those assessments. Adolescents often inaccurately judge their own body size and weight. Understanding the accuracy of these judgments among early adolescent boys may contribute to future research seeking to understand important decisions they make pertaining to food intake, activity levels, and the self-images they carry into their identity formation processes and their early close relationships with romantic partners.

Self-Report Measures

Paper-pencil techniques have been the predominant method for assessing body size and weight. Although self-report measures can have questionable reliability, Bulik et al., (2001) found self-reported Body Mass Index (BMI) , which is calculated as the ratio of self-reported weight (converted to Kilograms) and self-reported height (in meters squared), to be a reliable estimate of true BMI. Most people know these vital statistics for themselves so it is not surprising that correlations between self-reported and measured height and weight for men ($r=.90$, $r=.97$, respectively) and for women ($r=.94$, $r=.98$, respectively) are very high. Similarly, Elgar et al., (2005) used a sample of 418 adolescents (190 boys and 225 girls) with a mean age of 16 to assess the validity of self-reported height and weight. Although the discrepancy between self-reports and measures of weight was greater for girls (*M*=-.61 kg; *SD*=5.76) than for boys (*M*=-.43 kg; *SD*=3.84), the correlations between self-reported and objective weight were high for girls (r=.95) and boys (r=.94). Large correlations were also noted between self-reported and measured height for girls (r=.76) and boys (r=.87). Participants who were obese or overweight tended to underestimate their weight significantly more than those who were normal weight. Of the 4.4% who were objectively obese two-thirds (2.8%) self-reported as obese. Similarly, of the 18.7% who were objectively, overweight only three-quarters (13.9%) self-reported as overweight. Stunkard et al., (1983) introduced figural stimuli which can be used to assess a person's body size, body ideal, body (dis)satisfaction, and assumed appearance to others. Individuals choose one of nine progressively fatter silhouettes in response to the stem question of the assessment objective. The silhouettes range from extremely thin to extremely heavy. The use of body silhouettes has become a prominent strategy for assessing body image. In the literature I report here, I will refer to this measure, including modifications to the technique, as Stunkard's silhouettes.

Rasmussen et al., (2007) used Stunkard's silhouettes in a sample of adolescent boys and girls in Sweden. Overweight and obesity are rare in Sweden. Only 11.4% of the girls were overweight; only 14.3% of the boys were overweight; rates of obesity were only 2.8% for girls and 3.6% for boys. The 2,726 participating adolescents (1,317 female; 1,409 male) had a mean age of 15. Height and weight were measured two times by a trained study nurse. Participants also provided self-reported weight and height, which were defined as 'accurate' if the difference was less than 1.0 kg and 1.0 cm, respectively. The results showed that, on average, girls under-reported their weight by 1.3 kg and boys under-reported their weight by .3 kg. Obese boys and girls had a tendency to underestimate their weight more, girls by 3.8 kg and boys by 5.2 kg. More girls underreported their weight (48.2%) than reported it accurately (41.5%) and only

10.3% over-reported. The boys' reports were more even across categories of accuracy (under-report = 31.6%, over-report= 33.1%, and accurate = 31.6%).

Al-Sendi et al., (2004) administered Stunkard's silhouettes to 504 Bahraini adolescent males (249) and females (257) between the ages of 12-17. A trained person measured weight and height, and BMI was calculated for each participant. When comparing adolescents' perceptions of current weight in relation to their actual weight, the majority of overweight boys (60%) perceived themselves to be normal but only 34% of the overweight girls did. Almost 24% of obese girls considered themselves obese versus only 19.4% of obese boys. Overall, adolescents in this sample tended to underestimate their body size, but boys were significantly less accurate than girls in this study. When selecting silhouettes for their actual versus ideal body size, underweight adolescents of both genders and normal weight boys chose a heavier silhouette as their ideal, normal size girls chose a lighter silhouette for their ideal, and overweight and obese adolescents of both genders chose a silhouette that was significantly lighter for their ideal. From the results, we can conclude that the ideal selection is a good predictor for self-selection in that underweight participants tend to select a heavier silhouette; whereas, overweight tend to select a lighter silhouette.

Bulik et al., (2001) mapped BMI values to the standard figural stimuli developed by Stunkard et al. (1983) in a sample of 16,728 females and 11,366 males ranging in age from 18-100. The sample was divided into 6 age cohorts: 18-30, 31-40, 41-50, 51-60, 61-80, and >80. A BMI>30 was used to indicate obesity and a BMI<20 was used to indicate thinness. Associations between objectively measured BMI and choice of figural stimuli were .81 for females and .73 for males, indicating a strong relation between true BMI and self-selected silhouettes. The modal silhouette chosen by women was 4, which goes with the BMI of 23.1. This mode was slightly lower than the mean BMI of the female sample of 24.1. The modal silhouette chosen by men was 5 which corresponds with a BMI of 25.8, quite near the mean BMI of 25.5 for the male sample.

Kaufer-Horwitz et al., (2006) looked at a sample consisting of 2339 Mexicans (1092 men and 1247 women) between the ages of 20-69. Participants were excluded if they had been on a weight reduction diet within 6 months prior to the study, had fever, infection, or other catabolic diseases, were pregnant or lactating, or had given birth within 6 months prior to the study. BMI was measured objectively, and each participant selected the silhouette that best represented their current body size. The researchers developed two statistical models (one for each gender) for reliably predicting BMI based on silhouette selection. The models statistically explained 49.3% of BMI variance in males and 58.7% of BMI variance in females with the 'silhouette' self-selection. Among Mexicans, the selected silhouette was a good predictor of BMI except for the first (smallest) silhouette. Both men and women who selected this silhouette tended to be heavier than expected (BMI = 21.7 versus 19.4 expected for men and 22.9 versus expected 18.9 for women).

Discrepancies in women's self-appraisals (how they think they look) and reflected appraisals (how they think others think they look) were studied by Leary and Quinlivan (2005). Three-hundred and eighty female undergraduate participants rated themselves using a modification of Stunkard's silhouettes. Participants selected from 27 possibilities such that each of Stunkard's original 9 silhouettes could be identified as "exactly like me," "slightly larger than me," or "slightly smaller than me". Participants then stood alone in a room facing a one-way mirror while an observer supposedly viewed them for two minutes in order to provide feedback on their appearance. However, the "feedback" was bogus and actually was one of three pre-determined randomly selected possibilities. The feedback conditions were: self-congruent (feedback was identical to the participant's self-rating); social-congruent (feedback was identical to the participant's expectation of how other people view them); and idealized (feedback was thinner than the participant's self-rating). After receiving feedback, the participants rated the accuracy of the bogus observer's feedback. The results showed that participants whose self-appraisals were heavier than their anticipated reflected appraisals judged self-congruent feedback as less accurate. In other words, on average, participants preferred reflected appraisals indicating they were thinner than they rated themselves, even though that feedback was not congruent with self-appraisals. This is an indication that girls' self-reports, at least in the experimental context, may be defensively pessimistic and that they want inaccurate but flattering feedback from others.

Peterson, Ellenberg, and Grossan (2003) assessed the reliability of BMI-based Stunkard-like silhouettes. Their sample included 215 adolescents (75 females, 140 males) from grades 9 through 12. The scale consisted of 27 variations on a scale of 9 silhouettes. Each of the 27 points along the scale represented an increase of one BMI unit ranging from a low of 14 BMI points to a high of 40 BMI points. Participants were asked to select a box to reflect their current appearance and a box to reflect their ideal appearance. Test-retest reliability revealed strong Pearson r coefficients (ranging from .79-.99). For the actual body image, reliability was .85 for females .79 for males. For the ideal body image, reliability was .82 for females and .83 for males. For both males and females, there was not a significant difference between perceived actual BMI and desired BMI.

Conley and Boardman (2007) compared self-report and actual weight among 20,745 adolescents included in the three waves of the National Longitudinal Study of Adolescent Health. The participants were originally in grades 7 through 12. Participants first self-reported their weight in pounds, and then researchers used a standard scale. The study then focused on

2,858 adolescent girls with normal weight (measured BMI between 20 and 25). Participants who overestimated their weight by more than 40 pounds were excluded from analysis. Consistent with prior research showing a general tendency for underestimation, participants tended to report weights that were 1.5 pounds lighter than their actual weight. However, when asked to report if they considered themselves underweight, normal, or overweight, 22.3% of the participants who were actually normal weight, reported perceiving themselves to be overweight. As participants actual weight increased, the average weight discrepancy increased as well. This study found that among normal weight girls there is a tendency to overestimate weight and that this tendency increases among objectively thinner (normal) girls.

Unlike the above literature, which instructed participants to estimate their own body weight and/or size, Vartanian et al., (2004) instructed their participants to estimate weight and evaluate size on a target individual (color photograph of a woman). The sample included 214 undergraduate students (165 women, 44 men, and 5 unspecified). Participants were identified as dieters or nondieters (based on the Restraint Scale which measures dietary restraint). Each participant viewed one photograph (chosen randomly from 10 pictures) of the front view of a woman's body (no face was shown) dressed in close-fitting dark pants and a red long-sleeved top. The photographs represented a range of BMI values within normal range (19-24). Participants estimated the weight and rated the body size of their target individual. Ratings of the body size were based on a 7-point scale; a rating of 1 indicated that the target was perceived to be on the thin side and a rating of 7 indicated that the target was perceived to be on the heavy side. All of the numbers between 2 and 6 were between the thinnest and heaviest selection. The accuracy was the difference between estimated and actual target weight. Dieters and nondieters did not differ in their estimates of the target's body weight. Ignoring dieting status, about 60% of participants underestimated the targets' weight, whereas approximately 40% overestimated it. Interestingly, the heavier the target was objectively, the more her weight was underestimated.

To summarize the findings pertaining to research on the accuracy of self-reports when participants judge their own weight or size, or that of another, several patterns emerge across the studies. Among normal weight girls, the tendency was to report being overweight and girls with the lowest BMI had the highest rate of overestimation (Conley & Boardman, 2007). Furthermore, girls tended to prefer inaccurate but flattering feedback (Leary & Quinlivan, 2005).

Most obese adolescents regardless of gender did not self-report being obese (Al-Sendi et al., 2004). The majority of overweight boys tended to perceive themselves as normal (Rasmussen et al., 2007). When asked to estimate weight and evaluate size on a target individual, female undergraduates tended to underestimate the target's weight. Also, if the target's BMI was heavier, her weight was underestimated more indicating that participants were bad guessers of weight (Vartanian et al., 2004).

Technological Approaches

The previous measures focused on self-report and simple objective measures of accuracy. The following section focuses on more technological approaches that rely on instrumentation rather than self-report from the participants. These procedures involve image distortions that participants attempt to adjust to an accurately undistorted state or an adjustable light beam apparatus with which participants attempt to represent accurately the width of body parts.

Collins (1987), Gardner and Brown (2010), Probst, Coppenolle, Vandereycken, and Goris (1992), Probst et al., (1995), and Rhodes and O'Neil (1997) used a video camera to distort photographs of participants' bodies. The common components of this procedure will be reviewed before the findings are detailed from the studies using it. The procedure begins as photographs are taken of the individual participant in a black leotard on a platform against a light grey background. A video camera is used to distort the photographic image. The distortion may range over the entire continuum of extreme overweight through to extreme underweight. The distorted image is fed into a monitor and viewed by the participant. Participants then adjust their photo by turning a dial. During some trials, the subject is shown a thinner image and is asked to adjust the image upward until it represents her/his true body shape (ascending). During other trials, the subject is shown a wider image and is asked to adjust it downward until it represents her/his true body shape (descending). Typically, the starting position of the picture is counterbalanced between ascending and descending trials to eliminate any ordering effects. Accuracy is measured on a percentage-based scale where 100 indicates 100% accuracy, 50 indicates an underestimation of body size by 50% and 150 indicates an overestimation by 50%. Collins (1987) tested the reliability of this technique in increments of minutes, days, weeks, and months across different age groups ranging from 17-60, years with body weights ranging from normal weight to obesity and obtained reliabilities that ranged from .61-.97.

Collins (1987) used this video distortion technique with 60 obese females attending a weight control program at Macquarie University, 25 hospitalized anorectic patients, and a control group of 50 female university students from an introductory course in psychology. The control group and anorexic group were the most accurate with mean estimates of 99.12 (SD=10.67) and 101.04 (SD=15.79), respectively, and not significantly different from each other. The obese group was significantly different from both groups and revealed an average overestimate of 12% (M=112.22, SD=18.7). Although a significant difference between the control group and anorexic group would be expected (Schneider, et al., 2009), it is possible that the treatment received in the hospital helped the anorexic patients perceive themselves more accurately.

In a variation of this procedure, Gardner and Brown (2010) had participants not only adjust the pre-distorted images to represent their true shapes, they were also asked to view a static distorted image to judge if it was wider or thinner than they actually were. The participants included 92 college undergraduates; including 66 women (mean age = 22.02) and 26 men (mean age = 23.35). The static image of the participant's frontal profile was randomly distorted to be either too wide or too thin. Participants were asked to judge whether the static image of them was distorted wider or thinner than they actually are. Each participant was shown a total of 320 images with varying percentages of distortion. Participants also completed the Body Image Assessment Scale-Body Dimensions, which is similar to the Stunkard silhouettes. On average, both male and female participants tended to overestimate their body size with the Stunkard-like drawing scale (4.04% and 6.95% respectively), but tended to underestimate their body size (-2.05 and -2.08 respectively) in the video distortion procedure. Finally, with the static distorted image, men slightly overestimated (.32%) and women slightly underestimated (-.06%) their actual size.

Rhodes and O'Neil (1997) retrospectively examined 101 obese women (mean age = 39.4) who had joined a weight loss program. Weight, height, waist and hip circumference, and elbow breadth were all obtained for each participant at entry of the weight loss program. The women were placed in one of three categories based on the measurements: gluteal-femoral obesity (34 participants), abdominal obesity (34 participants), and mixed-type obesity (33 participants). In a live video distortion procedure, 29.4% of the gluteal-femoral obesity group underestimated, 8.8% overestimated and 61.8% were accurate in body size estimation. Of the abdominal obesity group, only 5.9% underestimated, 20.6% overestimated, and 73.5% were accurate in body size estimation. Like the abdominally obese, 6.1% of the mixed-type obesity group underestimated, 9.1% overestimated, and 84.8% were accurate in body size estimation. Abdominally obese women were more likely to overestimate their body size, while gluteal-femorally obese women were more likely to underestimate their body size in the video distortion procedure. This suggests that where women carry their weight affects a bias in their body image.

Probst et al., (1995) studied 53 anorexia nervosa patients (mean age = 22.39), 38 bulimia nervosa patients (mean age = 25.2), and 36 college students with no history of eating disorders (mean age = 22.2). The participants were all female. The anorexia nervosa and bulimia nervosa were inpatients at the Eating Disorders Unit of the University Center of Kortenberg. The video distortion procedure was completed under three conditions: (a) they adjusted their own distorted image to represent their true shape, (b) their ideal body shape, and (c) they adjusted the distorted image of a neutral object to produce its true shape. Accuracy did not differ among the groups in terms of the participant's own image or the neutral image. However, for the ideal body, bulimics (M=80.1, SD=12.5) had a significantly smaller ideal body image than did anorexia patients (M=98.1, SD=12.6) and controls (M=98.6, SD=7.7). These results are similar to those of Collins (1987) and show that using this procedure; anorexic patients judge their bodies as accurately as control participants.

McCabe et al., (2006) allowed participants to view the undistorted image while adjusting the distorted image so they could base their estimations on more than just memory. They also included the estimation of a neutral object (a vase) for control. The participants included males (82) and females (107) aged between 18 and 36, and the mean BMI for both genders was near the top of the normal BMI range (24). Participants manipulated the distorted images at five different regions. For the self-image, the sites were chest, waist, hips, thighs, and calves. The images could be increased or decreased in 1% increments. Both men and women were more accurate with the vase than their own bodies, and they tended to overestimate all five specific sites, but their error was greatest for thighs and calves. However, men tended to overestimate more for all body sites compared to women.

When looking across these findings, there are several observations that can be made. Interestingly, having a diagnosed eating disorder was less biasing than was expected (Collins, 1987; Probst et al., 1995). Counter to self-reporting bias, it appears that obese participants tend to overestimate their size with this procedure (Collins, 1987). Also, the distribution of weight appears to be a biasing factor with this procedure. Abdomially obese women were more likely to overestimate while gluteal-femorally obese women were more likely to underestimate their body size (Rhodes & O'Neil, 1997). One study suggested that men tended to overestimate their body size at all body sites compared to women (McCabe et al., 2006).

Adjustable Light Beam Apparatus

Several studies (Thompson & Thompson, 1986; Altabe & Thompson, 1992; Docle et al., 1987) have used another technological approach to assess body size using an adjustable light beam apparatus. For the purpose of the current study, we will discuss Thompson and Thompson and Docle et al.. The basic procedure involves a single light beam displayed onto an adjacent wall from an overhead projector. When using the single light beam, the participant adjusts the width of the light beam until it represents the participant's estimation of the size (width) of a single body part. The body parts typically include sites that are related to weight such as cheeks (from side to side), waist (from side to side at the narrowest point), hips (from side to side at the widest point), and thighs (from side to side with legs together where the fingertips reach when arms are relaxed). After the participants estimate the width of each body part, the actual body site widths were measured by the experimenter and the amount of over or underestimation is calculated, where 100 represents an accurate estimation; values over 100 indicate the percentage of the overestimation, and values under 100 indicate the percentage of the underestimation.

Docle et al., (1987) used the adjustable light beam apparatus to study a sample of 34 female undergraduates (age range 18-35). The sample included 17 blacks and 17 whites. In this study, participants estimated their own body parts using the light beam and they estimated the same parts of a mannequin. In addition to weight sensitive body sites, non-weight-relevant body parts were also included, such as the knee. Findings indicated that overestimation was common. Both blacks and whites tended to make larger overestimates for their own weight-relevant and non-weight relevant sites compared to the matched sites on the mannequin. The only difference between ethnicity, was that blacks overestimated the mannequin's waist significantly more than their own whereas white participants did not.

Thompson and Thompson (1986) used four light beams to measure four different body parts concurrently. The participants were 30 male and 30 female undergraduate students ages 18-24 who had normal body weight, no history of anorexia or bulimia, no self-report of past or present eating disorder behaviors, and no history of obesity. A significant overestimation by an average of 14% and 25% was found for males and females, respectively; and this gender difference was also significant. Cheeks, waist, and thighs were overestimated significantly more than the hips. This is the only study using the adjustable light beam procedure that included males.

The adjustable light beam method tends to produce overestimation of body parts for both males and females, but females tended to overestimate more than males. From this research, it is clear that assessment of specific body parts may also be important when measuring accuracy.

Parent/other Report

The previous reviewed research has looked at different methods for measuring a child's body size and body perception. Parent's report of their child's body size can also be a biasing factor. In the following review of literature, we will review studies that looked at parent and child perceptions of the child's weight and body size.

Goodman et al., (2000) looked at differences between adolescent self-report and parental report of obesity. The sample included adolescents in grades 7 through 12 from the National Longitudinal Study of Adolescent Health. Data at baseline (T1) included 15,483 adolescents and included parental home interviews. One year later (T2), 11,495 adolescents completed a follow-up interview. At T1 and T2, participants were asked to give a self-report of their height and weight. At T2 participants were weighed and measured by a trained interviewer. BMI was calculated from self-reported height and weight at T1 and T2 (self-reported BMI) and measured height and weight at T2 (measured BMI). Weight perception was assessed by a 5-point Likert-type scale ranging from 'very underweight' to 'very overweight'. Parents reported if they believed the teen had a health problem concerning obesity. Participants' self-reports were considered inaccurate if their self-reported BMI did not fall in the obese range but their measured BMI did (underestimation) or if they described themselves as "very overweight" when they did not meet the criteria for obesity by measured BMI (overestimation). Significant gender differences were found for both weight and BMI such that adolescent girls tended to underreport their weight more than adolescent boys (M = 1.02 kg, M= .19 kg, respectively, $p<.000$). However, girls were more likely to report being very overweight at T1 and T2 (4.9%, 5.0%, respectively) compared to boys (2.0%, 2.0%, respectively). Girls were also more likely to have a parent report that they had a problem with obesity (7.4%) compared to boys (5.9%). Of the 9.7%

of participants who were classified as persistently obese, only 60.6% were reported by parent report as being obese and only 28.8% self- reported being obese. Thirty-four percent of the participants classified as persistently obese were not identified by parent or self-report. All teens were more likely to be identified as obese by a parent if they were from families with obese parents.

Van Vliet et al., (2009) looked at waist circumference in relation to the way adolescent girls perceive their body and the way their mothers perceive their daughter's body size. The sample included all 5th to 12th grade girls and their parents from a small town in Finland. Parents and adolescents completed questionnaires and anthropometric measurements over three consecutive years. The final sample to be analyzed included paired data from 237 girls and mothers. The girls self-reported their height and weight and indicated on a five-point Likert scale whether they were 'far too thin' to 'far too fat'. Mothers answered the same item about their daughter. The height and weight of each girl was measured to calculate BMI, and waist circumference was measured (midway between the tenth rib and the iliac crest). Inaccuracy was common, with underweight individuals overestimating their weight by 0.43 kg, normal weight individuals underestimating their weight by 0.41 kg, and overweight individuals underestimating their weight by 0.84 kg. Overall, 37% of the girls overestimated their BMI and 20% overestimated their waist circumference. However, among mothers, 98% underestimated their daughters' waist circumference. Mothers' perceptions agreed more often with the BMI than the waist circumference. On average, mothers were more accurate when estimating BMI than they were estimating waist circumference. Among girls, even when they were not overweight, they were more likely to describe themselves as overweight than their mothers were.

Skelton et al., (2006) assessed the difference between actual and perceived weight status of African American children (140) and their parents (103). Children's ages ranged from 10-19, and each child self-reported height and weight. Parents completed surveys if they had a child between the ages of 4-20 years and only one parent survey was allowed for each family. The child survey asked "Do you think you are: underweight (too skinny), normal weight, or overweight (weigh too much)"; ''Do you think your weight is: healthy, unhealthy, or other?" Parents also answered these questions for their child and indicated their attitude about weight (given a child's height) with the question ''Do you think being heavier is: good for your health, bad for your health, does not affect your health?" Based on self-report BMI measures, 37% of the children were either at risk of being overweight (19%) or overweight (18%) based on BMI measures from parents' descriptions of their child, 38% of parents classified their child as at risk of overweight (21%) or overweight (17%). Of the 52 children at risk of being overweight or actually overweight, 67% perceived themself as having normal weight and 77% thought their weight was healthy. However, as a group, the overweight children were less likely to perceive themselves as having a normal weight or a healthy weight. The kids who were actually overweight were more likely to think they are overweight than kids who are only at risk of being overweight. Furthermore, among parents, 68% felt their child's weight was normal and 80% thought their child's weight was healthy. Among the children, 17% considered being heavy 'good for your health'; 64% considered it 'bad for your health'; and 19% thought it 'does not affect health'. However, more overweight children recognized that being overweight was bad for your health. Surprisingly, a number of parents (28%), said that being heavier is 'good for your health'. Even when the parent identified their child as overweight, the majority reported their child's weight as healthy. Similarly, the majority of children who self-identified as at risk for overweight or overweight (self report of BMI) also self-identified their weight as normal and healthy.

Eckstein et al., (2006) studied 396 parents or guardians and their child, aged 2 through 17 years. Of the parents, 87% were mothers. Of the children, 60% were younger than 6 years and 42% were male. BMI was measured for 261 of the children who were present for the measures. Parents answered several questions about their child's weight and selected one of seven Stunkard-like sketches of boys and girls that most resembled their child. The sketches had been developed for different age groups (ages 2-5; ages 6-9; ages 10-13; ages 14-17). When asked to indicate whether their child was underweight, a little underweight, about the right weight, a little overweight, or overweight, parents of objectively overweight children were the most likely to report that their child was a little overweight or overweight and more often selected sketches of a heavier child. Among these parents, 26% were worried about their child's weight. Parents of older children (over age 6) were more likely to report their child as overweight (56%; 18% respectively) and more likely to be worried about their child's weight than those with children younger than 6 (40%; 15% respectively). Interestingly, only 22% of the parents of overweight children and only 14% of the parents of children at risk of overweight recalled their child's doctor ever mentioning that their child was gaining weight too fast or was overweight. The children that were as-risk of being overweight were those children whose BMI was not within the overweight category but were right below. Parents of at-risk or overweight children did not perceive their children as more physically limited than did the parents of non-overweight children in terms physical activity but they did report feeling that they had less influence over their child's physical activity levels.

Geller et al., (2003) examined 66 families consisting of mothers, fathers, and their high school aged daughters. The mean age for daughters, mothers, and fathers was 14.8 years, 42.9, and 44.5, respectively. The daughters completed Stunkard-like silhouettes (1983) but with 21 figures to represent the way they think they look and the way they would like to look. Daughters also described their weight and attractiveness on 7-point scales ranging from “extremely overweight” to “extremely underweight” and “extremely unattractive” to “extremely attractive” (note that higher scores indicate less heavy and more attractive). Mothers and fathers described their daughters on the same measures. Daughters chose a significantly larger silhouette (M=10.45, SD=3.77) than did mothers (M=8.45, SD=3.54) and fathers (M=9.35, SD=3.37). Daughters’ ratings of their ideal figure were significantly slimmer than their rating of their actual figure. Daughters also described themselves as significantly heavier (M=3.82, SD=.61) and less attractive (M=4.65, SD=.71) than did mothers (M=4.03, SD=.53; M=5.42, SD=1.18, respectively) or fathers (M=4.08, SD=.56; M=5.50, SD=1.01, respectively). Mothers’ and fathers’ ratings did not differ significantly for any of the variables.

Epstein, McCurley, and Murdock, (1991) assessed 53 families who had at least one obese child between 6 and 12 years of age and one obese parent. The participants were part of a study of family-based weight regulation from the University of Pittsburgh. This sample included 85 children and 74 parents. The average parent was 50 years of age and the average parent exceeded their optimal weight by 34.6%. The average child exceeded their optimal weight by 36.9%. Family members estimated their own weight and height and that of other family members, and they selected the Stunkard silhouette that best resembled the body shape of the person being judged. Weight and height also were objectively measured by the researchers. Estimated and measured percent overweight were highly correlated (r=.90) as were the silhouettes and measured percent overweight (*r*=.79). However, estimates of one's own weight was most accurate (R^2 = .96 and .97 for children and parents, respectively). Parents were somewhat less accurate in their estimates of their children's weight (R^2 = .87 and .87, respectively). Finally, children's estimations of their parents were least accurate (R^2 = .75 and .75, respectively). It appears that when judging one self, participants tend to be most accurate. Both parents and children tend to be less accurate when judging each other.

Jackson et al., (1990) looked at the mothers of preschool aged children to assess the mothers' accuracy in estimating the child's weight status. The sample consisted of 52 girls and 55 boys with a mean age of 5 years and mothers were between the ages of 20 to 40 years old. Mothers provided their own weight and height and estimated their child's weight status by answering the question, "Do you consider your child to be overweight, underweight, or about average in weight?" Investigators measured height and weight for each child. Children whose weight was at or above the population 90^{th} percentile for sex, height, and age were classified as overweight and those whose weight and height were at or below the population 10^{th} percentile were classified as underweight. Seventeen children (15.9%) were classified as overweight, 85 (79.4%) were classified as average, and 5 (4.7%) as underweight. Of those 17 children classified as overweight, 16 were considered to be average by their mothers. Of the 85 classified as average, only 9 (10.59%) were inaccurately classified as underweight. Inaccurate mothers tended to be heavier than those who were accurate. Results indicated that 72% of all mothers were accurate in identifying their child's weight status. Of those who inaccurately estimated (28%), 83% underestimated and only 17% overestimated.

From these findings, it appears that the majority of parents tend to consider their overweight and obese children average and healthy and overweight and obese children tend to consider themselves to be average and healthy as well (Jackson et al., 1990; Skelton et al., 2006). Perhaps parents want to be supportive and see the best in their child, but it could also reflect a lack of knowledge of child development and be problematic for the child at risk of health problems. Parents seemed more willing to see their overweight child as overweight if the child was older than 6 and especially when the child was a girl (Eckstein et al., 2006; Goodman et al., 2000). Although heavy parents tended to be less accurate in some ways, they also tended to be more willing to acknowledge that their overweight children were indeed overweight (Goodman et al.; Jackson et al.). Those parents who were inaccurate were significantly more likely to underestimate. Literature clearly shows that parents influence children in areas such as self-esteem (Reese, Bird, & Tripp, 2007) and even eating behaviors (Elfhag, Tynelius, & Rasmussen, 2010). However it is not clear if parents have a direct effect on children's ability to accurately judge their body size or what role parents' play in the child's biased self-perceptions.

Across all the studies reviewed, most studies that examine parental perceptions use an older sample (Bulik et al., 2001; Collins, 1987; Docle et al., 1987; Fernandez et al., 1994; Gardner & Brown, 2010; Kaufer-Horwitz et al., 2006; Leary & Quinlivan, 2005; McCabe et al., 2006; Probst et al., 1995; Rhodes and O'neil, 1997; Thompson & Thompson, 1986; Vartanian et al., 2004) and several include both male and female participants. None look just at males, but several look just at females. The studies that include younger adolescents are those that also include parents (Eckstein et al., 2006; Epstein et al., 1991; Geller et al., 2003; Goodman et al., 2000; Jackson et al., 1990; Skelton et al., 2006; Van vliet et al., 2009;) and all of these except two (Geller et al., 2003; Van vliet et al., 2009) include males, but again, none look just at males. Most of the studies that include parents use a younger sample where the age range begins at ten years old or even younger (Eckstein et al., 2006; Epstein et al., 1991; Geller et al., 2003; Goodman et al., 2000; Jackson et al., 1990; Skelton et al., 2006; Van vliet et al., 2009).

For the current study, I plan to contribute to the previous literature by looking specifically at accuracy and the biasing factors. Most of the literature presented here does not suggest parents might contribute to the bias of the child even though it is clear that they may contribute to the size of the child (Goodman et al., 2000; Jackson et al., 1990). Previous literature has attempted to look at accuracy (Al-Sendi et al., 2004; Conley & Boardman, 2007; Rasmussen et al., 2007) but not to the extent of the current study. The majority of previous research used self-report based on the child or the child and the parent; whereas the current study includes self-report, parent report, measured BMI, and body scans.

For the current study, I plan to look at the following questions:

1. Does knowing actual BMI of the child predict Stunkard silhouette of the child?
2. Does knowing actual BMI of the child and the selected preferred silhouette for the child predict Stunkard silhouette of the child?
3. Does knowing actual BMI of the child, child's preferred silhouette, and the Stunkard silhouette of the mother for the child predict child's silhouette?
4. Does knowing the actual BMI of the child, the child's preferred silhouette, and the Stunkard silhouette of the mother for herself (or the child's Stunkard silhouette for the mother) predict the child's Stunkard?
5. Does knowing the actual BMI for child, the child's preferred silhouette, the Stunkard silhouette of the mother for herself (or the child's Stunkard silhouette for the mother) and the actual body size of various body parts predict Stunkard silhouette of the child.

Specifically, how do Stunkard silhouettes, parent's reports, and actual body size of various parts of the body such as hips, waist, thighs, length from elbow to wrist, length from shoulder to shoulder, and biceps predict the silhouette of the child? In one final question, I consider whether the agreement between mother's and son's Stunkard silhouette of the child is affected by the degree to which the child's BMI is out of the norm.

It is expected that there will be an association between the boy's self-reported body size and (a) his preferred (ideal) body size, (b) his mothers' Stunkard estimate of his body size, (c) her self-reported body size, (d) the boy's estimate of his mother's body size and (e) the objectively measured size of six body parts (hips, waist, thighs, full chest, bicep, and distance from the floor to mid-back) controlling for the boy's objectively measured BMI. It is also expected that when boys are more out of the norm (overweight or underweight) mothers' estimates will be less accurate.

III. METHOD

Participants

The data for this study were collected as part of a larger project for which Dr. Lenda Jo Connell and Dr. Pamela Ulrich were principal investigators (Connell & Ulrich, 2006-2009). The purpose of the larger project was to investigate the physical and social-psychological dimensions of demand for apparel by “tween” boys (ages 8-14). The data did not include fathers because it was focused more on shopping and clothing. With one exception, the sample consisted or boys ranging from 9 to 14 years old. The sample for the funded study consisted of 147 mother-son pairs who participated in data collection that took place in Auburn, AL (November-December, 2006 and July-August, 2008). Sixteen cases were excluded from the current analysis because they were siblings to a study participant. The current analysis focused on only one child per family. Mother and son participants both provided survey data and the boy participated in a body scan procedure. To be included in the current analysis, both mother and son had to provide complete data on the survey, and a readable scan for the boy was also a necessity. Out of the 135 possible original participating pairs, there were 16 that were not included because one or more of these criteria were not met. Statistical comparisons between those dropped and those retained on all demographic variables revealed no differences that even approached statistical significance.

Frequency counts on variables descriptive of the sample are reported in Table 1. Table 2 presents descriptive statistics for variables included in the analysis. The mean age of the 119 participating boys was 11.41 years. The mean age of the 119 mothers in the current analysis was 41.27. The majority of mothers (75.6%) were married and generally well educated. Almost half of the mothers selected bachelor’s or master’s degree as their highest level of education and another 9% reported earning professional or doctoral degrees. Fathers were also well educated, with over half having education higher than an associate's degree. In terms of occupation, slightly over a fourth of mothers described themselves as professional and another quarter said they were home makers. Fathers' occupations were similar with the largest occupation category being professional. Exactly half of the families reported being dual earning families, and the other half said they were single earning families. The sample tended to over-represent upper income families with over 57% earning $75,000 or more. Although the majority of the boys in this study attended public school, nearly a fifth were described as home schooled.

Procedure

This convenience sample consisted of volunteers recruited through newspapers, e-mail, and posted flyers during the first data collection. Parents were required to give permission and be present during the procedure in order for the boys to volunteer. The first step was to determine if each boy fit the age 8-14 profile by asking when they were born. During data collection, participants were body scanned using a $[TC]^2$ NX 12 Body Scanner. The body scanner equipment dressing room was completely enclosed to ensure privacy. Participants entered and left the dressing room in their street clothes. During the scan, which only took a few seconds, participants wore appropriately sized closely fitted clothing, stood up straight, with feet positioned in marked locations, held handholds, and looked straight ahead. The scanner computer was located outside of the scanning booth and operated by a trained researcher. Mothers were able to be in the dressing room or nearby to observe the scanning process of their sons. Height and weight were measured at the time of scanning by research personnel and these were used to calculate BMI for each participant.

The mother and son participants also completed questionnaires addressing a variety of issues important to the goals of the funded project. Participants were identified by a code number on each body scan and the matching questionnaire. Once the boy and the mother completed the questionnaire and the boy completed the body scan, the boy was given a monetary incentive.

Measures

Body Mass Index (BMI). BMI was the operational definition of the child's accurate body size and was calculated using weight in pounds and height measured in inches with the following formula (*weight in pounds/height in inches^2 * 703)*. Although BMI was used as our assessment of accuracy, there are limitations to this measure. BMI is a useful screen for obesity, overweight, healthy weight, or underweight, but it is not a direct measure of excess fat. Since muscle has greater density than fat, a very muscular person of a particular height may have a higher BMI than an out-of-shape fat person of the same height. The Centers for Disease Control (CDC, 2011) use the same formula for children and adults but the criteria used to interpret the meaning of the BMI are different. According to the CDC, for children, age and sex specific percentiles are needed because the amount of body fat changes with age and the amount of body fat differs between girls and boys. BMI increases, on average, across the age groups 8-14 in the population. The CDC defines healthy weight as anything between the 5th and 84th percentile for BMI. On average, boys in the current sample had a BMI of 21.4 (SD = 5.54), which falls into the overweight range for ages 8-12; however, for ages 13 and 14, the overweight category is at 21.8 and 22.6, respectively. See Table 2 for descriptive statistics for BMI and all other variables included in the analyses. We also used this growth chart to map where the boys BMI is according the obese and overweight statistics. We did find that a large portion of the boys did fall above the 50th percentile and that the boys did tend to be overweight or obese.

Boy's discrepancy from the norm BMI. The CDC (2011) provides BMI growth charts that take into account age and sex for children. For the current study, we used BMI scores from this growth chart to calculate the norm for each year of age (8-14). We then calculated three norm discrepancy variables: absolute discrepancy, amount under norm, and amount over norm (see Table 2). The absolute discrepancy was calculated as the absolute value of the difference between the age-based norm and the boy's BMI. The absolute value showed the size of the discrepancy from the norm but not the direction. The scores of amounts above and below the norm were calculated as follows: for amount above, the norm was subtracted from the boy's BMI and any negative scores were coded zero, while for the amount below, the BMI was subtracted from the norm and any negative scores were coded zero.

Dimensions of Body Parts. Body scanners used were derived from the [TC]^2 NX-16 3D body scanner. Scanner accuracy is point accuracy <1mm (0.0394 in.) and circumferential accuracy <3mm (0.1181 in.) ([TC]^2 , 2007). These scans were used to measure specific body dimensions. For this study, six specific measurements, all in inches, were made: thighs at their maximum girth, hips around the seat, waist at its maximum girth, biceps at maximum girth, chest at maximum girth, and the distance from the floor to the waist on the back side. Since the sizes of the various body parts were highly correlated, it would not be possible to use more than one measure at a time in the analysis because of multicolinearity. Therefore, a factor score was generated using the principal components factor analysis procedure. Factor scores were output by that procedure and used in the analysis.

Perceptions of Body Size. The Stunkard Silhouettes (Stunkard et al., 1983) were used to assess the participants' perceptions of aspects of the body size of participating boys and mothers. Individuals chose one of nine progressively fatter silhouettes in response to the stem question of the assessment objective. The silhouettes range from extremely thin to extremely heavy. For the current study, the boy and the mother selected the silhouette that looked most like their own figure, they each selected from a set of silhouettes that they believed looked most like the other (son selects for mother; mother selects for son), and the boy selected the silhouette that would be his current preferred body size. Sons, on average, selected a silhouette of 3.82 (SD = 1.28) for their actual and 3.87 (SD = .94) for their preferred size. The difference between boy's perceived actual and preferred body size was not significant for this sample (p = .825). Interestingly, mothers' selection for their sons averaged smaller than sons' selection for themselves. Mothers selected a much larger silhouette for themselves and their son's estimates of her size were not statistically different from hers. The fact that silhouettes are subjective perceptions rather than objective assessments is evident from the wide range of BMI scores found among the boys that endorsed each silhouette. For the 6th of the nine silhouettes, for example, the BMI range is 26.73-37.55.

Demographic Control Factors. Age, ethnicity and income were included in the multivariate analysis as control factors. Age was measured in years and ranged from 8 to 14. Ethnicity was assessed in terms of six categories, African American, Asian, Caucasian, Hispanic, Native American, and Other. However, among the analysis sample, four of those categories were represented by a total of four individuals. Hence, ethnicity was collapsed to a categorical variable to indicate Caucasian (coded 1) versus other (coded 0). The latter group was represented predominantly by African American participants. Income was a categorical variable with six categories. Higher scores indicated greater income.

Table 1. Descriptive statistics for the full sample.

Variable	Category	N	%
Son's Age	8	1	.8
	9	19	16.0
	10	21	17.6
	11	19	16.0
	12	21	17.6
	13	20	16.8
	14	18	15.1
Son's Ethnicity	African American	23	19.3
	Asian	1	.8
	Caucasian	92	77.3
	Native American	2	1.7
	Other	1	.8
Marital Status	Single	14	11.8
	Married	90	75.6
	Divorce	13	10.9
	Widowed	1	.8
Mother's level of education	Some high school	1	.8
	High school diploma	12	10.1
	Some college	28	23.5
	Associates degree	9	7.6
	Bachelor's degree	37	31.1
	Master's degree	20	16.8
	Professional degree	4	3.4
	Doctorate degree	8	6.7
Father's level of education	Grade school	1	.8
	Some high school	1	.8
	High school diploma	16	13.4
	Some college	21	17.6
	Associate's degree	10	8.4
	Bachelor's degree	23	19.3
	Master's degree	12	10.1
	Professional degree	6	5.0
	Doctorate degree	19	16.0
Mother's occupation	Upper management	6	5.0
	Middle management	11	9.2
	Professional	34	28.6
	Sales	4	3.4
	Service worker	4	3.4
	Student	2	1.7
	Home maker	30	25.2
	Retired	3	2.5
	Other	25	21.0

Table Continues

Table Continued

Father's occupation	Upper management	13	10.9
	Middle management	13	10.9
	Professional	45	37.8
	Sales	4	3.4
	Service worker	14	11.8
	Student	1	.8
	Retired	1	.8
	Other	27	22.7
Income source	Dual	57	49.6
	Single	58	50.4
Income level	Under $24,999	9	7.6
	$25,000 to $49,999	25	21.0
	$50,000 to $74,999	19	16.0
	$75,000 to $99,999	23	19.3
	$100,000 to $149,999	28	23.5
	Over $150,000	15	12.6
Son's schooling	Public	93	78.2
	Private	8	6.7
	Home school	17	14.3

Table 2. Descriptive statistics for all variables used in the analysis.

Variable Name	M	SD	Minimum	Maximum	Skew Statistic
BMI	21.14	5.49	11.42	39.24	1.14
Son's selection of silhouette for self	3.95	1.26	1	7	-.14
Son's preferred silhouette	3.92	.89	1	6	-.41
Son's selection of silhouette for mother	4.81	1.07	2	7	-.44
Mother's selection of silhouette for son	3.60	1.61	1	8	.48
Mother's selection of silhouette for self	4.94	1.33	2	8	.31
Maximum measure of chest in inches	34.01	4.98	26.57	50.83	.79
Maximum measure of waist in inches	29.07	5.32	21.11	43.37	.83
Maximum measure of hips in inches	33.68	4.95	24.87	47.02	.59
Distance from the floor to the mid back in inches	37.05	3.90	24.64	46.22	.07
Maximum measure of biceps in inches	10.55	3.03	7.23	33.24	3.79
Maximum measure of thighs in inches	18.98	3.39	12.92	31.06	1.10
Factor Score	-.01	.99	-1.53	2.68	.68
Income	3.68	1.53	1	6	-.11
Son's Age	11.45	1.71	8	14	.01
Ethnicity	2.69	1.03	1	9	1.32
Discrepancy from the norm	4.17	4.94	.00	22.74	1.53
Over the norm	3.92	5.10	.00	22.74	1.47
Under the norm	.26	.67	.00	4.58	4.08

Plan of Analysis

We first calculated descriptive statistics (i.e., mean, standard deviation, minimum, maximum and skew statistic) for all variables examined in our research questions. We also explored the variables to see if they varied in different subsamples based on race, age and other demographic attributes. We also examined differences between mother and son across paired variables (questions that both mothers and sons answered). In addition to these mother-son comparisons, which emphasize mean differences, we also correlated mother-son paired variables to see how closely they varied together.

For the primary analysis for this study, regression analyses were conducted. In total, six hierarchically nested regression analyses were conducted. Each regression model added an additional predictor or set of predictors to a prediction equation explaining variance in the adolescent boy's self-selected Stunkard silhouette:

1. The first step tested the association between the boy's Stunkard silhouette and his BMI. This step accounted for "accuracy". All subsequent steps explained forms of bias in boy's body size estimate.

   Child's silhouette = BMI

2. The second step added the boy's Stunkard preferred silhouette.

   Child's silhouette = BMI + child's preferred silhouette

3. The third step added Stunkard silhouette selected by the mother for the child.

   Child's silhouette = BMI + child's preferred silhouette + mother's silhouette for the child

4. The fourth step added Stunkard silhouette selected by the mother for herself.

Child's silhouette = BMI + child's preferred silhouette + mother's silhouette for child + mother's silhouette for self

5. The fifth step added the child's Stunkard silhouette selected for the mother.

   Child's silhouette = BMI + child's preferred silhouette + mother's silhouette for child + mother's silhouette for self + child's silhouette for mother

6. The sixth step added the factor score representing the body size of various body parts.

   Child's silhouette = BMI + child's preferred silhouette + mother's silhouette for the child + mother's silhouette for self + child's silhouette for mother + factor score for size of body parts

Finally, the seventh step repeated the sixth but included the three control variables, child age, ethnicity and income, to test whether findings were robust to these control factors.

The final research question was whether mother's silhouette selection for the son was affected by the degree to which the child's BMI was out of the norm (discrepant). We tested this in two ways. The first test ignored the direction of the norm discrepancy (absolute value). For this analysis we conducted a two-step regression entering BMI in the first step and discrepancy in the second. The second test did not ignore the direction of the norm discrepancy. In this test, we again conducted a two-step model with BMI in the first step. Then, the variables representing amounts over and under the norm were entered in the second step.

IV. RESULTS

For the current study, we will interpret <.10 as significant. Comparisons between the younger age group (8-11 inclusive) and the older age group (12-14 inclusive) are shown in Table 3. Significant differences were only found in measurements of the six different body parts and the factor score that represents their combination. Since older boys would be expected to be larger and taller, these differences are no surprise. Self-perceptions registered by Stunkard silhouette choices for self, preferred body size or from mother did not differ by boy's age group.

Comparisons between the different ethnicities in the current study are presented in Table 4. Of the 11 variables examined, only one was significant. The thighs of the minority participants were significantly larger than those of Caucasian participants.

Table 5 shows paired comparisons between means for mothers and boys on paired sets of variables. Mothers perceive their sons to be smaller than the boys do themselves. Sons and mothers tend to agree on the size of the mother.

Table 6 shows the bivariate correlations between the variables included in multivariate analyses. Note that some correlations are very strong. Of the 120 correlations in Table 6, 36 of them are greater than .60. Not surprisingly, BMI of the son tends to be strongly correlated with mother's Stunkard for son, son Stunkard for self, and for all of the body part measurements except for biceps. Mother's Stunkard for son was strongly related to sons' Stunkard for self and all body part measurements except biceps. There is also a significant correlation between boys' selection for actual self and boys' selection for preferred self.

The primary analyses for this study were the hierarchical multiple regressions presented in Tables 7 and 8. Table 7 shows the contributions to explained variance made at each step of the hierarchical regression, and Table 8 gives the unstandardized and standardized coefficients at each step. The boy's BMI was added in the first step because it was our definition of accuracy.

BMI accounted for two-thirds of the variance explained by the seven step model (i.e., 45.1% of the total 68.1%). By looking at the coefficients in Table 8, the unstandardized coefficient of .154 means that a one unit increase in BMI is associated with an increase of .154 units on the Stunkard scale. Said differently, boys separated by one silhouette on the Stunkard scale would be 6.5 BMI units apart on average. The standardized measure indicates that a standard deviation increase in boys' BMI is associated with a .67 standard deviation increase in silhouette selection. This coefficient and the very large variance component indicate this is a strong association.

Step 2 added the boy's Stunkard silhouette for his preferred self and explained 11.4% more of the variance. In Table 8, we see a positive relationship between son's silhouette selection for self and for preferred self. This finding reveals the effect of the first biasing factor in the model. Boys who prefer to be larger perceive themselves to be larger, controlling for their actual size (BMI). To be specific, a one silhouette increase in one's preferred size is associated with a .48 silhouette increase in silhouette selection for self, controlling for BMI. The standardized effect shows that a standard deviation increase in the preferred silhouette is associated with a .34 standard deviation change in actual silhouette, controlling for BMI. This is a moderate association.

In the third step, mother's silhouette for son was added. This significant contributor explained almost 10% more of the variance and revealed another source of bias in boy's silhouette selections. Boys whose mothers perceive them to be larger see themselves as larger, controlling for their BMI, self-selected size and preferred size. A one silhouette increase in mother's silhouette for son is associated with a .37 silhouette increase in the boy's silhouette selection for himself. The standardized parameter shows a .47 standard deviation increase in the boy's silhouette selection with a 1.0 standard deviation increase in the mother's selection for the boy. This is a moderate sized association.

Steps 4-7 add the silhouettes selected for the mother by the mother herself and the son, respectively, the factor score representing the principle component of the six physical dimensions derived from the body scan, and the control variables. None of these steps added significantly to the variance already accounted for in the son's physical self-description. However, several of the coefficients seen in these steps are significant. In order for this to occur, these variables included in the later steps must be splitting variance that is already accounted for. It could be argued that since no new variance is added, the first three steps effectively tell the story. However, since we expected to find associations with the boy's silhouette selection among the later-entered variables and in several cases our expectations are supported, we continue to present these subsequent steps.

Step 4 included mother's silhouette for self but its coefficient in that step was non-significant controlling for the other variables present. However, in Step 5 when the boy's silhouette for mother was included, not only did it predict the boy's silhouette selection ($p = .07$), but mother's selection for self also became significant ($p = .035$). Mother's silhouette selection for self is a significant negative predictor of son's silhouette selection controlling for the other variables in the model at Step 5 and remains so at Steps 6 and 7 (see Table 8). The larger the mother's self-description, the smaller the boy's silhouette selection controlling for BMI and the other variables in the model. A one-silhouette change in the mother's self-description is associated with a .15 silhouette decrease in the boy's silhouette selection for himself (and in standard deviation units the decrease is approximately -.16). This is a small but potentially interesting effect.

The boy's silhouette selection for his mother had the opposite effect on his own self-description. An increase of one silhouette in the boy's description of his mother is associated with a .16 increase in his own silhouette selection (and in standard deviation units, this increase is approximately .14). This is also a small effect that technically only approaches statistical significance (p = .07). Together these results suggest that the mother's size has opposing biasing effects on the boy's self-assessments. Holding boy's views of their mother's size constant, boys appear to understate their size when their mother's see themselves as larger. Conversely, holding mother's self-views constant, boys tend to overstate their own size when they see their mother's as heavier.

In Step 6 of the model, a factor score representing the dimensions of six body parts was added. The redundancy of this factor score with BMI is immediately seen because once this variable is added, the coefficient for BMI becomes non-significant in the model even though it initially accounted for over 40% of the variance. Furthermore, in Step 6 when it is initially entered, the coefficient for the factor score is also not a significant predictor of boy's silhouette selection. Interestingly, however, in Step 7, when the control variables income, age and ethnicity are included, the effect of the factor score approaches significance (p = .067) even though its tolerance is very low (tolerance = .219) due to its strong correlation with BMI and other variables. Table 3 shows that age is related to all of the measures of body parts included in the factor score, and Table 6 shows a strong correlation between age and the factor score (r = .53). At Step 7, with age controlled, a standard deviation change in the boy's body size factor score is associated with a .28 standard deviation increase in silhouette selection. Therefore, another factor biasing silhouette selection may exist in the sheer size of boys as they get older. With BMI and other variables controlled, bigger boys tend to select larger silhouettes even after accounting for their actual BMI. No other changes in the pattern of findings from Step 6 appear when the controls are included in the seventh step, suggesting the findings are robust to their influence.

Given that the factor score was largely redundant with BMI in the main regression analysis, we decided to explore whether the size of individual body parts would make a unique contribution to boys' self-selected silhouettes after controlling for BMI. For these analyses, we ignored the other perception-based assessments and control variables. Six regression models were examined (see Table 9). From these analyses we find waist and hips significantly and positively predict son's silhouette selection for self above and beyond the effect of BMI. A one inch increase in the waist is associated with a .15 increase in the silhouette selection. In standard deviation units, this ratio is 1:62. This is a strong association. A one inch increase in the hips is associated with a .08 increase in the silhouette selection and in standard deviation units this ratio is 1:31. This is a moderate association.

In the final analysis, the goal was to see whether and how mothers' silhouette selections for their sons are affected by their sons' discrepancy from the norm. In one hierarchical model we regressed mother's Stunkard silhouette selection for son on BMI (Step 1) and the absolute discrepancy (Step 2, see Table 10 for variance components and Table 11 for parameter estimates). Boy's BMI explained 60% of the variance in mother's selection of silhouette for her son. This is interesting since BMI accounted only for 41% of the variance in boy's silhouette selection for himself. However, the son's absolute discrepancy from the norm was not related to mother's silhouette selection for the son with BMI controlled. This expectation was not supported.

In a second hierarchical regression, we replaced absolute discrepancy in Step 2 with the discrepancies assessed specifically as over and under the normative BMI (see Tables 12 and 13) and found that almost 2% of the variance in mother's selection of the son's silhouette is explained by the direction of the discrepancy. Although the amount the boy's BMI departed from the norm in the overweight direction was unrelated to the mother's silhouette selection for her son when his BMI was statistically controlled, for boys under the BMI norm, there was a significant additional effect on mother's silhouette selection. With BMI controlled, mothers selected smaller silhouettes for their sons the more under the norm they were. Specifically, a standard deviation increase in their sons' deviation below the norm was associated with a .15 standard deviation decrease in mothers' silhouette selections for their sons over that expected by their known BMI. This was a small but significant association.

Table 3. Comparisons of the younger age group (8 year olds – 11 years old) and the older age group (12 years old – 14 years old) for physical self-descriptions, as well as actual measurements for certain body parts.

Variable Name	Mean(SD) Younger Age Group	Mean(SD) Older Age Group	T-value	P-level
Son Stunkard for self	3.87 (1.30)	4.03 (1.23)	-.417	.677
Son Stunkard for preferred self	3.85 (.86)	4.00 (.95)	-1.19	.237
Son Stunkard for mother	4.87 (.99)	4.75 (1.15)	.611	.542
Mother Stunkard for self	4.97 (1.22)	4.92 (1.44)	.612	.542
Maximum measure of chest in inches	31.99 (4.49)	36.04 (4.63)	-5.08	.000
Maximum measure of waist in inches	27.85 (5.41)	30.30 (4.97)	-2.79	.006
Maximum measure of hips in inches	32.03 (4.91)	35.37 (4.43)	-4.16	.000
Distance from floor to waist on the back side in inches	34.81 (2.79)	39.33 (3.53)	-8.29	.000
Maximum measure of biceps in inches	9.68 (2.13)	11.45 (3.53)	-3.58	.000
Maximum measure of thighs in inches	17.89 (2.93)	20.09 (3.51)	-3.95	.000
Factor Score	-.40 (.89)	.43 (.94)	-5.02	.000

Table 4. Comparisons of responses made by the minority and Caucasian participants for physical self-descriptions and actual measurements of specific body parts.

Variable Name	Mean(SD) Minority	Mean(SD) Caucasian	T-value	P-level
Son's selection of Stunkard for self	4.17 (1.47)	3.90 (1.23)	.921	.359
Son's selection of Stunkard for preferred self	4.26 (.81)	3.87 (.89)	1.95	.053
Son's selection of Stunkard for mother	5.00 (.91)	4.82 (1.12)	.744	.459
Mother's selection of Stunkard for self	4.91 (1.38)	4.96 (1.31)	-.157	.875
Full measure of Chest in inches	35.07 (5.23)	33.72 (4.98)	1.15	.251
Full measure of Waist in inches	29.36 (5.61)	28.98 (5.32)	.303	.762
Full measure of Hips in inches	35.31 (5.39)	33.29 (4.81)	1.76	.080
Distance from floor to waist on the back side in inches	38.42 (3.94)	36.69 (3.76)	1.96	.053
Full measure of Biceps in inches	10.99 (2.36)	10.45 (3.15)	.775	.440
Full measure of Thighs in inches	20.36 (3.75)	18.66 (3.27)	2.18	.031
Factor Score	.26 (1.04)	-.08 (.98)	1.50	.136

Table 5. Comparison of mothers and sons self-physical descriptions and actual versus ideal silhouette for boys.

Variable Name	Mean(SD) Mother	Mean(SD) Son	T-value	P-level
Stunkard silhouette for son	3.62 (1.61)	3.95 (1.27)	-3.27	.001
Stunkard silhouette for mother	4.92 (1.32)	4.84 (1.09)	.933	.353
Variable Name	Mean (SD) Boy Actual	Mean (SD) Boy Ideal	t-value	p-level
Stunkard silhouette	3.96 (1.23)	3.93 (0.87)	.221	.825

Table 6. Correlations of variables used in the regression analysis.

Variable Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Son BMI															
2. Mother Stunkard for son	*.78														
3. Mother Stunkard for self	.15	*.23													
4. Boy Stunkard for self	*.64	*.70	.07												
5. Boy Stunkard for preferred self	*.18	.12	-.08	*.46											
6. Boy Stunkard for mother	.15	.15	*.65	*.17	.15										
7. Chest	*.88	*.68	.13	*.59	.16	.10									
8. Waist	*.91	*.80	.17	*.69	.15	.16	*.93								
9. Hips	*.90	*.71	.13	*.64	*.19	.14	*.95	*.93							
10. Distance from floor to back	*.48	*.28	.02	*.32	*.22	.05	*.69	*.54	*.72						
11. Biceps	*.69	*.53	.09	*.52	*.21	.09	*.71	*.70	*.72	*.48					
12. Thigh	*.84	*.65	.17	*.49	.15	.12	*.86	*.82	*.89	*.64	*.66				
13. Factor Score	*.89	*.69	.14	*.61	*.20	.13	*.97	*.93	*.98	*.75	*.79	*.92			
14.Income	-.10	-.04	-.10	-.09	-.10	*-.21	-.11	-.12	-.17	*-.20	-.12	*-.18	-.17		
15. White	-.16	.01	.06	-.08	-.14	-.01	-.12	-.06	-.17	-.15	-.08	*-.21	*.50	*.50	
16. Son's Age	*.26	.08	-.04	.12	.15	.01	*.54	*.36	*.48	*.71	*.36	*.43	*.53	-.01	-.02

Table 7. Seven nested regression models testing correlations between predictors and son's selected silhouette for self.

Model	Variables added	R Square	R Square Change	Adjusted R Square	Significant F Change
1	Boy's BMI	.413	.413	.408	.000
2	Boy's preferred silhouette	.530	.117	.522	.000
3	Mother's silhouette for son	.623	.093	.613	.000
4	Mother's silhouette for self	.625	.002	.612	.420
5	Boy's silhouette for mother	.626	.001	.610	.519
6	Boy's body size factor score	.629	.003	.609	.367
7	Income, son's age, white	.681	.010	.655	.331

Table 8. Coefficient table for seven nested regression models testing correlations between predictors and son's selected silhouette for self

Step	Variables	Unstandardized		Standardized	*t*	Sig.
		B	*S.E.*	*Beta*		
1.	Constant	.702	.342		2.06	.042
	Boy's BMI	.154	.016	.671	9.84	.000
2.	Constant	-.889	.420		-2.12	.036
	Boy's BMI	.140	.014	.611	9.87	.000
	Boys' preferred silhouette	.480	.087	.343	5.53	.000
3.	Constant	-.508	.382		-1.33	.186
	Boy's BMI	.055	.020	.241	2.77	.007
	Boy's preferred silhouette	.500	.078	.357	6.43	.000
	Mother's silhouette for son	.373	.068	.474	5.49	.000
4.	Constant	-.215	.452		-.475	.636
	Boy's BMI	.056	.020	.244	2.80	.006
	Boy's preferred silhouette	.492	.078	.351	6.32	.000
	Mother's silhouette for son	.385	.069	.490	5.62	.000
	Mother's silhouette for self	-.065	.054	-.068	-1.21	.230
5.	Constant	-.421	.462		-.912	.364
	Boy's BMI	.056	.020	.245	2.84	.005
	Boy's preferred silhouette	.455	.080	.325	5.72	.000
	Mother's silhouette for son	.390	.068	.496	5.74	.000
	Mother's silhouette for self	-.154	.072	-.162	-2.14	.035
	Boy's silhouette for mother	.160	.087	.136	1.83	.070
6.	Constant	.128	.704		.183	.855
	Boys' BMI	.032	.031	.141	1.058	.292
	Boy's preferred silhouette	.446	.080	.319	5.58	.000
	Mother's silhouette for son	.391	.0668	.497	5.75	.000
	Mother's silhouette for self	-.155	.072	-.164	-2.16	.033
	Boy's silhouette for mother	.160	.087	.136	1.83	.070

Table Continues

Table Continued

	Boy's body size factor score	.152	.147	.119	1.03	.304
7.	Constant	1.52	1.16		1.31	.194
	Boy's BMI	.008	.033	.036	.251	.802
	Boy's preferred silhouette	.440	.081	.314	5.46	.000
	Mother's silhouette for son	.380	.071	.483	5.33	.000
	Mother's silhouette for self	-.156	.072	-.165	-2.17	.032
	Boy's silhouette for mother	.171	.089	.146	1.92	.057
	Boy's body size factor score	.352	.190	.276	1.85	.067
	Income	.053	.054	.065	.980	.329
	Son's Age	-.079	.054	-.107	-1.46	.147
	White	-.206	.197	-.070	-1.05	.298

Table 9. Coefficient table testing associations between each of the six body parts and the boy's silhouette controlling for BMI

Model	Variables	Unstandardized		Standardized	*t*	Sig.
		B	*S.E.*	*Beta*		
1.	Constant	.521	.712		.732	.466
	BMI	.133	.033	.590	4.06	.000
	Chest	.017	.036	.070	.481	.631
2.	Constant	-.713	.501		-1.42	.157
	BMI	.020	.035	.087	.557	.579
	Waist	.146	.036	.621	3.99	.000
3.	Constant	-.465	.732		-.636	.526
	BMI	.084	.036	.371	2.36	.020
	Hips	.078	.039	.311	1.98	.050
4.	Constant	.968	.836		1.16	.249
	BMI	.149	.018	.659	8.41	.000
	Distance from floor to waist on the back side in inches	-.005	.025	-.015	-.192	.848
5.	Constant	.672	.355		1.89	.060
	BMI	.127	.021	.560	5.97	.000
	Biceps	.056	.039	.134	1.43	.156
6.	Constant	1.39	.500		2.78	.006
	BMI	.184	.028	.811	6.54	.000
	Thigh	-.070	.045	-.191	-1.54	.126

Table 10. Regression model testing the effects of discrepancy on mother's silhouette selection for son.

Model	R Square	R Square Change	Adjusted R Square	Significant F Change
1	.604	.604	.600	.000
2	.604	.000	.597	.943

Table 11. Coefficient table for regression model testing the effects of discrepancy on mother's silhouette selection for son.

Step	Variables	Unstandardized		Standardized	*t*	Sig.
		B	*S.E.*	*Beta*		
1.	Constant	-1.23	.372		-3.31	.001
	BMI	.227	.017	.777	13.35	.000
2.	Constant	-1.29	.949		-1.36	.176
	BMI	.231	.056	.790	4.09	.000
	Discrepancy	-.004	.063	-.014	-.072	.943

Table 12. Regression model testing the effects of discrepancy depending on the direction (over/under weight) on mother's silhouette selection for son.

Model	R Square	R Square Change	Adjusted R Square	Significant F Change
1	.604	.604	.600	.000
2	.620	.017	.611	.083

Table 13. Coefficient table for regression model testing the effects of discrepancy depending on the direction (over/under weight) on mother's silhouette selection for son.

Step	Variables	Unstandardized		Standardized	*t*	Sig.
		B	*S.E.*	*Beta*		
1.	Constant	-1.23	.372		-3.31	.001
	BMI	.227	.017	.777	13.35	.000
2.	Constant	1.37	1.50		.911	.364
	BMI	.082	.086	.282	.956	.341
	Over	.141	.089	.448	1.58	.117
	Under	-.350	.165	-.146	-2.12	.036

V. DISCUSSION

The purpose of the current study was to explore the associations between potential biasing factors affecting the accuracy of boys' estimates of body size. These factors include boys' views about preferred body size, parents' perceptions of their child's size, boys' perceptions of their mother's size, and finally, physical dimensions derived from a 3D body scan. For children approaching and entering adolescence, an important part of development involves gaining a healthy and accurate viewpoint of their own body. Friestad and Rise (2004) report that body image, self-esteem and dieting are strongly related, which suggests that an accurate body image will equip youth to view themselves in a more positive and empowered way and would therefore help them make good decisions about dieting and other health related behaviors. Therefore, looking deeper into this topic is of value.

Some of our findings support the conclusion that boys tend to be relatively accurate in selecting their own silhouette. We see that as BMI increases, the selection for silhouette increases. This tells us that boys are able to accurately assess their body shape because when they are larger, they typically select a larger silhouette. However, correlational findings tell only part of the story. As described in the sample, we mapped each boy's BMI on a growth chart to check for boys who were overweight or obese. We found that boys tended to select a silhouette for themselves that seemed to map to a smaller BMI than that which characterized the participants. Based on mean BMI scores, which approached or entered the overweight range, there tended to be a substantial tendency toward boys selecting small body size silhouettes for the boys participating in this study (approximately the 4th of 9 silhouettes and thus below the mid-point of the range). Once that widely shared apparent bias was accounted for, however, the order in BMI and silhouette, bigger going with bigger, produced the strong correlation.

Therefore, with the general tendency to underestimate considered as a caveat, we can justifiably say that in the current study, the adolescent boys tend to be relatively accurate. This finding is important because most research on body size, shape, and satisfaction focuses on girls and not boys, and there is not much to compare to our current findings. The research that is available does not allow us to make a conclusion, because it focuses on samples that are older than the current one. For example, Rasmussen (2007) found little consistency among 15 year old males when it comes to reporting about their body size. There was no tendency to a consistent bias (over/under reporting). Instead, their 15 year olds tended to be random in their inaccuracy. Other studies, however, find that boys between the ages of 12-17 tend to underestimate their size (Gardner et al., 2010; Al-Sendi et al., 2004), which is consistent with our findings. These studies, however, did not control or otherwise account for individual age in their analysis. The age range 12-17 is relatable to the upper range of the current study, 12-14; however, the current study includes a much younger age range (9-11) than previous research. Therefore, this is an important aspect of our study. We are contributing to the understanding of the ability of boys to assess their body size at a younger age and it appears that the tendency to underestimate extends to younger boys.

The coefficient of association between BMI, our operationalization of true size and thus accuracy, and silhouette selection was large and accounted for fully 40% of the variance in silhouette selection. This shows us that, as BMI gets bigger, silhouette selection gets bigger. However, there is still 60% of variance left to explain and other studies of older males and females have found even stronger correlations between BMI and silhouette. Therefore, in spite of our claim of generally accurate estimates for the boys of this sample, they appear to be less accurate than other studies find. Importantly, our full analysis accounted for considerably more variance in silhouette selection than that associated with BMI. We interpret this additional explanation of silhouette selection in terms of biasing factors because these significant predictors explain variance above and beyond that accounted for by our assessment of accuracy.

Interestingly, in the current sample of 9 to 14 year old boys, the silhouette selections for self and ideal were moderately and positively correlated but the mean silhouette selections in these two domains were not significantly different. Since the coefficient in the regression is positive, it would be easy to conclude that the bias is linked to the desire to be bigger. Before concluding that a sample that on average was already approaching overweight generally wanted to be yet larger, we conducted an additional analysis to see whether the desire to be bigger was shared across the entire sample or whether it was restricted to the smaller boys. We divided the sample at the median for BMI to create large and small sized groups, and we subtracted the preferred silhouette from the actual silhouette so that positive scores reflected a desire to be larger and negative scores indicated a wish to be smaller. With an independent samples t-test we found a strong difference in preferred size ($t = 7.95$, $p > .001$) based on whether the boy's BMI was above or below the median BMI. Those above the median reported a mean preferred silhouette of -.71 Stunkard units, indicating an average desire to be almost three-quarters of a silhouette smaller than their selected actual silhouette, while those below the median BMI reported a preferred silhouette that was .61 Stunkard units larger than their selected actual silhouette. Thus, small boys wanted to be larger and large boys wanted to be smaller. Previous literature shows that males tend to prefer a muscular body and tend to associate this with being larger (Leone, Fetro, Kittleson, Welshimer, Partridge, & Robertson, 2011). Perhaps the smaller boys in the current study that selected the larger ideal have this same desire. Previous research looking at the tendency for males to choose an ideal that was larger typically looked at older age groups. We do not see these same results for the current study because not all our participants choose a larger ideal size. Those who are already large do not select a larger silhouette as their ideal.

By including son's ideal, we explained almost 12% more of the variance in son's selection of silhouette. This ideal silhouette helps us to understand their actual silhouette selection. The preference boys have for the size they would like to be is biasing their judgment of their actual size. The positive association between preference for size and actual silhouette selection does not imply that all boys want to be bigger, but rather boys bias their selection for actual self in the direction of their preference. Boys below the median BMI of the sample tend to want to be bigger and they tend to exaggerate their actual silhouette selection, while boys who are above the median BMI prefer to be smaller and they therefore exaggerate their selection toward a smaller size. Previous research found that adolescent males and females between the ages of 12-17 select an ideal Stunkard silhouette that is significantly smaller than the current silhouette selection if they are overweight or obese and select an ideal Stunkard silhouette that is significantly larger if they are normal weight or underweight (Al-Sendi et al., 2004). Our findings are consistent with this. It is clear, that in our sample, size preference depends on whether the boy is under or above the median BMI. Small boys want to be bigger and, given how young the sample is, many are likely to become bigger as they mature and acquire a more mature size and shape. Perhaps those who are overweight and obese are less satisfied with themselves, and that is why they chose a significantly smaller silhouette for ideal.

In a study of mothers and their children, Goodman et al. (2000) found that mothers were more likely to report an obesity problem for their daughters than their sons even though the objective data did not support that conclusion. Mothers in the current study were similar to mothers in that and other studies in that they tended underestimate their sons' size (Geller et al., 2003; Goodman et al.,; Van Vliet et al., 2009). More specifically, the mothers in the current study selected a smaller silhouette for their son than their son selected for himself. This could be in part because mothers tend to view their boys as healthy and normal even if they are overweight or obese (Geller et al., 2003; Jackson et al., 1990; Skelton et al., 2006). They could be selecting smaller silhouette because they think it is the 'healthier' silhouette and they see their son as 'healthy'.

What is interesting about the mother's bias is that it also had a biasing effect on their son's selection of silhouette for self. The effect was positive. When mothers viewed their son to be larger, their sons selected larger silhouettes than would be expected based on their sons' BMI and preferred silhouette, and vice versa when mothers viewed their son to be smaller. In order for the mother's bias to affect the boy's independent silhouette selection, there must be some overt or inadvertent communication between the mother and son about the son's size. Because mothers tend to see their children as healthy and normal, they may suggest through things they say or through the meals they prepare or through their descriptions of other male models something about the desirability of size in a male. Ultimately, in the current study, mothers appear to contribute to son's inaccuracy.

Mother's size was also a biasing factor for son's selection of silhouette for self. The findings pertaining to this bias are interesting and somewhat complex and potentially artificial because opposite side effects were found for the biasing effect of mother's size depending on the perspective of the rater. This needs to be replicated to truly see what is going on with this effect. We found that when the mother was bigger in the eyes of the boys, there was a reliable tendency for the boy to select a bigger silhouette for himself. Alternately, when mother was bigger in her own estimation, there was a modest but significant tendency for the boy to select a smaller silhouette for himself. Importantly, mother's view of self only became relevant in the model after the boy's view of mother was included which means that the negative impact of her self-rated size depended on the statistical control of the boy's view of her size. The tendency for a mother's larger size, when estimated by sons, to be associated with larger silhouette selections for sons suggests that sons identified with their mothers in terms of the size they perceive her to be. At the same time, and controlling for this tendency to identify with the mother's size, the larger the mother said she was, the smaller the silhouette her son tended to select. This bias could be linked to the many messages coming from current culture. It is no secret that overweight and obesity are frequently mentioned and portrayed as problems in the media. Within a given child-perceived maternal size, as mothers describe themselves as larger, their sons appear to identify less with that size and they select a smaller silhouette for themselves.

As we expected, the factor score (which was a weighted composite of all six body part measurements) and BMI were highly correlated. When initially entered into the model, this score masked the predictive power of BMI. This occurrence was not surprising because the two scores were measuring nearly identical things (their intercorrelation was .89, meaning that they shared 79% of their variance). What was interesting was the fact that when the three control variables, income, ethnicity (white versus other), and age, were included in the model the association between the factor score and the boy's silhouette selection neared significance even controlling for BMI. Given that the correlations for the factor score with income and ethnicity were non-significant, while its relationship with age was significant and substantial ($r = .50$), it seems likely that this pattern is due to age. Older boys who were also bigger, and therefore had a larger body size factor score, revealed a trend toward selecting larger silhouettes even after accounting for BMI. It does not seem that this finding represents a bias. Rather, it may actually suggest a better measure of accuracy since the factor score captures some of the physical dimensions that the silhouettes also emphasize. It could be argued that a set of physical dimensions combined into a score could provide the objectivity of the BMI score without its limitations.

The factor score combined multiple physical dimensions. Initially, our reasoning was that silhouette selection could be affected by specific body dimensions. McCabe et al., (2006) looked at men and women ages 18-36 that assessed the following body parts: chest, waist, hips, thighs, and calves. In this study the sizes of all of the body parts were overestimated by men. Therefore we also examined the effect of each body measurement individually in the prediction of boy's silhouette selection. We found that the boy's choice of silhouette, controlling for BMI, was affected by the size of the boy's waist and hips. It appears that boys attribute more meaning to waist and hips when selecting a silhouette. A boy with bigger hips and waist tends to select larger silhouettes than we would expect knowing the boys BMI. This finding is consistent with previous research that considered these two body parts to be of great importance when judging body size (Rhodes et al., 1997). Rhodes et al., showed that adult women who were larger in the waist area tended to overestimate their size, while women who were larger in the hips tended to underestimate their size. These findings do not fully map to ours because we found larger waist and hips influenced choices of silhouettes in the same direction. However, Rhodes and colleagues studied adult women, who could be expected to respond differently than pre-adolescent or early adolescent boys. Our findings are in agreement that these body parts tend to be important cues about body size regardless of age or gender, even if they work in different ways. When looking across the Stunkard silhouettes for males from the middle to largest, as each silhouette becomes larger, the silhouettes quickly become much larger in these two areas: waist and hips.

Given that mothers appear to bias their son's silhouette selections, we wanted to evaluate whether we could detect a pattern to the biases that mothers bring to their views of the size of their sons beyond their simple tendency to underestimate (already discussed above). Mothers presented a mixed capacity for accuracy. Based on the correlations between BMI and mother's versus boy's silhouette selection for the boy, mothers appeared to be more accurate than sons in in estimating his size. Correlations are based on the ordering of observations, and mothers more consistently picked larger silhouettes for larger boys than did the boys themselves. However, the mean silhouette selected by mothers was smaller than those the boys chose for themselves, which reveals the bias commonly found in the literature. We wondered if mothers might show differences in the level of their bias as their sons diverged from the norm. Previous research shows larger discrepancies between normal BMI and son's BMI predict larger silhouette selections among mothers (Eckstein et al., 2006). Our findings, however, did not replicate Eckstein's findings (Eckstein et al., 2006). We found that mothers of boys who increasingly exceeded the BMI norm did not demonstrate a bias in selecting a silhouette for their sons. Instead, her silhouette selection was predicted well by her son's BMI. Interestingly, we did find some evidence for a bias in mother's reports for sons who were under the norm. Mothers tended to select smaller silhouettes for their sons than would be expected based on their son's BMI as their son fell farther under the norm for BMI. Mothers in the current study appear more accurate when selecting a silhouette if the son is above the norm versus below the norm.

Limitations

The current study focused on mothers and sons. It would be interesting and potentially important to see what biasing effects, if any, fathers have. This is a cross-sectional study but the biases we are interested in may change with development. Although we statistically control for age, that does not capture any developmental change that could be important. Our operational definition of accuracy is BMI, but we acknowledge that BMI is a flawed measure for body size because it does not directly measure body fat. The sample is a convenience sample which means it is not representative of the general population of 9-14 year olds. Furthermore, with only one 8 year old in the analysis sample, it could be more accurate to describe the sample as 9-14. Other sample based limitations include the fact that it over represents the privileged income and education levels in society, which also limits its generalizability, and the current study over represents Caucasians. Previous research has shown that poorer nutrition and obesity tend to be more common in lower-income families (Murasko, 2011).

Future Directions

For future directions, it would be interesting to include fathers in a similar study. Since the focus is on boys, the father figure could be a more salient model even than the mother. Because so few studies have examined perceived body size among such young boys, the current study needs to be replicated in a more representative sample to see if the findings are actually reliable. To consider the role of development in perceptions of body size, a longitudinal study would be valuable to see if there are changes within age groups over time. Ethnicity is likely to be more important than the current study found. The current study included African Americans and Caucasians; however, the African American sample was relatively small. Furthermore, other ethnic groups were so under represented that they could not even be analyzed. Studies of more ethnicities in sufficient numbers to detect small to moderate differences would be desirable. Finally, a study to determine what set of body part dimensions could serve as an objective assessment of body size while avoiding the limitations of the BMI measure would be worthwhile.

Conclusion

From the current study, we have contributed to the literature in several ways. We have learned that there are several biasing factors for son's selection of silhouette for self including son's ideal, parent report, mother's size and the dimensions of body parts. We looked at only boys and saw that boys from 8-14 are moderately accurate when assessing their body size. As their BMI increases, the selection of silhouette rise also increases. The current study contributes to the literature by examining younger ages than previous research. Similar to previous findings, these young boys selected a larger ideal than actual silhouette. Young boys want to grow up and part of that means being bigger. There is also a trend for boys who are above the norm wanting to be smaller and select a smaller ideal than actual silhouette, but also a smaller silhouette than would be expected from their BMI. On average, mothers selected a smaller size for their son than the sons selected for themselves, which is also a pattern seen in literature. Mother's size also had an interesting effect on son's silhouette selection. When son's selected a silhouette for themselves, they seemed to identify with mother's size; if the mother was bigger, the boy selected a bigger silhouette for self. However, when boy's perception was controlled, he did not identify with a larger silhouette when mother reported a larger silhouette for self. Also consistent with prior findings, we saw that these youth attributed more meaning to waist and hips when selecting a silhouette. Through this study, we have shown that the use of body scans was a valuable addition. The factor score created from the six different body parts used, actually explained more variance than did BMI, when BMI was controlled.

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