Problematic eating behaviors are more prevalent in low-income African American women with overweight/obesity than low-income African American women who are lean/normal weight and the accuracy of self-report versus actual height and weight in a low-income, ethnically diverse sample

A THESIS
SUBMITTED TO THE FACULTY OF THE
UNIVERSITY OF MINNESOTA
BY

Katelyn Opichka

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF SCIENCE

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August 2018

ACKNOWLEDGEMENTS

I would like to thank all of the women who took the time to participate and share their beliefs, opinions, and personal eating behaviors and experiences with us. I was able to learn so much about their community, culture and way of lives from them. I would also like to thank all the staff at libraries, community centers, and other sites who helped with the recruitment process and allowing us to hold the focus groups at these various places.

I deeply would like to thank Dr. Chery Smith for allowing me to work with her over the past 2 years. She has taught me so much about the process of research such as qualitative research, conducting focus groups, analyzing focus groups and analyzing secondary data, the field of nutrition, eating behaviors and community nutrition, career paths, writing, teaching, and even traveling. She has helped me grow professionally and as a person and I will forever be grateful for the opportunity to learn from and work with her. I also would like to thank Dr. Allen Levine and Dr. Virginia Solis-Zuiker for their expertise, insights, support and being so patient and understanding during this process.

I also would like to thank all of Chery's previous graduate students who collected data for my second project regarding the accuracy of height and weight. This project would not have been possible without all of their hard work. Lastly, I would like to thank my family and friends, especially my parents, who have supported my dreams my entire life and I would not have been able to be where I am today without them.

ABSTRACT

Much research has focused on exploring the prevalence, repercussions, and possible causes linked to obesity including certain eating behaviors that could lead to an increased weight. Few qualitative studies have looked at how certain eating behaviors can lead to obesity in the light of neuronal control of intake. Also, many research and clinical settings use self-report height and weight to determine the prevalence of obesity of morbidity of the patient. However, self-report height and weight is not always an accurate measure and therefore could lead to underestimation of obesity and patients not acknowledging the dangers of obesity. Therefore, the objectives of this project was 1) to compare problematic eating behaviors between African American women who were lean or normal weight and women who were overweight or obese and 2) to determine the accuracy of self-report height and weight in an ethnically and age diverse sample of predominately low-income adults and children. Focus groups, the Palatable Eating Motives Scale (PEMS), and a taste test were used to compare problematic eating behaviors of low-income African American women. For the second part of this project, data from multiple previous studies were analyzed to compare self-reported heights and weights to actual heights and weights in a diverse sample that included both genders, all ages, and multiple races. Results from this study suggest problematic eating behaviors such as overeating, eating in the absence of hunger, and the loss of control over consumption are more abundant in women with obesity/overweight. This study also suggests self-reported height and weight vary from actual measurements for both children and adults and may lead to underestimation of obesity prevalence and a lack of acknowledgement of the comorbidities of obesity.

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Literature Review: Problematic Eating Behaviors, Eating Motives, and the accuracy of self-report height and weight for use with adults and children

INTRODUCTION

Problematic eating behaviors such as loss of control over consumption, overeating, continued consumption despite negative consequences, eating in the absence of hunger, and inability to stop eating despite the desire to do so is of great interest because of its association with obesity and the rising epidemic of obesity. Understanding problematic eating behaviors and its implications could change the current treatment of obesity because dieting may not be the best option for patients who use problematic eating behaviors. Comprehending such behaviors and its implications is crucial for further knowledge of obesity and treatment.

Problematic eating behaviors are associated with behaviors that promote weight gain and with other diseases. These eating behaviors appear to be found in individuals with obesity.[1–7] Obesity is higher in certain groups of people such as African Americans (76% are overweight or obese) than the general population.[8,9] Also, 42% of women living below the 130% poverty level suffer from obesity, compared to 29% that are living at or above the 350% poverty level.[10] Research investigating the prevalence of problematic eating behaviors in a cross-sectional analysis of women U.S. nurses found that problematic eating behaviors was most strongly associated with BMI and age.[11] These behaviors were also less predominant in women who were moderately to vigorously active.[11] This research suggests there is a correlation between BMI and physical activity level. This study also found that those with more problematic eating behaviors were more liking to exhibit binge-like eating behaviors, higher rates of craving, reduced weight loss in response to treatment and elevated weight regain after bariatric surgery.[11] Possessing multiple problematic eating behaviors also correlated with hypercholesterolemia, depression, hypertension, and diabetes.[11] Other research has found depression to be associated with emotional eating, another type of problematic eating behavior.[12] Because of the associated diseases with problematic eating behaviors, it is essential to better understand such behaviors. The objective of this review is to provide insight to the research studying problematic eating behaviors in hopes of gaining a better understanding of such behaviors can affect obesity and other health diseases.

Comparison of Individuals Who Are Normal Weight vs. Obese

Food preferences appear to vary between individuals who are normal weight and individuals with obesity/overweight. Stunkard et al.[13] found that a desire for sucking nonnutritive sweeteners in 3-month old infants predicted weight gain at two years of age, inferring the rewarding effects of a sweet taste and its correlation to obesity. Drewnowski and Schwartz[14] found that individuals with obesity have a higher preference for dietary fat than individuals that were lean encouraging consumption of foods higher in fat. Likewise, Dressler and Smith[1] found that women with obesity/overweight possessed an increased liking of fats compared to women who were normal weight. This study also found that individuals with obesity/overweight liked a greater variety of foods than their counterparts who were normal weight.[1]

There are also differences in eating behaviors between individuals who are normal weight and individuals with obesity/overweight. Women with obesity/overweight described engaging in weight-promoting behavior and atypical eating behaviors such as possessing a stash of food when women who were normal weight did not commonly express this.[3] Also, individuals with obesity/overweight described eating in response to emotions whereas individuals who were normal weight more often described eating to satisfy hunger.[1,3] Further, individuals who were normal weight stated they used healthful coping strategies such as going for a walk, praying or eating fruits rather than coping by eating energy-dense foods. Individuals who were normal weight also displayed more nutrition knowledge and a more preventative approach to health than individuals with obesity/overweight.[3,4] Earlier research has shown that those who are overweight are more likely to have food related thoughts during the day, while those with a lower BMI tend to be less preoccupied with food which could contribute to problematic eating behaviors.[15,16]

Eating in the absence of hunger, or eating for reasons other than physically being hungry such as emotional eating, eating because food is available, and eating from boredom has also been studied. Much of this research has worked with children and found that girls with obesity/overweight were more likely to eat in the absence of hunger than girls who were normal weight.[5,17] Mean opportunistic snack intake was positively associated with BMI suggesting the people who are overweight or obese snack because food is available and there rather than snacking because of physical hunger.[6] Another study also found that eating in the absence of hunger and BMI in children predicted binge eating behavior, another problematic eating behavior later in life.[18] This research suggests eating in the absence of hunger, another problematic eating behavior, appears to be a more common behavior with individuals of larger BMIs.

Neuroimaging studies have given insight to the differences in the human brain between individuals who are normal weight and individuals with obesity/overweight. The results of these neuroimaging studies indicated that the activation and deactivation of certain parts of the brain differ in response to satiation among individuals with obesity and individuals who are normal weight.[19,20] Those data support the hypothesis that obese individuals produce weaker satiety signals. Further confirming this is Johnson and Kenny's[21] study that displayed that the development of obesity in rats was closely associated with worsening reward deficits in the brain. This suggests that individuals who are overweight continue eating due to their decreased satiety signals, while normal individuals are more likely to stop eating sooner. This is supported by Dressler and Smith[1] who observed that women who were normal weight talked of responding to satiety cues and stopping consumption once they were full, whereas individuals with obesity/overweight were more descriptive of their cravings and described self-control issues.

A weaker satiety signaling found in individuals with obesity could explain the sense of deprivation individuals with obesity can feel despite their excess energy stores. For instance, research looking at the association between preoccupation with food and perceived deprivation with the actual caloric and fat intake of 121 women found that perceived deprivation did not stem from actual caloric deprivation.[22] These results suggest that individuals ate because they felt they were in a state of deprivation rather than truly being in a physiological deprivation. This is thought to occur because the individual is eating less than they want rather than less than they need. Eating less than a person wants could stem from a weak satiety signal.

Eating Motives

Other research focuses on the factors that influence eating and different types of eating motives. Passamonti et al.[23] studied the effects of external food sensitivity (ie.

sights of foods) and found that individuals with high external food sensitivity possessed a reduction in the connectivity in specific regions of the brain's feeding network. This reduction suggests a neuronal marker for an individual's increased vulnerability to problematic eating behaviors, such as food cravings and overeating. This study also found that the sight of food activated the reward mechanisms of consumption which could motivate an individual to eat and overeat[23]**;** suggesting that some individuals may be more likely to eat than others by being stimulated through external cues.

Various reasons have been explored regarding what motivates a person to eat besides hunger. Research used the Palatable Eating Motives Scale (PEMS) questionnaire to assess how frequently college students (n=169) consumed foods and drinks in the past year for various reasons.[24] The motives assessed in that study were categorized into 4 groups: coping, reward enhancement, social and conformity. It was shown that the PEMS coping motive was the only motive out of the four to be positively associated with BMI[24]; suggesting that individuals who use food as a coping tool are more likely to be overweight than those who do not. Furthermore, Dressler and Smith[1,3] found that women with obesity/overweight tended to use food as a coping mechanism in times of stress, depression or boredom, while normal weight individuals mentioned negative emotional influences had no effect or lessened their eating.

Accuracy of self-report heights and weights compared to measured heights and weights for use with adults

Obesity is a global epidemic that affected approximately 36.5% U.S. adults.[25] There are a number of comorbidities associated with obesity such as diabetes, cardiovascular disease, sleep apnea, respiratory problems, and some cancers. The morbidity of these diseases increases as BMI increases above 20 kg/m^2.[26] Because of these comorbidities, individuals with obesity (BMI $\geq$30kg/m^2) have an increased mortality rate from all causes compared to an individual with a healthy weight.[26] Obesity also has a psychological effect. Westernized countries such as the U.S. tend to favor thin body image ideals and obesity is often associated with negative connotations such as lack of control.[26] This social stigma could lead to poor self-esteem and depression.[12,26] Also, obesity is expensive in the U.S. In 2008, about $147 billion was spent on medical expenses of obesity.[27] Tracking accurate obesity trends are important because of its health complications, expense, and social impact on those suffering with obesity. To track obesity trends, self-report heights and weights are frequently used in clinical and research environments because of its low cost and feasibility compared to measured heights and weights. However, whether self-report heights and weights are accurate is unclear. In general, individuals tend to overestimate their height and underestimate their weights resulting in an underestimation of BMI and an underestimation of obesity prevalence.[28–32] How much is misreported, what factors influence misreporting, and who misreports most are also unknown. Age, gender, race, education level, and current weight and height status have been suggested to influence self-reporting bias, but not all research agrees on which factors may influence self-report bias. Whether self-report heights and weights are valid to use in epidemiological or clinical settings still appears to be unclear.

Research that supports the use of self-report height and weight

Research supporting the use of self-report height and weight among adults has indicated high correlations between self-report and actual height and weight. Fillenbaum et al.[33] found high correlations between self-report and actual height and weight in a sample of older African American and Caucasian adults aged 71 years or older. High correlations between self-report and actual height and weight were also found in a sample of U.S. college students and in reproductive aged women.[34,35] Internationally, Lim et al.[36] found high correlations between self-report and actual heights and weights in a college sample of Thai adults. Likewise, Bowring et al.[37] found high correlations between self-report and actual height and weight in a sample of 16-29-year-olds in Australia. The results of this studies suggest self-report height and weight are reliable.

Quick's et al.[34] research suggest using self-report height and weight to calculate BMI is appropriate because differences between self-report BMI and actual BMI did not lead to different BMI category classifications in a sample of U.S. college students. Internationally, Bowring et al.[37] found that 88% of the Australian sample was correctly classified by self-report height and weight. Also, there were high correlations between self-report and measured BMI.[37] Furthermore, some studies indicate that self-reported

BMI is not significantly different from measured BMI.[33,36,38] A sample of Japanese women showed that self-report heights and weights were significantly different from measured heights and weights, but these differences did not result in self-report BMIs being significantly different from actual BMIs.[38] These studies suggest the differences between self-report and actual values are minimal, but tend to be outside of the USA.

Research that does not support the use of self-report height and weight

However, other research has indicated that though self-report heights and weights may be reliable, they are not accurate for use with adults. Mueller et al.[30] found that outpatients from a clinic in Minnesota overestimated their height and significantly underestimated their weight. This was also found in a sample of U.S. outpatient veterans of primarily Caucasian and African American race.[39] Likewise, Johnson et al.[40] found that height was significantly overestimated by all subgroups in the study (female African Americans, male African Americans, female European Americans, male European Americans) and weight was significantly underestimated in all groups. Wen and Kowaleski-Jones[41] also found that individuals tend to overestimate height and underestimate weight across the U.S. Significantly overestimating height and underreporting weight has also been seen in samples of adults of all ages in countries such as Australia and Canada.[28,42,43] This suggests self-report height and weight values are often inaccurate and could be misleading.

Furthermore, there is research that implies the use of self-report values to calculate BMI results in different BMI category classifications than actual BMI and a different obesity prevalence. For instance, Craig and Adams[44] found that only 60% of pregnant women and 79% of nonpregnant women were correctly classified in a U.S. study. Mozumdar and Liguori[45] found that only 31% of females with obesity and only 37% of males with obesity were accurately classified using self-report values. Johnson et al.[40] found the obesity prevalence from self-report values and measured values to be significantly different in all gender, age and ethnicity groups except for 30-39-year-old African American men in a sample of African American and European American adults. Similarly, Wen and Kowaleski-Jones[46] found an underestimation of the prevalence of obesity when using self-report values across the U.S. These results indicate that self-report values should be avoided because they tend to underestimate BMI and obesity prevalence.

Factors that may influence extent of misreport

Research has indicated that actual weight may be correlated with differences in self-report weights in adults. Johnson et al.[40] found that those who weighed less were more likely to overestimate their weight and heavier individuals were more likely to underestimate their weight to a greater extent. Similarly, Mozumdar and Liguori[45] found that U.S. male college students in the lowest weight quartile overestimated their weights by a mean of 5 pounds, while the heaviest men underestimated their weights resulting in self-report BMIs to be under or overreported. They also found that college women underestimated their weights regardless of quartile.[45] However, as the quartile increased, the women underestimated their weights to a greater extent resulting in BMIs to be underestimated to a greater extent as actual BMIs increased.[45] Similar results have been shown for American adults in other studies.[47,48] Actual BMI status might influence extent of misreporting internationally as well. In Japan, Wada et al.[49] found that adults with BMIs over 22 kg/m^2 were more likely to underestimate their weight, whereas those with BMIs under 22 kg/m^2 were more likely to overestimate their weight.[49] Similarly, Dahl et al.[50] found that those with larger measured BMIs were more likely to overreport their height and underreport weight resulting in a lower BMI in a Swedish sample. Nyholm et al.[51] found actual BMI to be significant predictor for self-report BMI in a Swedish population. This was also found by Flood et al.[52] who showed Australian adults who were overweight or obese underreported their weights more than those who were normal weight. Weight status seems to influence self-report biases.

Similarly, the actual height of a person may influence bias in self-reporting height. Multiple studies have found that shorter individuals tend to overreport their height to a greater level than taller individuals.[42,48,51] Similar results were found for Japanese individuals in that shorter women had larger differences between self-report height and actual height.[38] However, Johnson et al.[40] reported that in a sample of African American and European American adults, participants tended to overestimate their height more as their actual height increased. Actual height may influence the extent of misreporting height.

Race may also influence the extent of misreport. Johnson et al.[40] found that overestimation of height was significantly greater for African American women than European American women and that underestimation of weight was significantly greater in European American men compared to African American men.[40] Another study found that Caucasians were more likely to underreport BMI than African Americans and Hispanics.[41]   This study also found that Caucasian and African American men overreport their heights more than Caucasian and African American women, but Hispanic women overreport their heights more than Hispanic men.[41] Mexican Americans have also been found to overreport their heights and underreport their weights the more than African Americans and Caucasians.[47] Another study of Americans, showed race to be a significant predictor of self-report height and weight for men and that underweight African American men overreported weight more than Caucasian men.[48] African American women were also found to significantly underestimate BMI compared to all other groups (European American women, African American men and European American men).[40] Race seems to influence the extent of misreporting height and weight in U.S. adults.

Race has also been found to influence self-report biases internationally. According to Wada et al,[49] Japanese men significantly overestimated their height, but the mean difference of 0.078 centimeters was small. Their BMI was significantly underestimated, but this was also small (-0.035).[49] This suggests that Japanese men may be more accurate when self-reporting heights and weights than other ethnicities. Likewise, the self-report height and weight of Japanese women may also be more valid than other ethnicities because differences between actual and self-report height, weight, and BMI have been found not to be significant.[49] In the Netherlands, Dijkshoorn et al.[53] found that differences between measured and self-report height, weight, and BMI were larger among Turkish and Moroccan women than Dutch women. A study with Scottish adults found that in addition to weight being underestimated, height was also underestimated.[54] Underestimation of height is atypical and maybe unique to the Scottish population as most adults overestimate height.[32,40,53]   Other research has found that race/ethnicity does not influence self-report bias.[55,56] Which ethnicities underreport or overreport BMIs the most is conflicting in the literature.

Multiple studies with adult samples also have found differences in the way males and females report their heights and weights. Many studies have found males overestimate their height more frequently and to a greater extent than females.[34,40,42,45] In addition to overreporting height, Quick et al.[34] found that males also overreport their weights. Furthermore, females frequently have been found to underreport their weights more often and to a greater extent than males.[34,37,40,42,57] This suggests that sex should be considered when using self-report height and weight values.

Age may also influence bias regarding self-report height and weights in adults. Rowland[48] found age to be a significant predictor of self-report height and weight for American women. Gillum and Sempos[58] found the number of Americans who were not considered overweight based on self-report height and weight, but were considered overweight based on actual height and weight were higher among older individuals than younger individuals. Multiple studies have found that older people overestimate their height more so than younger individuals.[47] In addition, some studies have also found that older people tend to underreport their weights, resulting in an underestimation of BMI more than younger individuals.[41,47] This has been found in both Australian and Swedish populations as well.[51,52] However, Bolton-Smith et al. found that all ages including the older individuals did not overestimate their height, but actually underestimated their height in a Scottish population.[54] It should be noted that the older population underestimated their height the least compared to the rest of the sample.[54] In the Netherlands, Dijkshoorn et al.[53] found the difference between measured BMI and self-reported BMI increased with age for men. In contrast, Dahl et al.[50] argued that old age does not have an effect of self-report height and weight because they found that Swedish older people were more likely to overestimate their height only by a small difference from younger ages. Also, old age did not seem to affect self-report weight compared to younger individuals.[50] Age seems to influence self-report bias, but there is conflicting evidence.

Education may also be linked to bias in self-report height and weight. A higher education has been associated with underreporting BMI.[41,44] However, Gillium and

Sempos[58] found false negative rates, those who were not considered obese by self-report values but were obese by measured values, were higher in less educated Americans than more educated Americans. Likewise, Mueller et al.[30] indicated that a higher education was associated with a more accurate self-report BMI. Rowland[48] found no significant correlation between self-report values and education for men, but women who were severely overweight with a high school education underreported more than women who were severely overweight without a high school education. Likewise, Conner Gorber et al.[28] found that education was a significant predictor of actual BMI for women, but not for men in Canada. Dijkshoorn et al.[53] found a person's level of education to not be associated with differences in self-report and actual values in a sample of Turkish, Moroccan, and Dutch individuals. The influence education has on self-report heights and weights varies from study to study.

Correction equations for self-report height and weight values

Multiple studies have tried to produce correction equations that can be used to correct for self-reported biases. Though some of these improve sensitivity, equations vary from study to study and are typically specific to a certain population such as the gender specific prediction equations for height and weight suggested by Bolton-Smith et al.[54] This correction equation may only be applicable to Scottish populations as this study found differing results in self-report biases from studies done with other ethnicities.[54] Conner Gorber et al.[28] created and tested four different models to measure actual BMI from self-reported BMI for a Canadian population. The proportion of individuals considered obese by self-report values was 13.8%, but 23.1% by actual measurements.[28] The corrected data gave an obesity estimate range (19-22%), which was closer to the actual values.[28] For women, the prevalence of obesity as indicated by self-report was 12.5% and 18.9% by actual measurements.[28] The corrected values were very close to the actual values (18.2-18.7%).[29] The corrected data increased sensitivities for the obese population and could correctly identify 86.1% of women with obesity, 76% of men with obesity, 82.8% of men who were overweight, and 79.9% of women who were overweight, but the corrected values decreased sensitivity for those who were normal weight.[28] Nyholm et al.[51] also proposed a correction factor for a population of Swedish adults and found that the correct obesity prevalence was closer to the actual obesity prevalence than the self-reported obesity prevalence.

College students have also been a target of research because body size frequently changes during this time. Mozumdar and Liguori[45] developed 16 correction equations, one for each height quartile and gender specific and one for each weight quartile that were specific to gender for college students. They also used an equation suggested by Conner Gorber et. al.[28] Sensitivity for BMI using the Conner Gorber correction factor showed a slight increase for men who were overweight or normal weight.[45] The sensitivity for corrected BMI using the Conner Gorber equation for males with obesity increased from 77% to 81% and for females who were overweight, the sensitivity increased from 71% to 81%.[45] Correcting for BMI using the quartile specific equations showed similar improvements.[45] Corrected BMI did not improve sensitivity for men who were low weight and actually decreased for women who were low weight. However, when using the quartile specific correction equation for males with a low BMI, sensitivity increased from 53% to 65%, but sensitivity did not improve much for females with low BMIs.[45] Equations to calculate actual values from self-reported values have been suggested for adults, but they may only be applicable to certain populations.

Similarly, Dauphinot et al.[57] tried to determine a new BMI cut-off point for obesity when using self-report heights and weights. Their results indicated that the mean self-report BMI was significantly lower than the measured BMI and 1/3rd of his Swiss adult sample that were obese were categorized as non-obese based on self-report height and weight.[57] He suggested 29.2kg/m^2 as the cut-off point for obesity when using self-report heights and weights.[57] However, this cut off point may differ for other races.

Accuracy of children's self-report heights and weights compared to actual measurements

Research regarding self-report height and weight in children is also unclear. Obesity affected 17% U.S. children in 2011-2014.[9] Those supporting the use of self-report values are Morrissey et al.[59] who explored self-report height and weight compared to measured height and weight of 416 primarily Caucasian and African American middle schoolers and found self-report anthropometrics and measured anthropometrics were highly correlated. Perez et al.[60] found statistical differences between self-report and actual heights and weights in sample of US adolescents, but these differences were small (-0.23-2.02 cm for height and -0.98-0.004 kg for weight) suggesting errors associated with self-report values are minor and self-report values are relatively accurate in children. Some studies have found misclassification of BMI categories based on self-report height and weight to be minor and therefore concluded self-report values are okay to use. Bowring et al.[37] found that 88% of the sample could be correctly classified by self-report height and weight, and Goodman et al.[61] found that 96% of their primarily white adolescent sample was correctly classified by self-report height and weight. Internationally, Fonseca et al.[62] found that Portuguese adolescent self-report heights and weights were different than measured heights and weights, but the difference did not result in different BMI category classifications.[62] These results suggest the use of self-report values are okay to use with white and Portuguese adolescents because they do not result in a difference of BMI category classifications or obesity prevalence in children, but this may not be generalizable to other population groups.

Research that does not support the use of children's self-report height and weight values

In contrast, there are multiple studies suggesting that self-report height and weight are not appropriate to use with children. Though Brener et al.[63] found correlations of self-report height and weight to be high, they also found self-report height and weight were not accurate because only 71.2% of U.S. adolescents were correctly classified into the correct BMI category by self-report height and weight. This occurs internationally as well. Tokmakidis et al.[64] also found high correlations between self-reported and actual heights and weights in Greek elementary and high schoolers. However, paired t-tests of actual versus self-report height and weight values were significantly different except for height in elementary school girls.[64] A correlation between self-reported and measured height and weight does not indicate that both methods necessarily agree.[65] These results imply that self-report height and weight are reliable, but may not be accurate. Further supporting the inaccuracy of self-report values, self-report height and weight were found to be statistically different from measured values in a sample of Chinese adolescents.[66]

Other research has indicated self-report values are not accurate because they result in different BMI category classifications. For example, Powell-Young[67] concluded self-report values were not accurate in a sample of U.S. teenagers because only 86% of the sample could be correctly classified into the correct BMI category. Another study found that 1 out of 6 children were misclassified based on self-report BMI (16.6%).[59] Hauck et al.[31] found that only 76% of Native American adolescents were correctly classified by self-report height and weight. Multiple children and adolescent studies have suggested self-report values result in different BMI category classifications and an incorrect representation of obesity.

Factors that may influence self-report bias in children/adolescents

Research has explored possible factors that may influence self-report bias, such as race. Whether race plays a role into the level of misreporting height and weight in adolescents is also controversial. Some studies have found African Americans are more likely to underestimate weight and BMI more than other races, whereas other studies have shown that Caucasian students were significantly more likely to overreport their height.[59,63] Himes et al.[68] found that race did not influence bias for girls, but Asian boys were found to underestimate their weight more and overestimate their stature less than other races. In contrast, other research has suggested that race does not influence self-report values in children.[55,69] The influence race has on self-report values of children seems to be conflicted.

The role sex plays in potential self-report bias is less known for children. Strauss[69] found female adolescents were more likely to underreport their weight than males. However, Morrissey et al.[59] found sex not to be a significant predictor regarding self-report height and weight in an U.S. adolescent study. Likewise in Greece, a study of 378 elementary school students and 298 high school students found gender did not influence the accuracy of self-report height and weight.[64] These results indicate conflicting conclusions of the influence sex has on self-reported data by children and this may be because research is limited.

Increased differences between self-report and measured values based on age has also been found in adolescents. Himes and Faricy[56] found the youngest age groups of

U.S. children had the largest standard deviations implying they are less reliable and found that when age increases, validity also increases. The youngest two age groups also had the most missing data (40% and 25%) compared to an overall missing data of 2-4%.[56] Missing data could indicate either refusal to answer self-report questions or that these children did not know their height or weight. In contrast, a study exploring the validity and reliability of self-report height and weight found that the extent of height, weight and BMI differences increased as grade levels, and therefore age, increased.[63] Tokmakidis et al.[64] also found that Greek high school students overestimated their height and underestimated their weight more than Greek elementary school children. These differences in results imply how age influences self-report bias in children is less known.

Actual weight status may influence self-report weight in children. For instance, one study that examined accuracy of self-report heights and weights of children found that those who were overweight were more likely to underestimate weight than adolescents that were normal weight.[59] This was also found by Fortenberry,[70] who explored the accuracy of self-report heights and weights of inner city adolescents and by Himes and Faricy[56] who studied adolescents from the NHANES III study. Weight status seems to influence self-report biases in children.

Actual BMI status may influence self-report heights and weights in children. For instance, one study that examined accuracy of self-report heights and weights of children found that those who were overweight were more likely to underestimate weight than adolescents that were normal weight.[59] This was also found by Fortenberry,[70] who explored the accuracy of self-report heights and weights of inner city adolescents and by Himes and Faricy[56] who studied adolescents from the NHANES III study. BMI status seems to influence self-report biases in children.

Correcting for self-report bias with children

Models for correcting self-report BMIs has also been suggested for children and adolescents. Liechty et al.[55] developed a linear equation to correct for self-report height and weight for adolescents. Self-reported weight, age, puberty status, weight status, body size estimation, dieting, depressive symptoms, self-rated health and self-esteem were all found to influence weight and from these an equation was created.[55] Measured height was found to be influenced by self-report weight, age, puberty status, weight status, body size estimation, dieting, depressive symptoms, self-rated health status, self-esteem, race, sex and parent education.[55] The corrected values improved sensitivity for obesity, but did not improve sensitivity to detect underweight or normal weight adolescents.[55] Though this correction equation is extensive and includes multiple factors, it may only work for adolescents in grades 7-12 living in the US. Drake et al.[71] attempted to correct for self-report BMI by using multiple imputation in sample of American adolescents. The corrected values gave a prevalence of obesity that was more similar to the measured values than the self-report values.[71] The actual prevalence of obesity was 20%, whereas self-report values indicated an obesity prevalence of only 12% and the corrected values indicated an obesity prevalence of 20%.[71] There are methods to correct for self-report values, but these vary and may not be applicable to certain populations.

Rationale for research based on literature review

Overall, there is a plethora of research focused on many different aspects of problematic eating behaviors. There is also an abundance of animal research focusing the neurological pathways of eating, and feeding behaviors. Rat research has found opioids, which are released when eating highly palatable foods, to play a large role in feeding as well as many different parts of the brain. Some research has focused on the types of foods that may lead to problematic eating behaviors. There are studies to support that any type of food can be associated with problematic eating behaviors, all though highly-palatable foods seem to be most problematic.

Other research focuses on eating behavior, taste preference, and neurological differences among individuals who normal weight and those with obesity. There seems to be differences within the brain between obese rats and lean rats during consumption of food. Also, studies of eating motives indicate that individuals who use food to cope are more likely to have a higher BMI. Other studies suggest a lack of satiety signaling and reward systems resulting in individuals with obesity to consume large amounts in order to gain a sense of reward and feel satisfied. Overall, much of the neurological research studying problematic eating behaviors uses rat models rather than humans despite the different social and environmental factors that influence human consumption. More research is needed to understand the role problematic eating behaviors play in humans and its correlation to the obesity epidemic.

Furthermore, self-report height and weight seem to give inaccurate measures of actual BMI and underestimate obesity prevalence. In general, individuals tend to overestimate height and underestimate weight. Individuals who are shorter seem to overestimate height to a greater degree and those who are overweight tend to underestimate weight to a greater degree. Age, sex, race and education level may also influence the level of misreporting height and weight. Multiple studies have tried to create prediction or correction equations to calculate actual anthropometrics from self-reported anthropometrics. These resulted in a more accurate estimate of obesity, but the equations proposed are all different and may only be accurate with specific populations. Assessing the accuracy of self-report heights and weights in both children/adolescents and adults is necessary because of all the inconsistencies within the current literature.

PURPOSE STATEMENT

The purpose of this research project was to explore problematic eating behaviors in a sample of low-income African American women and to determine the accuracy of self-report height and weight in an ethnically diverse, low-income sample of both children and adults. These populations were chosen as the focus of the study because of the large prevalence of obesity in the African American population, and in the low-income community.

RESEARCH QUESTIONS

Project 1:

- How do low-income African American women think of food? What is their relationship to food?
- How do low-income African American women decide when to eat? What are their motives to eat?
- How do low-income African American women decide to stop eating?
- What factors influence what low-income African American women decide to eat?

- How much of low-income African American women's day is preoccupied with thoughts of food?
- What factors do low-income African American women believe body size can be attributed to?
- Do the answers to the above questions differ among body sizes?
- Do problematic eating behaviors seem to be prevalent among those with obesity?

Project 2

- How accurate is self-report height and weight for use with adults?
- What factors influence adult biases in self-report heights and weights?
- How accurate is self-report height and weight for use with children/adolescents?
- What factors influence children/adolescent biases in self-report heights and weights?
- How do adults view their health and diet?
- How do children/adolescents perceive their health and diet?

SUMMARY OF STUDY DESIGN AND METHODOLOGY

Project 1 (problematic eating behaviors) was completed using quantitative (a taste test and the Palatable Eating Motives Scale [PEMS] and qualitative (focus group discussions) research methodologies. African American women, ages 18 to 64 years were recruited via flyers and in person at libraries, WIC offices, community centers, community schools, hot meal sites, and food shelves. Participants were asked if they qualified for any food assistance programs such as SNAP, WIC, or children that received free or reduced lunch during the recruitment process in order to recruit low-income individuals. Low-income African Americans were chosen as the focus of this study because of the increased obesity rate in this population. Focus group questions were created to gain insight about the women's eating and exercise habits. They were developed after conducting a literature review and upon discussion with Dr. Chery Smith and Dr. Allen Levine, who have experience in the eating behavior field. Transcriptions of focus group discussions were analyzed using Krueger's open coding method.[72]

As well as participating in the focus group discussion, participants also answered the PEMS survey and a participated in a taste test. The survey consists of 20 questions asking when palatable foods are consumed and explores four motives: coping, reward, social, and conformity, in order to gain information about the participants motives for consuming palatable foods.[73] Motive scores were calculated by the taking the average response of each question within the motive.[24]

The taste test was done using a Labeled Magnitude Scale (LMS). The LMS was developed as a way to measure taste sensation.[74] Participants were asked to taste M&M's chocolate candies, peanuts, chips, brownies, and grapes. These foods were chosen because of their varying degrees of saltiness/sweetness and nutritional value. Participants tasted each food item and marked their likeness of the food on the LMS scale.

Project 2 was a secondary data analysis project with data from past research studies conducted by my advisor, Dr. Chery Smith. Data was collected between the years of 2001-2016. During each study, participants were asked what they thought their height and weight was. Then, a trained researcher measured the participants' actual height and weight. Data from all studies were entered into SPSS and combined into one file for statistical analysis.

Further details regarding study design and analysis can be found in Chapters 2-4. All studies were approved by the University of Minnesota's International Review Board.

Chapter 2: Problematic eating behaviors are more prevalent in low-income African American women with obesity/overweight than low-income African American women who are lean or normal weight

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Submitted to Journal of Hunger and Environmental Nutrition

CHAPTER SUMMARY

Neuronal control of food intake can be associated with problematic eating behaviors such as overeating and loss of control over consumption and can lead to obesity. Problematic eating behaviors among women of differing BMIs were explored through focus group methodology, the Palatable Eating Motives Scale (PEMS), and a taste test in a sample of low-income African American women (n=45). Women with overweight/obesity (W-O/O) reported more problematic eating behaviors including eating in the absence of hunger, frequent overeating, increased food thoughts than women who were lean or normal weight (W-L/N). W-O/O appear to possess more problematic eating behaviors than W-L/N.

INTRODUCTION

Obesity is a global epidemic that affected approximately 36.5% US adults between 2011-2014, and 32.8% of adults were overweight between 2013-2014.[25,75] There are a number of comorbidities associated with obesity such as diabetes, cardiovascular disease, and some cancers.[26] Because of these comorbidities, individuals with obesity (BMI $\geq 30 kg/m^2$) have an increased mortality rate from all causes compared to an individual with a BMI between 20 and 25 kg/m^2.[26] Furthermore, obesity is expensive. In 2008, about $147 billion was spent on medical expenses associated with obesity in the U.S.[27] Because of the comorbidities and expenses related to obesity, it is important to try to understand eating behaviors that may promote weight gain and obesity.

Problematic eating behaviors such as overeating and eating in the absence of hunger may be related to neuronal control of food intake. Eating highly palatable foods has been shown to be regulated by the brain's reward system engaging opioids, dopamine, and other neuronal circuits, thus encouraging intake of these foods.[76,77] Also, opioid antagonists appear to decrease consumption of high sugar and high fat foods in binge eaters, but not in controls.[78] This suggests that disordered eating and eating behaviors, such as the consumption of highly palatable foods may also be influenced by the opioids from the brain's reward system.

Eating behaviors such as eating in the absence of hunger, overeating, and loss of control over consumption, have been studied. These eating behaviors appear to be found in individuals with obesity.[1–7] Obesity is higher in certain groups of people such as African Americans (76% are overweight or obese) than the general population (68% are overweight or obese).[8,9] Also, 42% of women living below the 130% poverty level suffer from obesity, compared to 29% that are living at or above the 350% poverty level.[10] Research has found individuals who were lean or normal weight expressed more nutrition knowledge, were more health conscious, prioritized buying fruits and vegetables, and ate by internal cues more than those who were overweight or obese.[1,3,4] Also, those who are overweight or obese have been shown to exercise less, eat in the absence of hunger, overeat and emotional eat, and express enjoyment of eating and a greater liking of a variety of foods more than those who are lean or normal weight.[1–4,79] These results suggest problematic eating behaviors may be more prevalent in the obese population. Thus, the purpose of this research was to investigate eating behaviors of women who were lean or normal weight (referred to as W-L/N) and women who were overweight or obese (referred to as W-O/O) and to explore whether problematic eating behaviors were more common among W-O/O than W-L/N using focus group methodology, actual heights and weights data, and measuring taste preferences and palatable eating motives. Focus group methodology has been used in previous research to fill gaps in nutrition information.[80–83]

METHODS

Qualitative data (focus group discussions) and supplemented with quantitative data (a taste test and Palatable Eating Motives Scale [PEMS]) were used with African American (n=45) women, ages 18 to 64 years. Low-income African Americans were chosen as the focus of this study because of the increased obesity rate in this population. Participants were recruited through flyers and in-person at libraries, WIC offices, community centers, community schools, hot meal sites, and food shelves. Participants were asked if they qualified for any food assistance programs such as SNAP, WIC, or children that received free or reduced lunch during the recruitment process in order to recruit low-income individuals. At the focus groups, women gave written consent, had actual heights and weights measured, completed forms, and participated in a group discussion. Cash compensation was provided for 90 minutes their time. The University's Institutional Review Board approved this study.

Focus groups

Eight focus groups with an average of 5 women (range of 2-8 women), were conducted by 2 researchers trained in focus group methodology. One researcher led the focus group, while the other researcher took notes during the focus group. Questions were developed based on previous literature and discussion with researchers in the eating behavior field.[1–4] Focus group questions were created to gain insight about eating/exercise habits among African American W-L/N versus W-O/O. Audio recordings of discussions were transcribed verbatim. The same researchers that conducted the focus groups coded each transcription separately using Kreuger's open coding method, reconciled any differences, and organized codes into themes and subthemes.[72] Quotes were organized into a table that separated W-L/N from W-O/O for each theme.

Palatable Eating Motives Scale

The Palatable Eating Motives Scale (PEMS) assessed reasons for consuming palatable foods to explore if these women ate highly palatable foods for reasons other than hunger. The survey consists of 20 questions **(Table 2)** asking when palatable foods are consumed and explores four motives: coping, reward, social and conformity.[73] Each motive included 5 questions. Motive scores were calculated by the taking the average response of each question within the motive.[24]

Taste test

Women were asked to taste 5 different snack foods varying in sweetness and saltiness (salted peanuts, M&M's milk chocolate candies, green grapes, brownies, and regular potato chips) to test for differences in food preferences. These foods were chosen because they vary in sweet/ saltiness and in nutritional value. The degree of liking of each food was measured using the Labeled Magnitude Scale (LMS). The LMS was developed as a way to measure taste sensation.[74] Women were asked to mark their degree of liking of the food on the LMS that went from most imaginable dislike to greatest imaginable like after each taste. Women were asked to take a drink of water to clear their palate after tasting each item. Researchers measured the distance from the beginning of the scale line to the mark made by the participants with a ruler to determine the degree of liking.[74]

Anthropometric Data Collection

Actual heights and weights were assessed using a portable stadiometer and calibrated digital scale. Participants were measured without shoes and outdoor clothing. Measurements were taken twice and the maximum height measured and averaged weight were used. These measurements were used to calculate BMI (kg/m^2). BMI categories were <18.5 kg/m^2 (lean or underweight), 18.5-24.9 kg/m^2 (normal weight), 25-29.9 kg/m^2 (overweight), and ≥30 kg/m^2 (obese).

Statistical Analysis

Data was entered into SPSS for Windows Statistical Analysis Software Package Version 22. Independent t-tests compared W-L/N (BMI: <25 kg/m^2) to W-O/O (BMI: ≥25 kg/m^2) to analyze differences in demographic, the PEMS, and the taste test data.

RESULTS

Sample Characteristics

Sample characteristics are shown for 45 African American. The mean age was 45 years. W-L/N had statistically larger household sizes. **(Table 1)**.

Palatable Eating Motives Scale

The PEMS assessed reasons for consuming palatable foods. Mean responses and motive scores can be seen in **Table 2**. The coping score to feel more confident was significantly higher for W-L/N compared to W-O/O, indicating food helps W-L/N feel more confident. W-L/N also scored higher for "gives pleasant feeling," suggesting W-L/N eat for pleasure more than W-O/O. Social scores between W-L/N were significantly higher than W-O/O, specifically to make gatherings fun and to celebrate special occasions, suggesting W-L/N eat palatable foods to be social more so than W-O/O. Overall, the results of PEMS suggest W-L/N eat for hedonic reasons more than W-O/O which contrasts what was said in the focus groups.

Sweet vs. Salty Preference

Preference for sweet or salty food was mixed between W-L/N and W-O/O. However, W-L/N identified fruits as sweet foods they liked; as one said, "Sweets. I like bananas…I eat that everyday" [BMI: 19.2 kg/m^2]. In contrast, W-O/O tended to like sweets such as ice cream, pastries, and candy; as a woman stated "Sweet foods…I want chocolate. I want ice cream" [BMI: 27.1 kg/m^2]. W-O/O who liked fruits had lower BMIs compared to the rest of the W-O/O. Liking vegetables was also mentioned more frequently by W-L/N. W-L/N often said phrases such as, "Yeah, I love veggies" [BMI: 20.0 kg/m^2] or "…Oh yeah, vegetables. I eat my vegetables fresh. I like em with stir fry..." [BMI: 23.4 kg/m^2]. Vegetables were mentioned much less by W-O/O.

The results of the taste test found that W-L/N liked grapes (18.5 cm) best, followed by M&M's (17.6 cm), then brownies (17.2 cm), then potato chips (16.9 cm), and lastly peanuts (15.3 cm). Similarly, W-O/O liked grapes (18.4 cm) best, followed by potato chips (17.0 cm), then peanuts (15.6 cm), then brownies (14.1 cm), and lastly M&M's (13.7 cm). W-L/N had significantly higher scores for liking of M&M's than W-O/O.

Focus Groups

Five themes identified through focus groups were: (1) Internally and externally motivated eating differ between BMI status, (2) Concept of health affects eating habits according to BMI status, (3) Reasons for exercise is related to BMI status, (4) Reaction to stress is related BMI status, and (5) Factors that determine body size is different between BMI status.

Theme 1: Internally and externally motivated eating differ between BMI status.

Internal hunger cues stimulated eating for W-L/N, whereas external environmental cues influenced eating behaviors among W-O/O. The subthemes that emerged were deciding when to start and stop eating, overeating, food thought frequency, and occurrence of forgetting to eat. W-L/N ate mostly when they felt hungry. One woman stated, "I eat because I be hungry" [BMI: 20.8]. In contrast, W-O/O often reported eating in the absence of hunger, as this woman reported, "I eat about when I feel like the urge. Like I'm not even hungry." [BMI: 36.4 kg/m^2]. These data show W-L/N ate when hungry, while W-O/O ate in response to other factors.

When women stopped eating differed between women of different sizes. W-L/N stopped eating once they felt full, listening to internal cues, as reflected by one woman "I don't like the feeling of being overfull…I don't even like getting overfull on [chips] cause my body just doesn't like to hold a lot of grease. So I eat to the point where I'm comfortable and I can stop…" BMI: 20.8 kg/m^2]. In contrast, W-O/O talked of overeating on a regular basis, as one stated "We all go out [to restaurants]… Yeah, but I sit there all day long. I don't think I ever get full. My jaw get tired" [BMI: 33.2 kg/m^2]. W-L/N constantly reported listening to internal hunger cues and were less influenced by external environmental cues than W-O/O.

W-L/N also thought about food less frequently. One woman stated, "I don't ever think about food. I just eat when I'm hungry. I never think about food" [BMI: 18.4 kg/m^2]. In contrast, W-O/O thought about food frequently, with food often a topic of conversation. As one said, "I think about [food] a lot. I like to eat every hour. I am thinking about food. When I'm walking down the streets, I'm looking at the restaurants…Where can I stop at?" [BMI: 27.7 kg/m^2]. When discussing going out to social gatherings, W-O/O thought more of the food days before the event, but W-L/N thought of the event, contrasting with the PEMS finding that W-L/N eat palatable foods at social events. W-O/O were often preoccupied by food thoughts, but W-L/N rarely thought of food.

Another difference between women of different sizes was forgetting to eat. Forgetting to eat was often verbalized by W-L/N. As one woman said, "I don't think I start thinking about food until my stomach grrrrr. Sometimes I forget to eat. I thought I ate and I probably haven't eaten all day, so I just be sitting there, I hear grrrr. Did I eat something?" [BMI: 24.5 kg/m^2]. Conversely, W-O/O reported rarely forgetting to eat. Forgetting to eat, food thought frequency, and factors that influence eating differed between W-O/O and W-L/N.

Theme 2: Concept of health affects eating habits according to BMI status.

Eating for health was common among W-L/N, and less common among W-O/O. The subthemes that developed were food as a nutrient versus food as pleasure and acceptance of a larger body size. W-L/N discussed using food as a nutrient, whereas the W-O/O used food for pleasure. Eating nutritiously was motivated by health benefits and avoidance of disease for W-L/N. One woman explained "I'm mindful of what it is I eat because my blood pressure, I'm affected by what I eat, my blood pressure is. I really like bacon. I've had to discipline myself with how much of it I eat" [BMI: 20.8 kg/m^2]. Health and prevention of disease was a common motivator of nutritious eating among W-L/N.

In contrast, health was not a concern for the majority of W-O/O. The few W-O/O who desired to eat healthy expressed barriers to doing so such as current health problems, lack of time, or cost, as one mentioned "…I know what I'm supposed to eat. I know what's best for me, but when it comes to finances and what you can afford, you go down the fresh produce aisle, they're sky-rocketed… A lot of times I know what I'm supposed to get but you end up getting the canned goods. They got sodium in it" [BMI: 31.6 kg/m^2]. Cost, lack of time, and current health issues were common obstacles to consuming healthy foods for W-O/O.

W-O/O often discussed eating for pleasure, which differed from the PEMS findings in that W-L/N ate for pleasure more than W-O/O. However, in focus group discussions, comments like "I just got to be in that kitchen and wherever I go if I don't have any money, I have attitude because I'm going to eat. I ain't hungry. I just want to eat" [BMI: 33.8 kg/m^2] were common among W-O/O. Also, these women showed more acceptance of a larger body size as seen by this quote "We big boned you know" [BMI: 36.6 kg/m^2]. In contrast to the PEMS findings, W-L/N emphasized the importance of a healthy lifestyle, while W-O/O emphasized how much they enjoy eating.

Theme 3: Reason for exercise is related to BMI status.

Exercise habits were also different between W-L/N and W-O/O. W-L/N exercised for health benefits. As one woman stated, "For my health and keep my body going and energy. I do yoga. I do squats in the morning. I do walking. Those are the basic ones I do" [BMI: 23.1 kg/m^2]. W-L/N also indicated that they enjoyed exercise. One woman reported "I like [exercise]. It's not like a regular yoga studio. It's a lot of dancing… it's fun..." [BMI: 23.7 kg/m^2]. W-O/O reported being less active. For them, physical activity was done if required to watch their children, and walk places because they lacked transportation, as one said "I walk everywhere. Limited funds so what I can afford. I [walk] because I have to [because of no transportation]" [BMI: 27.1 kg/m^2]. W-L/N saw exercise as enjoyment, a hobby, and a way to relieve stress, whereas W-O/O saw exercise as a chore.

Theme 4: Reaction to stress is related to BMI status.

W-L/N coped with stress differently than W-O/O. Subthemes that emerged were the use of comfort foods and the use of sedentary activities versus non-sedentary activities during stress. Some W-O/O used food as a coping mechanism as one woman explained, “If I’m feeling stressed or depressed I find my comfort in food… I’ll eat anything... I open that refrigerator a hundred times… I’m not even hungry. It’s the stress” [BMI: 36.4 kg/m^2]. Other W-O/O used sedentary activities to handle stress such as laying down, praying, or talking through their stress. One woman stated “When I’m stressed out, I’m laying down” [BMI: 29.7 kg/m^2]. In contrast, W-L/N mostly handled stress through physical activity, such as walking or working out. One woman reflected “I’ll stretch or I dance a lot…I love dancing. It’s a stress reliever” [BMI: 18.4 kg/m^2]. W-L/N were more active during stressful times than W-O/O. This finding contradicts the results of the PEMS scale in that W-L/N had higher coping scores meaning they to turn to food as a coping mechanism more than W-O/O.

Theme 5: Factors that determine body size are different between BMI status. Women of different sizes believed body size was determined by different factors. W-L/N believed body size was mostly determined by controllable factors such as eating habits and physical activity levels. One woman explained “I think it’s pretty much like people’s eating habits. The genetics, I think it could be but from that point of view, with a mom and a child, if a mother’s overweight the child might be more prone to be overweight because of the mother’s eating habits” [BMI: 20.3 kg/m^2]. W-O/O believed body size was mostly influenced by uncontrollable factors like genetics as woman mentioned “I look at all my aunties, my mother. Every single aunt has big legs and big butt. That’s genetic. So how come my grandma has big legs. So it is what it is…” [BMI: 32.4 kg/m^2]. Another common reason for body size was medication, as one woman explained, “My weight gain comes from because… they put me on a steroid…it’s not the food I’m consuming, it’s the medication. You don’t even have to eat nothing cause it’s a steroid. It gonna make you gain weight” [BMI: 36.4 kg/m^2]. Difficult life situations were also regularly stated as a reason for body size among W-O/O. One woman said, “Some people are depressed. Some people are addicts. Some people have physical disabilities. Some people have mental disabilities. [Body size] is just kind of what’s going on with that person” [BMI: 25.6 kg/m^2]. W-O/O believed body size was determined by less modifiable factors, while W-L/N thought body size was a result of modifiable lifestyle factors.

DISCUSSION

This study adds to the literature by investigating eating behaviors using qualitative methodology and including low-income African American W-L/N and W-O/O. Key findings of this study were, a) W-L/N did not overeat, thought of food less often, forgot to eat, responded to internal hunger cues, and did not eat in the absence of hunger indicating less characteristics of problematic eating behaviors in contrast to W-O/O, who overate frequently, constantly thought of food, ate in the absence of hunger, and responded to external environmental cues, b) W-L/N ate nutritious foods and exercised for health reasons, whereas W-O/O were not motivated by health to consume nutritious foods or exercise, c) W-L/N used non-sedentary activities to cope with stress, but W-O/O used sedentary activities or food to cope with stress, and d) W-L/N viewed body size as modifiable, whereas W-O/O saw body size caused by genetics or side effects of medication.

The results of this study indicated strong eating behavior differences among W-L/N and W-O/O. W-L/N reported less problematic eating behaviors; for example, they listened to internal hunger cues rather than external environmental cues. Specifically, they ate only when hungry and rarely overate because they were able to stop eating once full. Previous research found that individuals who were lean or normal weight ate based on internal cues; only eating when hungry and rarely overeating.[1,3] Also, food seemed less of a priority for W-L/N, as they did not think of food often, and many W-L/N simply forgot to eat because they were busy. Other research indicated that adolescents and adults with lower BMIs were less preoccupied with food [15,16], similar to the findings in this study. However, the PEMS results suggest W-L/N ate for hedonic reasons more than W-O/O. In contrast, findings from the focus groups suggest W-L/N were able to stop eating once full, whereas W-O/O could not stop eating and would often overeat.

In contrast, W-O/O expressed more problematic eating behaviors. They reported that they responded to external environmental cues, ate in the absence of hunger, had a difficult time stopping eating, overate on a regular basis, and frequently thought of food. W-O/O emphasized the frequency of their food thoughts, eliminating the chance to ever forget about eating. Earlier research has shown that those who are overweight are more likely to have food related thoughts during the day.[15,16] Increased food thoughts in those who are overweight or obese could stem from earlier dieting and restricting foods, as the frequency of food thoughts increases during starvation and food restriction associated with dieting [39,84], consistent with this research.

This data also indicated W-O/O frequently ignored internal satiety cues and ate in the absence of hunger. Eating in the absence of hunger, or eating palatable foods beyond satiation, has been researched in both adults and children and indicates that it is predictive of higher BMIs throughout the lifecycle.[18,85,86] Eating in the absence of hunger occurs during emotional eating and when food is readily available.[5,6,87] Higher scores on the PEMS scale have been linked with larger BMIs suggesting women with larger BMIs often eat for hedonic reasons instead of hunger.[24,73,88] This contradicts what the PEMS found in this study. The PEMS has only been validated in young college students and may not be appropriate to use with less educated, low-income, or middle-aged or minority populations. Consuming food because of its availability rather than hunger, has been positively correlated with BMI and food insecurity.[6,39,89] Similarly, W-O/O discussed eating in the absence of hunger when food was available.

Another possible reason for eating in the absence of hunger would be eating for pleasure rather than hunger, as the results of this study indicated. W-O/O discussed how much they enjoyed eating and that sometimes they ate for pleasure, even though they were not hungry. Because eating is pleasurable, it was difficult for W-O/O to stop eating; a problem often observed in the overweight population.[1,3] This lack of control leading to overeating could be due to weakened satiety signals in individuals who are overweight or obese, or because external environmental factors overcome internal satiety cues.[19,20] Eating behaviors that could lead to obesity, such as overeating, and eating in the absence of hunger were discussed by W-O/O in this study.

This study also found that health influences eating and exercise habits based on BMI. W-L/N consumed fruits and vegetables and exercised to maintain a healthy weight and avoid diseases. Other research indicated women who were lean or normal weight were more health aware, which reflected in their eating choices.[1,3,4,79] Research has also indicated cost as a barrier to eating healthy foods for women who were overweight or obese, but less for women who were lean or normal weight.[1,3] Furthermore, research has found adults who are overweight or obese to be more sedentary than adults who are lean or normal weight.[3,90,91] Food choices and activity levels appear to be influenced by health benefits based on BMI status and could contribute to the differing BMI statuses among participants.

Women also had different stress coping mechanisms based on weight status. Most W-L/N reported losing their appetite and eating less during stress. Dammann and Smith[2] also found that African American women with lower BMIs tended to lose weight during stressful times. Results from this study indicated that these women performed non-sedentary activities to cope with stress including working out or walking. In contrast, W-O/O used food or sedentary activities to cope with stress. They often described themselves as emotional eaters. Depressed, low-income women are particularly at risk for using food to cope with negative emotions as emotional eating has been linked to depressed, low-income women.[12] Other research has reported overeating as a coping mechanism and that emotional eating was common among women who were overweight or obese.[1–4,7] Similarly, higher scores on the PEMS scale for the coping category has been associated with larger BMIs.[24,73,88] Other common ways W-O/O coped with stress were with sedentary activities such as sleeping, laying down, watching T.V. or praying. These different coping mechanisms may help explain the difference in BMIs seen in these participants.

This data suggests that perceptions about causal factors for obesity differ by weight category. Most W-L/N saw body size as modifiable and attributed body size to lifestyle choices, including choices about food intake and physical activity. However, W-O/O felt that body size was mostly influenced by factors beyond their control such as metabolism, genetics, medication, depression, and stressful situations, and that eating habits and physical activity had little to do with body size. Dressler and Smith[3] found that women from both BMI categories believed that genetics greatly influenced body size whereas, Lin et al.[92] found low-income women who attributed body size to genetics had larger BMIs, consistent with the findings of this study.

CONCLUSIONS

Overall, this study adds to the literature by comparing eating behaviors, reasons for consuming highly palatable foods, and taste preference among low-income African

American W-L/N and W-O/O using focus group methodology, PEMS, and a taste test. The results suggest that problematic eating behaviors such as overeating, constantly thinking of food, eating in the absence of hunger are common among W-O/O. Ways of handling stress and exercise habits were also different among W-O/O and W-L/N. PEMS results of this study contradicted what was said in the focus groups and other studies that have used PEMS. This difference could be from a difference in sample population. The PEMS may not be culturally appropriate for African Americans, low-income populations, or middle-aged women as this scale has only been validated with college students of mostly white ethnicity. Further research is needed to know if the PEMS scale is valid to use in minority populations, middle aged populations, and less educated populations. Findings from this study are insightful to obesity and eating behavior research, but some limitations exist. The results may not be generalizable to the entire population because only African American women in the area participated.

Findings from this study indicated that problematic eating behaviors that may lead to obesity seemed to be more prevalent in W-O/O than W-L/N; however, how to stop these eating behaviors is still uncertain. Simply teaching these individuals to avoid such eating behaviors and listen to internal hunger cues rather than external environmental cues has not been effective, possibly because the consumption of highly palatable foods affect the opioid circuits involved with the brain's reward system.[77] If eating highly palatable foods are regulated by the brain's reward system in individuals with obesity, it makes sense that these individuals would have a difficult time losing weight and may be why weight loss programs are often ineffective. One review of weight loss programs indicated only 20% of individuals that successfully lose weight are able to maintain that weight loss for a year,[93] and patients are more likely to regain more weight with time.[93,94] This suggests different methods of treatment are needed for individuals with obesity.

Perhaps other treatments are needed to assist individuals with obesity control their weight. The weight control registry could be helpful to individuals with obesity. This program could give insight to how certain individuals managed to keep weight off long term. A study of the weight control registry showed that weight regain was associated with decreases in leisure time caloric expenditure and self-weighing frequency and those with a longer history of weight maintenance were more likely to participate in long term follow-ups.[95] This could indicate that long term behavioral changes and follow-ups may help individuals control their weight.

One other method of treatment to consider would be to help these individuals manage internal hunger/satiety signals using drug therapy to alter the brain's reward system. However, current research regarding altering the brain's reward system chemically has not been successful. Medications such as Rimonabant, Taranabant, and Topiramate have been shown to help individuals lose weight, but cannot be used because of adverse health effects including psychiatric and gastrointestinal issues,[96,97] indicating the need for further drug-therapy research.

Though this study gives insight to eating behaviors that may lead to obesity of low-income African American women, who are likely to be overweight or obese, further research is needed to learn how to avoid obesity in the general population and how to help individuals with obesity focus on internal satiety cues through drug or behavioral-therapy, to control their weight.

Table 1. Focus Group Anthropometrics and Socioeconomic Data by BMI Status		
Characteristics	**Mean±SD** **Lean/Normal Weight (n=23)**	**Mean±SD** **Overweight/Obese (n=22)**
Age (years)	44.9±15.3[a]	44.7±13.2[a]
Household Size	2.6±1.9[a]	1.6±1.1[b]
Height (meters)	1.7±0.1[a]	1.6±0.1[a]
Weight (kg)	57.6±8.0[a]	84.7±15.5[b]
BMI (kg/m^2)	20.9±2.8[a]	31.9±5.4[b]
	%	%
Income (Yearly)		
Less than $10,000	66.7	76.3
$10,000-19,000	19.0	14.3
$20,000-$29,000	4.8	0.0
$30,000-$40,000	4.8	4.8
Greater than $40,000	4.8	4.8
Unemployed	4.8	4.8

[a-d]Superscript differences indicate significant different using t-test between groups by row

Table 2. Palatable Eating Motives Scale by BMI			
	Lean/Normal Weight (n=23)	**Overweight/Obese (n=22)**	
	Mean±SD	**Mean±SD**	**Sig.***
Coping Score	2.3±1.1	2.0±0.8	0.248
To forget worries	1.9±1.3	1.9±0.9	0.889
Helps when depressed/nervous	2.2±1.3	2.0±1.0	0.693
To cheer up	2.3±1.5	2.3±1.2	0.910
Feel more self-confident	2.7±1.5	1.5±0.7	0.002*
To forget problems	2.3±1.5	2.0±1.1	0.474
Reward Score	2.4±1.0	2.0±1.0	0.237
You like the feeling	2.4±1.5	2.1±1.4	0.583
It's exciting	2.3±1.4	2.1±1.2	0.559
Get high-like feelings	1.7±1.0	1.6±1.0	0.753
Gives pleasant feeling	3.0±1.5	2.0±1.2	0.035*
It's fun	2.6±1.5	2.2±1.3	0.395
Social Score	3.0±1.1	2.2±0.8	0.019*
Helps enjoy party	2.8±1.4	2.2±0.9	0.135
To be sociable	2.6±1.5	1.9±0.9	0.083
Makings gatherings fun	2.9±1.5	2.0±0.9	0.032*
Improves parties/celebrations	3.1±1.4	2.4±1.3	0.072**
Celebrate special occasion	3.2±1.2	2.4±1.3	0.045*
Conformity Score	1.8±1.0	1.5±0.5	0.301
Friends want you to	2.0±1.3	2.1±1.2	0.802
So others won't kid you	1.6±1.1	1.5±0.9	0.760
To fit in	2.0±1.2	1.2±0.9	0.008*
To be liked	1.7±1.4	1.3±0.7	0.306

Won't feel left out	1.7±1.4	1.5±0.7	0.576
Total Score	46.8±18.3	38.3±12.6	0.088**

*Significant differences using t-test

**Trend using t-test

Chapter 3: Accuracy of self-report heights and weights in a predominately low-income, diverse adult population living in the U.S.

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Accepted in American Journal of Human Biology

CHAPTER SUMMARY

Objectives: The objectives of this study were to explore the accuracy of self-reported heights and weights and factors that may be associated with self-reported bias in a U.S. diverse sample.

Methods: Demographic, self-reported, and measured height and weight data from different studies with the same PI were compiled into one SPSS file and analyzed with paired t-tests to detect differences between self-reported and actual values. Kruskal Wallis tests followed by pairwise t-tests detected any differences among age, ethnicity, sex, income, and education. Stepwise regression analyses were done using anthropometric differences as the dependent variable and age category, sex, and ethnicity as independent variables to explore which variable was most predictive of anthropometric differences.

Results: Individuals overreported height and underreported weight leading to an undercalculated BMI from self-reported height and weight by 0.6-1 kg/m2. These undercalculations of BMI led to misclassifications of obesity by 3%, 6%, 8%, and 4% for African American, Euro-American, Native American, and total women and by 5%, 6%, 8%, and 8% by African American, Euro-American, Native American men, and total men. Older individuals overreported height more than younger individuals. Males overreported height more than females. African American females overreported height to a lesser extent than other ethnicities. Asian males overreported height to a lesser extent than other ethnicities.

Conclusions: Self-reported heights and weights lead to invalid results and should be avoided. Most individuals overreport height and underreport weight resulting in an inaccurate underweight and obesity prevalence. Being misclassified into the incorrect BMI category could result in inappropriate healthcare treatment because a person may be wrongfully told to gain weight or not be treated for obesity when needed. Age, ethnicity, and sex appear to influence the misreporting of height and weight.

INTRODUCTION

Body mass index (BMI), a calculation incorporating a person's height and weight, is used to measure body mass and adiposity. Changes in BMI category percentages can be used to track trends in obesity (CDC, 2015a). BMI is often used as an indicator for disease risk (World Health Organization, 2018a). Underweight (BMI <18.5 kg/m2) and obesity (BMI ≥30kg/m2) are associated with increased mortality risk (Flegal, Graubard, Williamson, & Gail, 2005). In particular, underweight is associated with increased infections, poor bone health, and cardiovascular disease (Dobner & Kaser, 2018; Lim & Park, 2016; Suastika et al., 2012), while diabetes, cardiovascular diseases, and some cancers are associated with a BMI of ≥ 30 kg/m2 (CDC, 2015b). Because of these comorbidities, individuals with obesity (BMI ≥30kg/m2) have an increased mortality rate from all causes compared to an individual with a BMI between 20 and 25 kg/m2 (CDC, 2015b). Obesity also has a psychological effect. Westernized countries, such as the U.S., tend to have thin body image ideals and obesity is associated with negative connotations such as lack of control (Dressler & Smith, 2015). This social stigma could have negative effects on an individual with obesity such as poor self-esteem or depression (Brewis, Sturtz Sreetharan, & Wutich, 2018; CDC, 2015b; Dressler & Smith, 2015). Therefore, it is important to track underweight and obesity trends because of its health complications and social impact on those suffering with underweight or obesity. Self-reported heights and weights are frequently used in clinical and research environments because of its low cost and feasibility compared to measured heights and weights to assess obesity. However, some research suggests that individuals tend to overreport their height and underreport their weight resulting in an undercalculated BMI from self-reported height and weight and a smaller obesity prevalence (Connor Gorber, Tremblay, Moher, & Gorber, 2007; Conner Gorber, Shields, Tremblay, & Mcdowell, 2008; Gunnare, Silliman, & Morris, 2013; Mueller, Hurt, Abu-Lebdeh, & Mueller, 2014). How much is misreported, what factors influence misreporting, and who misreports most are unclear. Most research indicates differences in self-reported biases are large enough to result in an inaccurate calculation of their obesity prevalence (Craig & Adams, 2009; Johnson, Bouchard, Newton, Ryan, & Katzmarzyk, 2009; Mozumdar & Liguori, 2016; Wen & Kowaleski-Jones, 2012). However, conflicting evidence suggests self-reported height and weight errors are minor (Goodman, Hinden, & Khandelwal, 2000; Quick et al., 2015; Wada et al., 2005). Research has explored possible predictors of self-reported bias. Age, sex, ethnicity, education level, and income level have been suggested to influence their self-reported bias. However, not all research agrees on which factors influence self-reported bias. Whether self-reported heights and weights are valid to use in epidemiological, clinical, or research settings still appears to be unknown (Fillenbaum et al., 2010; Quick et al., 2015; Roth, Allshouse, Lesh, Polotsky, & Santoro, 2013).

Ethnicity has been explored as a possible factor that may influence self-reported bias. Johnson et al. (2009) found that the overreporting of height was significantly greater for African American females than Euro-American females. Underreporting of weight was significantly greater in Euro-American males compared to African American males and significantly greater in African American females compared to Euro-American females (Johnson et al., 2009). Another study showed underweight African American males overreported weight more than Euro-American males (Rowland, 1990). Ethnicity seems to influence the extent of misreporting height and weight.

Sex could also influence self-reported bias. Research found males overreported their height more frequently and to a greater extent than females, while females underreported their weight more often and to a greater extent than males (Flood, Webb, Lazarus, & Pang, 2000; Johnson et al., 2009; Mozumdar & Liguori, 2016; Quick et al., 2015; Wen & Kowaleski-Jones, 2012). This suggests that sex should be considered when using self-reported height and weight values.

Age may also influence bias regarding self-reported height and weights. Gillum and Sempos (2005) found the number of individuals who were not considered overweight based on self-reported height and weight, but were considered overweight based on actual height and weight was higher among older individuals than younger individuals. Also, some studies found older people tend to overreport their height and underreport their weight, resulting in a smaller calculated BMI from self-reported values more than younger individuals (McAdams, Van Dam, & Hu, 2007; Wen & Kowaleski-Jones, 2012). Age seems to influence the extent of misreporting height and weight.

Education may also be linked to self-reported height and weight bias. A higher education has been associated with an undercalculation of BMI from self-reported height and weight (Craig & Adams, 2009; Wen & Kowaleski-Jones, 2012). However, Gillium and Sempos (2005) found false negative rates, those who were not considered obese by self-reported values but were obese by measured values, were higher in less educated Americans than more educated Americans. Rowland (1990) found no significant correlation between self-reported values and education for males, but females who were severely overweight with a high school education underreported weight more than females who were severely overweight without a high school education. The influence education has on self-reported heights and weights varies between studies.

Income has also been suggested as a variable that may influence self-reported bias. Research has found the income ratio was associated with the undercalculation of BMI from self-reported height and weight for females, but not for males (Villanueva et al., 2001; Wen & Kowaleski-Jones, 2012). Other research has found no significant differences between self-reported values among income levels (Bolton-Smith, Woodward, Tunstall-Pedoe, & Morrison, 2000; Fillenbaum et al., 2010; Stommel & Schoenborn, 2009). How income affects self-reported bias is unclear.

Results of previous research regarding the accuracy and the use of self-reported heights and weights, and information about how factors such as sex, ethnicity, age, education, and income level affect self-reported bias are unclear. The purpose of this study was to explore the accuracy of self-reported heights and weights and factors that may be associated with self-reported bias in a diverse sample including mostly low-income, both sexes, a range of ages, African Americans, Euro-Americans, and Native Americans.

METHODS

Demographic and anthropometric data were analyzed from 18 different U.S. studies from the same lab with the same principal investigator. The studies included young adults, middle-aged adults, elderly, males and females, and different ethnicities including African Americans, Euro-Americans, and Native Americans from the years 2001-2016 (Dressler & Smith, 2013a; Eikenberry & Smith, 2004; Oemichen & Smith, 2016; Richards & Smith, 2007; Rustad & Smith, 2012; Schryver, Smith, & Wall, 2007; Smith, Klosterbuer, & Levine, 2009; Smith & Miller, 2011; Wigg Damman, Smith, & Richards, 2011; Wiig Dammann & Smith, 2009; Wu & Smith, 2016; Gallop & Smith; Smith &

Yentzer, unpublished; Smith, & Sais, under preparation.). All research was approved by the University's Institutional Review Board.

Recruitment methods varied in each study, but included flyers, emails, advertisements in local newspapers, verbal announcements, in person, and word of mouth. The focus of each study varied, but included food security and eating behaviors among elderly, minorities college students, homeless individuals, low-income individuals, and veterans. Places of recruitment also varied by study but utilized places with a high frequency of the target population. Examples of recruitment places included homeless shelters, low-income housing developments, community centers, libraries, food shelves, food stores, health clinics, college campus buildings, food assistance programs, elderly resident homes, hot meal sites, senior apartment homes, medical centers (outpatient), veteran's residential homes, and churches in Minnesota.

All studies used the same measurement protocol with the same principal investigator training her students in the same manner. All heights and weights were always measured without shoes and outer clothing such as jackets and sweaters, and with everything from pockets removed by a single researcher in each study. Height was measured using a portable stadiometer and weight was measured using a digital scale. Each measurement was taken twice. The maximum height measured to the nearest 0.1 cm and the average of the two weights to the nearest .1 kg were recorded. These were used to calculate actual BMI. BMI classifications were underweight (<18.5 kg/m2), normal weight (18.5-24.9 kg/m2), overweight (25-29.9 kg/m2), and obese (≥30 kg/m2) (CDC, 2015a). Prior to actual measurements being taken, participants were asked what they thought weighed and how tall they thought they were. Then a BMI measurement was calculated using that data and is referred to as BMI-SR in this paper. BMI calculated from actual height and weight is referred to as BMI-actual in this paper.

Demographic data were collected through a survey that asked participants their age, sex, income level, education level, height, weight, and ethnicity. Data from all studies were combined into one file in SPSS for Windows Statistical Analysis Software Package Version 24. Demographic and anthropometric data of females were organized into age categories (18-40, 41-60, and >60 years) and analyzed by these age categories shown in Table 1.   Age category cut-offs were determined based on literature regarding body mass changes with age and other self-reported height and weight literature (Hattori & Sturm, 2013; Rosen, Glowacki, & Bilezikian, 1999; Stommel & Schoenborn, 2009; Wen & Kowaleski-Jones, 2012; Yoong, Carey, Este, & Sanson-fisher, 2013). The sample size of males was too small to split by age category. BMI was calculated with actual weight and self-reported height, and again with self-reported weight and actual height to detect which parameter (self-reported height or self-reported weight) influenced BMI-SR the most (Table 1). Mean anthropometric differences between self-reported and actual anthropometric measurements were calculated by subtracting the self-reported height, weight, or BMI-SR from the actual height, weight, or BMI-actual and organized into a table by ethnicity and sex (Table 1). Paired t-tests were calculated and organized into a table to analyze differences between actual and self-reported anthropometric means using a significance factor of $P \leq 0.05$ (Table 1). Mean demographic data were calculated and organized into a table (Table 1). Stepwise regression analyses were done using anthropometric differences as the dependent variable and age category, sex, and ethnicity as independent variables respectively to explore which variable was most predictive of anthropometric differences (Table 2). Frequency tables organized into BMI-SR and BMI-actual separated by BMI category were created to determine if BMI-SR resulted in a different BMI category classification from BMI-actual (Table 3). Kruskal Wallis tests were performed to test for any differences between sex, age, ethnicity, income, and education levels. Variables that showed a significant difference between groups were further explored with pairwise t-tests to show specific groups that were significantly different from each other.

RESULTS

Sample Characteristics

Sample characteristics can be seen in Table 1. The sample consisted of 2676 U.S. adults of African American, Euro-American, and Native American ethnicity. The mean age was 40.7 years (Table 1). The percentage of the sample that was female was 82%, while 18% were males.

Anthropometrics

Mean anthropometric values, anthropometric differences (actual value – self-reported value), and paired t-test values comparing self-reported and actual anthropometrics separated by ethnicity can be seen in Table 1. Females, of all age categories, and males significantly overreported height and underreported weight. The overreporting of height and underreporting of weight led to BMI-SR to be significantly smaller than BMI-actual. The underreporting of weight influenced BMI-SR more than the overreporting of height in the 18-40 and 41-60 age categories for females. The BMI-SRs were most influenced by the overreporting of heights in the females older than 60 age category and males.

Kruskal Wallis tests and t-tests between age categories, ethnicities, sex, education, and income

Kruskal Wallis tests followed by pairwise t-tests were performed to detect significant differences of anthropometric differences between age categories. Females aged 41-60 and males significantly overreported their height more than adults aged 18-40. Likewise, females older than 60 significantly overreported height more than both younger age categories. Males older than 60 significantly overreported height more than the 18-40 age group. The only significant difference between weight reporting was females aged 18-40 underreported weight significantly more than females older than 60. BMI-SRs of males and females who were older than 60 were significantly undercalculated more than individuals who were 18-40 years.

Kruskal Wallis tests, followed by pairwise t-tests between ethnicities indicated Euro-American and Native American females significantly overreported height more than African American females. The BMI-SRs of Euro-American females were significantly undercalculated more than African American females. No significant differences were found between ethnicities among males.

Kruskal Wallis tests followed by pairwise t-tests that compared differences between sexes showed males significantly overreported height more than females leading to BMI-SRs to be significantly undercalculated more than the undercalculation of females' BMI-SRs. No significant differences were found between income or education levels.

Stepwise regression

A stepwise regression analysis using anthropometric differences as the dependent variable and age category, sex, and ethnicity as the independent variables can be seen in Table 2. Height difference was mostly predicted by sex, followed by age category, and lastly ethnicity. Sex, age category, and ethnicity all significantly influenced height difference. A stepwise regression analysis using weight difference as the dependent variable indicated sex, age category, or ethnicity did not predict weight difference. BMI difference was mostly predicted by ethnicity, followed by age category. BMI difference was not predicted by sex.

Misclassification of BMI categories

The frequencies and percentages of the population who were considered underweight, normal weight, overweight, or obese by self-reported values compared to the frequencies and percentages of the population that who were considered underweight, normal weight, overweight, or obese by actual values organized by ethnicity and sex can be seen in Table 3. The number of males considered underweight by self-reported values was increased compared to those considered underweight by actual measurements. Likewise, the number of individuals considered normal weight by self-reported values was greater than those considered normal weight by actual measurements. Four percent of the total sample of females (3% of the African Americans, 6% of the Euro-Americans, and 8% of the Native Americans) and 8% of the total sample of males (5% of the African Americans, 6% of the Euro-Americans, and 8% of the Native Americans) would not have been correctly classified as obese using BMI-SR. The prevalence of obesity was underreported by males and females.

DISCUSSION

This research adds to the literature by investigating the accuracy of self-reported heights and weights of a large, diverse sample of predominately low-income individuals that includes both sexes, young, middle-aged, and older adults, multiple ethnicities, and varying education and income levels. Major findings of this study indicate that self-reported height and weight values significantly differ from actual values and result in an undercalculation of BMI-SR. The undercalculation of BMI-SRs led to misclassifications of BMI categories. These results also indicate age, ethnicity, and sex influence the extent of self-reported bias. Specifically, height difference was mostly predicted by sex, followed by age category, and lastly ethnicity; while BMI difference was mostly predicted by ethnicity, followed by age category.

The results of this study suggest that self-reported height and weight values differ significantly from actual values and result in an undercalculation of BMI-SR. Individuals

were found to overreport height and underreport weight resulting in a undercalculation of BMI-SR, similar to previous research (Mueller et al., 2014; Wen & Kowaleski-Jones, 2012). The extent of undercalculation of BMI-SR observed in this study led to a misclassification of BMI category for some individuals, similar to other research (Craig & Adams, 2009; Johnson et al., 2009; Wen & Kowaleski-Jones, 2012). For example, if a person's actual height is 163.5 cm and actual weight is 65 kg, his/her BMI-actual would be 26.1 kg/m2, which would be considered overweight. If this person overreported his/her height by 2.8 cm and underreported his/her weight by 2.5 kg, the BMI-SR would be 24.3 kg/m2, which would be considered normal weight. Being misclassified could be detrimental because an individual incorrectly classified into an underweight category may be told to gain weight by healthcare professionals even though they are actually at a normal weight. This could put these individuals at risk for overweight or obesity. Furthermore, a person incorrectly classified into the normal weight range may not receive the same education and healthcare treatment as someone who is classified as overweight or obese. Recommendations for clinicians regarding the treatment of obesity are available (Jensen et al., 2014). However, many providers do not feel equipped to treat obesity (Puhl & Heuer, 2009). Furthermore, despite guidelines, many obese patients are not being diagnosed with obesity. Up until 2011, obesity was not considered a diagnostic category by Medicare/Medicaid and therefore, there was no reason to document obesity or need for treatment of obesity in patients' charts (Jacques, Jensen, Schafer, McClain, & Chin, 2011). Mueller et al. (Mueller et al., 2014) found that only 24% of patients that were obese actually had obesity as a diagnosis in their chart, implying these individuals also did not receive counseling or treatment for weight management.
Furthermore, national programs such as the CDC, NIH, and WHO estimate overweight/obesity prevalence through the use of BMI categories (National Institutes of Health, 2017; Ogden, Carroll, Fryar, & Flegal, 2015; World Health Organization, 2018b). If these programs used self-reported data, nationally used obesity statistics would be inaccurate. These results suggest self-reported heights and weights are not accurate and may lead to an undercalculation of BMI-SR and misclassification of BMI category.

Certain factors seem to influence misreporting of self-reported height and weight including age. The results of this study suggested that as age increased, the extent of overreporting height increased. Likewise, as age increased, weight was underreported and BMI-SR was undercalculated to a greater extent. Multiple studies have found that older people overreport their height and underreport their weight more than younger individuals resulting in an undercalculation of BMI-SR (Fillenbaum et al., 2010; McAdams et al., 2007; Wen & Kowaleski-Jones, 2012). One possible reason why older individuals may overreport height and underreport weight more than younger individuals is because of the body mass changes that occur in aging such as the vertebra compressing over time, the loss of muscle mass, and gaining of fat (Rosen et al., 1999), so misreporting by older individuals maybe unintentional, while misreporting among younger individuals maybe intentional. The results of this study as well as other research suggest as age increases, BMI-SR is undercalculated to a greater extent.

The extent of self-reported bias also differed among ethnicity. Euro-American females and Native American females significantly overreported their height more than African American females in this study. In contrast, African Americans have been found to overreport height more than Euro-American females (Johnson et al., 2009). Ethnicity was found not to influence self-reported bias for males. Ethnicity may influence self-reported height and weight values because of different cultural beliefs about body image and body dissatisfaction (Lovejoy, 2001). For instance, larger body types may be more accepted in certain ethnic groups. Ethnicity appears to influence the extent of self-reported bias.

Sex may also influence self-reported bias. Males significantly overreported height more than females resulting in a significantly larger undercalculation of BMI-SR in males compared to females. Many studies have found males overreport their height more frequently and to a greater extent than females because males desire to be taller (Flood et al., 2000; Johnson et al., 2009; Mozumdar & Liguori, 2016; Quick et al., 2015). Sex may influence the extent of misreport because of different ideal body images between males and females (Fallon & Rozin, 1985), and should be considered if using self-reported values.

Income could potentially influence the extent of misreporting height and weight because low-income individuals are less likely to have access to healthcare, a scale, or a stadiometer, or because of social stigmas that associate body size with poverty (Nickasch

& Marnocha, 2009). However, this study found no significant differences among income levels. Likewise, other studies have found no statistical differences among self-reported bias among income levels (Bolton-Smith et al., 2000; Fillenbaum et al., 2010). Income level does not appear to strongly influence self-reported bias.

Education may also influence self-reported of height and weight. A higher education has been associated with underreporting BMI-SR (Craig & Adams, 2009; Wen & Kowaleski-Jones, 2012). People of differing education may have been exposed to more or less health courses or anti-fat messages in school, which could explain potential differences of reporting among education levels. However, education did not seem to influence self-reported values in this study. Fillenbaum et al. (2010) found education not to influence the extent of misreporting, similar to the results of this study.

Overall, it appears that self-reported height and weight values can lead to invalid results and should be avoided because most individuals overreported height and underreported weight resulting in an undercalculation of BMI-SR and obesity prevalence. One aspect of this study to note is that the demographic variables were also self-reported and therefore, may also biased. However, certain factors such as age, ethnicity, and sex seem to influence the extent of self-reported bias, which can also lead to misleading results when using self-reported data.

Table 1 Sample Characteristics	Total	African American	Euro-American	Native American
Mean age (years)[a]	40.7±16.7	38.4±14.0	44.6±19.1	37.4±12.0
Income	n=2451	n=900	n=1086	n=465
Less than $10,000	72.9%	77.3%	63.1%	83.0%
$10,000-19,999	10.8%	11.6%	9.5%	11.7%
Greater than $20,000	16.3%	11.1%	27.4%	5.3%
Education				
Some high school	22.7%	27.0%	11.4%	40.9%
Completed high school	31.9%	37.2%	27.0%	33.1%
Some college/technical/vocational school	28.8%	26.3%	35.1%	19.1%
Completed college or graduate school	16.5%	9.5%	26.5%	6.9%
Adult Anthropometric means				
Females (ages 18-40)	n=1302	n=660	n=366	n=276
Self-report height (cm)	164.9±7.0	164.2±7.0	165.4±7.0	165.7±6.5
Actual Height (cm)	164.5±6.4	163.9±6.4	165.0±6.6	165.1±5.8
Height paired t-test value	0.00	0.06	0.00	0.00
Height difference (cm)	-0.4±2.9	-0.2±3.2	-0.4±2.5	-0.6±2.7
Self-report weight (kg)	83.3±25.2	83.7±25.1	76.4±24.6	91.3±23.2
Actual weight (kg)	85.5±29.1	85.4±27.4	78.4±30.2	92.8±26.2
Weight difference (kg)	1.7±11.1	1.7±10.5	2.0±11.7	1.5±11.7
Weight paired t-test value	0.00	0.00	0.00	0.04
Self-reported BMI (kg/m^2)	30.6±8.8	30.9±8.8	27.7±8.2	33.1±7.9
Actual BMI (kg/m^2)	31.2±8.9	31.5±8.9	28.3±8.8	33.7±7.9
BMI difference (kg/m^2)	0.6±3.0	0.6±3.1	0.6±2.6	0.5±2.9
BMI paired t-test value	0.00	0.00	0.00	0.00
BMI calculated from actual height and self-reported weight	30.8±8.9	31.1±9.1	28.1±8.7	33.4±7.9
BMI calculated from self-reported height and actual weight	31.3±10.0	31.7±9.7	28.8±10.8	33.7±8.7
Females (ages 41-60)	n=598	n=209	n=236	n=153
Self-reported height (cm)	163.8±7.1	163.8±7.7	164.5±6.7	162.8±6.7
Actual Height (cm)	163.0±6.5	163.4±7.0	163.4±6.2	161.5±6.0
Height paired t-test value	0.00	0.07	0.00	0.00
Height difference (cm)	-0.9±2.8	-0.4±3.0	-1.1±2.1	-1.3±3.2
Self-reported weight (kg)	81.3±21.4	82.7±22.2	78.8±22.4	83.7±18.3
Actual weight (kg)	83.1±23.2	84.2±24.3	80.4±22.5	85.0±18.7
Weight paired t-test value	0.00	0.04	0.00	0.02
Weight difference (kg)	1.6±8.5	1.5±11.7	1.6±4.3	1.4±7.3
BMI-SR (kg/m^2)	30.3±7.9	30.6±7.9	29.1±8.3	31.5±6.4
Actual BMI (kg/m^2)	31.2±7.9	31.0±7.7	30.1±8.4	32.3±6.7
BMI paired t-test value	0.00	0.01	0.00	0.00
BMI difference (kg/m^2)	0.8±2.4	0.5±2.9	1.0±1.8	1.0±2.7

BMI calculated from actual height and self-reported weight	30.6±7.9	30.8±8.1	29.5±8.4	32.0±6.4
BMI calculated from self-reported height and actual weight	31.0±8.8	31.5±10.2	29.8±8.4	32.2±6.9
Females >60 years	n=283	n=104	n=164	n=15
Self-reported height (cm)	160.9±6.5	159.8±6.3	161.3±6.5	163.5±7.0
Actual Height (cm)	159.2±6.4	159.6±6.3	158.7±6.5	161.5±5.8
Height paired t-test value	0.00	0.01	0.00	0.25
Height difference (cm)	-1.7±3.2	-0.3±1.0	-2.6±3.8	-2.0±1.8
Self-reported weight (kg)	75.0±16.9	77.0±18.6	73.4±16.2	78.8±8±9.7
Actual weight (kg)	76.3±17.0	76.7±18.5	75.3±16.6	80.5±9.3
Weight paired t-test value	0.00	0.17	0.00	0.25
Weight difference (kg)	1.1±3.1	-0.3±1.9	1.9±3.1	1.7±5.4
BMI-SR (kg/m^2)	29.0±6.2	30.3±6.8	28.2±5.9	29.5±3.9
Actual BMI (kg/m^2)	30.1±6.2	30.2±69.8	29.8±6.0	31.0±4.1
BMI paired t-test value	0.00	0.70	0.00	0.02
BMI difference (kg/m^2)	1.0±1.7	0.0±0.9	1.6±1.8	1.4±2.1
BMI calculated from actual height and self-reported weight	29.6±6.2	30.4±6.8	29.1±5.9	30.3±3.9
BMI calculated from self-reported height and actual weight	29.5±6.2	30.2±6.7	29.0±6.1	30.2±4.1
Males	n=493	n=141	n=312	n=40
Self-reported height (cm)	178.2±7.7	177.8±8.0	178.4±7.6	177.4±8.1
Actual Height (cm)	175.8±7.5	175.9±7.3	176.0±7.5	174.6±1.4
Height paired t-test value	0.00	0.00	0.00	0.00
Height difference (cm)	-2.3±3.8	-1.9±4.6	-2.4±3.1	-2.8±5.4
Self-reported weight (kg)	86.8±18.5	86.5±18.7	86.7±18.4	88.1±18.4
Actual weight (kg)	88.5±26.5	88.1±26.0	88.9±27.9	87.8±19.3
Weight paired t-test value	0.01	0.19	0.01	0.62
Weight difference (kg)	1.9±15.2	1.7±15.1	2.3±16.0	-0.4±4.8
BMI-SR (kg/m^2)	27.4±5.7	27.2±5.4	27.2±5.6	28.0±6.0
Actual BMI (kg/m^2)	28.1±5.9	28.0±5.7	28.1±5.6	28.7±5.4
BMI paired t-test value	0.00	0.00	0.00	0.16
BMI difference (kg/m^2)	0.9±2.1	0.7±2.6	1.0±1.6	0.6±2.8
BMI calculated from actual height and self-reported weight	28.1±5.8	28.0±5.9	28.0±5.9	28.8±5.2
BMI calculated from self-reported height and actual weight	27.9±7.7	27.8±7.2	27.9±8.1	27.9±6.6

Table 2: Stepwise regression analysis using anthropometric differences as dependent variables				
Variable	B	Standard error	R^2	p-Value
Dependent variable: Height difference				
Age category	-0.137	3.100	0.057	0.000
Sex	0.196	3.130	0.038	0.000
*****Ethnicity	-0.880	3.080	0.064	0.000
Dependent variable: BMI difference				
Age category	0.060	2.600	0.006	0.002
******Ethnicity	0.066	2.600	0.009	0.001

***Coded as 1= African American (default), 2=Euro-American, 3=Native American**

****Coded as 1=African American (default), 2=Native American, 3=Euro-American**

Table 3 Frequency of self-report and actual BMIs								
Females	Self-report BMI <18.5 kg/m²	Actual BMI <18.5 kg/m²	Self-report BMI 18.5-24.9 kg/m²	Actual BMI 18.5-24.9 kg/m²	Self-report BMI 25.0-29.9 kg/m²	Actual BMI 25.0-29.9 kg/m²	Self-report BMI ≥30 kg/m²	Actual BMI≥30 kg/m²
African American	19 (2.0%)	18 (1.8%)	244 (25.4%)	237 (23.9%)	237 (24.7%)	234 (23.6%)	460 (47.9%)	502 (50.7%)
Euro-American	15 (2.0%)	16 (2.1%)	297 (39.4%)	260 (33.5%)	196 (26.0%)	197 (25.4%)	246 (32.6%)	303 (39.0%)
Native American	3(0.7 %)	1(0.4 %)	67(15.2 %)	38(13.7 %)	108(24.5 %)	50(18.0 %)	263(59.6 %)	189(68.0 %)
Total	37 (1.7%)	36 (1.6%)	608 (28.2%)	552 (24.9%)	541 (25.1%)	531 (24.0%)	969 (45.0%)	1094 (49.4%)
Males								
African American	3 (2.2%)	1 (0.7%)	52 (38.0%)	54 (37.8%)	45 (32.8%)	4 3(30.1%)	37(27.0%)	45(31.5%)
Euro-American	5 (1.6%)	3 (1.0%)	111 (35.9%)	100 (32.4%)	114 (36.2%)	107 (34.6%)	79(25.6%)	99(32.0%)
Native American	1 (2.5%)	0 (0.0%)	7(17.5%)	9(22.5%)	23(57.5%)	19 (47.5%)	9(22.5%)	12(30.0%)
Total	9 (1.9%)	4 (0.8%)	170 (35.0%)	163 (33.1%)	182 (37.4%)	169 (34.3%)	125 (23.5%)	156 (31.7%)

Chapter 4: The accuracy of self-reported versus actual height and weight values among low-income, ethnically diverse group of children, aged 9-18 years

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Submitted to Maternal Child Health

CHAPTER SUMMARY

Objectives: The objectives were to explore the accuracy of self-reported heights and weights and multiple variables that may influence misreporting in a large sample of ethnically diverse children aged 9-18 years.

Methods: Data were analyzed from 4 studies conducted by the same PI. Studies collected demographic data and self-reported and measured height and weight. Differences between self-reported and actual values were detected with paired t-tests. Any differences between age, ethnicity, and sex were detected with Kruskal Wallis tests followed by pairwise t-tests.

Results: Younger children significantly underreported height and weight resulting in a significant undercalculation of BMI percentile. Older children significantly overreported height and underreported weight resulting in an undercalculation of BMI percentile. Misreports led to incorrect BMI percentile classifications. African Americans underreported height and weight more than Asians. No differences were found between males and females.

Conclusions for Practice: The use of self-reported values should be avoided because values appear to be inaccurate leading to BMI percentile misclassifications and an undercalculation of obesity prevalence. BMI percentile misclassifications may be detrimental because children may not receive the same healthcare treatment as if they were correctly classified. Younger children may not know their height or weight because they are growing rapidly. Older children may misreport height and weight because they want to appear thinner and taller.

SIGNIFICANCE

Children's self-reported height and weight values appear to be inaccurate. Ethnicity, age, and sex may influence misreporting. However, there are discrepancies in these results and few studies incorporate all of these variables. Research that explores ethnicity mostly incorporates African Americans, Euro-Americans, and sometimes Hispanics. Few include a comparison of Asians or Native Americans. Also, few studies incorporate a large age range of children. Most studies sample only high school, middle school, or elementary school students. This study assesses differences among age, ethnicity, and sex incorporating a large age range of 9-18-year-olds and includes African American, Asian, and Native American low-income children living in Midwest America.

OBJECTIVES

Height and weight are important tools used to measure human growth and adiposity. Height measures linear growth, while weight can be used as a measure of mass and together, these values can be used to indicate BMI, a commonly used measurement of body mass [98]. BMI can detect underweight, normal weight, and excess weight. BMI has been used to assess health problems associated with obesity since the 19th century [99]. Comorbidities associated with childhood obesity include hypertension, elevated fasting glucose, non-alcoholic fatty liver disease, and these children are likely to be obese later in life [100–102]. Obesity also influences psychological health as well. Children with obesity are more likely to have a poor self-esteem, depression, anxiety, and a decreased quality of life [100,103–105]. Being underweight also has health complications such as reduced bone mineralization and poor skeletal health, poor growth, and developmental delay [106,107]. Trends of childhood obesity and underweight are important to follow because of the physical and psychological health complications associated with obesity and being underweight.

Self-reported heights and weights are a cheap and easy way to follow trends in obesity. Self-reported heights and weights have been frequently used in research and clinical settings since the 1970's, despite known inaccuracies [31,56,59,63,67,70,108,109]. These inaccuracies could lead to misclassifications of BMI categories [31,59,63,67]. Being misclassified into the wrong BMI category could lead to inaccurate prevalence of obesity estimates and could be detrimental to the person being misclassified.

The extent of misreporting height and weight may be influenced by certain factors. Age, ethnicity, and sex may influence the accuracy of self-reported height and weight, but it is unclear how. Few studies incorporate all of these variables, a large age range, and multiple ethnicities. No studies to our knowledge incorporate Native Americans and Asians for comparison among ethnicities. Therefore, the purpose of this study was to compare self-reported height and weight values to actual measurements in an ethnically diverse sample of children ages 9-18, that includes both sexes, and African

American, Asian, and Native American children, and to discover factors that may be associated with self-reported biases.

METHODS

Demographic and anthropometric survey data were analyzed from 4 different studies from the same lab with the same principal investigator, which included African American, Asian, and Native American children ages 9-18, males and females from years 2009-2012 [110–113]. All research was approved by the University's Institutional Review Board.

Recruitment methods varied in each study but included flyers, emails, advertisements in local newspapers, verbal announcements, in person and word of mouth. Places of recruitment also varied by study, but utilized places with a high frequency of children. Examples of recruitment places included homeless shelters, community centers, outreach after school programs, activity-based organizations, and schools. Focuses of each study varied, but included ideas such as how certain factors can affect food choice, perceptions of health, food security, and dietary acculturation among children. Qualifications for participation in these studies were dependent on the target population for each specific study.

All studies used the same measurement protocol with the same PI training her students in the same manner. Before being measured, participants were asked how tall they were in inches and how much they weighed in pounds. These values were converted to kilograms and centimeters. The self-reported height and weight values were used to calculate a BMI from self-reported values and a BMI percentile from self-reported values. BMI percentile-SR refers to BMI percentile calculated from self-reported height and weight in this study. Heights and weights were measured with shoes and outer clothing removed by a single researcher in each study. Heights were taken with a Seca stadiometer. The child was instructed to stand erect with heels together, arms at their side, legs straight, shoulders relaxed, head the Frankfort horizontal plane, and to take a deep breath. Hair pieces were removed if needed. Weights were taken using a high quality electronic Health0meter digital scale. Scales were placed on a hard, flat surface and were checked for accuracy using standardized weights routinely. Each measurement was taken twice. The maximum height measured to the nearest 0.1 cm was recorded, while for weight the average of the two weights measured to the nearest .1 kg was used. These were used to calculate actual BMI. BMI was converted to BMI percentile by Epi Info version 7.2.1. Child BMI classifications were underweight (<5th percentile), normal weight (5th percentile-84.9 percentile), overweight (85th percentile-94.9 percentile) and obese (≥95th percentile) [114].

Data from all studies were combined into one file in SPSS for Windows Statistical Analysis Software Package Version 22. Demographic and anthropometric data were organized into age categories (9-10, 11-12, 13-14, 15-16 and 17-18 years) and analyzed by these age categories shown in Table 1. Because no significant differences were found between males and females, they were grouped together. Mean anthropometric differences between self-reported and actual anthropometric measurements were calculated by subtracting the self-reported height, weight, or BMI percentile from the actual height, weight, or BMI percentile and organized into a table by ethnicity and gender (Table 1). Paired t-tests were calculated and organized into a table to analyze differences between actual and self-reported anthropometric means using a significance factor of $P \leq 0.05$ (Table 1). Mean demographic information were calculated and organized into a table (Table 1). Because data were found to be nonnormally distributed, Spearman Rho correlation coefficients were used to examine any associations between anthropometric and demographic data. Actual ages were used for Spearman Rho correlations. Frequency tables organized into BMI percentile-SR and actual BMI percentile separated by BMI category were created to determine if self-reported BMI percentiles resulted in a different BMI percentile category classification from actual BMI percentiles (Table 2). Kruskal Wallis tests were performed to test for any differences between sex, age, and ethnicity. Variables that showed a significant difference between groups were further explored with pairwise t-tests to show specific groups that were significantly different from each other.

RESULTS

Sample Characteristics

The sample consisted of 579 children (Table 1). The sample was Asian (59.5%), African American (35.0%), Native American (5.5%).

Anthropometrics

Mean anthropometric values and paired t-tests comparing self-reported and actual anthropometrics separated by age category and ethnicity can be seen in Table 1. Children aged 9-10 significantly underreported height, while those who significantly overreported height were children aged 15-16 and 17-18. Those who significantly underreported weight were children aged 9-10, 11-12, 13-14 and 17-18. BMI percentile-SR was significantly undercalculated for children aged 9-10, 11-12, 13-14, and 17-18. The total percentage of children that did not know their height or weight was 10.5%. The percentage of 9-10-year-olds that did not know their height or weight was 22.5%, while 11.9% of 11-12-year-olds, 1.0% of 13-14-year-olds, 1.2% of 15-16-year-olds, and 0% of 17-18-year-olds did not know their height or weight.

Anthropometric differences separated by age category and ethnicity can be seen in Table 1. The 9-10 years age category, 11-12 years age category, and 13-14 years age category underreported height and weight. Age groups 15-16 and 17-18 underreported weight, but overreported height.

Comparison of age categories, ethnicities, and sex data

Kruskal Wallis tests with pairwise t-tests were used to determine differences among categories (Table 2). The greatest significant difference between ages in children was seen when comparing younger children (≤14 years) to older children (>14 years). Height differences were significantly different because younger children underestimated height by 3.5 cm on average, whereas older children overestimated height by 1.1 cm on average. Younger children also significantly underestimated weight more than older children. Height and weight differences did not result in a significant difference between BMI percentile between younger and older children. T-tests among ethnicities showed African American children underreported height and weight to a greater extent than Asian children. Native American were also found to underreport weight significantly more than Asians. No significant differences were found between sexes.

Spearman Rho Correlations

Significant Spearman Rho correlations (Table 3) between height difference (difference between self-reported and actual height) and age, self-reported height, self-reported weight, BMI percentile-SR, actual height, weight difference and BMI percentile difference were found in African Americans. Significant correlations were found between height difference and age, self-reported height, self-reported weight, self-reported BMI percentile, actual height, actual weight, and BMI percentile difference in Asians. For Native Americans, significant correlations were found between height difference and age, self-reported height, self-reported weight, BMI percentile-SR, actual weight, actual BMI percentile, and BMI percentile difference.

Weight difference (difference between actual and self-reported weight) was significantly correlated with self-reported weight, actual weight, actual BMI percentile, height difference, and BMI percentile difference for African Americans. Weight difference was significantly correlated with actual weight, actual BMI percentile, and BMI percentile difference in the Asian population. In the Native American population, weight difference was significantly correlated with actual weight, actual BMI percentile, and BMI percentile difference.

BMI percentile difference was significantly correlated with self-reported height, self-reported weight, BMI percentile-SR, height difference, and weight difference in the sample of African Americans. BMI percentile difference was also correlated with self-reported height, BMI percentile-SR, height difference, and weight difference in the sample of Asians and Native Americans.

Misclassification of BMI Percentile Categories

The frequencies and percentages of the children that were considered underweight, normal weight, overweight, and obese by self-reported values compared to the frequencies and percentages of the population that were normal weight, overweight, and obese by actual measurements can be seen in Table 4. Underweight was overcalculated in the 9-10, 11-12, and 15-16 age categories. Normal weight was undercalculated in the 9-10 and 11-12 age categories, but overcalculated in the 15-16 and 17-18 age categories. Overweight was overcalculated by the 11-12, 13-14 and 15-16 age categories, but undercalculated in the 17-18 age category. Obesity was overcalculated in the 9-10, and 11-12 age categories, but undercalculated in the 13-14, 15-16, and 17-18 age categories.

DISCUSSION

This research adds to the literature by investigating the accuracy of self-reported heights and weights of a diverse sample that includes children ages 9-18, multiple ethnicities, and both sexes. Other studies may have studied how ethnicity, or age, or sex may influence self-reported bias in children (Fortenberry 1992; Hauck et al. 1995; Himes & Faricy 2001; Morrissey et al. 2006; Powell-Young 2012), but few look at all of these variables.

Major findings of this study indicate that self-reported height and weight values significantly differ from actual values and result in an undercalculation of BMI percentile indicating the use of self-reported height and weight should be avoided. This undercalculation of BMI percentile led to misclassifications of BMI percentile categories. Being incorrectly classified could be detrimental because that child may not receive the same healthcare treatment or education as if they were correctly classified. Riley et al.[115] found that only 4% and 8% of children with a BMI percentile of 85-89% and 90-95% were diagnosed with overweight respectively, and only 48% of children that were obese (>95%) had a diagnosis of overweight. A person diagnosed with overweight was more likely to receive nutrition counseling (66%) compared to those who did not have a diagnosis of overweight as only 9% of these individuals received nutrition counseling [115]. This suggests that it is likely that some individuals may not have been told they were obese and may not recognize they are obese and are less likely to modify lifestyle habits. Furthermore, 12% of Asian and 9.7% of African American children's self-reported measurements would classify them as underweight when they were clearly normal weight. This is problematic because the health care provider would recommend additional calories to gain weight when they do not to and could lead to overeating and overweight in the future.

These results suggested age may influence misreporting. Many children, especially younger children simply do not know their height or weight because they are rapidly growing and may not have been measured recently. This is evident when looking at anthropometric differences because all children who were under the age of 15 underreported both height and weight. This makes sense if they were shorter and lighter the last time they were measured. In contrast, older children who may not be growing as rapidly underreported weight but overreported height. This misreporting could be intentional in order to appear taller or thinner. These results also suggest that certain factors such as ethnicity may influence the extent of self-reported bias. African

Americans were found to underreport height and weight more than Asians, and Native Americans underreported weigh more than Asians. Ethnicity may bias self-reported values because of different ideal body images among cultures. For instance, some cultures may be more accepting of a larger body size.

Overall, it appears that self-reported height and weight values are invalid with children leading to inaccurate results and should be avoided as most children tend to overreport or underreport height and weight, and a few overreported their measurements which can lead to and underestimation of obesity prevalence and overestimation of underweight. Furthermore, many children simply do not know their height or weight because they are rapidly growing and may not have been measured recently. This misperception of weight could mean that children who are obese do not recognize the health consequences associated with obesity and would be less likely to try to achieve a healthier weight or those who consider themselves underweight may try to gain weight when it is not needed leading to overweight. Certain factors such as age and race may influence the extent of self-reported biases, which can also lead to misleading results.

Table 1 Sample Characteristics	Total	African American	Asian	Native American
Anthropometric means				
Ages 9-10 (n=178)				
Self-report height (cm)	134.0±23.6	134.7±17.3	131.2±31.4	137.6±18.8
Actual Height (cm)	139.6±8.5	142.6±8.2	134.4±6.4	143.0±8.4
Height paired t-test value	0.00	0.00	0.45	0.08
Self-report weight (kg)	36.0±10.8	36.1±12.0	32.8±8.0	41.4±9.8
Actual weight (kg)	40.1±12.1	41.0±12.9	35.5±8.7	46.7±10.7
Weight paired t-test value	0.00	0.00	0.00	0.00
Self-report BMI percentile (kg/m^2)	68.8±34.7	65.2±36.9	65.3±35.7	84.7±21.4
Actual BMI percentile (kg/m^2)	74.9±24.6	73.0±25.3	71.2±25.4	90.2±13.4
BMI percentile paired t-test value	0.02	0.08	0.26	0.19
Height difference (cm)	5.7±21.2	7.8±14.0	3.2±29.8	5.4±14.8
Weight difference (kg)	4.3±6.8	4.9±7.3	2.7±5.4	5.3±7.1
BMI percentile difference (kg/m^2)	6.7±33.0	7.8±34.9	5.9±36.1	5.5±20.5
Ages 11-12 (n=152)				
Self-report height (cm)	146.9±21.5	149.7±16.9	145.1±23.8	
Actual Height (cm)	149.5±9.5	154.8±9.2	146.4±8.3	
Height paired t-test value	0.09	0.01	0.57	
Self-report weight (kg)	45.9±13.4	48.3±14.6	44.3±12.5	
Actual weight (kg)	50.4±15.5	55.3±15.4	46.8±13.9	
Weight paired t-test value	0.00	0.00	0.00	
BMI percentile-SR (kg/m^2)	70.5±33.1	74.2±30.6	68.0±34.5	
Actual BMI percentile (kg/m^2)	74.8±24.6	84.2±15.9	73.5±24.9	
BMI percentile paired t-test value	0	0.01	0.10	
Height difference (cm)	3.5±21.0	7.0±20.0	1.3±21.4	
Weight difference (kg)	4.4±7.5	7.0±9.8	2.6±4.5	
BMI percentile difference (kg/m^2)	7.2±28.3	10.0±25.6	5.5±29.8	
Ages 13-14 (n=117)				
Self-report height (cm)	156.7±11.3	162.6±10.7	153.8±10.5	
Actual Height (cm)	157.6±8.4	163.6±8.9	154.6±6.3	
Height paired t-test value	0.19	0.43	0.31	
Self-report weight (kg)	58.9±16.8	64.4±20.8	56.2±13.8	
Actual weight (kg)	61.7±19.3	68.4±23.4	58.7±16.3	
Weight paired t-test value	0.00	0.02	0.04	
BMI percentile-SR (kg/m^2)	74.4±28.7	74.1±30.7	74.6±27.8	
Actual BMI percentile (kg/m^2)	77.3±25.1	78.9±24.9	76.9±25.2	
BMI percentile paired t-test value	0.05	0.12	0.23	

Height difference (cm)	0.9±7.1	1.0±8.1	0.8±6.7
Weight difference (kg)	3.0±10.1	4.0±9.9	2.5±10.3
BMI percentile difference (kg/m^2)	3.1±17.4	4.8±18.7	2.3±16.8
Ages 15-16 (n=81)			
Self-report height (cm)			158.6±8.8
Actual Height (cm)			157.2±8.0
Height paired t-test value			0.00
Self-report weight (kg)			60.5±14.9
Actual weight (kg)			61.6±15.4
Weight paired t-test value			0.09
BMI percentile-SR (kg/m^2)			70.6±26.4
Actual BMI percentile (kg/m^2)			72.4±24.4
BMI percentile paired t-test value			0.45
Height difference (cm)			-1.4±3.4
Weight difference (kg)			1.1±6.0
BMI percentile difference (kg/m^2)			1.8±21.5
Ages 17-18 (n=51)			
Self-report height (cm)			159.2±8.4
Actual Height (cm)			157.5±8.1
Height paired t-test value			0.00
Self-report weight (kg)			64.9±17.4
Actual weight (kg)			66.5±17.2
Weight paired t-test value			0.00
BMI percentile-SR (kg/m^2)			71.2±25.9
Actual BMI percentile (kg/m^2)			78.0±22.5
BMI percentile paired t-test value			0.00
Height difference (cm)			-1.6±1.9
Weight difference (kg)			1.6±3.5
BMI percentile difference (kg/m^2)			6.8±12.3

Table 2 Kruskal-Wallis tests and t-tests among age category, race, and sex			
Variable	P-value Height difference	P-value Weight difference	P-value BMI percentile difference
Age category	0.00	0.01	0.46
≤14 years and >14 years	0.00	0.00	0.34
Ethnicity	0.00	0.00	0.77
African American and Asian	0.00	0.00	0.17
African American and Native American	0.89	0.94	0.69
Native American and Asian	0.12	0.03	0.79
Sex	0.55	0.96	0.23

Table 3 Correlations of anthropometrics

1. Age	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
2. Self-Reported Height										
African American	0.68^{**}	1.00								
Asian	0.52^{**}	1.00								
Native American	-0.13	1.00								
3. Self-Reported Weight										
African American	0.57^{**}	0.72^{**}	1.00							
Asian	0.67^{**}	0.61^{**}	1.00							
Native American	-0.15	0.74^{**}	1.00							
4. BMI percentile-SR										
African American	0.03	-0.06	0.57^{**}	1.00						
Asian	-0.02	-0.20^{**}	0.47^{**}	1.00						
Native American	-0.03	-0.50^{*}	0.10	1.00						
5. Actual height										
African American	0.46^{**}	0.81^{**}	0.74^{**}	0.17^{*}	1.00					
Asian	0.66^{**}	0.82^{**}	0.74^{**}	0.05	1.00					
Native American	0.32	0.70^{**}	0.54^{**}	-0.27	1.00					
6. Actual weight										
African American	0.58^{**}	0.61^{**}	0.85^{**}	0.54^{**}	0.78^{**}	1.00				
Asian	0.63^{**}	0.59^{**}	0.94^{**}	0.44^{**}	0.71^{**}	1.00				
Native American	0.11	0.69^{**}	0.84^{**}	0.01	0.69^{*}	1.00				
7. Actual BMI percentile										
African American	0.14^{**}	0.22^{**}	0.60^{**}	0.67^{**}	0.32^{**}	0.73^{**}	1.00			
Asian	0.07	0.13^{*}	0.61^{**}	0.66^{**}	0.16^{**}	0.71^{**}	1.00			
Native American	-0.26	0.48^{*}	0.75^{**}	0.20	0.31	0.87^{**}	1.00			
8. Height difference										
African American	-0.24^{*}	-0.64^{**}	-0.28^{**}	0.37^{**}	-0.18^{*}	-0.13	0.02	1.00		
Asian	-0.28^{**}	-0.63^{**}	-0.26^{**}	0.39^{**}	-0.25^{**}	-0.25^{**}	-0.07	1.00		
Native American	0.48^{**}	-0.82^{**}	-0.58^{**}	0.53^{**}	-0.26	-0.45^{*}	-0.49^{*}	1.00		

9. Weight difference										
African American	0.01	-0.11	-0.16*	-0.10	0.08	0.28**	0.37**	0.16*	1.00	
Asian	-0.08	-0.04	-0.05	0.04	-0.02	0.22**	0.39**	0.09	1.00	
Native American	0.07	0.14	-0.04	-0.34	0.20	0.44*	0.41*	-0.07	1.00	
10. BMI percentile difference										
African American	0.06	0.18*	-0.24**	-0.66**	-0.01	-0.03	-0.02	-0.41**	0.53**	1.00
Asian	0.05	0.32**	-0.09	-0.58**	0.04	0.07	0.07	-0.55**	0.48**	1.00
Native American	-0.12	0.63**	0.20	-0.84**	0.36	0.32	0.21	-0.65**	0.46*	1.00

* indicates a P-value ≤0.05

** indicates a P-value ≤0.01

Table 4 Self-report BMI percentile categories differ from actual BMI percentile categories

	BMI percentile-SR (<5%)	Actual BMI percentile (<5%)	BMI percentile-SR (5-84.9%)	Actual BMI percentile (5-84.9%)	BMI percentile-SR (85-94.9%)	Actual BMI percentile (85-94.9%)	BMI percentile-SR (≥95%)	Actual BMI percentile (≥95%)
Ages 9-10								
African American	6(9.7%)	0(0.0%)	25(40.3%)	37(59.7%)	14(22.6%)	9(14.5%)	17(27.4%)	16(25.8%)
Asian	6(12.0%)	0(0.0%)	22(44.0%)	31(62%)	6(12.0%)	7(14.0%)	16(32.0%)	12(24%)
Native American	0(0.0%)	0(0.0%)	8(33.3%)	5(20.8%)	3(12.5%)	7(29.2%)	13(54.2%)	12 (50.0%)
Total	12(8.8%)	0(0.0%)	55(40.4%)	73(53.4%)	23(16.9%)	23(16.9%)	46(33.8%)	40(29.4%)
Ages 11-12								
African American	4(7.8%)	0(0.0%)	16(31.4%)	21(42%)	14(27.5%)	8(16.0%)	17(33.3%)	21(42.0%)
Asian	8(9.6%)	1(1.2%)	35(42.2%)	48 (57.8%)	12(14.5%)	11(13.3%)	28(33.7)	23(27.7%)
Total	12(9.0%)	1(0.7%)	51(38.1%)	69(51.4%)	26(19.4%)	19(14.2%)	45(33.6%)	44(32.8%)
Ages 13-14								
African American	1(2.6%)	1(2.6%)	17(44.7%)	15(39.5%)	8(21.1%)	7(18.4%)	12(31.6%)	15(39.5%)
Asian	1(1.3%)	1(1.3%)	33(42.3%)	35(44.9%)	19(24.4%)	14(17.9%)	25(32.1%)	28(35.9%)
Total	2(1.6%)	2(1.6%)	50(43.1%)	50(43.1%)	27(23.3%)	21(18.1%)	37(32.0%)	43(37.1%)
Ages 15-16								
Asian	2(2.5%)	0(0.0%)	46(57.5%)	44(55.0%)	12(15.0%)	10(12.5%)	20(25.0%)	26(32.5%)
Ages 17-18								
Asian	0(0.0%)	0(0.0%)	34(66.7%)	25(49.0%)	6(11.8%)	12(23.5%)	11(21.6%)	14(27.5%)

Chapter 5: Summary of key findings, conclusions, and implications

SUMMARY OF KEY FINDINGS

PROJECT 1: The following has been adapted from the manuscript: Opichka K, Smith C, Levine Allen. Problematic eating behaviors are more prevalent in low-income African American women with obesity/overweight than low-income African American women who are lean or normal weight. *Journal of Hunger and Environmental Nutrition.* (Submitted for review)

Participants of this study included 45 African American. The mean age was 44 years. W-L/N had statistically larger household sizes. **(Chapter 2, Table 1)**.

The PEMS assessed reasons for consuming palatable foods. Also, the coping score to feel more confident was significantly higher for W-L/N compared to W-O/O, indicating food helps W-L/N feel more confident. W-L/N also scored higher for "gives pleasant feeling," suggesting W-L/N eat for pleasure more than W-O/O. Social scores between W-L/N were significantly higher than W-O/O, specifically to make gatherings fun and to celebrate special occasions, suggesting W-L/N eat palatable foods to be social more so than W-O/O. **(Chapter 2, Table 2).**

Sweet vs. Salty Preference

Preference for sweet or salty food was mixed between W-L/N and W-O/O. However, W-L/N identified fruits as sweet foods they liked. In contrast, W-O/O tended to like sweets such as ice cream, pastries, and candy. W-O/O who liked fruits had lower BMIs compared to the rest of the W-O/O. Liking vegetables was also mentioned more frequently by W-L/N, while W-O/O stated they disliked vegetables.

Focus Groups

Five themes identified through focus groups were: (1) Internally and externally motivated eating differ between BMI status, (2) Concept of health affects eating habits according to BMI status, (3) Reasons for exercise is related to BMI status, (4) Reaction to stress is related BMI status, and (5) Factors that determine body size is different between BMI status.

Theme 1: Internally and externally motivated eating differ between BMI status.

Internal hunger cues stimulated eating for W-L/N, whereas external environmental cues influenced eating behaviors among W-O/O. The subthemes that emerged were deciding when to start and stop eating, overeating, food thought frequency, and occurrence of forgetting to eat. W-L/N ate mostly when they felt hungry. In contrast, W-O/O often reported eating in the absence of hunger, eating for boredom, emotions, and because the food was availability. When women stopped eating differed between women of different sizes. W-L/N stopped eating once they felt full, listening to internal cues. In contrast, W-O/O talked of overeating on a regular basis. W-L/N constantly reported listening to internal hunger cues and were less influenced by external environmental cues than W-O/O.

W-L/N also thought about food less frequently while, W-O/O thought about food frequently, with food often a topic of conversation. When discussing going out to social gatherings, W-O/O thought more of the food days before the event, but W-L/N thought of the event, contrasting with the PEMS finding that W-L/N eat palatable foods at social events. During focus group discussions, it was apparent that W-O/O were often preoccupied by food thoughts, but W-L/N rarely thought of food. Another difference between women of different sizes was forgetting to eat. Forgetting to eat was often verbalized by W-L/N. Conversely, W-O/O rarely forgot to eat. Forgetting to eat, food thought frequency, and factors that influence eating differed between W-O/O and W-L/N.

Theme 2: Concept of health affects eating habits according to BMI status.

Eating for health was common among W-L/N, and less common among W-O/O. The subthemes that developed were food as a nutrient versus food as pleasure and acceptance of a larger body size. W-L/N discussed using food as a nutrient, whereas the W-O/O used food for pleasure. Eating nutritiously was motivated by health benefits and avoidance of disease for W-L/N. In contrast, health was not a concern for the majority of W-O/O. The few W-O/O who desired to eat healthy expressed barriers to doing so such as current health problems, lack of time, or cost.

W-O/O often discussed eating for pleasure, which differed from the PEMS findings in that W-L/N ate for pleasure more than W-O/O. However, in focus group discussions, W-O/O mentioned eating for pleasure more so than W-L/N. Also, these women showed more acceptance of a larger body size. In contrast to the PEMS findings, W-L/N emphasized the importance of a healthy lifestyle, while W-O/O emphasized how much they enjoy eating.

Theme 3: Reason for exercise is related to BMI status.

Exercise habits were also different between W-L/N and W-O/O. W-L/N exercised for health benefits and because they enjoyed exercise. W-O/O reported being less active. For them, physical activity was done if required to watch their children, and walk places because they lacked transportation. W-L/N saw exercise as enjoyment, a hobby, and a way to relieve stress, whereas W-O/O saw exercise as a chore.

Theme 4: Reaction to stress is related to BMI status.

W-L/N coped with stress differently than W-O/O. Subthemes that emerged were the use of comfort foods and the use of sedentary activities versus non-sedentary activities during stress. Some W-O/O used food as a coping mechanism. Other W-O/O used sedentary activities to handle stress such as laying down, praying, or talking through their stress. In contrast, W-L/N mostly handled stress through physical activity, such as walking or working out. This finding contradicts the results of the PEMS scale in that W-L/N had higher coping scores meaning they to turn to food as a coping mechanism more than W-O/O. However, during focus group discussions, W-L/N shared they were more active during stressful times than W-O/O.

Theme 5: Factors that determine body size are different between BMI status.

Women of different sizes believed body size was determined by different factors. W-L/N believed body size was mostly determined by controllable factors such as eating habits and physical activity levels. W-O/O believed body size was determined by less modifiable factors such as genetics, medications, and difficult life situations and stressful events.

PROJECT 2A: The following has been adjusted from the following manuscript: Opichka K, Smith C. Accuracy of self-report heights and weights in a predominately low-income, diverse population living in the U.S. *American Journal of Human Biology* (Accepted)

The sample consisted of 2676 U.S. adults of African American, Euro-American, and Native American ethnicity. The mean age was 40.7 years. The percentage of the sample that was female was 82%, while 18% were males.

Anthropometrics

For females, aged 18-40 years, self-reported BMIs to be significantly smaller than actual BMI for all women ages 18-40 because of the extent of overreporting height and underreporting weight. For females aged 41-60 years, African American, Caucasian, and Native American significantly underestimated BMIs because height was overestimated and weight was underestimated. For females older than 60 years, Caucasians and Native Americans significantly underestimated their BMIs. For men, all races had statistically smaller self-reported BMIs from actual BMIs except Native Americans.

T-tests between age categories, races, sex, education, and income levels

Pairwise t-tests between each age category indicated that 41-60-year-olds significantly overreported height more than adults aged 18-40. Likewise, females older than 60 significantly overreported height more than both younger age categories. Adult males older than 60 significantly overreported height more than the 18-40 age group, but not significantly more than the 41-60 age group. The only significant difference between weight reporting was women aged 18-40 underestimated weight significantly more than women older than 60. Males and females who were older than 60 underestimated BMI significantly more than individuals who were 18-40 years.

Kruskal-Wallis tests were done, followed by pairwise t-tests between races which indicated that Caucasian women, Hispanic women, and Native American women significantly overreported height more than African American women. Caucasian women also underestimated their BMI significantly more than African American women. Asian men were found to significantly overreport their heights to a lesser extent than Caucasians, and Native Americans.

Kruskal-Wallis tests followed by pairwise t-tests comparing differences between sexes showed that men significantly overreported height more than women and that men significantly underestimated BMI more than women. There were no significant differences between incomes or education level.

Misclassification of BMI categories

The number of women considered normal weight by self-report (32.3%) was greater than those considered normal weight by actual values (29.8%). The number of women considered overweight (21.5%) was slightly greater than the amount of those considered overweight by measured values (20.4%). The prevalence of obesity was underestimated by self-report values (43.9%) compared to the prevalence of obesity using measured values (47.5%) in the population of women aged 18-40. The number of individuals considered underweight by self-report report was increased compared to those considered underweight by actual measurements in the category of women aged 41-60, women older than 60, and men of all ages. Likewise, the amount of those considered normal weight by self-report was greater than those considered normal weight by actual measurements in subgroups of women aged 41-60, women older than 60, and men of all ages. The proportion of women aged 41-60, women aged older than 60, and men of all ages that was considered overweight by self-report measurements was slightly greater than those considered overweight by actual measurements. The prevalence of obesity was underestimated in all subgroups (all men and all women) except African American women aged older than 60.

PROJECT 2B: The following has been adapted from the manuscript: Opichka K, Smith C. Accuracy of children's self-report height and weight values. *Annals of Human Biology.* Submitted.

Sample characteristics

The sample consisted of 579 children (Table 1). The sample was Asian (59.5%), African American (35.0%), Native American (5.5%).

Anthropometrics

African American children, aged 9-10, significantly underreported height and weight. Asian boys, aged 9-10, significantly underreported weight, as did Native American children. African American girls, aged 11-12, significantly underestimated weight and therefore, BMI percentile, while African American boys underreported height and significantly underestimated weight. Native Americans, aged 11-12, also significantly underestimated weight. The underestimation of weight by Asian females, aged 11-12, led to a significantly underestimated BMI percentile. African American boys aged 13-14 underestimated weight. Asian females, aged 15-16, significantly overestimated height and significantly underestimated weight resulting in BMI percentile to be significantly underestimated. Asian boys, aged 17-18, significantly overestimated height and underestimated BMI percentile. Asian girls, aged 17-18, also significantly overestimated height and underestimated weight resulting in BMI percentile to be significantly underestimated. The percentage of children that did not know their height or weight was 10.5%.

Comparison of age categories, races, and sex data

Kruskal Wallis tests with pairwise t-tests were used to determine differences among categories. The greatest significant difference between ages in children was seen when comparing younger children (≤14 years) to older children (>14 years). Height differences were significantly different because younger children underestimated height by 3.5 cm on average, whereas older children overestimated height by 1.1 cm on average. Younger children also significantly underestimated weight more than older children. Height and weight differences did not result in a significant difference between BMI percentile between younger and older children. Pairwise t-tests between races showed African American children underestimated height and weight to a greater extent than Asian children for both sexes. Native American girls were also found to underestimate weight significantly more than Asian girls. No significant differences were found between sexes.

Misclassification of BMI categories

Two age categories, 9-10 and 11-12 years, 8% and 8.5% of the sample reported being underweight, but actual measures found none. The percentage of 15-16-year-olds that were considered underweight by self-report values was greater than those considered underweight by actual values. The percentage of 9-10-year-olds and 11-12-year-olds considered normal weight by self-report was less than those considered normal weight by actual measurements. In contrast, the percentage of 17-18-year-olds that were considered normal weight by self-report was more than those considered normal weight by actual measurements. The percentage of 11-12-year-olds considered overweight by self-report values was greater than those considered overweight by actual values. However, the percentage of the 13-14-year-old and 15-16-year-old population that was considered overweight by self-report values was greater than those considered overweight by measured values, causing the prevalence of obesity to be underestimated by self-report values compared to actual measurements. Those considered overweight by self-report values in the 17-18 age category, was less than those considered overweight by actual measurements. This was also true of those considered obese by self-report values compared to actual values.

CONCLUSIONS AND IMPLICATIONS

The purpose of this research was twofold; to compare problematic eating behaviors between W-O/O and W-L/N in a predominately low-income population using qualitative and quantitative methodology and to explore the accuracy of self-report heights and weights for the use with both adults and children. Problematic eating behaviors were explored through focus group discussion in order to receive a better understanding of these behaviors and through the PEMS, and a taste test in order to understand reasons why these women eat and taste preferences. The exploration of the accuracy self-report height and weight was done through a secondary data analysis of 18 different studies in which participants were asked what they thought their height and weights were. After indicating their height and weight, actual measurements were taken by a trained researcher.

Key findings of these projects were, a) W-L/N tended not to overeat, thought of food less often, forgot to eat, responded to internal hunger cues, and did not eat in the absence of hunger indicating less characteristics of problematic eating behaviors in contrast to W-O/O, who overate frequently, constantly thought of food, ate in the absence of hunger, and responded to external environmental cues, b) W-L/N ate nutritious foods and exercised for health reasons, whereas W-O/O were not motivated by health to consume nutritious foods or exercise, c) W-L/N used non-sedentary activities to cope with stress, but W-O/O used sedentary activities or food to cope with stress, d) W-L/N viewed body size as modifiable, whereas W-O/O saw body size caused by genetics or side effects of medication, e) self-report height and weight appears to be inaccurate and can lead to an underestimation of obesity in both adults and children, f) race, sex, age, and education level may influence the extent of misreporting height and weight.

Overall, this study adds to the literature by comparing the eating behaviors, reasons for consuming highly palatable foods, and taste preference among low-income minority W-L/N and W-O/O using focus group methodology, PEMS, and a taste test. The results suggest that problematic eating behaviors such as overeating, constantly thinking of food, eating in the absence of hunger are common among W-O/O. Ways of handling stress and exercise habits were also different among W-O/O and W-L/N. PEMS results of this study contradicted what was said in the focus groups and other studies that have used PEMS. The PEMS may not be culturally appropriate for African Americans, low-income populations, or middle-aged women as this scale has only been validated with college students. Further research is needed to know if the PEMS scale is valid to use in minority populations, middle aged populations, and less educated populations.

Further research is also needed to learn how to stop these eating behaviors. Simply teaching these individuals to avoid such eating behaviors and listen to internal hunger cues rather than external environmental cues has not been effective, possibly because the consumption of highly palatable foods affect the opioid circuits involved with the brain's reward system.[77] If eating highly palatable foods are regulated by the brain's reward system in individuals with obesity, these individuals might have a difficult time losing weight and may be why weight loss programs are often ineffective. This suggests different methods of treatment are needed for individuals with obesity such as exploring the weight control registry or medications that can alter the brain's reward system to help manage individuals' hunger/satiety signals. Though this study gives insight to eating behaviors that may lead to obesity of low-income African American women, who are likely to be overweight or obese, further research is needed to learn how to avoid obesity in the general population and how to help individuals with obesity focus on internal satiety cues through drug or behavioral-therapy, to control their weight

This research also adds to the literature by investigating the accuracy of self-report heights and weights of large, diverse sample of predominately low income that includes both sexes, children, young, middle-aged, and older adults, multiple races, and varying education levels. Major findings of this study indicate that self-report height and weight values significantly differ from actual values and result in an underestimation of BMI. This underestimation of BMI led to misclassifications of BMI categories. Furthermore, these results show a surprisingly number of adults and children who are overweight or obese still view their health as very good or excellent despite repercussions of being overweight or obese suggesting they may not acknowledge that they are overweight or obese or they are unaware of the comorbidities associated with obesity.

These results also indicate that certain factors influence the extent of self-report biases such as age, race, and sex for adults, education level for women, and income level for women.

Overall, it appears that self-report height and weight lead to invalid results in both the adult population and the children population and should be avoided as most individuals overestimate height and underestimate weight resulting in an underestimation of obesity. Some children may not know their height and weight as they are rapidly growing and misreporting maybe unintentional. Also, the sample was mostly low-income, who may not have access to scales or stadiometers.[116] Older children and adults may intentionally misreport height and weight to appear taller or thinner. Furthermore, individuals with obesity may not recognize the health consequences associated with obesity suggesting the need for nutrition/health education throughout the community. Certain factors such as age, race, sex, education level and income level seem to influence the extent of self-report biases, which can also lead to misleading results when using self-report data.

BIBLIOGRAPHY

1. Dressler H, Smith C. Food choice, eating behavior, and food liking differs between lean/normal and overweight/obese, low-income women. *Appetite*. 2013;65:145-152. doi:10.1016/j.appet.2013.01.013.
2. Dammann KW, Smith C. Food-related environmental, behavioral, and personal factors associated with body mass index among urban, low-income African-American, American Indian, and Caucasian women. *Am J Heal Promot*. 2011;25(6):1-11. doi:10.4278/ajhp.091222-QUAN-397.
3. Dressler H, Smith C. Health and eating behavior differs between lean/normal and overweight/obese low-income women living in food-insecure environments. *Am J Heal Promot*. 2013;27(6):358-365. doi:10.4278/ajhp.120119-QUAL-55.
4. Dressler H, Smith C. Environmental, Personal, and Behavioral Factors Are Related to Body Mass Index in a Group of Multi-Ethnic, Low-Income Women. *J Acad Nutr Diet*. 2013;113(12):1662-1668. doi:10.1016/j.jand.2013.07.009.
5. Tanofsky-Kraff M, Ranzenhofer LM, Yanovski SZ, et al. Psychometric properties of a new questionnaire to assess eating in the absence of hunger in children and adolescents. *Appetite*. 2008;51(1):148-155. doi:10.1016/j.appet.2008.01.001.
6. Fay SH, White MJ, Finlayson G, King NA. Psychological predictors of opportunistic snacking in the absence of hunger. *Eat Behav*. 2015;18:156-159. doi:10.1016/j.eatbeh.2015.05.014.
7. Laitinen J, Ek E, Sovio U. Stress-Related Eating and Drinking Behavior and Body Mass Index and Predictors of This Behavior. *Prev Med (Baltim)*. 2002;34(1):29-39. doi:10.1006/pmed.2001.0948.
8. Barnes PM, Adams PF, Powell-Griner E. Health characteristics of the American Indian or Alaska Native adult population: United States, 2004-2008. *Natl Health Stat Report*. 2010;(20):1-22.
9. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011-2012. *J Am Med Assoc*. 2014;311(8):806-814. doi:10.1001/jama.2014.732.
10. Ogden CL, Lamb MM, Carroll MD, Flegal KM. Obesity and socioeconomic status in adults: United States, 2005-2008. *NCHS Data Brief*. 2010;127(50):1-8.

11. Flint AJ, Gearhardt AN, Corbin WR, Brownell KD, Field AE, Rimm EB. Food addiction scale measurement in 2 cohorts of middle-aged and older women. *Am J Clin Nutr*. 2014:578-586. doi:10.3945/ajcn.113.068965.
12. Dressler H, Smith C. Depression Affects Emotional Eating and Dietary Intake and Is Related to Food Insecurity in a Group of Multiethnic, Low-income Women. *J Hunger Environ Nutr*. 2015;10(October):496-510. doi:10.1080/19320248.2015.1045666.
13. Stunkard AJ, Berkowitz RI, Stallings VA, Schoeller DA. Energy intake, not energy output, is a determinant of body size in infants. *Am J Clin Nutr*. 1999;69(3):524-530. doi:http://dx.doi.org/10.1097/00004583-199910000-00029.
14. Drewnowski A, Schwartz M. Invisible fats: Sensory assessment of sugar/fat mixtures. *Appetite*. 1990;14(3):203-217. doi:10.1016/0195-6663(90)90088-P.
15. Israel A, Stolmaker L, Andrian C. Thoughts About Food and Their Relationship to Obesity and Weight Control. *Int J Eat Disord*. 1985;4(4):549-558.
16. Lynch WC, Eppers KD, Sherrodd JR. Eating Attitudes of Native American and White Female Adolescents: A Comparison of BMI- and Age-Matched Groups. *Ethn Health*. 2004;9(3):253-266. doi:10.1080/1355785042000250094.
17. Fisher JO, Birch LL. Eating in the absence of hunger and overweight in girls from 5 to 7 y of age. *Am J Clin Nutr*. 2002;76(1):226-231.
18. Balantekin KN, Birch LL, Savage JS. Eating in the absence of hunger during childhood predicts self-reported binge eating in adolescence. *Eat Behav*. 2016;24:7-10. doi:10.1016/j.eatbeh.2016.11.003.
19. Gautier JF, Chen K, Salbe AD, et al. Differential Brin Responses to Satiation in Obese and Lean Men. *Diabetes*. 2000;49:838-846.
20. Gautier JF, Del Parigi A, Chen K, et al. Effect of satiation on brain activity in obese and lean women. *Obes Res*. 2001;9(11):676-684. doi:10.1038/oby.2001.92.
21. Johnson PM, Kenny PJ. Dopamine D2 receptors in addiction-like reward dysfunction and compulsive eating in obese rats. *Nat Neurosci*. 2010;13(5):635-641. doi:10.1038/nn.2519.
22. Timmerman GM, Gregg EK. Dieting, perceived deprivation, and preoccupation with food. *West J Nurs Res*. 2003;25(4):405. doi:10.1177/0193945903251653.

23. Passamonti L, Rowe JB, Schwarzbauer C, Ewbank MP, von dem Hagen E, Calder AJ. Personality predicts the brain's response to viewing appetizing foods: the neural basis of a risk factor for overeating. *J Neurosci*. 2009;29(1):43-51. doi:10.1523/JNEUROSCI.4966-08.2009.
24. Boggiano MM, Wenger LE, Turan B, et al. Real-time sampling of reasons for hedonic food consumption: Further validation of the Palatable Eating Motives Scale. *Front Psychol*. 2015;6:1-8. doi:10.3389/fpsyg.2015.00744.
25. Ogden CL, Carroll MD, Fryar CD, Flegal KM. Prevalence of Obesity Among Adults and Youth: United States, 2011-2014. *NCHS Data Brief*. 2015;(219):1-8. http://www.ncbi.nlm.nih.gov/pubmed/26633046.
26. Pi-Sunyer FX, Becker D, Bouchard C, et al. *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults. The Evidence Report, NIH Publication No. 98-4083.* Vol 158.; 1998. doi:10.1001/jama.2012.39.
27. Finkelstein EA, Trogdon JG, Cohen JW, Dietz W. Annual medical spending attributable to obesity: Payer-and service-specific estimates. *Health Aff*. 2009;28(5). doi:10.1377/hlthaff.28.5.w822.
28. Gorber SC, Shields M, Tremblay MS, Mcdowell I. The feasibility of establishing correction factors to adjust self-reported estimates of obesity. *Heal Reports*. 2008;19(82):71-83. http://www.statcan.gc.ca/pub/82-003-x/2008003/article/10680-eng.htm.
29. Gorber SC, Tremblay M, Moher D, Gorber B. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: A systematic review. *Obes Rev*. 2007;8(4):307-326. doi:10.1111/j.1467-789X.2007.00347.x.
30. Mueller KG, Hurt RT, Abu-Lebdeh HS, Mueller PS. Self-perceived vs actual and desired weight and body mass index in adult ambulatory general internal medicine patients: a cross sectional study. *BMC Obes*. 2014;1:26. doi:10.1186/s40608-014-0026-0.
31. Hauck FR, Woolf N, White L, Cao G, Strauss K. Inaccuracy of Self-Reported Indian Adolescents Weights and Heights among American Indian Adolescents. *Ann Epidemiol*. 1995;5(5):386-392.

32. Gunnare NA, Silliman K, Morris MN. Accuracy of self-reported weight and role of gender, body mass index, weight satisfaction, weighing behavior, and physical activity among rural college students. *Body Image*. 2013;10(3):406-410. doi:10.1016/j.bodyim.2013.01.006.

33. Fillenbaum GG, Kuchibhatla MN, Whitson HE, et al. Accuracy of Self-reported Height and Weight in a Community-Based Sample of Older African Americans and Whites. *J Gerontol A Biol Sci Med Sci*. 2010;(10):1123-1129. doi:10.1093/gerona/glq096.

34. Quick V, Byrd-bredbenner C, Shoff S, et al. Concordance of self-report and measured height and weight of college students. *J Nutr Educ Behav*. 2015;47(1):94-98. doi:10.1016/j.jneb.2014.08.012.

35. Roth LW, Allshouse AA, Lesh J, Polotsky AJ, Santoro N. The correlation between self-reported and measured height, weight, and BMI in reproductive age women. *Maturitas*. 2013;76(2):185-188. doi:10.1016/j.maturitas.2013.07.010.

36. Lim LLY, Seubsman S, Sleigh A. Validity of self-reported weight , height , and body mass index among university students in Thailand : Implications for population studies of obesity in developing countries. *Popul Health Metr*. 2009;8. doi:10.1186/1478-7954-7-15.

37. Bowring AL, Peeters A, Freak-Poli R, Lim MS, Maelenn G, Margaret H. Measuring the accuracy of self-reported height and weight in a community-based sample of young people. *BMC Med Res Methodol*. 2012;12:175-182. doi:10.1186/1471-2288-12-175.

38. Nakamura K, Hoshino Y, Kodama K, Yamamoto M. Reliability of self-reported body height and weight of adult Japanese women. *J Biosoc Sci*. 1999;31(4):555-558. doi:10.1017/S0021932099005556.

39. Smith C, Klosterbuer A, Levine AS. Military experience strongly influences post-service eating behavior and BMI status in American veterans. *Appetite*. 2009;52(2):280-289. doi:10.1016/j.appet.2008.10.003.

40. Johnson WD, Bouchard C, Newton RL, Ryan DH, Katzmarzyk PT. Ethnic differences in self-reported and measured obesity. *Obesity*. 2009;17(3):571-577. doi:10.1038/oby.2008.582.

41. Wen M, Kowaleski-Jones L. Sex and ethnic differences in validity of self-reported adult height, weight and body mass index. *Ethn Dis*. 2012;22(1):72-78. http://www.ncbi.nlm.nih.gov/pubmed/22774312%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC3590903.
42. Flood V, Webb K, Lazarus R, Pang G. Use of self-report to monitor overweight and obesity in populations: Some issues for consideration. *Aust N Z J Public Health*. 2000;24(1):96-99. doi:10.1111/j.1467-842X.2000.tb00733.x.
43. Pursey K, Burrows TL, Stanwell P, Collins CE. How Accurate is Web-Based Self-Reported Height, Weight, and Body Mass Index in Young Adults? *J Med Internet Res*. 2014;16:1-9. doi:10.2196/jmir.2909.
44. Craig BM, Adams AK. Accuracy of Body Mass Index Categories Based on Self-Reported Height and Weight Among Women in the United States. *Matern Child Heal J*. 2009;13:489-496. doi:10.1007/s10995-008-0384-7.
45. Mozumdar A, Liguori G. Corrective Equations to Self-Reported Height and Weight for Obesity Estimates Among U.S. Adults: NHANES 1999–2008. *Res Q Exerc Sport*. 2016;87(1):47-58. doi:10.1080/02701367.2015.1124971.
46. Junjie Qin, Yingrui Li, Zhiming Cai, Shenghui Li, Jianfeng Zhu, Fan Zhang, Suisha Liang, Wenwei Zhang, Yuanlin Guan, Dongqian Shen, Yangqing Peng, Dongya Zhang, Zhuye Jie, Wenxian Wu, Youwen Qin, Wenbin Xue, Junhua Li, Lingchuan Han, Donghui Lu, Peixian W SZ. A metagenome-wide association study of gut microbiota in type 2 diabetes. *Nature*. 2012;490(7418):55-60. doi:10.1038/nature11450.
47. McAdams MA, Van Dam RM, Hu FB. Comparison of Self-reported and Measured BMI as Correlates of Disease Markers in U.S. Adults. *Obesity*. 2007;15(1):188-188. doi:10.1038/oby.2007.504.
48. Rowland M. Self-reported and height. *Am J Clin Nutr*. 1990;52:1125-1133.
49. Wada K, Tamakoshi K, Tsunekawa T, et al. Validity of self-reported height and weight in a Japanese workplace population. *Int J Obes*. 2005;29(9):1093-1099. doi:10.1038/sj.ijo.0803012.
50. Dahl AK, Hassing LB, Fransson EI, Pedersen NL. Agreement between self-reported and measured height, weight and body mass index in old age-a

longitudinal study with 20 years of follow-up. *Age Ageing*. 2010;39(4):445-451. doi:10.1093/ageing/afq038.

51. Nyholm M, Gullberg B, Merlo J, Lundqvist-Persson C, Råstam L, Lindblad U. The Validity of Obesity Based on Self-reported Weight and Height: Implications for Population Studies. *Obesity*. 2007;15(1):197-197. doi:10.1038/oby.2007.536.
52. Flood V, Webb K, Lazarus R, Baur L. Monitoring overweight and obesity in NSW: A guide. *NSW Heal Dep*. 8(6-7):46-48.
53. Dijkshoorn H, Ujcic-Voortman JK, Viet L, Verhoeff AP, Uitenbroek DG. Ethnic variation in validity of the estimated obesity prevalence using self-reported weight and height measurements. *BMC Public Health*. 2011.
54. Bolton-Smith C, Woodward M, Tunstall-Pedoe H, Morrison C. Accuracy of the estimated prevalence of obesity from self reported height and weight in an adult Scottish population. *J Epidemiol Community Heal*. 2000;54(2):143-148. doi:10.1136/jech.54.2.143.
55. Liechty JM, Bi X, Qu A. Feasibility and validity of a statistical adjustment to reduce self-report bias of height and weight in wave 1 of the Add Health study. *BMC Med Res Methodol*. 2016;16(1):124. doi:10.1186/s12874-016-0227-y.
56. Himes JH, Faricy A. Validity and Reliability of Self-Reported Stature and Weight of US Adolescents. *Am J Hum Biol*. 2001;260(July 2000):255-260.
57. Dauphinot V, Wolff H, Naudin F, et al. New obesity body mass index threshold for self-reported data. *J Epidemiol Community Heal*. 2008;63(2):128-132. doi:10.1136/jech.2008.077800.
58. Gillum R, Sempos CT. Ethnic variation in validity of classification of overweight and obesity using self-reported weight and height in American women and men: the Third National Health and Nutrition Examination Survey. *Nutr J*. 2005;4(1):27. doi:10.1186/1475-2891-4-27.
59. Morrissey SL, Whetstone LM, Cummings DM, Owen LJ. Comparison of self-reported and measured height and weight in eighth-grade students. *J Sch Health*. 2006;76(10):512-515. doi:10.1111/j.1746-1561.2006.00150.x.
60. Pérez A, Gabriel KP, Nehme EK, Mandell DJ, Hoelscher DM. Measuring the bias, precision, accuracy, and validity of self-reported height and weight in assessing

overweight and obesity status among adolescents using a surveillance system. *Int J Behav Nutr Phys Act*. 2015;12(Suppl 1):1-11.

61. Goodman E, Hinden B, Khandelwal S. Accuracy of Teen and Parental Reports of Obesity and Body Mass Index. *Pediatrics*. 2000;106(1).

62. Fonseca H, Silva AM, Matos MG, et al. Validity of BMI based on self-reported weight and height in adolescents. *Acta Paediatr Int J Paediatr*. 2010;99(1):83-88. doi:10.1111/j.1651-2227.2009.01518.x.

63. Brener ND, McManus T, Galuska DA, Lowry R, Wechsler H. Reliability and validity of self-reported height and weight among high school students. *J Adolesc Heal*. 2003;32(4):281-287. doi:10.1016/S1054-139X(02)00708-5.

64. Tokmakidis SP, Christodoulos AD, Mantzouranis NI. Validity of Self-Reported Anthropometric Values Used to Assess Body Mass Index and Estimate Obesity in Greek School Children. *J Adolesc Heal*. 2007;40(4):305-310. doi:10.1016/j.jadohealth.2006.10.001.

65. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Int J Nurs Stud*. 2010;47(8):931-936. doi:10.1016/j.ijnurstu.2009.10.001.

66. Zhou X, Dibley MJ, Cheng Y, Ouyang X, Yan H. Validity of self-reported weight, height and resultant body mass index in Chinese adolescents and factors associated with errors in self-reports. *BMC Public Health*. 2010;10:190. doi:10.1186/1471-2458-10-190.

67. Powell-Young YM. The validity of self-report weight and height as a surrogate method for direct measurement. *Appl Nurs Res*. 2012;25(1):25-30. doi:10.1016/j.apnr.2010.06.001.

68. Himes JH, Hannan P, Wall M, Neumark-Sztainer D. Factors associated with errors in self-reports of stature, weight, and body mass index in Minnesota adolescents. *Ann Epidemiol*. 2005;15(4):272-278. doi:10.1016/j.annepidem.2004.08.010.

69. Strauss R. Comparison of measured and self-reported weight and height in a cross-sectional sample of young adolescents. *Int J Obes*. 1999;23.

70. Fortenberry JD. Reliability of adolescents' reports of height and weight. *J Adolesc Heal*. 1992;13(2):114-117. doi:10.1016/1054-139X(92)90076-N.

71. Drake KM, Longacre MR, Dalton MA, et al. Two-method measurement for adolescent obesity epidemiology: Reducing the bias in self-report of height and weight. *J Adolesc Heal*. 2013;53(3):322-327. doi:10.1016/j.jadohealth.2013.03.026.
72. Krueger R, Casey MA. *Focus Groups: A Practical Guide for Applied Research*. 5th ed. Sage; 2015.
73. Burgess EE, Turan B, Lokken KL, Morse A, Boggiano MM. Profiling motives behind hedonic eating. Preliminary validation of the Palatable Eating Motives Scale. *Appetite*. 2014;72:66-72. doi:10.1016/j.appet.2013.09.016.
74. Green B, Dalton P, Cowart B, Shaffer G, Rankin K, Higgins J. Evaluating the "Labeled Magnitude Scale" for Measuring Sensations of Taste, and Smell. *Oxford Univ Press*. 1996:323-334.
75. National Center for Health Statistics. *Health United States Report 2016*. Hyattsville, MD; 2017. https://www.cdc.gov/nchs/data/hus/hus16.pdf#053.
76. Olszewski PK, Levine AS. Central opioids and consumption of sweet tastants: When reward outweighs homeostasis. *Physiol Behav*. 2007;91(5):506-512. doi:10.1016/j.physbeh.2007.01.011.
77. Jewett DC, Grace MK, Levine AS. Chronic sucrose ingestion enhances mu-opioid discriminative stimulus effects. *Brain Res*. 2005;1050(1-2):48-52. doi:10.1016/j.brainres.2005.05.012.
78. Drewnowski A, Krahn DD, Demitrack MA, Nairn K, Gosnell BA. Taste Responses and Preferences for Sweet High-Fat Foods: Evidence for Opioid Involvement. *Physiol Behav*. 1992;51(12):371-379.
79. Wiig Dammann K, Smith C. Factors Affecting Low-income Women's Food Choices and the Perceived Impact of Dietary Intake and Socioeconomic Status on Their Health and Weight. *J Nutr Educ Behav*. 2009;41(4):242-253. doi:10.1016/j.jneb.2008.07.003.
80. Wu B, Smith C. Acculturation and environmental factors influencing dietary behaviors and body mass index of Chinese students in the United States. *Appetite*. 2016;103:324-335. doi:10.1016/j.appet.2016.04.029.
81. Oemichen M, Smith C. Investigation of the Food Choice, Promoters and Barriers

to Food Access Issues, and Food Insecurity Among Low-Income, Free-Living Minnesotan Seniors. *J Nutr Educ Behav*. 2016;48(6):397-404. doi:10.1016/j.jneb.2016.02.010.

82. Farahmand M, Tehrani FR, Amiri P, Azizi F. Barriers to healthy nutrition: perceptions and experiences of Iranian women. *BMC Public Health*. 2012;12(1):1064. doi:10.1186/1471-2458-12-1064.

83. Edquist S, Koch P, Contento I. Understanding adolescent food choices through personal food stories. *J Nutr Educ Behav*. 2009;41(4):40-41. doi:10.1016/j.jneb.2009.03.093.

84. Keys A, Brozek J, Henschel A. *The Biology of Human Starvation*. University of Minnesota Press; 1950.

85. Fisher J, Birch L. Restricting Access to Foods and Children's Eating. *Appetite*. 1999;32(3):405-419. doi:10.1006/appe.1999.0231.

86. Lansigan RK, Emond JA, Gilbert-Diamond D. Understanding eating in the absence of hunger among young children: A systematic review of existing studies. *Appetite*. 2015;85:36-47. doi:10.1016/j.appet.2014.10.032.

87. Holland J, Masling J, Copley D. Mental Illness in Lower Class Normal, Obese and Hyperobese women. *Psychosom Med*. 1970;32(4).

88. Boggiano MM. Palatable Eating Motives Scale in a college population: Distribution of scores and scores associated with greater BMI and binge-eating. *Eat Behav*. 2016;21:95-98. doi:10.1016/j.eatbeh.2016.01.001.

89. Richards R, Smith C. Environmental, parental, and personal influences on food choice, access, and overweight status among homeless children. *Soc Sci Med*. 2007;65(8):1572-1583. doi:10.1016/j.socscimed.2007.06.013.

90. Stewart-Knox B, Duffy ME, Bunting B, Parr H, Vas De Almeida MD, Gibney M. Associations between obesity (BMI and waist circumference) and socio-demographic factors, physical activity, dietary habits, life events, resilience, mood, perceived stress and hopelessness in healthy older Europeans. *BMC Public Health*. 2012;12(1):1. doi:10.1186/1471-2458-12-424.

91. Boeckner LS, Pullen CH, Walker SN, Hageman PA. Differences in Eating and Activity Behaviors, Health History, and Biomarkers among Normal-Weight,

Overweight, and Obese Rural Midwestern Hispanic Women. *J Am Diet Assoc*. 2006;106(11):1870-1874. doi:10.1016/j.jada.2006.08.001.

92. Lin B, Huang C, French S. Factors associated with women's and children's body mass indices by income status. *Int J Obes*. 2004;28(4):536-542. doi:10.1038/sj.ijo.0802604.

93. Turk MW, Yang K, Hravnak M, Sereika SM, Ewing LJ, Burke LE. Randomized clinical trials of weight-loss maintenance: A review. *J Cardiovasc Nurs*. 2009;24(1):58-80. doi:10.1097/01.JCN.0000317471.58048.32.Randomized.

94. Karlsson J, Taft C, Rydén A, Sjöström L, Sullivan M. Ten-year trends in health-related quality of life after surgical and conventional treatment for severe obesity: the SOS intervention study. *Int J Obes*. 2007;31(8):1248-1261. doi:10.1038/sj.ijo.0803573.

95. Graham Thomas J, Bond DS, Phelan S, Hill JO, Wing RR. Weight-loss maintenance for 10 years in the national weight control registry. *Am J Prev Med*. 2014;46(1):17-23. doi:10.1016/j.amepre.2013.08.019.

96. Proietto J, Rissanen A, Harp J, et al. A clinical trial assessing the safety and efficacy of the CB1R inverse agonist taranabant in obese and overweight patients: low-dose study. *Inernational J Obes*. 2010;34:1243-1254. doi:10.1038/ijo.2010.38.

97. Ioannides-demos LL, Piccenna L, Mcneil JJ. Pharmacotherapies for Obesity: Past, Current, and Future Therapies. *Obesity*. 2011;2011. doi:10.1155/2011/179674.

98. Frisancho AR. *Anthropometric Standards: An Interactive Nutrition Reference of Body Size and Body Composition for Children and Adults*. Ann Arbor, Michigan: The University of Michigan Press; 2008.

99. World Health Organization. Body Mass Index-BMI. http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi. Published 2018.

100. Kumar S, Kelly AS. Review of Childhood Obesity: From Epidemiology, Etiology, and Comorbidities to Clinical Assessment and Treatment. *Mayo Clin Proc*. 2017;92(2):251-265. doi:10.1016/j.mayocp.2016.09.017.

101. Smith C, Franzen-Castle L. Dietary acculturation and body composition predict

American Hmong children's blood pressure. *Am J Hum Biol*. 2012;24(5):666-674. doi:10.1002/ajhb.22295.

102. Smith C, Rinderknecht K. Obesity correlates with increased blood pressures in urban Native American youth. *Am J Hum Biol*. 2003;15(1):78-90. doi:10.1002/ajhb.10121.

103. Rinderknecht K, Smith C. Body-Image Perceptions among Urban Native American Youth. *Obes Res*. 2002;10(5):315-327. doi:10.1038/oby.2002.45.

104. Mulasi-Pokhriyal U, Smith C. Assessing body image issues and body satisfaction/dissatisfaction among Hmong American children 9-18 years of age using mixed methodology. *Body Image*. 2010;7(4):341-348. doi:10.1016/j.bodyim.2010.08.002.

105. Ge X, Elder Jr G, Regnerus M, Cox C. Pubertal Transitions, Perceptions of Being Overweight, and Adolescents' Psychological Maladjustment: Gender and Ethnic Differences. *Soc Psychol Quartley*. 2001;64(4):363-375.

106. Bialo SR, Gordon CM. Underweight, overweight, and pediatric bone fragility: Impact and management. *Curr Osteoporos Rep*. 2014;12(3):319-328. doi:10.1007/s11914-014-0226-z.

107. Sadat Ali S. A brief review of risk-factors for growth and developmental delay among preschool children in developing countries. *Adv Biomed Res*. 2013;2(91).

108. Wing RR, Epstein LH, Ossip DJ, LaPorte RE. Reliability and validity of self-report and observers' estimates of relative weight. *Addict Behav*. 1979;4(2):133-140. doi:10.1016/0306-4603(79)90047-9.

109. Mahoney MJ. The obese eating style: Bites, beliefs, and behavior modification. *Addict Behav*. 1975;1(1):47-53.

110. Wigg Damman K, Smith C, Richards R. Low-income Minority and Homeless Mothers' Perceptions of their 9-13 Year-Old Children's Weight Status, Diet, and Health. *Matern Child Heal J*. 2011;15:106-114.

111. Mulasi-Pokhriyal U, Smith C, Franzen-Castle L. Investigating dietary acculturation and intake among US-born and Thailand/Laos-born Hmong-American children aged 9–18 years. *Public Health Nutr*. 2012;15(01):176-185. doi:10.1017/S1368980011001649.

112. Heidelberger LA, Smith C. A Child's Viewpoint: Determinants of Food Choice and Definition of Health in Low-Income 8- to 13-Year-Old Children in Urban Minnesota Communities. *J Hunger Environ Nutr*. 2014;9(3):388-408. doi:10.1080/19320248.2014.929547.
113. Dammann K, Smith C. Food-related Attitudes and Behaviors at Home, School, and Restaurants: Perspectives from Racially Diverse, Urban, Low-income 9- to 13-year-old Children in Minnesota. *J Nutr Educ Behav*. 2010;42(6):389-397. doi:10.1016/j.jneb.2009.09.003.
114. CDC. About child and teen BMI. https://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html. Published 2015. Accessed May 7, 2017.
115. Riley MR, Bass NM, Rosenthal P, Merriman RB. Underdiagnosis of pediatric obesity and underscreening for fatty liver disease and metabolic syndrome by pediatricians and pediatric subspecialists. *J Pediatr*. 2005;147(6):839-842. doi:10.1016/j.jpeds.2005.07.020.
116. Nickasch B, Marnocha SK. Healthcare experiences of the homeless. *J Am Acad Nurse Pract*. 2009;21(1):39-46. doi:10.1111/j.1745-7599.2008.00371.x.