Accuracy of Weight Perception and Disordered Weight Control Behaviors in Adolescents

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Abstract

Background: Perceived weight status is often a better predictor of weight control behaviors than actual weight status. The risk of dangerous weight control behaviors in adolescents can be determined based on their perceived body image. This study looks at the association between weight perception and BMI percentile in adolescents, as well as the association between disordered weight control behaviors and weight perception.

Methods: A cross-sectional study using the 2007 Youth Risk Behavior Surveillance Survey provided by the CDC was used to determine the associations between weight perception and weight status. Of the surveys collected from high-school aged students across the U.S., 13,062 surveys contained values for BMI percentile. BMI percentile was modeled using simple and multiple linear regression models with weight perception, controlled for age, sex, race/ethnicity. Odds ratios for disordered eating behaviors based on weight perception were determined using logistic regression, controlling for age, BMI percentile, sex, race/ethnicity.

Results: Only 1.7% for students described themselves as very underweight while 8.5% had BMI percentile values <5%. Conversely, 25.1% of adolescents described themselves as overweight and 4.1% as very overweight, while based on BMI percentile categories, 14.7% are overweight while 12.1% were obese. Three significant interactions, race by sex (p=0.01), sex by weight perception (p<.001), and age by weight perception (p<.0001) were found on the multiple linear regression model. When determining the odds ratio of eating disorders using logistic regression, a significant interaction term between race and weight perception was found (p<.0001). The effect of weight perception on the odds of eating disorders varied by race/ethnicity, while males had protective odds ratios for every race when holding sex, BMI percentile, weight perception and age constant (p<0.05).

Conclusions: Different race/ethnicities, ages, and sexes are affected by weight perception differently, that information can be used to better target different populations for public health programs.

Introduction

Weight perception has been shown to be a strong indicator of diet and exercise habits in both adults and adolescents. Often acting as a better predictor of weight control behaviors than actual weight status, weight perception information is helpful in assessing the risk of dangerous weight control behaviors in adolescents based on their perceived body image (1, 2). With the obesity epidemic looming, an increasing number of children perceive themselves as "overweight" (3). Those who underweight or at normal weight but perceive themselves to be overweight are at risk for eating disorders such as anorexia nervosa or bulimia. Conversely, overweight adolescents who do not perceive themselves as such are unlikely to engage in diet and exercise behaviors to control weight.

Past studies have shown that weight perception has a bigger influence on females in terms of depressive symptoms than males (4). Weight perception is influenced by both race and sex, for example in a study among university student females of African-descent were significantly more likely than those of other ethnic groups to report higher weights and to select larger silhouettes to represent their current body figure (1). One population specifically identified as high risk for eating disorders based on other cross-sectional studies, were normal-weight, white, adolescent females who consider themselves overweight based on the high proportion who has attempted to lose weight (5). In addition to dangerous weight control practices, weight perception also is associated with depression and low-self esteem.

The primary aim of this study is to validate the association found in previous studies between weight perception in adolescents and their actual body mass index (BMI) percentile based on reported height, weight, and age using simple linear regression. The null hypothesis being that there is no difference between perceived weight status and BMI percentile. A multiple linear regression model for weight perception and BMI, controlling for race, sex, and age will also be used to test the null hypothesis that there is no association when controlling for the specified covariates. Finally, as part of the secondary aims of this study, logistic regression will be used to test the association between perceived weight status and disordered eating or exercise behaviors to control weight.
Methods

Data Set The association between perceived weight and BMI was tested through a cross-sectional study using survey data from the 2007 Youth Risk Behavior Surveillance System (YRBSS), a publicly available database obtained through the Center for Disease Control and Prevention (CDC). This nationwide survey is administered biannually to high school students (13-18 years old) chosen based on a probability sample of students and schools, both public and private. For 2007, there was a school-level response rate of 81%, a student-level response rate of 84%, and an overall response rate of 64% giving a total sample size of 14,041. Students reported their height, weight, age, grade, sex and race/ethnicity as well as answered multiple choice questions pertaining to health-risk behaviors associated with morbidity and mortality for their age group.

The primary outcome of interest in this study was BMI percentile, any individuals with biologically implausible height and weight values by age, specified by the CDC, were removed from the data set prior to making it public. BMI was calculated using the formula weight (in kg)/height (in m)^2. BMI percentiles were derived from the 2000 CDC growth charts based on age and sex. If age or sex were missing, the BMI and BMI percentile variable were set as biologically implausible. With these edits there were a total of 13,062 student surveys containing values for BMI percentile. BMI percentile was used as a continuous variable however weight status categories exist based on the CDC definitions for underweight (<5th percentile), at risk for underweight (5th percentile to <15th percentile), healthy weight (15th percentile to <85th percentile), overweight (85th percentile to <95th percentile) and obese (95th percentile).

Simple Linear Regression The association between BMI Percentile and weight perception was further explored by controlling for age, sex, and race/ethnicity as well as any potential interaction terms, using multiple linear regression and testing for all linear model assumptions. Distributions for both BMI percentile and weight perception were looked at for normality using histogram and box plots. Weight variables given in the data set were used to satisfy violations of independence. The linear regression model was tested for assumptions of linearity, independence, normality and equal variance using Q-Q plots, Kolmogrov-Smirnov test, scatter plots and Loess curves. Influence points were investigated using residual plots. Significance testing was done using simple linear regression for BMI percentile as a continuous variable, and Chi-Square testing for perception with categorical BMI percentiles. p=0.5 were used as the marker for significance for both.

Multiple Linear Regression The relationship between BMI Percentile and weight perception was further explored by controlling for age, sex, and race/ethnicity as well as any potential interaction terms, using multiple linear regression and testing for all linear model assumptions. Distributions for both BMI percentile and weight perception by sex, age, and race ethnicity were looked at for normality using histogram and box plots. Weight variables given in the data set were used to satisfy violations of independence. The linear regression model was tested for assumptions of linearity, independence, normality and equal variance using Q-Q plots, Kolmogrov-Smirnov test, scatter plots and Loess curves. Influence points were investigated using residual plots. Significance testing was done using multiple linear regression with p=0.5 as the marker for significance.

Logistic Regression The odds ratio for any disordered weight loss behavior based on weight perception, BMI percentile, age, sex, and race/ethnicity as well as any potential interaction terms, will be determined using logistic regression. Disordered weight loss behavior is based on an individual answering yes to at least one of the three questions on the YRBSS pertaining to eating disorders: going without eating for 24 hours or more, taking diet pills, powders, or liquids without a doctor’s advice and vomiting or taking laxatives within the past 30 days with the intention to lose or to keep from gaining weight. Exploratory data analysis will look at disordered weight loss behaviors based on BMI percentile, weight perception by sex, age, and race ethnicity using scatter and box plots. Weight variables given in the data set were used to satisfy violations of independence. Influence points were investigated using residual plots. Final model was chosen based on the model with the lowest Akaake Information Criterion or Bayesian Information Criterion. All statistical analyses were done using SAS 9.2 for Windows.

Results

Simple Linear Regression Looking at the distribution of BMI percentile for adolescents, the histogram was slightly skewed to the left, while the distribution of weight perception was more normally distributed. While attempting transformations to BMI percentile none improved normality, so it was left alone. The Q-Q plot and other fit statistics of BMI percentile and weight percentage, the model was found to satisfy the assumptions of linear regression (Fig. 1), although the residual plot showed indication of uneven dispersion of the data. No influential points were found using residual plots or Cook’s distance. A chi-square test for significance between the categorical BMI percentiles and weight perception found a significant association (p<0.0001).

Comparing perceived weight status with BMI percentile, 1.7% for students described themselves as very underweight while 8.5% reported their height and weight values on the survey to describe a BMI as underweight. Conversely, 25.1% of adolescents described themselves as overweight and 4.1% as very overweight, while based on BMI percentile categories, 14.7% are overweight while 12.1% were obese (Table 1). Using simple linear regression, the association between actual weight and perceived weight is described in the equation: BMI Percentile=20.66+20.07(weight perception) (p<0.0001, R^2=0.354). Table 3 shows the predicted difference in reported BMI percentile for 15 year olds who categorized themselves as "slightly overweight" based on race and sex. For example 15 year old, white, females who perceive themselves as “slightly overweight” have a BMI percentile 11.7 points lower than their male counterparts.

Multiple Linear Regression Looking at the association between perceived weight and BMI percentile using the PROC GLM procedure on SAS there were three significant interactions, race by sex (p=0.01), sex by weight perception (p<.0001), and age by weight perception (p<.0001). Table 2 expands further upon Tables 1 by giving distributions of weight perception and reported weight status by sex, then further stratifying by race/ethnicity. Females tended to classify themselves as overweight or obese (34.5%) more than males (24.2%). Only 22.9% of females reported BMIs which fell into that category, while 30.8% of males had a reported BMI classified as overweight or obese (Fig 2). After exploring linearity assumptions, and finding no influential points of interest the final model contained all the covariates of interest and the three interaction terms: BMI Percentile=β0+β1 (Weight Perception) + β2 (Race) + β3 (Age)+(β4 (Male) + β5 (Race x Male)+ β6 (Age x Weight Perception) + β7 (Male x Weight Perception) (R^2=0.354). Table 3 shows the predicted difference in reported BMI percentile for 15 year olds who categorized themselves as "slightly overweight" based on race and sex. For example 15 year old, white, females who perceive themselves as “slightly overweight” have a BMI percentile 11.7 points lower than their male counterparts.
Looking at the students the role weight perception plays on eating disorders, 2,197 students reported disordered weight related behaviors in the past 30 days (15.6%), while 11,844 did not report any disordered eating (84.4%). Using backward selection with a selection entry criterion of p=0.5, all possible interactions and covariates were tested in the logistic regression model along with the variable of interest, weight perception. Deviance residuals for all the variables in the model were looked at and no outliers or influence points were found. The predicted probability of disordered eating behaviors based on weight perception increased with increased in perceived weight, with females having a higher predicted probability than males regardless of body perception (p<0.0001) (Figure 3). The final model for predicting disordered weight loss behaviors contained an interaction term between race and weight perception (p=0.0172). The final model for predicting disordered weight loss behaviors based on weight perception contained the following variables and interaction term: Logit(Eating Disorder)= log [p_{Disorder}/(1- p_{Disorder})]= -2.66+0.044(Weight Perception) + -0.067(Race) + -0.81(Male) + 0.01 (BMI Percentile) +0.085(Age) +0.052 (Race x Weight Perception). The differential effect of race and weight perception on the odds of partaking in disordered eating behaviors can be seen in weight perception in Asians is protective (OR=0.47) while in whites weight perception is a risk factor (OR=1.25) (Table 4). Among all races, males had a lower odds ratio for disordered eating; with black males 37% less likely to have an eating disorder than their female counterparts, while Asian males are 65% less likely to have an eating disorder than an Asian female with similar weight perception BMI percentile and age. Disordered eating was found to increase with age across all race/ethnicity groups, for example for each year increase in age for Hispanics there is a 13% increase in odds of having an eating disorder when controlling for weight perception, sex and BMI percentile.

Discussion

When comparing the simple linear regression model and the multiple linear regression models the multiple linear regression model explains more of the variance based on the higher R^2 value, this is accomplished by including known covariates associated with both weight perception and BMI percentile such as age, sex and race. While the simple linear regression model suggests that there is a difference of actual BMI percentile of 20.1 points between weight perception categories (i.e. those that think they're overweight compared to those that think they're normal weight will have a BMI percentile 20.1 points higher), the multiple linear regression model shows that the association is differential based on several covariates and interactions. Both models were found to have relatively low R^2 values and numerous interaction terms where a more appropriate model for the association may be found by stratifying by sex, race and age. The interaction terms found in the multiple linear regression model show the degree of difference between the protective odds ratio for males of each race further exemplified the complicated nature of body perception and the risky behaviors associated with it.

Using a publicly available dataset containing information about adolescents across the country, allows for a large sample size which expands the population for which this study can be generalized. This is enhanced through the use of the weights given by the CDC in the dataset. The surveys are internally validated within each test and have also been validated through studies comparing answers of individuals, which minimize some of the potential for misclassification due to incorrect survey answers, as well as other potential bias that come from self-reported data.

Some limitations of this study come from the nature of the survey design. Since it is a cross-sectional study, no temporal inferences can be made from the data and the weight perception, actual weight status and the disordered eating cannot be placed on a time scale. Another limitation comes from self-reported data, both weight perception and the height and weight data used to calculate BMI percentile are given by the student. If the student felt they were overweight and underreported their actual weight then an association would be seen when there actually is not one. Another potential scenario is that a student who perceives themselves as overweight may overestimate their weight, which in this case we would fail to reject the null hypothesis that there is no difference between perceived weight status and actual weight. While one study showed high-schoolers in general tend to overestimate their height and weight, no study has been done to look at if there is a correlation between weight perception and reporting (2). One way to control for this would be to randomly select a portion of the survey takers for clinical measurements of height and weight to validate the self reported numbers and look at their perceived deviations. Because the BMI percentile distribution is skewed to the left, in lines with the United States current weight distribution, rather than normally distributed, the self-reported height and weight values probably contain some underreporting by overweight students and some over reporting by underweight students, but in general the values fall as expected.

Due to the three different interactions, in the future, different modeling may be more appropriate using stratification of variable names. For example, only looking and Hispanic females, or white males, will lend and better scope to the association between perceived weight status and actual weight status. Also, it would be interesting to look only at the individuals who perceive themselves as bigger than they actually are, and the disordered eating behaviors associated with it. On the other hand it would be of interest to look at those individuals namely males, who perceive themselves as underweight, and the behaviors, such as participation in sports, associated with that perceived body image.

Conclusion

If weight perception drives behavior more than weight status, it is an important risk factor to hone in on for weight related morbidities. Weight perception is an important factor to examine when looking at BMI and weight related disorders such as obesity or disordered weight control behaviors. The differential effects that are associated with weight perception and BMI percentile or eating disorders lends the public health field knowledge that different races and ethnicities, ages, and sexes are affected differently, and that information can be used to target the different populations for education or intervention programs.

References

Image Downloaded from: http://umkcwomenc.wordpress.com/2009/10/27/eating-disorders/

Appendix

**Figure 1.** Fit diagnostics for BMI Percentile

![Image showing two graphs](Image Downloaded from: http://umkcwomenc.wordpress.com/2009/10/27/eating-disorders/)

Figure 1 shows relatively good fit for BMI percentile based on the Q-Q plot.

**Table 2.** Weighted distribution of weight status perception and BMI percentile based on sex and race (BMI percentile in italics)

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>White (W)</td>
<td>21.21%</td>
<td>22.33%</td>
</tr>
<tr>
<td>Black (B)</td>
<td>21.21%</td>
<td>22.33%</td>
</tr>
<tr>
<td>Hispanic (H)</td>
<td>21.21%</td>
<td>22.33%</td>
</tr>
</tbody>
</table>

Table 2 shows the weighted frequency of weight perceptions and BMI Percentile distribution stratified by sex and then further by race.

**Figure 2.** Scatterplot distribution of weight perception based on sex

![Image showing scatterplot](Image Downloaded from: http://umkcwomenc.wordpress.com/2009/10/27/eating-disorders/)

Figure 2 shows the distribution of perceived weight status compared to reported BMI percentile, stratified by sex.

**Table 3.** Predicted difference in BMI percentile by race/ethnicity and sex, for 15 year olds who classified themselves as “Slightly Overweight”

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>White (W)</td>
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</tr>
<tr>
<td>Hispanic (H)</td>
<td>21.21%</td>
<td>22.33%</td>
</tr>
</tbody>
</table>
Table 3 shows the difference in actual BMI percentile based on reported height and weight for 15 year olds who perceive themselves as "slightly overweight" based on race and sex when compared to white males.

Figure 3. The estimated probability of an eating disorder based on weight perception and sex

Figure 3 shows the estimated probability of disordered eating behaviors based on perceived weight status stratified by sex, with females tending to have a higher probability than males, and probability increasing with increases in perceived weight status.

Table 4. Odds ratio estimates for disordered eating stratified by race/ethnicity

<table>
<thead>
<tr>
<th>Effect</th>
<th>Black</th>
<th>Asian</th>
<th>Hispanic</th>
<th>White</th>
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</thead>
<tbody>
<tr>
<td>Weight Perception</td>
<td>1.15</td>
<td>0.47*</td>
<td>1.36</td>
<td>1.25*</td>
</tr>
<tr>
<td>BMI Percentile</td>
<td>1.02*</td>
<td>1.03*</td>
<td>1.01*</td>
<td>1.01*</td>
</tr>
<tr>
<td>Male</td>
<td>0.63*</td>
<td>0.35*</td>
<td>0.48*</td>
<td>0.316*</td>
</tr>
<tr>
<td>Age</td>
<td>1.11*</td>
<td>1.14</td>
<td>1.13*</td>
<td>1.08*</td>
</tr>
</tbody>
</table>

*95% Confidence Limits that do not include 1

Table 4 gives the estimated odds ratios for disordered eating based on weight perception, BMI percentile based on reported height and weight, sex and age, when stratified by race/ethnicity.


Project proposal

Tentative title

Weight Perception and Actual Weight Status

Data source: 2007 Youth Risk Behavior Surveillance System (YRBSS)

1. The Youth Risk Behavior Surveillance System (YRBSS) is a national school-based survey conducted by the Centers for Disease Control and Prevention (CDC). It monitors priority health-risk behaviors and the prevalence of obesity and asthma among youth and young adults.
2. This data set is publicly available through CDC
   a. About the YRBSS
   b. YRBSS 2007 National Data Files and Documentation

Research design

1. This is a cross-sectional study
2. The 2007 YRBSS data will be used
3. The survey is administered biennially to a random sample of public and private high schools based on a national probability sample. The survey is anonymous, completed by 9th through 12th graders who self-administer the computer-scannable questionnaire or answer sheet.
4. Total sample size = 14,041
5. This is a similar study using 2000 YRBSS data: The Association between Weight Perception and BMI among High School Students (Brener, et al.)

Draft research questions

1. I hypothesize that there is a difference between perceived weight status and actual BMI weight percentage
2. I also plan to see if there's an association between disordered weight control behaviors and weight perception

Major outcome variable(s) of interest and a list of suggested explanatory variable
<table>
<thead>
<tr>
<th>Type</th>
<th>Variable</th>
<th>Level of measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome for model I &amp; II</td>
<td>BMI Percentile for Age and Sex</td>
<td>Continuous</td>
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<tr>
<td>Outcome for model III</td>
<td>Disordered Weight Control Behavior (Yes/No)</td>
<td>Binary</td>
</tr>
<tr>
<td>Explanatory</td>
<td>Weight Perception</td>
<td>Categorical</td>
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<tr>
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<td>Age (years)</td>
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<tr>
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<td>Male (Y/N)</td>
<td>Binary</td>
</tr>
<tr>
<td>Explanatory</td>
<td>Race/Ethnicity</td>
<td>Categorical</td>
</tr>
</tbody>
</table>

Problems I anticipate and help I may need

Interpreting multiple interactions!