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# *FITNESSGRAM*® BMI Standards: Should They Be Race-Specific?

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*Background:* The purpose of the study was to evaluate race-specific *FITNESSGRAM*® body mass index (BMI) standards in comparison to the recommended standards, i.e., percent fat (%BF) ≥25 in boys and %BF ≥32 in girls. *Methods*: BMI and %BF were estimated in 1,968 Black and White children ages 6–14 years, using methods similar to those used to develop the current *FITNESSGRAM* standards. Multiple regression was employed to develop age-, sex-, and race-specific BMI standards. Percent agreement and modified kappa ($\kappa_q$) were used to evaluate agreement with the %BF standards, and sensitivity and specificity were used to evaluate classification accuracy. *Results*: Race significantly ($p < .05$) and meaningfully ($\beta$ = 2.3% fat) added to the relationship between BMI and %BF. Agreement of the race-specific BMI standards with %BF standards was moderate to high ($\kappa_q$ = .73–.88), and classification accuracy improved on the current *FITNESSGRAM* BMI standards. *Conclusions*: Race-specific BMI standards appear to be a more accurate representation of unhealthy %BF levels than the current *FITNESSGRAM* BMI standards.

***Key Words:*** body composition, fitness, criterion referenced standards, ethnicity

Levels of childhood obesity have risen at a rate that has been described in the popular media as constituting a "crisis" or "epidemic."[1–5] Obesity is associated with a variety of health problems in adults[6,7] and children.[8–10] The rise in obesity therefore constitutes a major concern for future health care costs.[11–13] Obesity tracks from childhood into adulthood in that obese children are more likely than nonobese children to become obese adults.[14] Identification of obesity in children is therefore important in order to improve the health of obese children, and ultimately reduce the likelihood of future health problems.

The school setting is one of the most convenient for mass screening of children, and the popular *FITNESSGRAM*® test battery provides standards for identifying children who have presumably unhealthy levels of body fatness. For convenience, the *FITNESSGRAM* program includes alternative test formats for each fitness component.[15] In this way, a school without the necessary resources to do the recommended test can elect to use an alternative test. For body composition, percent fat (%BF) from skinfolds is the recommended test, and body mass index (BMI) is

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suggested as an alternative test. Body mass index can be used in situations where school personnel are inexperienced at testing skinfolds, where school policies restrict the use of skinfolds, or where a more time-efficient method is needed. After measuring either %BF or BMI, the results are compared to standards to determine whether a child is in the "Healthy Fitness Zone." Although cutoffs are provided at the bottom as well as the top of the range, in this study we focused on the standards used to identify children who are overfat.

The *FITNESSGRAM* %BF standards are the same for girls of all ages (5–17+ years; ≥32% fat), and for boys of all ages (5–17+ years; ≥25% fat). However, because age adds to the relationship between BMI and %BF, there are different BMI standards for each age group, generally increasing as children get older. The procedures used for developing the *FITNESSGRAM* body composition standards were described in the *FITNESSGRAM* Technical Reference Manual.[16] The %BF standards were developed first, using procedures described in detail elsewhere.[10,17] Using a large-scale data set from the Bogalusa Heart Study, the researchers evaluated blood pressure, total cholesterol, and serum lipoprotein ratios in various body fat groups (boys <10%, 10–14.9%, 15–19.9%, 20–24.9%, 25+%; girls <20%, 20–24.9%, 25–29.9%, 30–34.9%, 35+%). Boys with %BF ≥25 and girls with %BF ≥30 were found to be at significantly greater risk of elevated blood pressure and blood lipids than those in lower fatness groups.

The *FITNESSGRAM* %BF standards were subsequently set at 25% fat for boys and 32% fat for girls.[10,17] Following this, Lohman used regression procedures on an already existing population data set from the National Children and Youth Fitness Studies[18,19] to estimate BMI scores that were equivalent to the *FITNESSGRAM* boys' and girls' %BF cutoffs.[16] Because age and sex added to the BMI/%BF relationship, these were also entered into the regression analysis. Thus there are separate standards for each sex and age group. As the standards all end in .0 or .5, we assumed that the cutoffs were rounded to the nearest 0.5 $kg \cdot m^{-2}$.

When the *FITNESSGRAM* BMI standards were developed, race was not included in the equation. There is some evidence that race should be considered when BMI is used to estimate %BF in children. From a review of the literature across all age groups, Wagner and Heyward[20] made a compelling case for differences in fat-free body density, fat distribution patterns, and limb-to-trunk proportionality between Blacks and Whites. Several studies have shown that the BMI/%BF relationship is different across different adult racial groups.[21] In a study of Black and White children, race, sex, and stage of maturation all added to the BMI/%BF relationship.[22] The purpose of the current study was therefore to investigate the need for race-specific *FITNESSGRAM* BMI standards, and to subsequently evaluate the accuracy of race-specific *FITNESSGRAM* BMI standards as an alternative to the current *FITNESSGRAM* %BF standards.

# Methods

## Data Collection Procedures

Participants in this study were 1,968 children ages 6–14 years, of African ($n$ = 1,219) or Caucasian ($n$ = 749) descent, hereafter referred to as Black or White children, respectively. Data were collected across a 10-year period in the Bahamas, Tennessee, and North Carolina. Means (± *SD*) for BMI and %BF are presented by sex,

**Table 1 Means and Standard Deviations for Body Mass Index (BMI) and Percent Fat, by Sex, Race, and Age**

| Age | Variable | Male Black | Male White | Female Black | Female White |
|---|---|---|---|---|---|
| 6 | BMI | 15.84 (3.47) | 15.79 (1.12) | 15.14 (1.85) | 15.46 (1.27) |
| | % Fat | 14.22 (8.02) | 15.76 (2.42) | 17.98 (5.04) | 17.89 (3.10) |
| 7 | BMI | 15.31 (1.80) | 16.16 (2.25) | 15.50 (2.98) | 16.02 (2.10) |
| | % Fat | 14.08 (5.97) | 15.23 (4.70) | 18.34 (5.78) | 18.87 (5.63) |
| 8 | BMI | 16.05 (2.82) | 17.88 (3.55) | 16.38 (3.09) | 16.43 (2.97) |
| | % Fat | 14.89 (7.09) | 23.95 (10.35) | 21.79 (7.68) | 22.84 (5.30) |
| 9 | BMI | 16.64 (3.70) | 19.73 (4.06)) | 17.98 (4.91) | 18.68 (3.92) |
| | % Fat | 16.05 (8.87) | 25.29 (10.62) | 24.36 (9.66) | 26.20 (8.67) |
| 10 | BMI | 19.08 (5.47) | 19.39 (4.49) | 18.55 (4.77) | 19.66 (4.31) |
| | % Fat | 19.23 (12.06) | 25.49 (11.79) | 24.01 (9.50) | 26.67 (8.74) |
| 11 | BMI | 18.93 (4.83) | 19.42 (3.59) | 19.08 (4.53) | 20.67 (4.98) |
| | % Fat | 19.69 (12.32) | 23.66 (9.91) | 23.22 (9.05) | 28.78 (10.18) |
| 12 | BMI | 21.34 (4.92) | 20.83 (4.41) | 22.41 (7.10) | 20.44 (3.94) |
| | % Fat | 22.02 (11.11) | 24.81 (10.62) | 26.19 (10.41) | 25.82 (8.40) |
| 13 | BMI | 21.69 (4.13) | 20.24 (2.62) | 22.71 (6.15) | 21.36 (3.99) |
| | % Fat | 20.95 (13.56) | 22.32 (8.56) | 27.18 (10.92) | 28.03 (9.16) |
| 14 | BMI | 23.96 (6.05) | 21.62 (4.96) | 23.43 (3.79) | 21.08 (3.46) |
| | % Fat | 23.88 (15.47) | 20.75 (9.17) | 31.58 (10.71) | 28.99 (7.33) |

age, and race in Table 1. Standardized procedures were used to measure height, weight, and triceps and calf skinfolds. All measures were taken either by the two authors or by trained research assistants. Training included practice and comparison to the two authors. At least two measures of height, weight, and each skinfold were taken to ensure consistency. Skinfolds were taken at calf and triceps using the same procedures as those in the National Children and Youth Fitness Studies (i.e., the data sets used to develop the current *FITNESSGRAM* %BF standards).[23] The sum of triceps and calf skinfolds was used with the equations of Slaughter et al.[24] to convert to %BF. In summary, the data collection procedures in this study replicated those for the data used in developing the current *FITNESSGRAM* BMI standards. All procedures were approved by the relevant institutional review boards and school districts, and parental consent was obtained for all children tested.

Regression analysis was employed to investigate whether race added to the relationship between BMI and %BF. Forced entry was used to add BMI, sex, then age, to the regression analysis to explain %BF. Race was then added to the regression model. The resulting regression equation was used to determine what BMI standards were equivalent to the %BF cutoffs used in the *FITNESSGRAM* body composition standards. This analysis followed the same statistical procedures used by Lohman to determine the current *FITNESSGRAM* BMI standards,[16] but added race to the analysis. Following this, agreement between the BMI and %BF standards was evaluated via proportion of agreement and modified kappa. Additionally, sensitivity and specificity were calculated to evaluate how the race-specific BMI standards performed in correctly classifying obese children and nonobese children (defined as those exceeding or lower than the %BF standards). All analyses were conducted using SPSS version 12.0 (SPSS, Inc., Chicago), and significance tests were conducted at the $p < .05$ level.

# Results

The results of the regression analysis are presented in Table 2. For each of Models 1 through 4, the forced entry of each new independent variable explained a significant amount of the variance in %BF. In the final model, race added significantly, and also meaningfully, to the explanation of %BF. Large sample data may lead to predictors that are statistically significant, although clinically meaningless, because of high statistical power. Examination of the unstandardized regression coefficient for race showed that in this study, for any given BMI, the equivalent %BF would be 2.3% fat lower for Black children than for White children. In the final model, BMI, sex, age, and race explained over 73% of the variance in %BF. The regression results were used to determine sex-, age-, and race-specific BMI cutpoints that are equivalent to the *FITNESSGRAM* %BF standards. These procedures are similar to those used in calculating the current *FITNESSGRAM* BMI standards, except that race was included in the equation as well as BMI, age, and sex.

**Table 2 Regression of Percent Fat on BMI, Sex, Age, and Race**

| Model | Predictors | *R* | Explained variance | *SEE* |
|---|---|---|---|---|
| 1 | BMI | 0.823 | 67.8% | 5.85 % fat |
| 2 | BMI, Sex | 0.846 | 71.7% | 5.49 % fat |
| 3 | BMI, Sex, Age | 0.851 | 72.3% | 5.42 % fat |
| 4 | BMI, Sex, Age, Race | 0.857 | 73.4% | 5.32 % fat |

The resulting 36 sets of race-specific BMI standards are presented in Table 3, alongside the current *FITNESSGRAM* BMI standards. The standards are higher for Black children than for White children, and higher for girls than for boys (this reflects a similar pattern between girls' and boys' current *FITNESSGRAM* BMI standards). The race-specific BMI standards were rounded to the nearest 0.5 $kg{\cdot}m^{-2}$ (as are the current *FITNESSGRAM* BMI standards), which means that the difference in BMI standards between Black and White children varies between 0.5 $kg{\cdot}m^{-2}$ and 1.0 $kg{\cdot}m^{-2}$. The agreement between the *FITNESSGRAM* %BF standards and the suggested race-specific BMI standards is presented in Table 4 through Table 7 for each sex and race group, collapsed across all ages. Proportion of agreement expresses the proportion of children in each group who were classified the same by

**Table 3 Comparison of Current *FITNESSGRAM* Body Mass Index Standards to Race-Specific BMI Standards**

| Age | Sex | *FITNESSGRAM* standard | Black | White |
|---|---|---|---|---|
| 6 | Male | 20.0 | 19.0 | 18.0 |
| | Female | 21.0 | 20.0 | 19.5 |
| 7 | Male | 20.0 | 19.5 | 18.5 |
| | Female | 22.0 | 20.5 | 20.0 |
| 8 | Male | 20.0 | 20.0 | 19.0 |
| | Female | 22.0 | 21.0 | 20.5 |
| 9 | Male | 20.0 | 20.5 | 19.5 |
| | Female | 23.0 | 21.5 | 20.5 |
| 10 | Male | 21.0 | 21.0 | 20.0 |
| | Female | 23.5 | 22.0 | 21.0 |
| 11 | Male | 21.0 | 21.5 | 20.5 |
| | Female | 24.0 | 22.5 | 21.5 |
| 12 | Male | 22.0 | 22.0 | 21.0 |
| | Female | 24.5 | 23.0 | 22.0 |
| 13 | Male | 23.0 | 22.5 | 21.5 |
| | Female | 24.5 | 23.5 | 22.5 |
| 14 | Male | 24.5 | 23.0 | 22.0 |
| | Female | 25.0 | 24.0 | 23.0 |

*Note*: Values were rounded to the nearest 0.5 $kg{\cdot}m^{-2}$

**Table 4 Agreement Between Race-Specific BMI Standards and *FITNESSGRAM* Percent Fat Standards for Black Males ($n = 555$)**

| | | Percent Fat criterion Below | Above | Total |
|---|---|---|---|---|
| Body Mass Index criterion | Below | 450 | 15 | 465 |
| | Above | 16 | 74 | 90 |
| | Total | 466 | 89 | 555 |

*Note*: Above criterion means classified as obese; below means classified as nonobese; Proportion of agreement = .94; $\kappa_q$ = .89; Sensitivity = 83%; Specificity = 97%.

**Table 5 Agreement Between Race-Specific BMI Standards and *FITNESSGRAM* Percent Fat Standards for White Males ($n$ = 362)**

| | | Percent Fat criterion | | |
|---|---|---|---|---|
| | | **Below** | **Above** | **Total** |
| Body Mass Index criterion | Below | 220 | 21 | 241 |
| | Above | 25 | 96 | 121 |
| | Total | 245 | 117 | 362 |

*Note*: Above criterion means classified as obese; below means classified as nonobese; Proportion of agreement = .87; $\kappa_q$ = .75; Sensitivity = 82%; Specificity = 90%.

**Table 6 Agreement Between Race-Specific BMI Standards and *FITNESSGRAM* Percent Fat Standards for Black Females ($n$ = 664)**

| | | Percent Fat criterion | | |
|---|---|---|---|---|
| | | **Below** | **Above** | **Total** |
| Body Mass Index criterion | Below | 534 | 19 | 553 |
| | Above | 24 | 87 | 111 |
| | Total | 558 | 106 | 664 |

*Note*: Above criterion means classified as obese; below means classified as nonobese; Proportion of agreement = .94; $\kappa_q$ = .87; Sensitivity = 82%; Specificity = 96%.

**Table 7 Agreement Between Race-Specific BMI Standards and *FITNESSGRAM* Percent Fat Standards for White Females ($n$ = 387)**

| | | Percent Fat criterion | | |
|---|---|---|---|---|
| | | **Below** | **Above** | **Total** |
| Body Mass Index criterion | Below | 264 | 16 | 280 |
| | Above | 24 | 83 | 107 |
| | Total | 288 | 99 | 387 |

*Note*: Above criterion means classified as obese; below means classified as nonobese; Proportion of agreement = .90; $\kappa_q$ = .79; Sensitivity = 84%; Specificity = 92%.

both standards (*FITNESSGRAM* %BF standards and the race-specific BMI standards). Modified kappa ($\kappa_q$) corrects for agreement due to chance. Agreement was slightly lower in White children than in Black children.

Interestingly, when compared to the current *FITNESSGRAM* BMI standards, agreement was quite similar though marginally better using the race-specific BMI standards (i.e., $\kappa_q = .73–.88$ for the current BMI standards, compared to $\kappa_q = .75–.89$ for the race-specific BMI standards). This does not mean that the race-specific BMI standards function similarly to the current *FITNESSGRAM* BMI standards, however. Further understanding can be gained by inspecting the sensitivity and specificity values. Using the *FITNESSGRAM* recommended test (%BF) to denote obesity or nonobesity, we calculated two indices (sensitivity and specificity) to evaluate classification accuracy of the race-specific BMI standards for obese and nonobese children. Sensitivity is the accuracy of correctly categorizing obese children, or the proportion of %BF-classified obese children who are correctly classified as obese via the BMI standards. Specificity is the accuracy of categorizing nonobese children, or the proportion of %BF-classified nonobese children who are correctly classified as nonobese using the BMI standards.

Because the race-specific BMI standards are generally lower than current *FITNESSGRAM* BMI standards, it was not unexpected that the race-specific BMI standards had a much higher sensitivity (82% to 84% correct classification) compared to the current *FITNESSGRAM* BMI standards (56% to 82% correct classification). In contrast, the specificity of the race-specific BMI standards was only marginally lower (90% to 97% correct classification) compared to the current *FITNESSGRAM* BMI standards (95% to 98% correct classification).

## Discussion

The results of this study indicate that race adds to the relationship between BMI and %BF in Black and White children. The influence of race was statistically significant, but more notably it was clinically important (i.e., for any given BMI, there is a meaningful 2.3% fat difference between Black and White children). From a similar analysis, Daniels et al.[22] determined that Black and White children differ by 1.5% fat. In that study, maturation stage was also included in the regression equation, which may explain the difference in the coefficient for race in the two studies. However, the direction of the race influence was the same in both studies, i.e., that White children have a higher %BF than Black children of the same BMI. These findings were not surprising, as there is prior evidence of differences in the body composition of Black and White children.[25,26] Race differences in the relationship between BMI and %BF also have been demonstrated in several studies of adults.[27–29] Additionally, in a meta-analysis of 32 studies involving several races, the BMI level associated with elevated disease risk (obesity) for adults was also determined to be higher for Blacks compared to Whites.[21]

The agreement of the race-specific BMI standards with the *FITNESSGRAM* %BF standards is acceptable, based on modified kappa. Additionally, the sensitivity of the race-specific BMI standards was clearly better than that of the current *FITNESSGRAM* BMI standards in this sample. In contrast, specificity was only marginally lower than for the current *FITNESSGRAM* BMI standards. This means that considerably more obese children were correctly classified, and only marginally fewer nonobese children were correctly classified, using the race-specific BMI standards. Besides the statistical evidence of classification accuracy, one must also consider the relative cost of the two types of misclassification (false positives and false negatives). In the current climate of concern with rising obesity rates, it seems preferable to markedly decrease the false-negative rate (percentage of obese children who are incorrectly classified as nonobese), rather than the false-positive rate (percentage of nonobese children who are incorrectly classified as obese). In this study, the false negative rate was reduced by 13.4% across all children, and there was only a marginal increase in the false-positive rate of 2.8% across all children.

These results support the use of race-specific BMI standards for Black and White children. However, the race-specific BMI standards from this study should first be cross-validated on a separate, large, nationally representative sample. Limitations of the current study include the sample size (because of the large number of separate standards, the *n* was small for some cells). Additionally, the current sample, though diverse, was not geographically representative of the United States. Before advocating widespread adoption of race-specific BMI standards, we also should carefully consider the logistical implications, including the need to inform the general public of the justification for separate standards for different racial groups.

The purpose of the current study was to determine race-specific BMI standards that are equivalent to current *FITNESSGRAM* %BF standards. It was not designed to determine what BMI cutoffs are associated with specific levels of health risk. To our knowledge, no researcher has used criterion-referenced methodology to answer this question; prior research has used norm-referenced methods to classify high-risk levels of health outcomes such as blood pressure and blood lipids in children. More specifically, we addressed a very pragmatic question of importance to practitioners using the *FITNESSGRAM* fitness test battery. When adopters of the *FITNESSGRAM* battery are unable to use the skinfold methods, it is important that they use BMI standards that are equivalent to skinfold-determined %BF standards, and that maximize classification accuracy using the *FITNESSGRAM* recommended test, i.e., %BF, as the reference method.

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