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I, Adrienne Found, hereby submit this original work as part of the requirements for the degree of Master of Science in Nutrition.

It is entitled:
Longitudinal changes in body mass index in kindergarten and third graders attending urban Cincinnati Public Schools

Student’s name: Adrienne Found

This work and its defense approved by:

Committee chair: Graciela Falciglia, PhD

Committee member: Debra Ann Krummel, PhD

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Longitudinal changes in body mass index in kindergarten and third graders attending urban Cincinnati Public Schools

A thesis submitted to the
Graduate School
of the University of Cincinnati
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by

Adrienne Found

B.A Ohio Wesleyan University

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Committee Chair: Grace Falciglia PhD
Abstract

Background. Body mass index (BMI) screenings in schools are a useful tool in tracking the prevalence of childhood obesity in a population. Following children over time, provides a longitudinal assessment of their body weight status.

Objective. To determine the incidence and track childhood overweight and obesity in children measured in kindergarten and third grade.

Sample. Eight hundred and fifty one children who attended urban, inner-city public school (Cincinnati). The sample included a near equal distribution of boys and girls, was 60% African American and 65% of the children attended schools with low participation in National School Lunch Program (<88%).

Design. Longitudinal Study

Methods. Children’s weight and height were measured in kindergarten and third grade. BMI and change in BMI were examined. Determinants of BMI (gender, ethnicity, and social economic status) were used for interpretation. SES was defined by the school’s participation in the National School Lunch Program (NSLP).

Results. BMI significantly increased beyond expected growth from kindergarten to third grade (p<0.01). Of the children who were obese in kindergarten, 75.5% remained obese in third grade. Obese kindergartners were also nearly 30 times more at risk for developing obesity in third grade versus children who were not obese (OR=28.97; 95% CI: 17.08, 49.14). BMI in kindergarten accounted for 53% of the variation of BMI in third grade. The sensitivity and specificity of obesity in kindergarten predicting obesity in third grade was 49% and 97% respectively. African-American children had significantly higher BMIs versus children of other races in both kindergarten and third grade respectively (p=0.001, p<0.001). Children who attended schools with high participation in NSLP had higher BMIs in kindergarten and third grade versus children who attended schools with lower participation (p=0.03). Between kindergarten and third grade, a higher percentage of girls and children of other races including Mexican Americans and Asians became overweight and obese. Experiencing greater than average changes in BMI between kindergarten and third grade was associated with presence of obesity in kindergarten, low SES and gender.

Conclusion. Between kindergarten and third grade, there was a significant increase in BMI, especially in children who were obese in kindergarten, attended a school with high participation in NSLP or female.
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Introduction

Childhood obesity (most often defined as a body mass index [BMI] percentile at or above 95%) has been steadily increasing in prevalence over the past 30 years. From 1980 to 2004, the rates more than tripled, from approximately 5% to 17%. Increased prevalence of childhood obesity may be associated with the greater incidence of type 2 diabetes, asthma and other negative health consequences in children. For the first time in history, it has been projected that the current generation’s children are expected to have a shorter lifespan than their parents. Therefore, childhood obesity has become a primary focus in today’s society and examining longitudinal changes in BMI is of upmost importance to determine when interventions in children should begin.

Ohio Legislation to Impact Childhood Obesity

In June 2010, Ohio legislators signed into law Senate Bill 210, also known as the Healthy Choices for Healthy Children Act. This bill proposes requirements for assessing the prevalence of childhood obesity specifically for children in kindergarten, third, fifth and ninth grades. The bill aims to require BMI screenings for children in these grades, improve the quality of the foods that are served in school cafeterias, and increase the amount physical activity. The requirements proposed in Senate Bill 210 originated from the national “Let’s Move Campaign”, which was introduced in February of 2010. The ultimate goal of Let’s Move is to reduce the prevalence of childhood obesity to 5% by 2030.
History and Benefits of BMI Screening

In 2005, guidelines for screening of BMI in schoolchildren were published. According to the American Association of Pediatrics several criteria need to be met before a screening program can be implemented in schools. First, the disease being screened for must be high in incidence and failure to detect must be associated with poor health outcomes. The dramatic increase in childhood obesity and its associated health problems meets this criterion. Second, the method should be sensitive, specific, and reliable. Several studies have shown BMI screenings have high specificity and sensitivity. When BMI percentile ≥95% was used as the cut-off, it was 75% sensitive and 95% specific in identifying a high percentage of body fat in both girls and boys ages 5-18. The sensitivity and specificity of BMI screenings is especially strong in predicting high body fat percentage in non-Hispanic white girls.

Third, the screener should receive appropriate training. Training for BMI screening takes little time; however, consistent methodology must be used to compare samples. Also, inter-rater reliability should be determined. Fourth, the condition being screened for should have a high prevalence in the target audience. According to the National Health and Nutrition Examination Survey (NHANES 2007-2008) data the prevalence of childhood obesity was 17% in children 2-19 years old. The prevalence of obesity was highest in children 6-11 years of age, irrespective of race. The prevalence of obesity in this age group has progressively increased from 4% in the 1960’s, 11% in the early 1990’s and finally 20% in the late 2000’s. Beginning in 2004, the state of Ohio has tracked the BMI status of third grade children via the Healthy Ohioans program. However, the rates of obesity in Ohio are
slightly above average (18.3%) when compared to other states. Based on these findings, there is a high prevalence of obesity in children between kindergarten and third grade, which warrants screening.

Fifth, a positive screen should be followed up with treatment advice. An important part of BMI screenings is sending letters home to parents informing them of their child’s weight status. These letters have been found to increase parent’s awareness of their child’s weight status as well as increase instances of discussing the child’s weight with their pediatrician and interest in changing child’s diet and physical activity level.

Sixth, the benefits of the screening should outweigh the costs. Potential harm to children includes weight-based teasing and privacy. Research examining several BMI screening programs has found screenings are often done behind privacy screens and nurses do not announce the results to the child. In another study no increase in weight based teasing was found at schools that completed BMI screenings, suggesting the programs in place to combat weight based teasing may be effective, but monitoring of these programs is still needed. Last, BMI screenings need an appropriate site and maintenance. Schools provide easy access to children and there are often areas to for private screenings such as a nurses office, empty classrooms or screened-off areas. Research on obesity prevention programs including BMI screenings have been found to be both effective in reducing weight and can be a cost effective. One study examining an afterschool program focused on reducing percent body fat in elementary schools students found the program did not cost significantly more than other afterschool programs and significantly
decreased body fat percentage in participants that attended more than 40% of meetings\textsuperscript{12}.

Demographic Differences in Childhood Obesity

There are racial differences in the prevalence of childhood obesity. NHANES (1974-2002) data shows a 16% increase in overweight Mexican-American boys and a 14% increase in overweight African American girls. African American and Mexican American children in general had the highest increase in percentage of overweight children between the ages of 6-17 with approximately 15% increase\textsuperscript{13}. There are also differences by race in children’s weight trajectories. When African American and white children had the same BMI at age 5, African American children of both genders experienced significantly greater changes in BMI than whites up to age 35\textsuperscript{14}.

Socioeconomic status (SES) has also been associated with childhood obesity. One way to define SES is the percentage of students in a school who participate in the National School Lunch Program (NSLP). High participation is indicative of low SES areas. There is a positive correlation between schools with high participation in the NSLP and number of children who are overweight or obese. This correlation explains 35% of the variance in the weight status of children in kindergarten and third grade\textsuperscript{15}. In addition, another study found children who live in a household below the poverty line were 69% more likely to be obese than children living in households 400% above the poverty line\textsuperscript{8}. 

Gender differences in childhood obesity have also been explored. In general, boys are more at risk for childhood obesity, with one study showing an 87% increased risk.

Changes in Childhood Weight Status

During childhood, body composition rapidly changes. The development of obesity in early childhood is often related to obesity in later childhood as well as in later years. For example, weight status at 2 years of age is a significant predictor of weight status at 8 years of age. Another critical time of increased risk for obesity is a period called adiposity rebound, which is where there is a second peak in growth of children following the initial peak in the first year of life. Adiposity rebound occurs around the age of six years of age. Children who experience early adiposity rebound (before the age of 5) are at an increased risk for obesity in adolescence and adulthood, and are more likely to have higher body fat percentage. In one study, girls with the earliest adiposity rebound were more likely to have higher BMI, fat mass and fat gain at age 9 versus girls with later adiposity rebounds. Another study found children with the most rapid rate of weight change between ages 3-6 were significantly more likely to have higher BMI, greater fat mass and waist circumference at the age of 17 years.

Other studies support the theory that obesity early in life is not something that children “grow out of.” For children who were overweight or obese at age 3-5 years, the probability of being overweight or obese at age 8-10 years was over 90%. This was significantly different than the 50-60% probability seen in normal weight
children. This study was supported by another that showed weight at age 5 coupled with amount of change in weight between ages 5-9 explained between 16-24% of the variance in weight at age 9. This was significantly greater than the 1-2% of variance predicted by birth weight. This study suggested that children gain most of their weight before age five and establish their growth trajectories from there on. For example, girls who were overweight at age 5 tended to follow growth curves at or above 85% according to CDC growth charts. This differs significantly from children who were at 50% or 60% BMI-for-age at age 5. These children tended to continue on their respective curves through age 15.

Childhood Weight Status and Problems During Childhood

Childhood obesity has several negative effects on children including school performance, social development and psychological well-being. When compared to their normal weight peers, overweight children are 60% more likely to repeat a grade than normal weight peers. Also, overweight children perform significantly worse on standardized tests and other tests of general mental ability. Even after adjusting for gender, grade level, race and participation in NSLP, overweight children were over 50% more likely to have poor school performance versus their normal weight peers. This relationship is strongly mediated by weight-based teasing. Children who experience weight based teasing are 56% more likely to have poor school performance versus children who are not teased. When standardized test scores from kindergarten and third grade were examined, children who were overweight at both of these times scored significantly lower on math and reading.
versus their normal weight peers. Poor academic performance at a young age could affect any number of future variables including academic performance in high school, college admittance, performance in college and earning potential as an adult.

In addition to poor academic performance, obese children are also at risk for disruptions in social development. In a sample of 6-11 year old children, overweight children were over two times more likely to have peer difficulties versus normal weight peers. Children who are overweight in kindergarten or turn overweight in third grade were found to have significantly lower teacher rated interpersonal skills versus their normal weight peers. Obese and overweight children are also more likely to experience negative social relationships including bullying. When adjusted for grade level overweight and obese children were 13 and 63% more likely to be bullied versus normal weight peers.

Overweight children have also been found to have lower levels of psychological well-being. There are several ways to assess psychological well-being including global self worth, physical appearance, self-esteem and presence of psychiatric disorders including depression, attention disorders or eating disorders. When compared to normal weight peers, overweight boys and girls were approximately 2.5 and 4.1 times more likely to have low global worth scores respectively. Overweight boys and girls were also 3.6 and 3.9 times more likely to have low physical appearance scores. Children with BMI z-scores above average were more likely to be depressed, display body dissatisfaction and eating disorders and have lower self-esteem. Overweight girls are also more likely to experience early puberty, which has been associated with low self-esteem, depression and
undesirable behaviors such as substance abuse and teenage pregnancy\textsuperscript{30}. Girls who experienced the greatest increase in BMI between 36 months and first grade were at nearly 2.5 times the risk of early puberty versus girls with the smallest increase\textsuperscript{31}.

**Childhood Weight Status and Adult Problems**

Several studies have examined the association between childhood weight status and adult health. In general weight status at 7 years of age is predictive of adult weight status\textsuperscript{32}. More specifically, a BMI over 16 at 7 years of age was associated with a three-fold increase in risk for obesity in adult years. In addition, 93 and 94\% of children who were obese at 7 or 11 years of age were overweight or obese as adults\textsuperscript{32}. An additional study found children between the ages of 5-7 who had an elevated BMI at a single examination were at 1.3 and 2.3 times higher risk for metabolic syndrome at age 30 or older for boys and girls respectively\textsuperscript{33}. This risk increased in a child had an elevated BMI between the ages of 8-13 (6.4 and 4.9 for boys and girls respectively\textsuperscript{33}. Rapid weight gain has also been shown to be associated with risk for obesity later in life. Weight gain between 2-11 years was significantly associated with weight status at age 56-70\textsuperscript{34}.

Childhood weight status is also associated with metabolic syndrome as an adult. Research has found that for every one standard deviation increase from the mean for BMI at ages 5 and 7 is associated with 19 and 36\% increase in risk for metabolic syndrome respectively\textsuperscript{35}.

There are also strong associations between child weight status and risk for heart disease as an adult. Beginning at age 8, one standard deviation increase in BMI
is associated with at least an 8% increase in risk for a fatal cardiac event in adulthood. This risk increases with age, where at age 13, a high BMI is associated with a 24% increased risk for a fatal cardiac event for both women and men. In addition, children who are overweight or obese at age 7 are at a 35% increased risk for developing hypertension as adults.

In general obese children are more likely to experience premature death from endogenous causes versus their non-obese peers. When compared to the lowest quartile, children who are in the highest quartile of weight status are 2.3 times more at risk for dying of endogenous causes as adults.

Purpose and Hypothesis

The purpose of this study was to establish baseline data, which can be used to assess the degree of change resulting from health initiatives made in schools. It also aims to explore how weight status has changed in children from kindergarten to third grade and whether there is a subset of the population who is especially at risk for developing obesity or experiencing greater than average weight changes. Finally, the predictive value of determining third grade weight status from kindergarten weight status will be examined.

Based on previous research it is hypothesized that children who attend schools with high participation in the NSLP will have a higher percentage of children in the overweight and obese categories versus those with lower participation. Also, minority children including African American’s and Hispanics are hypothesized to include more overweight/obese children. These children are
also hypothesized to be at higher risk for greater than average changes in BMI between kindergarten and third grade. Finally it’s hypothesized that children who are obese in kindergarten will remain to be obese in third grade, however the same relationship for overweight children is expected to have more variability.

**Methods**

*Participants*

Children (n= 851) from inner-city, urban public schools (27 of the 40 schools in the Cincinnati Public School district) were used for this study. Students were measured in kindergarten during the 2007-2008 and in 2010-2011 school year for third grade data. Informed consent was obtained from each parent via a waiver of consent form sent home. The sample was predominantly African American (61%) and attended schools with participation in the NSLP under 88%. There were near equal numbers of boys and girls featured in this study.

*Measures and Procedures*

Researchers were trained to collect BMI measurements by Cincinnati Health Department employees following standard CDC protocol. Measurements that were not collected by the researchers were collected by school nurses who received the same training. Height and weight of each child was taken to determine BMI and BMI percent. Weight was measured using a calibrated scale after each child removed his/her shoes, any heavy article of clothing (i.e., sweatshirt or coat), and/or articles in pockets. Different scales were used at each school and at the two time points. Weight was measured to the nearest 0.5 pound then changed to kilograms for BMI calculation. Height was taken using stadiometer (either wall mounted or part of
scale). Each child stood with his/her back to the stadiometer and measurements were taken to the nearest 0.25 inch. BMI was calculated by dividing each child’s weight in kilograms by meters squared (kg/m²).

BMI percent was determined using 2000 CDC growth curves.49 Normal weight was classified as BMI in the 0-85%, overweight 85-95% and obese over 95%. For the purposes of this study, normal weight and underweight were combined during analysis. Percents were calculated using the Powerschool computer program provided by Cincinnati Public Schools and produced by Pearson. Demographic information was also obtained via this program.

Participation in NSLP was used to define socioeconomic status. Percent of the school participating in NSLP was dichotomized into schools with high and low participation. This was done by listing the 27 schools in order of highest participation in NSLP to the lowest. Following this procedure, 88% was determined as the cut off point between high and low SES. Fourteen schools were determined to have high participation (≥88%) and 13 were considered to have low participation (<88%). NSLP participation has been used in past research to define SES.15 Race was divided into three categories: African American, white and other, which included multi-racial, Hispanic, American Indian and Asian. Race was identified by parents on a survey collected by the schools upon the child’s enrollment.

Weight change between kindergarten and third grade was examined using difference in BMI measures taken in kindergarten and third grade. This method was determined to be valid in examining adiposity changes in children40. Differences in BMI were divided into quartiles using the following cut-off points: quartile 1=-10.4-
0.3, quartile 2=0.4-1.6, quartile 3=1.7-3.4 and quartile 4=3.5-17.5. These values were chosen based on distribution of children. Change in BMI was further examined by defining children with greater changes in BMI as any value over the mean of 2.2. Children were dichotomized into those who did and did not experience greater changes in BMI between kindergarten and third grade.

*Statistical Analysis*

The differences in mean BMI and longitudinal changes in BMI by gender, race and participation in NSLP were examined using the independent t-test. Differences in children’s BMI between kindergarten and third grade were examined using a paired t-test. Differences in the proportion of children in each BMI class by gender, race and participation in the NSLP were examined using chi-square tests.

Differences in BMI in third grade by the presence of greater change in BMI were examined using an independent t-test. The distribution of children who experienced greater BMI change by gender, race and participation in school lunch program were examined using chi-square. Direct linear regression was used to examine the predictors of greater change in BMI between kindergarten and third grade. Odds ratios for risk factors were also determined using this method. Results were considered significant at the $\alpha=0.05$ level. Statistics were determined using SPSS.

**Results**

Demographic information for the study sample can be found in Table 1. Compared to BMI data available for the state of Ohio, the proportion of children in
each BMI class in third grade was not significantly different. No state BMI data at kindergarten was available. When children were compared to kindergartners in Columbus, Ohio the proportion of children in each BMI class was significantly different, with Cincinnati schools having fewer children than expected in the overweight and obese classes ($X^2=25.53, p<0.01$).

<table>
<thead>
<tr>
<th>Table 1. Characteristics of Students (%)</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size (n)</td>
<td>427 (50.1)</td>
<td>424 (49.9)</td>
</tr>
<tr>
<td>Age Kindergarten (years)</td>
<td>5.98</td>
<td>5.86</td>
</tr>
<tr>
<td>Age Third Grade (years)</td>
<td>8.74</td>
<td>8.66</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>136 (32)</td>
<td>133 (31)</td>
</tr>
<tr>
<td>African American</td>
<td>259 (61)</td>
<td>257 (61)</td>
</tr>
<tr>
<td>Other</td>
<td>32 (7)</td>
<td>34 (8)</td>
</tr>
<tr>
<td>School Participation in National School Lunch Program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low (&gt;88%)</td>
<td>277 (65)</td>
<td>296 (70)</td>
</tr>
<tr>
<td>High (&lt;88%)</td>
<td>150 (35)</td>
<td>128 (30)</td>
</tr>
</tbody>
</table>

Compared to national BMI data from NHANES (2007-2008), the proportion of children classified as obese in kindergarten and third grade was significantly different ($X^2=5.13, p=0.02; X^2=11.99, p=0.01$). Fewer children were classified as obese in the current study than was predicted by national data (See Table 2).

The percentage of normal weight children decreased from 75.8% in kindergarten to 67.4% in third grade. The percentage of overweight children changed little from kindergarten to third grade, with a slight increase from 13% to 15.6%. The percentage of obese children also increased from 11% to 16.9% between kindergarten and third grade (See Figure 1). In general, children had
significantly heavier BMI in third grade versus kindergarten (t=-23.6, p<0.01) (See Table 4). BMI measurements in kindergarten were significantly correlated with BMI in third grade and explained 53% of the variation in third grade BMI.

| Table 2. Current Percentage of Children by BMI Class Compared with Ohio and National Data |
|---------------------------------------------|---------------------------------------------|
| Kindergarten | Third Grade |
| ≤85% | 85-95% | ≥95% | ≤85% | 85-95% | ≥95% |
| Current Study | 75.9 | 13 | 11 | 67.5 | 15.6 | 16.9 |
| Healthy Ohioans | – | – | – | 65.4 | 16.3 | 18.3 |
| Columbus, OH | 68*a | 16*b | 16*b | – | – | – |
| Cleveland, OH | 62.8 | 25 | 12.2 | – | – | – |
| NHANES | – | – | 13.7b | – | – | 21.8c |

*a*significant at p≤0.05; – denotes no data available

b*Current study vs. Columbus, OH for kindergarten (X^2=25.53)

c*Current study vs. NHANES for kindergarten (X^2=5.13)

c*Current study vs. NHANES for third grade (X^2=11.99)

**Figure 1.** Percentage of Students in each BMI Class in Kindergarten and Third Grade
Of the children who had a normal weight in kindergarten, 81% were still normal in third grade. Approximately 6% of normal weight children became obese in third grade. Of the children who were overweight in kindergarten, 28.8% remained overweight in third grade. Approximately 31.5% of overweight children became obese and 39.6% became normal. Of the children who were obese in kindergarten 75.5% remained obese, 18.1% became overweight and 6.4% became normal weight (See Figure 2). There was a significant association between BMI status in kindergarten and BMI status in third grade ($X^2=349.52, \ p<0.01$). Obese kindergartners were also nearly 30 times more at risk for developing obesity in third grade versus children who were not obese (OR=28.97; 95% CI: 17.08,49.14). The sensitivity and specificity of obesity in kindergarten predicting obesity in third grade was 49% and 97% respectively. The sensitivity and specificity of a normal or overweight status in kindergarten and staying in the same BMI class was 56% and 91% respectively.

**Figure 2.** Percentage of Students in each BMI Class by Kindergarten BMI Class
The association between BMI status and race approached significance in kindergarten ($X^2=9.42$, $p=0.05$) and was significant in third grade ($X^2=20.71$, $p<0.01$). In all ethnic categories more children became overweight or obese between kindergarten and third grade, with the largest shifts seen in children of other ethnicities. The percentage of children of other ethnicities with normal weight decreased from 78.8% to 57.6% while the percentage of both overweight and obese children nearly doubled from approximately 10% to 20%. Finally, African American children had significantly higher mean BMI in kindergarten and third grade versus children of other races including white ($p=0.01$, $p<0.01$) (See Figure 3 and Table 4).

![Figure 3. Percentage of Students in BMI Class in Kindergarten and Third Grade by Race](image)

There was no significant difference in mean BMI by gender in kindergarten or third grade. However, in third grade not only were more girls overweight than boys, but more were also obese. There was a significant association between gender
and BMI in kindergarten ($X^2=6.79, p=0.03$) but this relationship was no longer significant in third grade.

Children who attended schools with a high participation in the NSLP had significantly higher BMI in both kindergarten and third grade ($p=0.026, p<0.01$) (See Table 4). There was little change in proportion of children in each BMI class by school’s participation in the NSLP between kindergarten and third grade. However, there was a significant association between school’s participation in the NSLP and BMI status in both kindergarten and third grade ($X^2=7.49, p=0.02, X^2=14.94, p=0.01$).

Change in children’s BMI between kindergarten and third grade ranged from a loss of 10.4 to a gain of 17.5, with a mean of 2.21 (SD=2.74). When BMI status in kindergarten was taken into consideration, changes in BMI experienced by children with normal BMI were significantly smaller ($m=1.84$) than that experienced by overweight ($m=2.74$) and obese children ($m=4.19$). Girls experienced significantly greater change in their BMI than boys ($t=-2.40, p=0.04$) (See Table 4). Change in BMI of African American and children of other races differed significantly from white children ($F=9.22, p<0.01$). Change in BMI of children who attend schools with participation in the NSLP was significantly greater than children who attend schools with lower participation ($t=4.33, p<0.01$) (See Table 4).

There was a significant association between quartile of change in BMI and BMI class in third grade ($X^2=506.64, p<0.01$). Approximately 86% of children in the highest quartile of change in BMI between kindergarten and third grade were considered obese in third grade versus 12.5% in the third quartile and 0.7% in the
lowest two quartiles. There was also a significant association between race and quartile of change in BMI ($X^2=19.51, p=0.03$). The proportion of African American children increased as BMI change quartiles increased, while the reverse relationship was seen in white children (see Fig. 4). The high percentage of children of other races in the 4\textsuperscript{th} quartile was primarily composed of multiracial children (19 out of the 23). Of the 8 Hispanic children in the study sample, no child was in the 4\textsuperscript{th} quartile.

Approximately 37.8\% of children experienced changes in BMI greater than average. There was a significant association between race and greater changes in BMI ($X^2=12.69, p=0.02$). There was also a significant association between gender and greater changes in BMI, with more girls experiencing greater changes versus boys ($X^2=15.19, p<0.01$). Finally there was a significant association between percent of school participating in NSLP and children who experienced greater changes in BMI ($X^2=5.68, p=0.02$). Children who experienced greater changes in BMI had significantly higher BMI in third grade versus children who did not ($t=22.79, p<0.01$) (See Table 4).

<p>| Table 4. Mean BMI and Change in BMI by Demographics* |
|---------------------------------|------------|
| <strong>Race</strong> | <strong>SES</strong> | <strong>Gender</strong> | <strong>Obese in K</strong> | <strong>Weight Change</strong>** |</p>
<table>
<thead>
<tr>
<th>AA</th>
<th>Not AA</th>
<th>Low</th>
<th>High</th>
<th>Boy</th>
<th>Girl</th>
<th>Yes</th>
<th>No</th>
<th>Yes</th>
<th>No</th>
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<tbody>
<tr>
<td>BMI K</td>
<td>16.4</td>
<td>15.9</td>
<td>16.4</td>
<td>16</td>
<td>ns</td>
<td>ns</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>BMI 3</td>
<td>18.8</td>
<td>17.7</td>
<td>19.2</td>
<td>17.9</td>
<td>ns</td>
<td>ns</td>
<td>25.1</td>
<td>17.5</td>
<td>21.8</td>
</tr>
<tr>
<td>Change in BMI</td>
<td>2.5</td>
<td>1.8</td>
<td>2.8</td>
<td>1.9</td>
<td>2</td>
<td>2.4</td>
<td>4</td>
<td>1.9</td>
<td>-</td>
</tr>
</tbody>
</table>

*Differences between categories were all significant $p<0.05$; **Weight change=experience of greater than average weight change ns=not significant; - signifies no applicable data
Direct logistic regression was used to examine the impact of several factors on the likelihood of children experiencing greater than average changes in BMI between kindergarten and third grade. The model included four variables (gender, obesity status in kindergarten, school’s participation in NSLP and race classification of African American). The model was able to significantly predict whether or not children would experience large changes in BMI ($X^2=66.66$, $p<0.01$). The model explains between 7.5 and 10.3% of the variance in changes in BMI and correctly identified 66.4% of cases. Three of the four variables, gender, school participation in NSLP and obesity status in kindergarten, made significant contributions to the model. The strongest predictor was obesity status in kindergarten. Children who were classified as obese in kindergarten were 4.68 times more at risk for greater changes in BMI between kindergarten and third grade (See Table 3). Boys were 49%
less likely to experience greater changes in BMI compared to girls. Children who attended a school with high participation in NSLP were 1.4 times more at risk for greater BMI changes between kindergarten and third grade.

<p>| Table 3. Logistic Regression Model Predicting Likelihood of Large BMI Change Between Kindergarten and Third Grade |
|---|---|---|---|---|---|---|</p>
<table>
<thead>
<tr>
<th></th>
<th>$B$</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>$p$</th>
<th>Odds Ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>$-0.67$</td>
<td>$0.15$</td>
<td>$20.15$</td>
<td>$1$</td>
<td>$&lt;0.001$</td>
<td>$0.51$</td>
<td>$0.38$</td>
</tr>
<tr>
<td>Obesity Status in Kindergarten</td>
<td>$1.54$</td>
<td>$0.24$</td>
<td>$40.53$</td>
<td>$1$</td>
<td>$&lt;0.001$</td>
<td>$4.68$</td>
<td>$2.91$</td>
</tr>
<tr>
<td>School Participation in NSLP</td>
<td>$0.34$</td>
<td>$0.17$</td>
<td>$3.92$</td>
<td>$1$</td>
<td>$0.048$</td>
<td>$1.4$</td>
<td>$1.03$</td>
</tr>
<tr>
<td>Race of African American</td>
<td>$-0.32$</td>
<td>$0.17$</td>
<td>$0.04$</td>
<td>$1$</td>
<td>$0.85$</td>
<td>$0.97$</td>
<td>$0.7$</td>
</tr>
</tbody>
</table>

**Discussion**

This study confirms the years between kindergarten and third grade are a dynamic time for weight change. Approximately 75% of the children underwent an increase in their BMI of some kind with nearly 38% experiencing above average increases in their BMI. More specifically, over 30% of children who were overweight in kindergarten became obese in third grade. In addition this study showed that BMI status in kindergarten is useful for predicting BMI status in third grade. Specifically, the presence of obesity in kindergarten was highly specific for the presence of obesity in third grade.

This study supports previous research that shows African American children specifically girls have higher rates of overweight and obesity versus children of
other races. This study also supports past research that found children at lower SES have higher rates of overweight and obesity versus children at higher SES. This study was unique because it identified risk factors for the presence of obesity in third grade as well as changes in BMI between kindergarten and third grade. Both obesity and change in BMI were strongly associated with presence of obesity in kindergarten. These findings underscore the importance of preventing early childhood weight gain.

There are many possible reasons for increased rates of obesity between kindergarten and third grade. Factors associated with increased BMI or change in weight status include daily consumption of two or more sugar-sweetened beverages \(^{41}\), diet characterized by high energy density, low fiber and high fat \(^{42}\), and consumption of three or less meals \(^{43}\). Other non-diet risk factors include shorter sleep duration \(^{44}\), less physical activity \(^{45}\), greater television viewing time \(^{46}\) and family weight status \(^{47}\). Future studies should examine whether these factors influence the increased prevalence in obesity seen in children as they progress from kindergarten to the third grade. There are several limitations in this study. First, the researchers did not complete all the BMI screenings personally. At several schools, the school nurse or other volunteers measured the children and entered into a database that was later accessed by the researchers. As a result, the BMI measurements may differ between schools if scales were not calibrated or if proper BMI measurement protocol was not followed. Related to this, no inter-rater reliability was determined for this study. Second, different equipment was used at different schools and between the two time periods. This could have resulted in
measurement error, which could have affected results. Third, data on the children’s diet, physical activity or family history of obesity was not available. This information could have added depth to the relationship between BMI in kindergarten and third grade. Fourth, BMI is not an optimal measure of body composition because it does not differentiate between fat and muscle mass. It is well established that African American’s have more bone and muscle mass than whites. Thus, an African American child could have a higher BMI than a white child, but this difference may because of muscle versus increased adiposity. This underscores the importance of using multiple measures of adiposity such as waist circumference or DEXA in order to accurately determine fat mass in children. Finally, children’s SES was defined using the school’s percent participation in the NSLP versus the individual student’s participation. Using individual data would be the preferred method of defining SES and should be used in future studies.

### Conclusion

Programs for childhood obesity should focus on the time between kindergarten and third grade because it is a time of significant weight change in children. Approximately 75% of obese kindergarteners remained obese to third grade and were more than four times as likely to experience large weight changes. Acknowledging that these children are not likely to grow out of their obesity will encourage parents and schools to attempt to decrease the child’s weight in order to avoid later health problems.
References


