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# Overweight and Obesity Prevalence and Trends Among Mississippi Public School Students: A Decade of Data Between 2005 and 2015

JEROME R. KOLBO, PHD, MSW; LEI ZHANG, PHD, MBA; NICHOLE WERLE, LMSW; ELAINE FONTENOT MOLAISON, PHD, RD;  
BONNIE L. HARBAUGH, PHD, RN; MELISSA KIRKUP, LMSW; EVELYN WALKER, MD, MPH

## Abstract

This study estimated the prevalence of overweight and obesity in Mississippi public school students in grades K-12 and examined changes between 2005 and 2015. In 2015, the prevalence of overweight, obesity, and both combined remained higher than national averages, yet the rates have neither increased nor decreased significantly since 2005 ( $p = 0.6904$ ). In 2015, as with all previous years, there was no difference between boys and girls ( $p=0.570$ ). As in all previous years, the prevalence of obesity in 2015 was significantly higher among black students ( $p < 0.001$ ) than among white students. Similar to 2011 and 2013, there was a significant difference by grade level in 2015 ( $p=0.0029$ ), with the lowest prevalence again among the elementary students. The significant linear decrease in obesity prevalence among elementary school students observed during 2013 continued to 2015 ( $p = 0.0209$ ). Trends are discussed in the context of state policy and recent research.

**Key Words:** *Childhood, Overweight, Obesity, Trends*

## Introduction

Over the past decade, the prevalence of child overweight and obesity have been assessed biannually within the state of Mississippi through the Child and Youth Prevalence of Obesity Survey (CAYPOS).<sup>1-6</sup> Data collected as part of the CAYPOS indicate the prevalence of overweight and obesity in Mississippi have not increased or decreased significantly since 2005, though it remains high and is higher than national rates. The CAYPOS data also suggest ongoing and increasing disparities between black and white students. Additionally, in recent years, the CAYPOS data offer some of the most encouraging findings in the significant decreases of overweight and obesity among elementary school level students.

National trends reflect a similar stability of prevalence rates. According to the most recent National Health and Nutrition Examination Survey (NHANES), there has been no significant change in the child obesity prevalence rate among children aged 2-19 years between 2003-2004 and 2011-2012, the most recent years for which data are available.<sup>7</sup>

Similar to Mississippi, disparities by race were observed in this national sample, with the prevalence of obesity for white youth (14.1%) being significantly lower than for black youth (20.2%). National data diverge, however, from what has been observed in Mississippi when comparing obesity rates by age. NHANES found no significant difference among age groups when comparing 6-11 year olds with 12-19 year olds but did note a significant decrease among 2-5 year old children (from 13.9% to 8.4%) between the 2009-2010 and 2011-2012 survey years.

The majority of legislative attempts to intervene from a public health standpoint have focused upon public school initiatives designed to reduce obesity. Though numerous factors have been identified as contributing to the high prevalence of child overweight and obesity including early life, neighborhood, and community factors, public school initiatives are an important part of the policy toolbox. Beginning in 2006, Mississippi started implementing several public school mandates that required the creation of school wellness policies, updated beverage standards, and increased regulation surrounding nutrition, physical activity, and physical education standards.<sup>8-16</sup> Since that time, there have been encouraging reductions in child overweight and obesity among a few, specific demographic subgroups though these outcomes have not been realized for all Mississippi students.

Despite the promising changes observed over this time period, child overweight and obesity rates remain a pressing concern; this is true not only for the significant percentage of children who fall within one of these two categories but also for broader society. Overweight and obesity are associated with a number of physical and psychological comorbidities. Childhood obesity is linked to global damage to the human body, particularly to the endocrine, cardiovascular, gastrointestinal, pulmonary, orthopedic, neurological, and dermatologic systems. Obese children also have higher rates of depression, low self-esteem, and poor body image, particularly if they have been subjected to weight-based social stigmatization.<sup>17-32</sup> Perhaps due to increased risk for negative health outcomes, the lifetime medical expenditures for an obese child has been estimated to be over \$19,000 more than those of a normal weight child who maintained normal

weight throughout adulthood.<sup>33</sup> In light of these serious ramifications and continuous public health efforts to reduce obesity rates, the 2015 CAYPOS study was intended to provide an updated landscape of the prevalence rates of child overweight and obesity and examine trends over the past decade among Mississippi public school students.

## Methods

The 2015 CAYPOS sampling frame consisted of 478,056 students in 892 public schools offering kindergarten or any combination of grades 1 through 12 in Mississippi. As in all previous CAYPOS, the sample design was a two-stage stratified probability design.<sup>1-6</sup> The first stage included the random selection of 95 schools. A systematic sample of schools was drawn with probability proportional to the enrollment in grades K-12 of each school. In the second stage of sampling, classes were randomly selected within the sampled schools. Classes were selected using equal probability systematic sampling. The sample was designed to result in a self-weighting sample so that every eligible student had an equal chance of selection, improving the precision of the estimates.

As in each of the previous CAYPOS, the weighting process was intended to develop sample weights so that the weighted sample estimates accurately represented the entire K-12 public school population in Mississippi.<sup>1-6</sup> In the sampling frame, every eligible student was assigned a base weight, which was equal to the inverse of the probability of selection for the student. Adjustments were made to the initial weights to remove bias from the estimates and reduce the variability of the estimates.

The most recent CAYPOS (2015) was conducted in March and April 2015. The study received continued institutional review board approval through the Human Subjects Committee at The University of Southern Mississippi, as the study protocol matched the six prior CAYPOS.<sup>1-6</sup> As with all of the previous CAYPOS, once selected schools agreed to participate and classes were chosen, a written protocol, measuring equipment (i.e., digital scales and stadiometers) and passive parental consent forms were delivered to the schools. Each school designated a school nurse or other individual who was responsible for collecting data and had been trained on the use of equipment. Approximately one week before data collection was to begin, students in the randomly selected classes were read a prepared paragraph containing information about the study. Each student was then given a passive parental consent form to take home to parents or guardians. If a parent did not want his or her child to participate in the study, the parent was instructed to indicate such on the form, sign it, and have the child return the form to the teacher. Prior to the collection of height and weight, the nurse checked with the teacher to determine if any students returned a signed form. Students who returned a signed form did not participate in the study. There were neither consequences for nonparticipation nor rewards for participation.

As with all the previous CAYPOS, the protocol for making measurements required that the weight scale be placed on a hard, smooth surface; carpeted areas were not to be used.<sup>1-6</sup> The scale was to be calibrated to zero before use and recalibrated after every 10<sup>th</sup> student. All students were to be weighed and measured in a location where the

information gathered would be confidential (e.g., nurse's office). Other students were not able to read the scale or height measurement or hear a weight or height given. Nurses reported the height and weight, rounded to the nearest whole inch or quarter pound, respectively, along with age, gender, date of birth, racial or ethnic background, and the school code number. No allowance was made for weight of clothing; however, students were asked to remove belts, heavy jewelry, jackets, and shoes. No student names or other identifying information were written on the data collection forms.

As in all previous CAYPOS, nurses returned the completed data forms to The University of Southern Mississippi by fax or mail.<sup>1-6</sup> These data were then entered into Excel by a Research Assistant. The completed database was submitted for statistical analysis to identify prevalence rates and trends of the whole and various subgroups. All completed data forms were destroyed once data had been entered and analyzed.

## Data Analysis

As in all of the previous CAYPOS, Body Mass Index (BMI) was computed for each responding student based on height (in meters) and weight (in kilograms).<sup>1-6</sup> The height in feet and inches was first converted to meters. The weight in pounds was then converted to kilograms. BMI was calculated using the SAS program, gc-calculate-BIV.sas as follows:  $BMI = \text{Weight (in kg)} / [\text{Height (in m)}]^2$ . BMI values were checked to ensure that the results were biologically plausible, using the limits developed by the Centers for Disease Control and Prevention (CDC). BMI percentiles were computed using the SAS program, gc-calculate-BIV.sas. Children and adolescents were classified into four categories: (1) underweight (BMI is less than the 5<sup>th</sup> percentile); (2) normal weight (BMI is equal to or greater than the 5<sup>th</sup> but less than the 85<sup>th</sup> percentile); (3) overweight (BMI is equal to or greater than the 85<sup>th</sup> but less than the 95<sup>th</sup> percentile); and (4) obese (BMI is equal to or greater than the 95<sup>th</sup> percentile).<sup>34</sup>

Likewise, as in all previous CAYPOS, SUDAAN 11.0135 was used to calculate weighted estimates and standard errors.<sup>1-6</sup> Proc Crosstab procedure was used to compare prevalence of child overweight and obesity among different subgroups, such as gender, race, and grade level. Differences were assessed independently for each survey year and considered statistically significant if the p-values from the Chi-square tests were less than 0.05. For comparisons of subgroups with more than two levels (e.g., obesity by gender by race by grade, etc.), no statistical tests were conducted due to substantially decreased sample sizes and possibly unreliable estimations. The comparison of their 95% confidence intervals (CIs) was simply used for these situations; differences between estimates were considered statistically significant if their associated 95% CIs did not overlap. The estimate and its 95% CI were marked as unreliable if the sample size was less than 50. In addition, SUDAAN logistic regression procedure was used to investigate linearity of the longitudinal trends in overweight and obesity. Since elapsed time was the same between successive CAYPOS surveys, the logistic regression used orthogonal variables to model longitudinal trends while controlling for students' gender, race, and grade level. The linear coefficient (-5, -3, -1, 1, 3, 5) and quadratic coefficients (13.33, -2.67, -10.67, -10.67, -2.67, 13.33) were assigned over the years 2005, 2007, 2009, 2011, 2013, and 2015, respectively.

## Results

### Characteristics of Participants from the 2015 CAYPOS

Eighty-two of the 95 randomly sampled schools participated in the study (86.3%). The student response rate was 90.0% (5,222 participating students / 5,808 sampled students). Thus, the overall response rate was 78.0% (product of school response rate and student response rate), which was above the threshold of 60% required to obtain weighted estimates. The final sample consisted of 5,222 students in grades K-12, including 2,644 males (50.6%), 2,578 females (49.4%), 2,057 white students (40.7%), 2,975 black students (55.4%), and 190 students from other racial/ethnic backgrounds (3.9%) (Table 1). The number of students in other race categories was too small for separate analysis, and therefore, was not included in the comparison analyses.

Characteristic	Unweighted count	Weighted percent
<b>Gender</b>		
Male	2,644	50.6
Female	2,578	49.4
<b>Race</b>		
White	2,057	40.7
Black	2,975	55.4
Other	190	3.9
<b>Grade</b>		
Elementary		
K	391	7.6
1st	440	8.3
2nd	501	9.9
3rd	480	8.4
4th	448	8.7
5th	410	8.0
Middle		
6th	475	8.9
7th	368	7.2
8th	399	7.8
High		
9th	392	7.4
10th	233	4.2
11th	344	6.9
12th	341	6.7
<b>Total</b>	<b>5,222</b>	<b>100</b>

### Results of 2015 CAYPOS Based on Subgroups of Participants

As a group, 25.2% of the children and youth in grades K-12 were classified as obese (Table 2). Another 18.2% of the children were classified as overweight, giving a combined total of 43.4% of the children and youth at or above the 85<sup>th</sup> percentile for BMI for age and gender.

#### Race

In terms of race, 21.8% of the white students were classified as obese, with another 18.0% as overweight (39.8% combined) (Table 2). Among the black students, 27.7% were obese and 18.2% were over-

weight (45.9% combined). The prevalence of obesity among black students was significantly higher than among white students ( $p < 0.001$ ).

#### Grade Level

Among elementary level students (grades K-5), 22.6% were classified as obese, with 17.8% classified as overweight (40.4% combined). Among the middle school students (grades 6-8), 27.3% were obese and 18.8% were overweight (46.1% combined). Among the high school students (grades 9-12), 28.2% were obese and 18.5% were overweight (46.7% combined). Differences in the prevalence of obesity by grade level were statistically significant ( $p = 0.029$ ).

#### Gender

In 2015, 24.7% of males were classified as obese, with another 17.3% as overweight (42.0% combined) (Table 2). As for females, 25.6% were obese and another 19.2% were overweight (44.8% combined). Differences in the prevalence of obesity by gender was not statistically significant ( $p = 0.570$ ).

#### Gender and Race

As for gender and race, among white males, 23.5% were obese and 17.0% were overweight (40.5% combined). Among black males, 25.5% were obese and 17.6% were overweight (43.1% combined).

Among white females, 19.9% were obese and 19.1% were overweight (39.0% combined). Among black females, 29.9% were obese and 18.9% were overweight (48.8% combined). The prevalence of obesity among black females was significantly higher than among white females.

#### Race and Grade Level

Among all students, the highest rates of overweight and obesity were at the high school level regardless of race (Table 2). Among white students, 27.3% were obese and 19.3% were overweight (46.6% combined) at the high school level; 22.6% were obese and 18.8% were overweight (41.4% combined) at the middle school level; and 18.6% were obese and 17.0% were overweight (35.6% combined) at the elementary school level (Figures 1-3).

Among black students, 29.2% were obese and 17.1% were overweight (46.3% combined) at the high school level; 31.1% were obese and 18.6% were overweight (49.7% combined) at the middle school level, and 25.3% were obese and 18.7% were overweight (44.0% combined) at the elementary school level. Obesity prevalence was significantly higher among black students compared to white students at both the middle ( $p = 0.003$ ) and elementary ( $p = 0.002$ ) school levels.

#### Gender, Race, and Grade Level

When race and gender were combined at the high school level, 23.5% of white females were obese and 19.2% were overweight (42.7% combined). Among black females, 30.6% were obese and 18.9% were overweight (49.5% combined). At the middle school level, 17.2% of white females were obese and 21.2% were overweight (38.4% combined).

**Table 2.** Prevalence of Overweight and Obesity by Grade Level and Race, CAYPOS, Mississippi, 2015

	All (K-12) (%, 95% CI) <sup>c</sup>	Elementary (K-5) (%, 95% CI)	Middle school (6-8) (%, 95% CI)	High school (9-12) (%, 95% CI)
<b>All</b>				
Overweight <sup>a</sup>	18.2 (17.2-19.3)	17.8 (16.6-19.1)	18.8 (16.5-21.4)	18.5 (16.3-21.0)
Obesity <sup>b</sup>	25.2 (23.3-27.1)	22.6 (20.1-25.4)	27.3 (23.5-31.4)	28.2 (24.6-32.0)
<b>White</b>				
Overweight	18.0 (16.4-19.8)	17.0 (14.7-19.7)	18.8 (14.9-23.5)	19.3 (16.8-22.1)
Obesity	21.8 (19.6-24.1)	18.6 (16.0-21.6)	22.6 (17.9-28.2)	27.3 (22.9-32.3)
<b>Black</b>				
Overweight	18.2 (16.7-19.8)	18.7 (17.0-20.4)	18.6 (15.7-21.8)	17.1 (13.5-21.3)
Obesity	27.7 (25.1-30.4)	25.3 (21.7-29.4)	31.1 (27.2-35.3)	29.2 (23.9-35.0)
<b>Male</b>				
Overweight	17.3 (15.9-18.8)	17.6 (15.7-19.7)	16.5 (13.5-19.9)	17.6 (15.6-19.9)
Obesity	24.7 (22.3-27.4)	21.5 (18.5-24.9)	27.3 (23.3-31.7)	28.7 (23.4-34.6)
<b>Female</b>				
Overweight	19.2 (17.5-20.9)	18.1 (16.4-19.8)	21.2 (17.7-25.2)	19.5 (15.8-23.8)
Obesity	25.6 (23.3-28.0)	23.8 (20.9-27.0)	27.2 (21.6-33.7)	27.7 (24.5-31.2)
<b>White male</b>				
Overweight	17.0 (14.3-20.0)	15.9 (12.0-20.8)	16.7 (11.5-23.7)*	19.4 (16.4-22.8)
Obesity	23.5 (20.5-26.9)	17.8 (14.1-22.1)	27.4 (21.6-34.0)	30.7 (24.1-38.2)
<b>Black male</b>				
Overweight	17.6 (15.7-19.6)	19.5 (16.8-22.5)	16.0 (12.0-20.9)	15.2 (12.3-18.7)
Obesity	25.5 (22.2-29.1)	23.5 (19.5-28.1)	27.2 (22.4-32.6)	27.8 (20.7-36.1)
<b>White female</b>				
Overweight	19.1 (17.5-20.9)	18.2 (16.0-20.5)	21.2 (17.5-25.5)	19.2 (15.6-23.4)
Obesity	19.9 (17.3-22.8)	19.5 (16.2-23.3)	17.2 (12.0-24.1)*	23.5 (19.8-27.7)*
<b>Black female</b>				
Overweight	18.9 (16.4-21.7)	17.8 (15.4-20.5)	21.0 (15.7-27.4)	18.9 (13.2-26.5)
Obesity	29.9 (26.8-33.1)	27.2 (22.9-31.9)	34.6 (28.3-41.4)	30.6 (25.7-35.9)

<sup>a</sup>Body mass index (BMI) > 85th percentile and < 95th percentile for age and gender.

<sup>b</sup>Body mass index (BMI) > 95th percentile for age and gender.

<sup>c</sup>95% confidence interval.

\*Sample size is less than 50. The estimates may not be reliable.

Among black females, 34.6% were obese and 21.0% were overweight (55.6% combined). At the elementary school level, 19.5% of white females were obese and 18.2% were overweight (37.7% combined). Among black females, 27.2% were obese and 17.8% were overweight (45.0% combined). The prevalence of obesity for black females was significantly higher than white females at the middle school level.

When race and gender were combined at the high school level, 30.7% of white males were obese and 19.4% were overweight (40.1% combined). Among black males, 27.8% were obese and 15.2% were overweight (43.0% combined). At the middle school level, 27.4% of white males were obese and 16.7% were overweight (44.1% combined). Among black males, 27.2% were obese and 16.0% were overweight (43.2% combined). At the elementary school level, 17.8% of white males were obese and 15.9% were overweight (33.7% combined). Among black males, 27.2% were obese and 17.8% were overweight (35.0% combined).

### Overweight and Obesity Trends

In 2015, the prevalence of overweight and obesity among students in

grades K-12 was 43.4%, compared to 43.9% in 2005. Neither a linear ( $p = 0.4486$ ) nor a quadratic change ( $p = 0.0531$ ) was observed (Figure 4). However, a significant linear change was shown among the high school students ( $p = 0.0229$ ), indicating an increase in obesity prevalence from 2005 to 2015.

As in 2011 and 2013, a significant linear drop was observed in the prevalence of combined overweight and obesity among the elementary school students between 2005 (43.0%) and 2015 (38.0%) ( $p = 0.0066$ ) (Figure 6). A separate analysis also revealed a significant linear decrease in the prevalence of obesity alone among the elementary school students during the same period ( $p = 0.0209$ ).

### Discussion

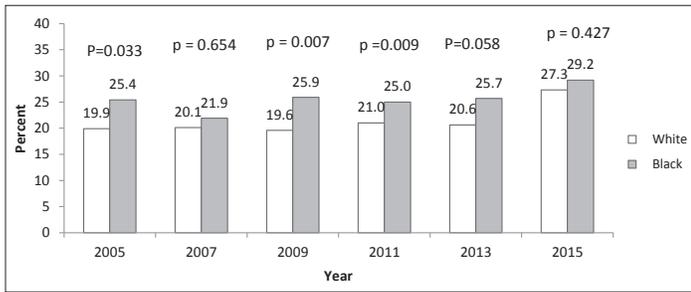
The findings of the 2015 CAYPOS suggest a continued stabilization of overweight and obesity among public school students over the past decade, with 43.9% in 2005 vs. 43.4% in 2015. The prevalence of overweight, obesity, and both combined remained higher than national averages, yet has neither increased nor decreased significantly since 2005. These findings are similar to other recent surveillance studies over time that continue to report high, yet stable, prevalence rates.<sup>7,36</sup>

A recent movement to differentiate levels of obesity provides an opportunity to examine the stability of these rates in greater detail. Using the American Heart Association's recommendations for defining Class 2 obesity as a

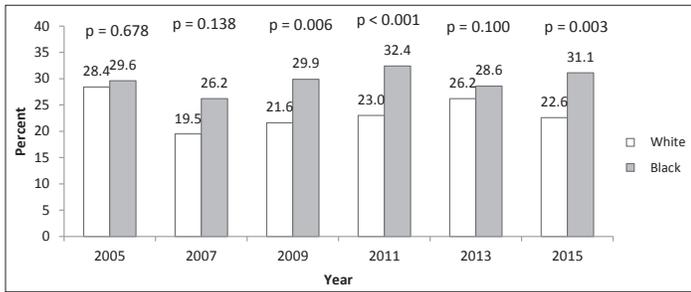
BMI greater than 120% of the 95<sup>th</sup> percentile and Class 3 obesity as a BMI greater than 140<sup>th</sup> of the 95<sup>th</sup> percentile allows for examining what is called, "Severe Obesity."<sup>37</sup> Using the 2005-2013 CAYPOS data, severe obesity decreased significantly over time among males, whites, and elementary school students. Changes were not only noted among the severe obesity categories. Examining the underweight category in the 2005-2013 CAYPOS indicates that the prevalence of underweight increased significantly between 2009 and 2013.<sup>38</sup> So, while the overall prevalence rates do not appear to have changed over time, several shifts in weight status distribution have occurred in the past decade.

In 2015, as in all previous years, the prevalence of obesity was significantly higher among black students than among white students. Disparities, while still present between black and white students, decreased in 2015 for the first time since 2005. The decrease, however, was not necessarily due to a reduction in the prevalence among black students, but rather an increase among white students. Racial disparities have been repeatedly reported<sup>7,36,37</sup> with others suggesting that existing school-based initiatives are not sufficient to address factors associated with higher prevalence rates among black students.<sup>38,40-43</sup>

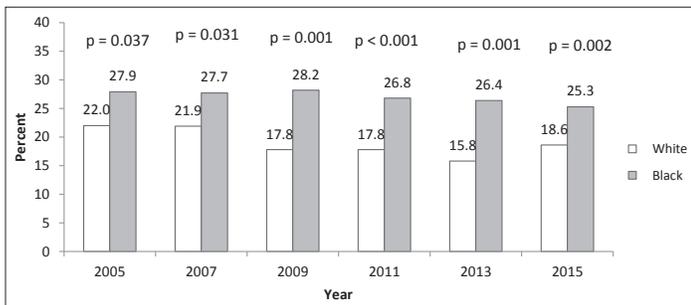
**FIGURE 1. Obesity Prevalence by Race among Mississippi High School Students, CAYPOS 2005-2015**



**FIGURE 2. Obesity Prevalence by Race among Mississippi Middle School Students, CAYPOS 2005-2015**



**FIGURE 3. Obesity Prevalence by Race among Mississippi Elementary School Students, CAYPOS 2005-2015**

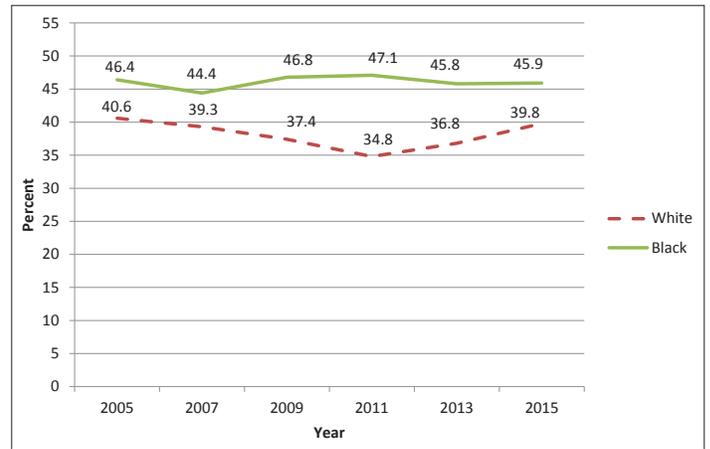


**FIGURE 4. Prevalence of Overweight and Obesity, Mississippi, K-12, CAYPOS 2005-2015**

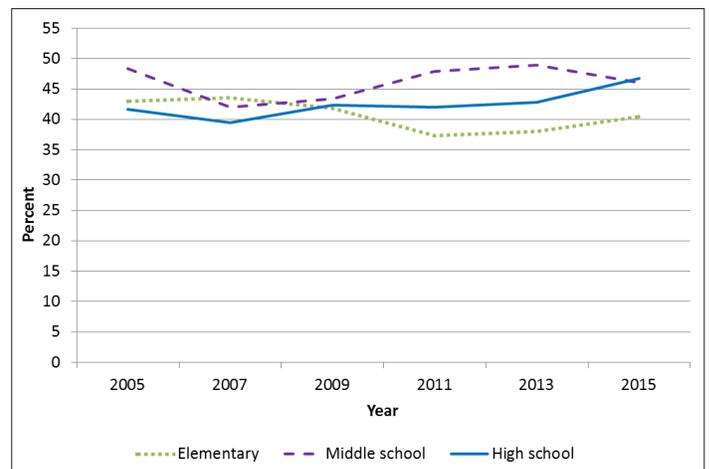


In 2015, as with all previous years, there was no difference between boys and girls ( $p=0.570$ ). Between 2009 – 2013, however, the prevalence was higher among black females than white females, especially in middle school where 55.6% of black girls were overweight or obese compared to 38.4% of white girls. These findings are consistent with

**FIGURE 5. Prevalence of Overweight and Obesity by Race, K-12, Mississippi, CAYPOS 2005-2015**



**FIGURE 6. Prevalence of Overweight and Obesity by Grade Level, Mississippi, CAYPOS 2005-2015**



several other studies reporting significant disparities between black and white females.<sup>33,37,44,45</sup>

The prevalence of obesity was significantly higher in 2015 among black students in elementary and middle school levels. In 2011 and 2013, black students' obesity prevalence was significantly higher at all three levels, including high school. The lack of significant difference in 2015 at the high school level was not due to the prevalence decreasing among black students but rather an increase among white students. For the first time, in 2015, the highest prevalence of obesity was among high school students. In 2015, a linear increase in overweight among high school students between 2005 and 2015 was also observed. It is somewhat difficult to speculate as to these most recent changes. However, in 2013, there was a similar statistically significant increase among middle school students, which then dropped in 2015. It is possible that students are not transitioning out of their weight status, but rather the students from the elementary grades with lower BMIs are making their way into the middle schools, while some of the middle school students with higher BMIs are making their way into high school. Recent research suggests a strong and stable association between earlier body size and adolescent overweight.<sup>18</sup>

The significant linear decrease in obesity prevalence among elementary school students observed during 2005-2013 continued to 2015.

The combined prevalence of overweight and obesity among elementary school students also showed a significant linear decline. These statewide findings in Mississippi are similar to those reported in New York City.<sup>46,47</sup>

While the CAYPOS is methodologically sound in the ongoing surveillance of obesity among public schools students in grades K-12, one of the limitations is the inability to determine if these significant declines noted at the elementary level in Mississippi public schools are due to something occurring at the elementary grade level or whether students are arriving in public school with BMIs that are already lower than in previous years. Numerous studies are now calling for earlier assessment and comprehensive treatment of factors associated with obesity<sup>17,18,39,41,44,45,47-49</sup> and racial disparities<sup>41,49,51</sup> at a time when significant declines among the pre-K population are being reported.<sup>7,47,50-53</sup> Factors associated with obesity include maternal (i.e., gestational diabetes, BMI and weight gain during pregnancy, smoking, gestational age of child at delivery),<sup>54-57</sup> child (i.e., high birth weight, weight gain in infancy),<sup>58</sup> and parenting practices (i.e., breastfeeding, age at introduction to solid foods, hours of sleep, active play vs. screen time).<sup>59-62</sup> Associating the prevalence of obesity with such variables among a Pre-K population would provide additional insight into, and a more comprehensive understanding of, differences in race, gender and grade levels observed over the past decade in grades K-12 through the CAYPOS. ■

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**Author Information:**

Professor in the School of Social Work at the University of Southern Mississippi (**Dr. Kolbo**). Director of the Office of Health Data and Research in the Mississippi State Department of Health and a Professor in the School of Nursing at the University of Mississippi Medical Center (**Dr. Zhang**). Research support staff member at the University of Southern Mississippi (**Ms. Werle**). Chair and Professor in the Department of Nutrition and Food Systems at the University of Southern Mississippi (**Dr. Molaison**). Professor in the School of Nursing at the University of Southern Mississippi (**Dr. Harbaugh**). Licensed social worker with the Veteran's Administration (**Ms. Kirkup**). Employed by United Healthcare of Mississippi (**Dr. Walker**).

**Corresponding Author:** Jerome R. Kolbo, PhD, MSW, 118 College Drive #5114, The University of Southern Mississippi, Hattiesburg, MS 39406, Ph: 601-266-5913, [Jerome.kolbo@usm.edu](mailto:Jerome.kolbo@usm.edu)

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