



2013-2014

Survey of Body Mass Index among Ottawa County Third Graders

INTRODUCTION

Research Regarding Youth Obesity

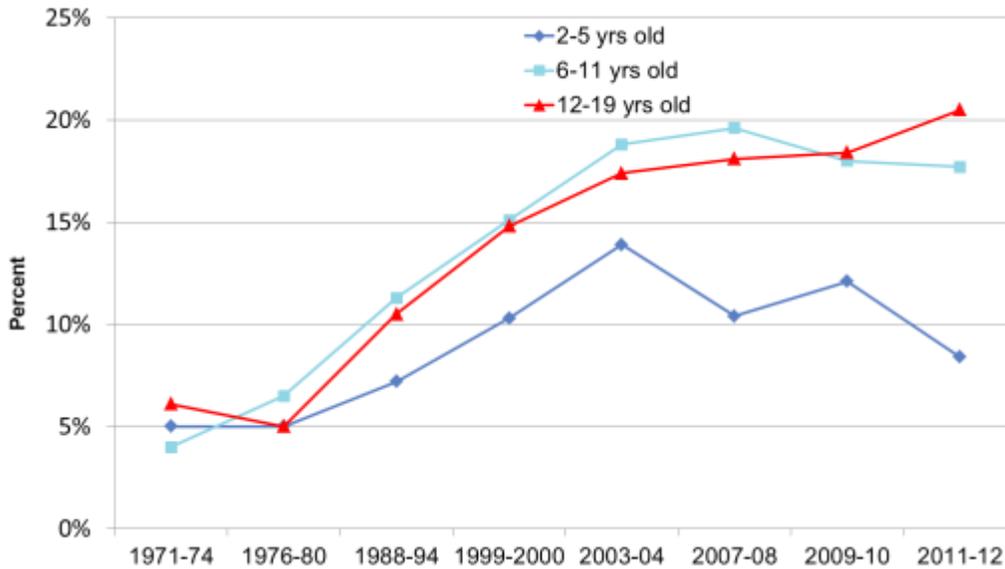
Over the past 40 years, the percentage of children who are obese in the United States has increased more than 400%. The National Health and Nutrition Examination Survey (NHANES) began to assess childhood obesity in the U.S. in 1963, providing a baseline for assessment of healthy weight into the future. To determine weight status, a child's Body Mass Index, calculated as weight in kilograms divided by height in meters squared, is plotted on Centers for Disease Control and Prevention sex-specific pediatric growth charts and tracked as a percentile according to a child's age. Percentiles can be grouped into four different weight categories. Table 1 displays the BMI percentile range that corresponds to each weight category.¹

Table 1. Child & Adolescent Weight Categories

BMI Percentile	Weight Category
< 5 th	Underweight
5 th to < 85 th	Healthy Weight
85 th to < 95 th	Overweight
95 th and above	Obese

In the United States, the prevalence of obesity among 6-11 year olds has increased from 4.0% in 1971-74 to a high of 19.6% in 2007-2008.² While a four-fold plus increase in childhood obesity is reason for concern, that concern became an important public health focus when further research associated childhood obesity with both short-term health consequences in children and long-term tracking of obesity into adulthood.² Obesity in adults is implicated in increased risk for hypertension, hyperlipidemia, diabetes, coronary heart disease, stroke, gall bladder disease, respiratory problems, some cancers and liver disease.¹ During the last decade, increases in obesity appear to be leveling off since NHANES trend analysis of overall childhood obesity data from 2003 to 2012 indicates no evidence of a significant change.⁴ In fact, obesity in 6-11 year olds is stable to decreasing while obesity in 2 to 5 year olds is statistically decreasing since 2003. The most recent NHANES results report an overall prevalence of obesity of 16.9% for youth ages 2 to 19 years old, 8.4% for 2 to 5 year olds, 17.7% for 6 to 11 year olds, and 20.5% for 12-19 year olds (see Figure 1).⁴

Figure 1. Trends in the prevalence of obesity (%) among ages 2-19 years, selected years 1971-74 through 2011-12.⁴



Trends over the past two or more decades show that the increase in obesity prevalence is a worldwide phenomenon.⁷ Since obesity is a largely preventable condition, intervention early in life should be able to slow and eventually reverse these trends. In addition to higher caloric intake and decreased physical activity, a factor that has been consistently associated with increased risk of obesity is socioeconomic status (SES).^{6,7} Interestingly, the effect of socioeconomic status on obesity varies throughout the world; in some countries a high SES increases the likelihood of obesity while in others a lower SES increases that likelihood. A review of the research literature suggests that the level of SES correlated with calorie dense and nutrition poor foods is associated with an increased risk of developing childhood overweight or obesity in a particular country.⁷ In developing nations, this is more often a higher SES while in the United States studies continue to link a lower SES with risk for obesity in children.

Background of the Ottawa County Study

While county level estimates of weight categories existed for adults and older youth through self-reported height and weight collected in periodically administered surveys, there were no data for youth younger than age 14. An Ottawa County pilot study was initiated 2004-05 to assess childhood obesity in pre-Kindergarten, third grade and sixth grade students in response to the increases seen nationally across the age spectrum.³ The OCDPH has continued to monitor the Body Mass Indexes (BMI) of third grade children every three years to track weight trends. This allows for county specific data that can assist public health and other community partners to better serve the health needs of Ottawa County residents. Starting in 2007-08 and continuing through the current study, an additional variable was added to explore whether SES was statistically associated with obesity in Ottawa County third graders. The variable is based on the proportion of third grade students in each school building eligible for the Free or Reduced Price School Meal Program (FRM) through the National School Lunch Program that provides low-cost or free lunches and breakfasts to children based upon a qualifying household income

of 185% or less of the federal poverty level.⁸ The 2013-2014 Survey of Body Mass Index among Ottawa County Third Graders had four primary research objectives:

1. Assess the distribution of third graders across each of the four BMI-based weight categories (underweight, healthy weight, overweight, and obese).
2. Assess whether SES is associated with being obese or above a healthy weight (a combination of the overweight and obese weight categories).
3. Assess whether being male or female is associated with being obese or above a healthy weight.
4. Assess whether there has been any change in either obesity or being above a healthy weight since the 2004-05 study.

The completed reports from previous BMI studies, as well as weight status data on other age groups in Ottawa County can be viewed at MiOttawa.org/healthdata.

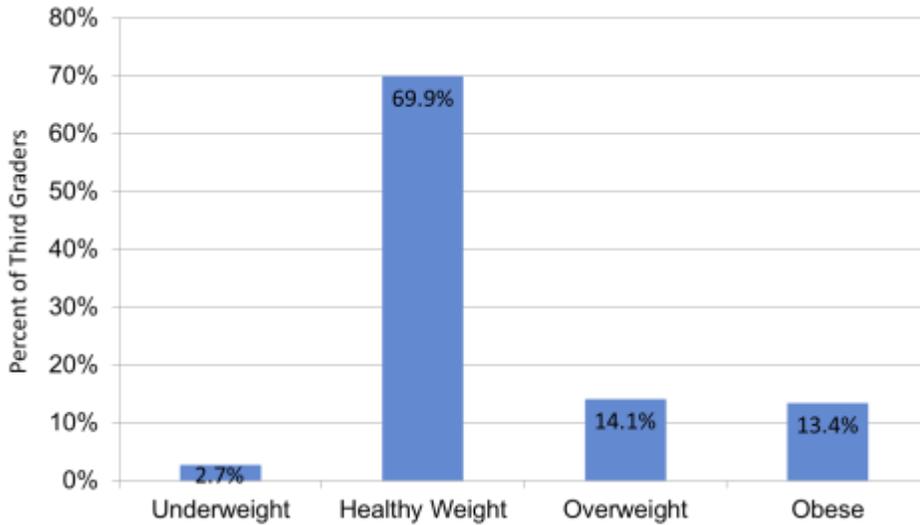
OVERALL RESULTS

Overall, 853 Ottawa County third graders from 15 different schools were assessed for BMI throughout the 2013-14 school year. The information collected on each student included:

- Measure date
- Date of birth
- Child's sex
- Height in inches (an average of two measurements)
- Weight in pounds (an average of two measurements)
- School type (based on the percentage of third grade students eligible for subsidized meals)

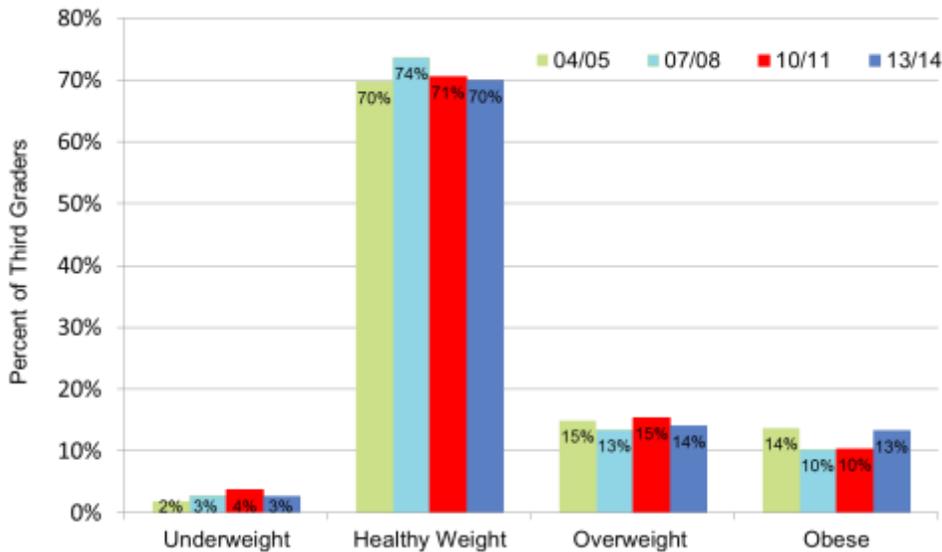
The first five variables are all required to calculate a student's BMI and assign them to the appropriate weight category based on their sex and age using pediatric growth charts.⁵ Figure 2 displays the distribution of third graders among the four weight categories for the 2013-14 school year. About one in every seven students is classified as obese, while more than one in four is above a healthy weight (27.5%).

Figure 2. Distribution of Ottawa County Third Graders by Weight Category



Since there are four study years of BMI data available for Ottawa County third graders, an analysis was done to assess whether or not there has been any statistically significant change in overweight or obesity from the 2004-05 school year to the 2013-14 school year. Figure 3 displays slight differences across the study years in the percentages for each weight category. Using logistic regression to test if there has been an increase or decrease in being either above a healthy weight (overweight or obese) or being obese, there was no evidence of a significant change in the prevalence of either weight status in Ottawa County third graders since 2004-05.

Figure 3. Trend in Distribution of Ottawa County Third Graders by Weight Category*



*Percentages rounded to the nearest whole number.

DISCUSSION

Significant Findings

Research has shown that lower household income is associated with increased risk of overweight or obesity in U.S. children.^{6,7} As mentioned above, a variable that could serve as a socioeconomic status indicator (SES) was included in the study beginning in 2007-08. Third graders in the study were analyzed by three school type categories. The school types were created to assess whether household income is associated with obesity in Ottawa County and were based on the proportion of eligible third grade students in each building for the Free and Reduced Price Meals Program (FRM).⁹ Private schools do not have publically available information regarding the count of third graders eligible for FRM so private schools were a default category. Public schools were divided into two categories based on the method used in the 2007-08 study: schools with less than 40% of third graders eligible for FRM were considered higher income and schools with 40% or more of third graders eligible for FRM were considered lower income (see Tables 2 and 3 under Methods for more information about the sample by school type). Both the sex and the school type of third grade students were evaluated and both were found to have a relationship to overweight or obesity in this study.

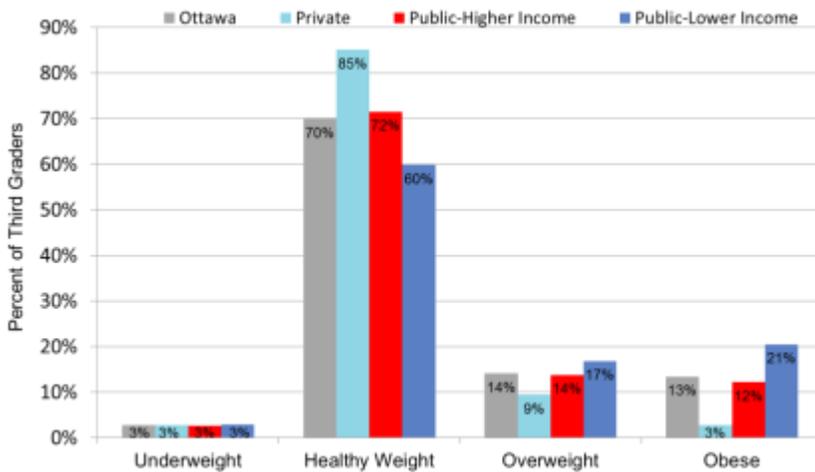
School type is statistically associated with overweight and obesity in Ottawa County third graders in the following ways:

- Holding sex constant, children in lower income public schools are almost **9 times** more likely to be **obese** and **4 times** more likely to be **above a healthy weight** than children in private schools. (Obesity OR: 8.72; CI: 2.36, 32.28. Above a healthy weight OR: 4.24; CI: 2.32, 7.75)
- Holding sex constant, children in higher income public schools are almost **5 times** more likely to be **obese** and **2.5 times** more likely to be **above a healthy weight** than children in private schools. (Obesity OR: 4.85; CI: 1.22, 19.18. Above a healthy weight OR: 2.54; CI: 1.24, 5.20)
- Holding sex constant, there is **no statistical evidence** of a difference in the likelihood of being obese or above a healthy weight comparing higher income to lower income public schools. (Obesity OR: 0.56; CI: 0.23, 1.32. Above a healthy weight OR: 0.60; CI: 0.30, 1.22)

In the previous two studies, third graders in lower income public schools were more likely to be obese than third graders in private schools, but they were also more likely to be obese than third graders in higher income public schools. This is the first study year that did not show evidence of a difference in the likelihood of obesity between the two categories of public schools.

Stratifying the results by school type provided important information about the distribution of obesity among Ottawa County third graders. Although the overall prevalence of obesity in Ottawa County remains lower than the national average for 6-11 year olds (17.7% in 2011-12)⁴ at just over thirteen percent, there were significant differences among students attending the three school types in this study. Twenty-one percent of third graders in lower income public schools are categorized as obese putting them at higher risk than the national average for 6-11 years olds and higher than third graders in Ottawa County's private schools. This association has held consistent since school type was first included in 2007-08.

Figure 4. Distribution of Weight Category by School Type in Ottawa County Third Graders*



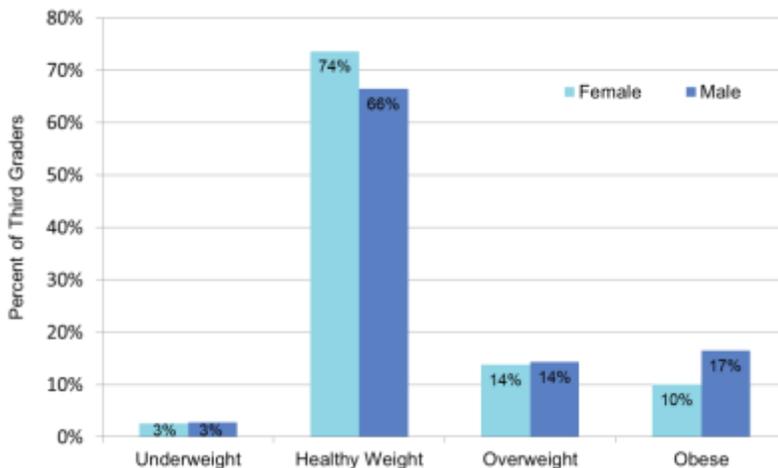
*Percentages rounded to the nearest whole number.

For the first time in the study’s history, a significant association was observed between a student’s sex and overweight and obesity:

- Holding school type constant, 3rd grade **boys** were slightly more likely than 3rd grade girls to be both **obese** and **above a healthy weight**. (Obesity OR: 1.72; CI: 1.16, 2.56. Above a healthy weight OR: 1.39; CI: 1.06, 1.81)
- There was **no evidence** of an interaction between sex and school type, meaning that males were not more likely to be obese than females based on one or more of the three types of school categories in the study.

Figure 5 shows that 17% of third grade boys were categorized as obese based on their BMI versus only 10% of third grade girls. When being overweight or obese were combined into one category as above a healthy weight, the difference between sexes was still statistically significant, though slight.

Figure 5. Distribution of Weight Category by Sex in Ottawa County Third Graders*



*Percentages rounded to the nearest whole number.

Implications for Intervention

Interventions aimed at promoting healthy lifestyles among Ottawa County elementary school students should be targeted toward public schools and there is a suggestion that lower income public school students may be at increased risk, though the 2013-14 study did not find a statistical difference between third grade students in higher and lower income public schools.

While there is some evidence that Ottawa County's third grade males may be at increased likelihood for being obese or above a healthy weight compared to females, this finding is new. Interventions and programming may want to consider how to involve males particularly but should not select for one sex over another until further studies substantiate this change.

Future Research

To better understand the demonstrated association between public and private schools and obesity in children, future research may want to consider incorporating a variable that indicates student-level eligibility for FRM since household income is a qualifying factor for eligibility. Additionally, contacting each private school with third grade students to record the actual proportion receiving FRM would allow for a more rigorous test of FRM as an SES indicator of obesity.

METHODS

The Sample

Stratified cluster sampling was used to randomly select elementary schools for participation in the Ottawa County BMI survey. Ottawa County elementary schools with third graders (N=67) were grouped (stratified) into three strata, or categories:

1. Private schools
2. Higher income public schools
3. Lower income public schools

The classification of schools was determined on the basis of the percentage of third grade students eligible in each building for the Free and Reduced Price Meals Program (FRM) during the 2012-13 school year.⁶ Schools with less than 40% of their students eligible for the FRM program were classified as **higher income public schools** and schools with 40% or more of their students eligible were classified as **lower income public schools** (see Table 2). FRM program information is not publically available for **private schools**, the third stratum.

Table 2. Description of Elementary School Buildings Included in the Study

School Participation	Buildings Sampled	FRM Range*
Private Schools	5 of 20	N/A
Public Higher Income	6 of 30	10% - 39.7%
Public Lower Income	4 of 17	40% - 86.4%

*Percent of students eligible for the Federal Free and Reduced Price Meal Program (2012).

Schools in each category were then randomized using SAS 9.3 statistical analysis software and invited to participate in the survey. If a school declined to participate, the next school in the randomly generated list was contacted until the desired number of students was met based on the proportion of third grade students within each school type stratum in Ottawa County (see Table 3).¹¹

Table 3. Characteristics of Students Included in the Study

Gender	Count	Percent
Girls	418	49%
Boys	435	51%
School Type	Count	Count
Private Schools	107	13%
Public Higher Income (< 40%)	502	59%
Public Lower Income (40% +)	244	28%

Lower income public schools were not oversampled for the 2013-14 study as they were in the previous two studies. Consistent with studies since 2007-08, all observations were assigned a weight based on the probability of being selected for the sample within each stratum.

Measurement

The method for measuring Body Mass Index was consistent with the previous three studies in Ottawa County. Consent for student participation was passively obtained from parents. All consenting third graders in attendance on the day of a screening were measured for height and weight in a private, participant blinded setting without footwear or large, bulky outer layers. Height and weight measures were obtained in duplicate using a digital scale and a tape measure attached to a flat vertical surface. After the initial weight measure, students were told to step off the scale while the scale was recalibrated. If the second weight measurement differed by more than 0.25 pounds from the initial reading, a third measurement was taken. Similarly, if the second height measurement was more than 0.25 inches different from the first height, a third measurement was taken. Height measurements were recorded by hand to the nearest quarter of an inch using a hand-held right angle while weight measurements were recorded to the nearest tenth of a pound. Additional information recorded included the student's date of birth, the student's sex, and date of measurement. All recorded information was entered into a Microsoft Excel database by the OCDPH epidemiologist.

Analysis

Average height and weight were calculated using the two closest measurements. If three measurements were equally spaced, the two lower measurements were used in order to prevent an overestimation of Body Mass Index. Body Mass Index was calculated using the formula $BMI = (\text{Weight in kilograms})/(\text{Height in meters})^2$. Age and gender specific BMI percentiles were calculated using a custom developed program for SAS statistical analysis software from the Centers for Disease Control and Prevention.¹⁰ BMI-for-age percentiles were classified into weight categories using the scale in Table 1.

SAS version 9.3 was used to analyze the data taking into account the stratified cluster sampling design. All county-wide estimates were weighted based on the probability of selecting schools in the different strata to adjust for stratification in the sampling design. Each building was assigned a numeric code and included in the analysis to adjust for the effect of measuring all third grade students (a cluster) in the sampling design. When testing for an increasing or decreasing linear trend in overweight or obesity since 2004-05, consistent building codes were included in the analysis to adjust for the cluster-based sampling used in all four study periods but strata and strata-based weights were not adjusted for since there is no evidence that the 2004-05 study included school type strata in sampling third grade buildings.

Logistic regression that accounted for the sampling design (Proc Surveylogistic) was used to assess which variables might be associated with overweight and obesity. All interactions were tested and none were statistically significant ($p < 0.05$).

Study Limitations

While the study shows an association between both higher and lower income public schools and overweight or obesity, the use of the proportion of third grade students eligible for free or reduced price school meals is merely an approximate indicator of the household incomes of students attending the school. This study does not attribute any association between school meals and overweight or obesity in Ottawa County children.

Students who were absent on the scheduled measurement day, as well as students whose parents requested that their child not be measured, were not included in the final results.

Sampling methodology differed between the four study periods, requiring some caution when interpreting the weight category trends over time.

- The 2004 pilot study consisted of a random cluster sample where school buildings were randomly sampled and all the students in those buildings in pre-Kindergarten, third and sixth grade, present on the measurement day, had their height, weight, age, and sex recorded.
- For the 2007 and 2010 studies, stratification was added to the random cluster sampling to select Ottawa County elementary schools within each category (stratum) of school type. Also, these two studies oversampled lower income public schools to ensure a sufficient sample size for

detecting an association between SES and overweight or obesity, if there was one. Since 2007, the BMI studies have only measured the height and weight of third grade students.

- In this year's study, stratified cluster sampling was employed as in the previous two studies of third graders, but without oversampling of lower income public schools. Analysis of the 2007 and 2010 study data indicated that removal of the oversampling did not change the results of either year's study.
- The analysis of obesity trends over time differs slightly in this study from how it was done in 2010, the first year linear trend analysis was conducted. Since that time, 2004 study data was discovered that allowed for the inclusion of a consistent building cluster code in the analysis of all study years. Also, all third grade measurements that included a code for building were employed in the linear trend analysis with the exception that oversampling was removed for the 2007 and 2010 studies using reported headcounts per grade per building for the study year. Therefore, while the overall finding of the 2013-14 trend analysis does not differ from that of the 2010-11 analysis, the percentages reported per study year are different than in the 2010-11 report.

Since this study is observational and collects a cross-section of data at a single point in time, it cannot demonstrate a cause-and-effect relationship between any of the study variables and the likelihood of overweight or obesity.

While this study demonstrates evidence that a student's school type and sex are associated with overweight and obesity, it doesn't provide information about why these associations exist in Ottawa County third graders.

There may be other factors that increase the likelihood of overweight and obesity that were not measured in this study.

REFERENCES

¹http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html

²NHANES data on the Prevalence of Obesity Among Children and Adolescents: United States, Trends 1963–1965 Through 2007–2008. CDC National Center for Health Statistics, Health E-Stat. http://www.cdc.gov/nchs/data/hestat/obesity_child_07_08/obesity_child_07_08.htm

³Chukwuma, U., Body Mass Index Screening Report for Pre-Kindergartens, Third Graders, and Sixth Graders in Ottawa County Schools: September 2004-June 2005. Ottawa County Health Department. 2005.

⁴Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of Childhood and Adult Obesity in the United States, 2011-2012. *JAMA*. 2014; 311(8):806-814. doi:10.1001/jama.2014.732.

⁵Centers for Disease Control and Prevention. Growth Charts. <http://www.cdc.gov/growthcharts/>

⁶Shrewsbury, V.; Wardle, J. Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990-2005. *Obesity*, 2008 Feb; 16(2):275-84. Accessed online 11/19/2012.

⁷Wang, Youfa & Lim, Hyunjung. The global childhood obesity epidemic and the association between socio-economic status and childhood obesity. *International Review of Psychiatry*, June 2012; 24(3): 176–188.

⁸United States Department of Agriculture, Food and Nutrition Service. <http://www.fns.usda.gov/school-meals/child-nutrition-programs>.

⁹Michigan Department of Education, Center for Educational Performance and Information, Building Level Free/Reduced Lunch Public Data. http://www.michigan.gov/cepi/0,1607,7-113-21423_30451_36965---,00.html. Accessed online May 17, 2013.

¹⁰Centers for Disease Control and Prevention, SAS Program for Pediatric BMI Percentiles. <http://www.cdc.gov/nccdphp/dnpao/growthcharts/resources/sas.htm>.

¹¹Michigan Center for Education Performance & Information. http://www.michigan.gov/cepi/0,1607,7-113-21423_30451_36965---,00.html. Accessed online May 17, 2013.