Analysis of Obesity Rates for School Children in Pennsylvania

By
Shailendra Gajanan, Ph.D., and Lisa Fiorentino, Ph.D., RN,
University of Pittsburgh-Bradford

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Executive Summary

This research tracked childhood obesity rates in rural and urban Pennsylvania public school districts over the 10-year period of 2005-2016, using data from the Pennsylvania Departments of Education and Health, and the U.S. Census Bureau.

The research compared historical trends in childhood obesity at the district level with various socio-economic variables, such as education, income, and employment, and various school district factors, such as PSSA scores and participation in the free and reduced school lunch programs, to identify any relationships between those indicators and obesity rates among Pennsylvania public school students.

The researchers also surveyed school district personnel to learn how their districts are addressing the obesity/overweight issue among students.

The key findings are:

1. The percent of overweight students and students who are at-risk of being overweight in Pennsylvania has been somewhat steady at 32.6 percent, on average, over the study period. On average, 17 percent of students are overweight and 15.7 percent of students are at-risk of being overweight.
2. The percent of students in grades K-6 who are overweight and at-risk of being overweight mimics the overall trend, with averages of 17.6 percent in the overweight category, and 16 percent in the at-risk category.
3. The percent of overweight students in grades 7-12 is greater than the overall trend, at about 19 percent, on average. The percent of students in grades 7-12 who are at-risk of being overweight is around 17 percent. Almost 36 percent of students in these higher grade levels are either overweight or at-risk of being overweight.
4. The percent of rural students in grades K-6 who are overweight consistently exceeded those in urban districts by at least 3 percentage points. Over the 10-year study period, about 19 percent of rural students and 16 percent of urban students, on average, are overweight.
5. The percent of overweight students in rural school districts in grades 7-12 also consistently exceeded those in urban districts by at least 4 percentage points. On average, about 21 percent of rural students and 17 percent of urban students in these grades are overweight.
6. These results indicate that youth obesity is an important issue in Pennsylvania, particularly among rural students, and rural students in grades 7-12.

7. Overall, lower educational attainment levels, lower employment rates, lack of health insurance, and poverty status among adults are key economic variables that are positively associated with youth overweight status. The incidence of youth overweight status declines as family income increases.

8. Other variables that are positively associated with youth obesity, especially in urban districts, are the percentage of families receiving public cash assistance and SNAP benefits, and the percentage of students participating in the free and reduced lunch programs.

9. Pennsylvania school officials who responded to the research survey said they are aware of the issue of youth obesity, and many schools have adopted U.S. Department of Agriculture and Pennsylvania Department of Education vending machine guidelines and menu-labeling systems. These schools also encourage student activity and undertake partnerships with local community health groups and related networks to increase awareness and help students make healthy choices.

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Introduction

The U.S. Department of Health considers about one-third of children and adolescents age 6 to 19 to be overweight or obese. *The State of Obesity: Better Policies for a Healthier America* by the Robert Wood Johnson Foundation (2016) indicates that adult obesity rates now exceed 20 percent in all states, with some states exceeding 35 percent. Similar observations are also evidenced for obesity rates among children ages 10-17, and among high school students.

In particular, the Pennsylvania Department of Health defines childhood obesity for persons aged 2-19 years as a Body Mass Index (BMI) at or above the 95th percentile for children of the same age and sex, which is also the measure used in the Centers for Disease Control and Prevention's (CDC) BMI-for-age growth charts, and is a standard used by other state agencies, health departments and the National Institutes of Health (NIH).

The BMI-for-age is a useful measure because it allows one to compare obesity rates of similar cohorts across different states, or across different counties in a particular state. *The State of Obesity* ranks all the states in descending order of childhood obesity of children age 10-17. Mississippi ranks 1st, being the "most obese," with 21.7 percent, while Oregon ranks 50th, the "least obese," with 9.9 percent. It is interesting to note that Pennsylvania ranks 36th, with a rate of 13.5 percent.

It is important to note that while the rate of childhood obesity of children age 10-17 for Pennsylvania has declined since 2007 from 15 percent, the report indicates that the current rate of 13.5 percent is still not acceptable. This concern becomes evident when examining the report's rankings of obesity rates among high school students across all states.[1] Pennsylvania ranks 14th highest in the nation, with an obesity rate of 14 percent among high school students, and importantly, this rate has *increased* from 12 percent in 2009.

Previous research conducted by the Center for Rural Pennsylvania (2005) indicated that rural areas have higher obesity rates. That is, the prevalence of obesity and its increase are much higher in rural school districts than in urban districts. The main reason for concern is that obesity in childhood is associated with obesity in adulthood.

From an economic standpoint, there are private and social costs associated with obesity. Private costs are those costs borne by the individual, while social costs reflect all external costs borne by the rest of the society. Crucial private costs of obesity are lower productivity, income inequality and higher health-care costs.[2]

[1] Mississippi ranks 1st in being the "most obese" with 18.8 percent.
[2] Wang and Dietz (2002) note that obesity-related hospital costs for school-aged children have more than tripled in real terms from 1979 to 1999.

Recent research in nutrition economics and health economics found that childhood obesity has a negative impact on academic performance and long-term human capital accumulation[3], leads to lower self-esteem, and exposes students to bullying (Van Geel et al., 2014; Mamun et al., 2013) and hidden bias among peers and teachers.[4]

Studies have also noted the important role of environmental stressors on childhood obesity (Peckham, 2013; Millimet et al., 2010; Roy et al., 2012; Schanzenbach, 2009). That research indicated that participation in SNAP (Supplemental Nutritional Assistance Program) and the National School Lunch Programs (NSLP) are good proxies of environmental stressors, and that students in these programs are most likely to be obese. Further, Price (2012), and Datar and Nicosia (2012) have also linked adolescent obesity to in-school consumption of soft drinks and complementary food items from vending machines. These observations are also relevant for Pennsylvania (Center for Rural Pennsylvania, 2010).

If obesity has serious costs on academic performance, future human capital accumulation, and on students' overall psychological well-being, then clearly the issue will be of interest to many stakeholders in Pennsylvania. For instance, Paul (2013) cited the resolution passed by the Pennsylvania House of Representatives to tackle childhood obesity more effectively in Pennsylvania. The resolution was based on the CDC's finding that Pennsylvania is one of only three states in which obesity rates continue to increase among low-income preschoolers. Paul (2013) noted the observation made by the Pennsylvania Advisory Commission on Childhood Obesity that overweight preschoolers have a 35 percent probability of being obese as adults, whereas, obesity is only a 7 percent risk for a normal weight child. The Advisory Commission noted that about 20 percent of overweight and obese children drank their way there by consuming too many fruit drinks, sports drinks, and sodas, and leading sedentary lives. The commission recommended increasing education and information to parents, school systems and medical providers. Goodyear and Everette (2010) made similar recommendations. Kalson (2009) detailed policies by the Pennsylvania Department of Health to actively tackle childhood obesity.

Goals and Objectives

The goal of this research was to track childhood obesity rates in rural and urban Pennsylvania public school districts over the 10-year period of 2005-2016, and to examine socio-economic conditions and

[3]See Ding, Lehrer, Rosenquist, and Audrain-McGovern (2009), Averett and Stifel (2010), Gurley-Calvez and Higginbotham (2010). Also noted in Sabia (2007), Averett and Korenman (1996) Cawley (2004), Mocan and Tekin (2009), Han, Norton, and Powell (2011).

[4]Zavodny (2013) demonstrates that children's weights are negatively related more to teacher assessments of their academic performance, than to their test scores. Vander Wal (2012) links obesity to unhealthy weight-control behavior, purely because of environmental stressors: low levels of parental support, low parental communication, exposure to bullying etc.

school district features that may be associated with obesity rates.

It also looked to gain insights into public school districts' understanding of youth obesity, and whether schools have adopted any preventative measures to address youth obesity in Pennsylvania.

The specific objectives were to:

- Derive the historical trends in obesity from the Growth Screens/BMI-for-Age Percentiles among school children in grades K-6 and 7-12 at the school-district level for the last 10 years.
- Derive the distribution of at-risk/overweight status in rural and urban school districts.
- Collect information on socio-economic characteristics, student academic achievement records and educational characteristics at the school district level.
- Link the above data to the information on BMI percentiles.
- Statistically test whether demographic, socio-economic and educational attainment are associated with the variance in obesity rates (whole data, rural/urban portions).
- Use analysis of variance techniques to characterize the link between obesity and the exogenous variables within rural and urban school districts and the overall data.
- Survey all public schools in Pennsylvania to get feedback and develop policy actions.
- Statistically test whether the survey responses differ across the distribution of obesity rates in the sample (whole data, rural/urban portions).

Methodology

The study used the Pennsylvania Department of Health's BMI percentiles for grades K-6 and grades 7-12 at the school district level for the years 2005 – 2016. Consequently, the level of analysis in this study is at the school district level. A typical observation is the BMI percentile of a particular grade within a school district for a given year.

The data were used to examine historical trends for different grades, for the whole sample, and for rural and urban school districts.

The data also provided information about the number of students falling in different BMI percentiles in a particular grade within a school district for a given year, and were used to compute the percent of students falling under different weight categories. Weight categories were derived from the CDC's standard measures based on BMI charts: BMI less than 5th percentile (underweight), BMI from the 5th to 85th percentile (normal weight or healthy weight), BMI from the 85th to 95th percentile (at risk), and BMI greater than 95th percentile (overweight).

The research used the Center for Rural Pennsylvania's definition of rural and urban school districts as follows: a school district is rural when the population density of the district is below the statewide average of 284 persons per square mile: a district is urban when the population density is above 284 persons per square mile.

The percentage of students for every school district for every year within the above weight categories can be calculated from the BMI data. Therefore, the number of students falling under each BMI percentile were used to classify school districts, according to the incidence of their overweight status, or the percent of students falling under the overweight category.

The distribution of BMI percentiles indicates the percent of overweight students in each school district for every year in the study sample. This study used the Center for Rural Pennsylvania's 2005 report to determine the classification of school districts into three types (Low, Medium and High), based on the following distribution of the average percentage of students who are in the overweight category:

- Low: School districts that have less than 16 percent overweight students;
- Medium: School districts where the percentage of overweight students ranges from 16 percent to 21 percent; and
- High: School districts that have more than 21 percent overweight students.

The research also collected data on key indicators for various socio-economic and school district characteristics. These included population in occupied housing, household size, householder type, race and ethnicity, age, educational attainment levels, poverty rates, housing values, income, number of business establishments and employees, PSSA scores in Math and Reading, the percent of students eligible for the free and reduced lunch programs, total enrollment in schools, staff-student ratios, the number bullying and other incidents dealing with misconduct, and other related variables.

The socio-economic and school district data were linked to the BMI data at the school district level. The study used correlation analysis to test the statistical association between BMI-distribution of the schools to all the socio-economic, academic performance and school-district characteristics, for the whole sample, and also for the rural-urban subsamples. Using individual variables from the full dataset as factors, the study also tested for equality of means using ANOVA, for the whole sample and within rural-urban subgroups.

The research also collected primary data using a survey to gain greater clarification and information on possible in-school policies, that can be adopted to promote awareness and implement specific actions. The seven-item survey was sent via the University of Pittsburgh's QUALTRICS Survey System. The survey solicited demographic data regarding the respondent's position (superintendent or principal) and county in which the school resides. The survey included:

- One question with three statements related to obesity in the school using a 5-point Likert Scale;

- One question with three statements related to vending machines in schools using a yes-no response;
- One question related to menu labeling in the schools using a yes-no response; and
- Two open-ended questions.

The survey was sent to all school superintendents using QUALTRICS. The superintendents were contacted initially via email to inform them about the research project. Subsequent email contacts provided them with a link to the online survey. The project was reviewed by the University of Pittsburgh's Institutional Review Board and approved as an Exempt Study.

Results

Historical Trends in Youth Obesity in PA

Table 1 and Figure 1 show the percentage of overweight and at-risk for overweight students in Pennsylvania school districts. Overall, the trends are clear: on average, 15 percent to 16 percent of the students are in the at-risk category, and 16 percent to 17 percent of the students are overweight. The percentages of overweight and at-risk have been rather steady over the last 10 years. Overall, about 33 percent of the students are either overweight or at-risk.

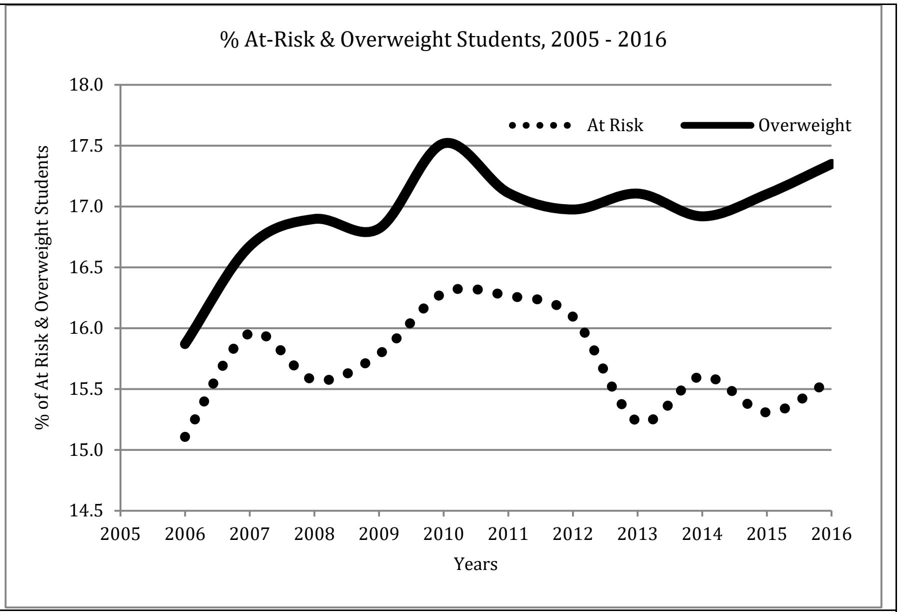
The percentage of overweight and at-risk students in grades K-6 (Table 2 and Figure 2) and for students in grades 7-12 (Table 3 and Figure 3) indicate the differences in trends between these groups. Of particular concern is the steady increase from 17.6 percent in 2006 to 20.5 percent in 2016 in the percentage of overweight students in grades 7-12. Based on these trends, the research found that, on average, about 34 percent of students in grades K-6 and about 36 percent of students in grades 7-12 belong to the overweight and at-risk groups. These recent figures for Pennsylvania children are much higher than those noted previously in *The State of Obesity*.

Of particular interest in this study is the difference in overweight and at-risk status between rural and urban school students. The trends in the percentage of overweight students in rural and urban school districts are presented in Table 4 and Figure 4 (K-6) and in Table 5 and Figure 5 (7-12). The analysis indicated that the percentage of overweight students in rural school districts is about 3 percent points greater than urban school districts. Further, Table 4 shows that the percentage of overweight students in grades 7-12 has been consistently high and steadily increasing.

Consequently, the overall trends from different grade levels, and from the rural-urban analysis, show that the problem of obesity among Pennsylvania children is ongoing.

Table 1 and Figure 1: Average Percent of At-Risk and Overweight Students in Pennsylvania, 2006-2016

Years	At-Risk	Overweight	Total
2006	15.1	15.9	31.0
2007	16.0	16.7	32.6
2008	15.6	16.9	32.5
2009	15.8	16.8	32.6
2010	16.3	17.5	33.8
2011	16.3	17.1	33.4
2012	16.1	17.0	33.1
2013	15.2	17.1	32.3
2014	15.6	16.9	32.5
2015	15.3	17.1	32.4
2016	15.6	17.4	32.9
Average	15.7	16.9	32.6



Notes: The table presents the annual average percent of at-risk and overweight students in grades K-12 attending Pennsylvania schools during the years 2006 to 2016. Students whose BMI falls between 85th to 95th percentiles are classified as at-risk, and those students whose BMI falls above the 95th percentile are classified as overweight. Data for 2005 not reported since data are available only for 82 school districts. See Appendix 1 for data sources.

Table 2 and Figure 2: Average Percentage of At-Risk and Overweight Pennsylvania Students in K-6, 2005 - 2016

Years	At-Risk	Overweight	Total
2005	16.3	17.6	33.9
2006	15.9	16.4	32.2
2007	16.3	17.7	34.1
2008	15.7	17.7	33.4
2009	16.2	17.8	33.9
2010	16.6	18.0	34.7
2011	16.4	17.9	34.3
2012	16.3	17.6	33.9
2013	15.2	17.5	32.7
2014	15.8	17.3	33.1
2015	15.6	17.5	33.1
2016	15.9	17.7	33.5
Average	16.0	17.6	33.6

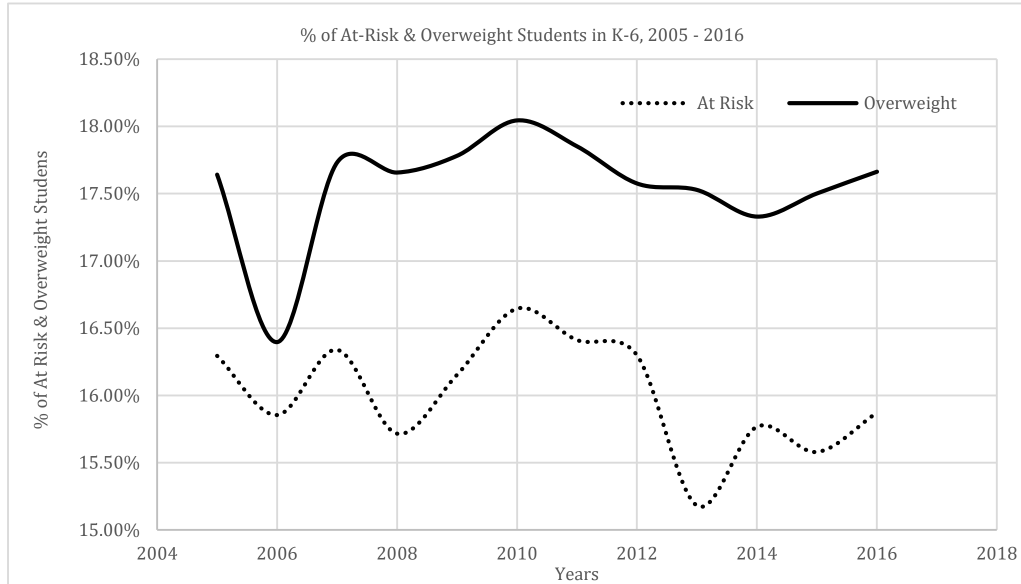


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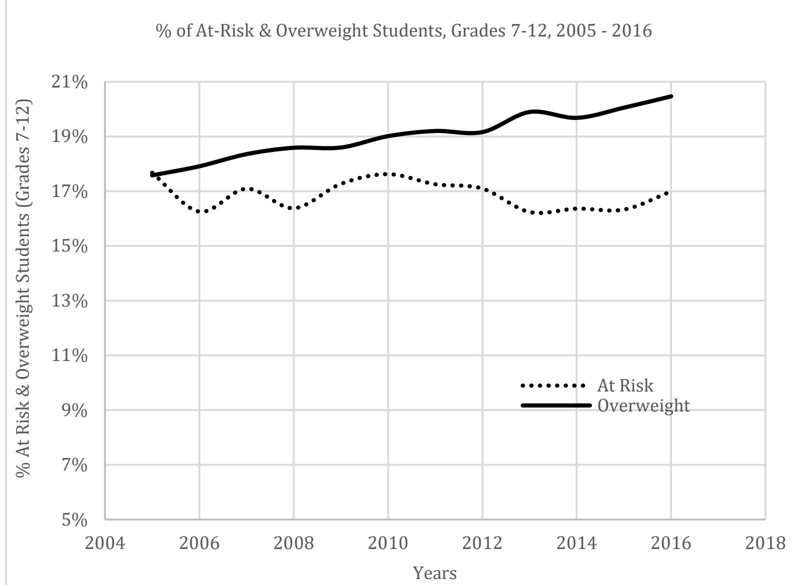
Table 3 and Figure 3: Average Percentage of At-Risk and Overweight Pennsylvania Students, Grades 7-12, 2005 - 2016

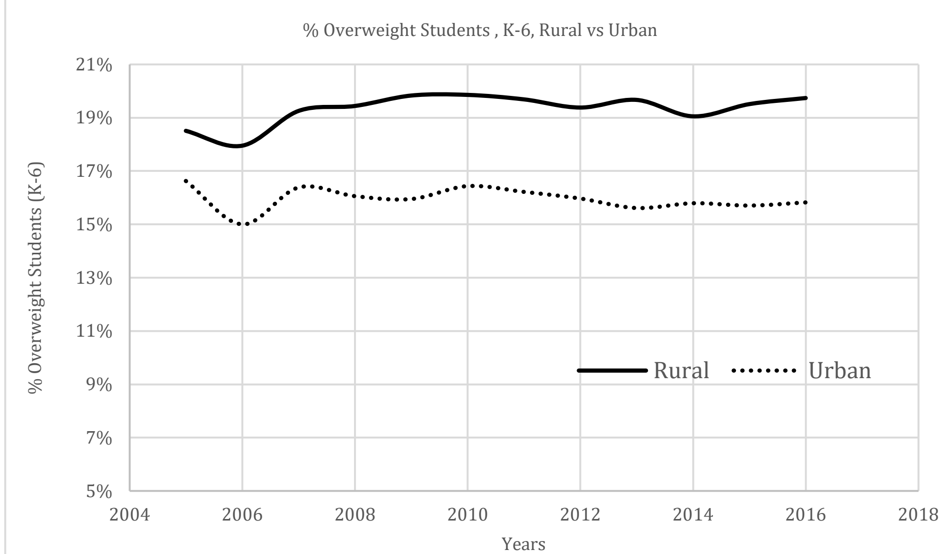
Years	At-Risk	Overweight	Total
2005	17.7	17.6	35.2
2006	16.3	17.9	34.2
2007	17.1	18.4	35.4
2008	16.4	18.6	35.0
2009	17.3	18.6	35.9
2010	17.6	19.0	36.6
2011	17.3	19.2	36.5
2012	17.1	19.2	36.3
2013	16.2	19.9	36.1
2014	16.4	19.7	36.0
2015	16.3	20.1	36.4
2016	17.0	20.5	37.5
Average	16.9	19.0	35.9



Notes: The table presents the annual average percent of at-risk and overweight students in grades 7-12 attending Pennsylvania schools during the years 2005 to 2016. Students whose BMI falls between 85th to 95th percentiles are classified as at-risk, and those students whose BMI falls above the 95th percentile are classified as overweight. See Appendix 1 for data sources.

Table 4 and Figure 4: Average Percentage of Overweight Pennsylvania Students, K-6, 2005 - 2016: Rural/Urban Comparison

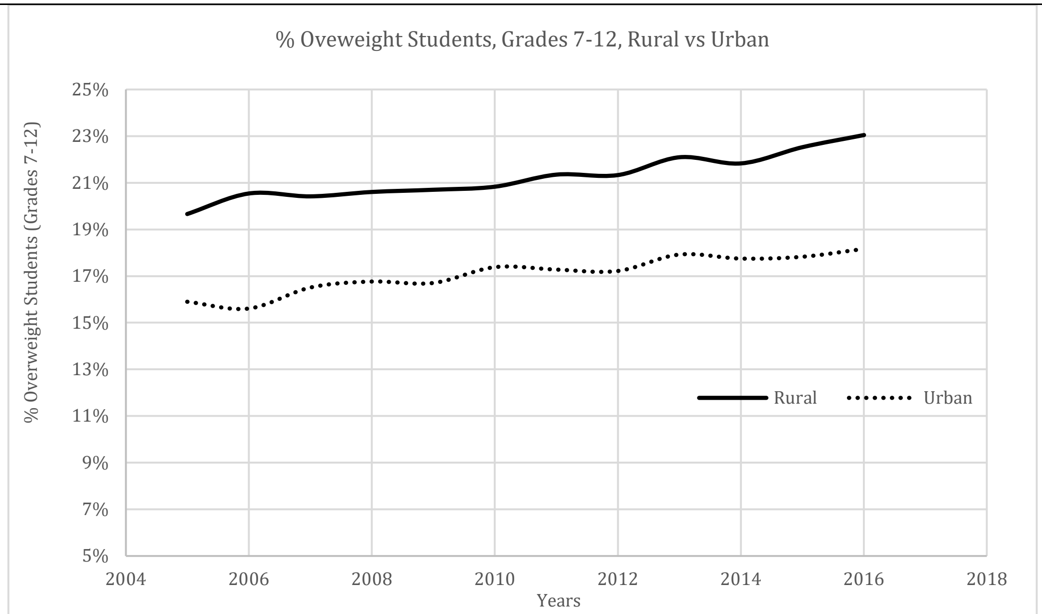
Years	Rural	Urban
2005	18.5	16.6
2006	18.0	15.0
2007	19.3	16.4
2008	19.4	16.1
2009	19.8	15.9
2010	19.9	16.4
2011	19.7	16.2
2012	19.4	16.0
2013	19.7	15.6
2014	19.1	15.8
2015	19.5	15.7
2016	19.7	15.8
Average	19.3	16.0



Notes: The table presents the annual average percent of at-risk and overweight students in rural and urban school districts from grades K-6 attending Pennsylvania schools during the years 2005 to 2016. Students whose BMI falls between 85th to 95th percentiles are classified as at-risk, and those students whose BMI falls above the 95th percentile are classified as overweight. School districts with a population density below the statewide average of 284 persons per square mile are classified as rural, and those at or above 284 persons per square mile are classified as urban. See Appendix 1 for data sources.

Table 5 and Figure 5: Percentage of Overweight Pennsylvania Students, Grades 7-12, 2005 – 2016, Rural/Urban Comparison

Years	**Rural**	**Urban**
2005	19.7	15.9
2006	20.5	15.6
2007	20.4	16.5
2008	20.6	16.8
2009	20.7	16.7
2010	20.8	17.4
2011	21.4	17.3
2012	21.3	17.2
2013	22.1	17.9
2014	21.8	17.8
2015	22.5	17.8
2016	23.0	18.2
Average	21.2	17.1



<u>Notes</u>: The table presents the annual average percent of at-risk and overweight students in rural and urban school districts from grades 7-12 attending Pennsylvania schools during the years 2005 to 2016. Students whose BMI falls between 85th to 95th percentiles are classified as at-risk, and those students whose BMI falls above the 95th percentile are classified as overweight. School districts with a population density below the statewide average of 284 persons per square mile are classified as rural, and those at or above 284 persons per square mile are classified as urban. See Appendix 1 for data sources.

Profile of School Districts

Table 6 shows the average number of students in grades 1 - 6 and grades 7 - 12, and the number of school districts in the study.

Table 6: Average Number of Students and School Districts in the Study, 2005 - 2016

	Grades 1 to 6	Grades 7 to 12	Overall
Number of students (Rural SD)	213,748	178,015	391,762
Number of students (Urban SD)	658,783	511,683	1,170,467
Number of students (whole sample)	872,531	689,698	1,562,229
Number of districts in the study (06 – 16)	497	475	499

Note: The table presents the average number of students in the years 2005-2016 at different grade levels from rural and urban districts. The average number of districts is for 2006 – 2016 (only 82 schools reported the data in 2005, and only 262 school districts reported BMI percentiles for grades 7-12 in 2006). BMI percentiles at the school district level (2005 – 2016) are from the Department of Education. Data sources are in Appendix 1.

Table 7 shows the average annual percentage for each of the weight categories for students from rural and urban school districts.

Table 7: Average Annual Percent of Rural and Urban Students by Weight Percentile, 2005 – 2016

Weight Categories	Rural	Urban	Overall
Underweight	2.20	2.55	2.39
Appropriate weight	61.21	64.86	63.14
At-Risk	16.39	16.16	16.27
Overweight	20.20	16.43	18.20
Number of districts	235	264	499

Note: Weight categories were based on the CDC's standard measures on BMI. BMI <5th percentile (Underweight), BMI between 5th to 85th percentile (Appropriate Weight), BMI between 85th to 95th percentile (At-Risk) and BMI > 95th percentile (Overweight). School districts with a population density below the statewide average of 284 persons per square mile are classified as rural, and those at or above 284 persons per square mile are classified as urban. BMI percentiles at the school district level (2005 – 2016) are from the Department of Education. Data sources are in Appendix 1.

Overall, Table 7 indicates that more than 32 percent of urban students and more than 36 percent of rural students are in the at-risk and overweight categories. About 61 percent of rural students and about 65 percent of urban students are the appropriate weight.

Table 8 adopts the above-mentioned weight classification and summarizes the above weight-distribution, based on the number of school districts, number of students, and rural-urban location. Taken together with Tables 7, 4 and 5, the analysis indicates that, on average, over the study period, the percentage of students in the High and Medium school district categories in both rural and urban school districts remains roughly equal. However, the annual percentage increase in Table 5 shows that the percentage of overweight students in the rural school districts has increased, and is consistently above the percentages observed in urban school districts.

Table 8: Percent Distribution of Weight Status in Rural and Urban School Districts

	RURAL DISTRICTS			URBAN DISTRICTS		
	Low SDs (<16% are overweight)	Medium SDs (16% to 21% are overweight)	High SDs (>21% are overweight)	Low SDs (<16% are overweight)	Medium SDs (16% to 21% are overweight)	High SDs (>21% are overweight)
Grades K– 6						
Average # of overweight students per district	1,913	2,207	1,753	3,624	5,644	6,255
Average # of students per district	13,345	11,747	7,742	29,452	30,836	28,367
Average %	14.3%	18.8%	22.6%	12.3%	18.3%	22.0%
Number of districts	28	147	60	129	112	23
Number of observations	313	1635	671	1346	1239	256
Grades 7 – 12						
Average # of overweight students per district	1,535	1,843	1,965	3,179	4,762	3,051
Average # of students per district	10,538	9,735	8,479	25,498	25,657	12,532
Average %	14.6%	18.9%	23.2%	12.5%	18.6%	24.3%
Number of districts	10	98	127	103	114	47
Number of observations	111	1,089	1,419	1,144	1,266	521

Notes: Following the 2005 Center for Rural Pennsylvania report, districts were divided into three categories based on the distribution of the average percentage of students who are in the overweight category: districts with less than 16% overweight students (Low), districts with 16% to 21% overweight students (Medium), and districts with greater than 21% overweight students (High). The districts are also subdivided into rural and urban locations, based on population per square mile. The total number of observations for K-6 = 5,460, and for 7-12 = 5,550. BMI percentiles at the school district level (2005 – 2016) are from the Department of Education. Data sources are in Appendix 1.

Obesity and Demographic Indicators

The average population in rural school districts in 1990 was about 12,600, and it has grown by about 10 percent from 1990 to 2016. The average population in urban school districts was about 31,700 in 1990, and it has grown by about 6 percent from 1990 to 2016. Minorities comprise roughly 4 percent of the rural population, and nearly 15 percent of the urban population.

About 20 percent of the population in both rural and urban school districts is school-aged. The percent of single-parent households without a spouse is much higher in urban districts, particularly in the High category districts. In urban districts, a greater percentage of the population has a college degree, particularly in the Low category districts (about 43 percent), compared to rural districts in the Low category (about 29 percent). The average number of SNAP retailers and the density of SNAP retailers are also much higher in urban districts, particularly in the High category (See Table 9).

Table 9: Demographic Characteristics of Rural & Urban School Districts by Percent of Overweight Status

DEMOGRAPHIC CHARACTERISTICS	RURAL DISTRICTS			URBAN DISTRICTS		
	Low Districts	Medium Districts	High Districts	Low Districts	Medium Districts	High Districts
SCHOOL DISTRICTS						
# SDs	10	140	85	112	122	30
POPULATION						
Average Total Population (1990)	13,566	13,624	10,615	27,632	42,272	25,404
Average Total Population (2000)	15,269	14,479	10,827	30,718	41,528	24,930
Average Total Population (2010)	16,126	15,131	10,668	33,327	41,894	24,742
Average Total Population (2016)	16,274	14,971	10,421	33,926	42,370	24,706
AGE DISTRIBUTION						
% < 18 years (2016)	21%	20%	20%	22%	21%	21%
% 18 to 64 years (2016)	62%	61%	60%	61%	62%	61%
% > 65 years 92016)	18%	19%	19%	18%	18%	18%
Median Age (2016)	43.28	43.50	44.54	42.56	41.51	41.59
RACIAL BREAKDOWN						
% Whites	96%	96%	96%	90%	85%	80%
% African American	1%	2%	1%	4%	9%	13%
% Hispanics or Latinos	2%	2%	2%	4%	5%	8%
FAMILIES						
# Households (2016)	6,161	5,795	4,112	12,950	16,612	9,702
# Families (2016)	4,394	3,974	2,792	8,919	9,811	5,837
Married Couples with Children (2016)	21%	18%	17%	23%	16%	11%
Married Couples with no Children (2016)	37%	37%	37%	35%	30%	26%
% Households with Single Parents with Children (<18) & No Spouse	6%	7%	7%	6%	9%	12%

Table 9 continued

DEMOGRAPHIC CHARACTERISTICS	RURAL DISTRICTS			URBAN DISTRICTS		
	Low Districts	Medium Districts	High Districts	Low Districts	Medium Districts	High Districts
FAMILIES						
Single Person Households (2016)	24%	26%	26%	26%	31%	35%
Other Types of Households & Families	11%	12%	12%	11%	14%	16%
Average # Persons per Household (2016)	2.53	2.47	2.47	2.52	2.42	2.33
EDUCATION ATTAINMENT						
% Without HS Diploma (2016)	8%	11%	12%	6%	10%	13%
% With HS Diploma or Equivalency (2016)	37%	46%	50%	27%	40%	42%
% With some college, no degree (2016)	17%	15%	15%	15%	17%	18%
% with Associates Degree (2016)	9%	9%	8%	8%	9%	9%
% with Bachelor's Degree or Higher (2016)	29%	19%	15%	43%	24%	18%
OTHER FEATURES						
Average # Bike Crashes (2011 - 2015)	3.08	3.09	1.52	10.62	37.62	15.09
Average # Pedestrian Crashes (2011 - 2015)	7.83	9.33	6.34	28.91	119.53	70.06
Average Crash Rate (Bike & Pedestrian)	13.95	14.87	13.59	21.44	31.53	43.50
Average Acreage of Local & State Parks	869.38	1,249.16	1,388.05	793.75	575.12	212.34
Average Miles of Biking Trails	9.80	12.22	6.21	7.83	4.81	4.64
Average Acres of Local/State Park Bike Trails	881	1,262	1,396	803	581	218
Average Parkland per 1,000 people	47	115	145	25	20	9
Average # SNAP Retailers	9.58	11	9	18	43	30
Average # of SNAP Retailers per 100,000	66	75	81.69	53.28	84.40	116.59

Data sources are in Appendix 1.

Table 10 presents the results of the correlation analysis between the percent of overweight students and certain demographic indicators. Correlation measures were estimated for the rural and urban sub-groups and also for the entire dataset. For rural school districts, none of the indicators are strongly correlated with the percentage of overweight students. The percentage of married couple families with children, the percentage of the population with some college, and the percentage of the population with a college a degree are all negatively, but weakly, correlated to the percentage of overweight students in rural districts.

There were some strong and significant correlations for urban school districts. The percentage of the population without a high school diploma is strongly and positively correlated with the overweight status, and the percentage of the population with a bachelor's degree or higher, and market values per capita are strongly and negatively correlated with overweight status in urban districts.

The average number of SNAP retailers per 100,000 is also positively correlated with overweight status in the urban school districts.

The overall grouped data also indicated the same features with respect to the percentage of the population without a high school diploma (negative and significant) and the average number of SNAP retailers per 100,000 (positive and significant).

Table 10: Correlation between Demographic Indicators and Percent of Overweight Students

Demographic Indicators	Rural	Urban	Overall
Minorities			
% African American	No	No	No
AGE			
% < 18 years (2016)	No	No	Weak (-)
% 18 to 64 years (2016)	No	No	No
% > 65 years (2016)	No	No	Weak (+)
Family Size & Status			
Married Couples with children < 18 years	Weak (-)	Yes (-)	Weak (-)
Married Couples with no children < 18 years	No	Weak (-)	No
Single Parents with Children, No Spouse	No	Weak (+)	Weak (+)
Single Person Household	No	Weak (+)	Weak (+)
Other types of Household & Families	No	Weak (+)	Weak (+)
Average # Persons per Household	No	Weak (+)	Weak (+)
Education Status			
% with no HS Diploma (2016)	Weak (+)	Weak (+)	Weak (+)
% with HS Diploma or equivalency	No	Yes (+)	Yes (+)
% with some college, no degree	Weak (-)	Weak (+)	Weak (+)
% with Associates degree	No	No	Weak (+)
% with Bachelor's degree or higher	Weak (-)	Yes (-)	Weak (-)
Total # Students enrolled in K-12 (2016)	Weak (-)	No	No
% enrolled in public schools (2016)	No	Weak (+)	Weak (+)
% enrolled in private schools (2016)	No	Weak (-)	Weak (-)
Revenues & Expenditures			
Total Revenue (2016)	Weak (-)	No	No
% Revenues from Local Sources	Weak (-)	Weak (-)	Weak (-)
% Revenues from State Sources	Weak (+)	Yes (+)	Weak (+)
% Revenues from Federal & Other Sources	No	Weak (+)	Weak (+)
Market Value of Taxable Properties	Weak (-)	Weak (-)	Weak (-)
Market Value per capita	Weak (-)	Yes (-)	Weak (-)
Total Expenditures	Weak (-)	Weak (-)	No
Expenditure per Student	No	Weak (-)	Weak (-)
Other Indicators			
Average # Bike Crashes (2011 - 2015)	No	No	No
Average # Pedestrian Crashes (2011 - 2015)	No	No	No
Average Crash Rate (Bike & Pedestrian)	No	Weak (+)	No
Average Acreage of Local & State Parks	No	Weak (-)	No

Average Miles of Biking Trails	No	No	No
Average Acres of Local/State Parks Bike Trails	No	No	No
Average Parkland per 1000 people	No	No	No
Average # SNAP Retailers	No	No	No
Average # of SNAP Retailers per 100,000	No	Yes (+)	Weak (+)
"Yes" refers to the demographic indicators that are significantly and strongly correlated with the overweight status. Indicators are strongly correlated with the overweight status if the correlation statistic is greater than or equal to 0.6. "Weak" refers to the demographic indicators that are significantly but weakly correlated with the overweight status. A weak correlation means that the coefficient of correlation is less than 0.6. "No" refers to the indicators that are not significantly correlated at the 0.05 level. Note: Data sources are in Appendix 1.			

Table 11 presents the results of ANOVA to test differences between the indicators in Low, Medium and High districts, and the percent of overweight students. ANOVA was applied separately to the rural and urban data subgroups and to the overall grouped data.

Among the indicators that differ significantly between school districts are: the percentage of married couples with children, the percentage without a high school diploma, the percent with a high school diploma or equivalency, the percent with some college degree, the percent with a Bachelor's degree or higher, the percent of revenues from local and state sources, the market value of taxable properties, and per capita market values. The same set of indicators also differs significantly across urban school districts. In addition, all family size and status indicators differ significantly across urban school districts. The percent with an associate's degree, and the percent enrolled in public and private schools are also significantly different. The average number of SNAP retailers per 100,000 is significantly different across urban school districts and in the whole sample.

Table 11: Demographic Indicators and the Percent of Overweight Students

Demographic Indicators	**Rural**	**Urban**	**Overall**
Minorities			
% African American	No	No	No
AGE			
% < 18 years (2016)	No	No	No
% 18 to 64 years (2016)	No	No	No
% > 65 years (2016)	No	No	No
Family Size & Status			
Married Couples with children < 18 years	Yes	Yes	Yes
Married Couples with no children < 18 years	No	Yes	No
Single Parents with Children, No Spouse	No	Yes	Yes
Single Person Household	No	Yes	Yes
Other types of Household & Families	No	Yes	Yes
Average # Persons per Household	No	Yes	Yes
Education Status			

% with no HS Diploma (2016)	Yes	Yes	Yes
% with HS Diploma or equivalency	Yes	Yes	Yes
% with some college, no degree	Yes	Yes	Yes
% with Associates degree	No	Yes	Yes
% with Bachelor's degree or higher	Yes	Yes	Yes
Total # Students enrolled in K-12 (2016)	No	No	no
% enrolled in public schools (2016)	No	Yes	Yes
% enrolled in private schools (2016)	No	Yes	Yes
Revenues & Expenditures			
Total Revenue (2016)	No	No	No
% Revenues from Local Sources	Yes	Yes	Yes
% Revenues from State Sources	Yes	Yes	Yes
% Revenues from Federal & Other Sources	No	Yes	Yes
Market Value of Taxable Properties	Yes	Yes	Yes
Market Value per capita	Yes	Yes	Yes
Total Expenditures	No	No	No
Expenditure per Student	No	No	No
Other Indicators			
Average # Bike Crashes (2011 - 2015)	Yes	No	No
Average # Pedestrian Crashes (2011 - 2015)	No	No	No
Average Crash Rate (Bike & Pedestrian)	No	No	No
Average Acreage of Local & State Parks	No	No	No
Average Miles of Biking Trails	No	No	No
Average Acres of Local/State Parks Bike Trails	No	No	No
Average Parkland per 1000 people	No	No	Yes
Average # SNAP Retailers	No	No	No
Average # of SNAP Retailers per 100,000	No	Yes	Yes

“Yes” refers to the indicators that are significantly different between the districts with low, medium and high percentages of overweight status, at the 0.05 level.
“No” represents indicators that are not statistically significant at 0.05 level.
Data sources are in Appendix 1.

These results indicate that there is partial evidence to suggest that key demographic variables are associated closely with the percentage of overweight students between different districts.

Obesity and Economic Indicators

Table 12 presents several economic indicators and their differences across rural and urban school districts based on the overweight distribution classification.

Rural districts are generally poorer, with fewer housing units, and with median rents of $730 and average rents of $774. In urban school districts, median rents are $848 and average rents are roughly $896. In urban districts, the median household income is $4,800 higher, on average, and per-capita income is $8,100 higher, on average than in rural districts.

There are more establishments and workers, and consequently, higher payrolls in urban districts. Labor force participation rates are higher in urban districts for the following occupation categories: Management, Business, Science, and Arts, and Sales and Service. Labor force participation rates in occupations involving Transportation, Agriculture, Construction and Manufacturing are higher in rural districts. Insurance coverage is roughly the same across urban and rural school districts. The data also indicate that the percentage of families receiving Supplemental Security Income, cash public assistance benefits, and SNAP benefits is higher in urban districts than rural districts, particularly in those urban districts where the incidence of overweight is High. For instance, when considering the school districts with High overweight status, 17.31 percent of families in urban districts received SNAP benefits compared to 12.27 percent of families in rural districts.

Family income and benefits also play an interesting role in overweight status. For instance, Table 12 indicates that as income and benefits brackets increase from the <$10,000 category to the $50,000 to $74,000 category, the percent of households in the High overweight category increases in both urban and rural districts (from 6.5 percent to 20.6 percent in rural districts, and 9.17 percent to 18.59 percent in urban districts). However, as income increases beyond $75,000, the percent of households in the High overweight category begins to fall in both rural and urban school districts. The same relation between higher incomes and the incidence of obesity is also present in districts in the Low and Medium categories.

Table 12: Differences between Economic Characteristics of Rural and Urban School Districts by Percent of Overweight Status

ECONOMIC CHARACTERISTICS	RURAL DISTRICTS			URBAN DISTRICTS		
	Low Districts	Medium Districts	High Districts	Low Districts	Medium Districts	High Districts
SCHOOL DISTRICTS						
# SDs	10	140	85	112	122	30
HOUSING CHARACTERISTICS						
# Housing Units (2016)	6,671	7,030	5,087	11,156	13,688	18,665
% Units Occupied (2016)	92%	84%	80%	86%	95%	90%
% Units Vacant (2016)	8%	16%	20%	14%	5%	10%
# Vacant Housing Units (2016)	509	1235	975	1454	738	2052
% Vacant for Seasonal, Recreational/Other uses	30%	38%	47%	6%	8%	7%
% Vacant for Rent, Sale or other reasons	70%	62%	53%	94%	92%	93%
# Occupied Housing Units (2016)	6161	5795	4112	9702	12950	16612
% Homeownership (Owner-Occupied)	81%	78%	78%	61%	76%	68%
% Renters (Renter-Occupied)	19%	22%	22%	39%	24%	32%
% Single-Family Homes (1 Unit Detached) (2016)	79%	76%	75%	59%	67%	60%
% Duplex or Townhouses (1 Unit Attached)	4%	4%	4%	15%	13%	16%
% Small Apartment Type Building (2 - 9 Units)	7%	7%	6%	17%	9%	13%
% Large Apartment Type Building (10 + Units)	3%	3%	2%	8%	9%	7%
% Mobile Homes and Other Types of Units	7%	10%	13%	2%	2%	3%
Median Gross Rent (2016)	$838	$704	$649	$1,043	$798	$704
Average Gross Rent (2016)	$903	$743	$678	$1,138	$837	$716
INCOME & BENEFITS (2007 – 2016)						
% Households < $10,000	5%	6%	7%	4%	6%	9%
% Households: $10,000 - $14,999	5%	6%	6%	4%	6%	8%
% Households: $15,000 - $24,999	10%	12%	13%	8%	11%	14%
% Households: $25,000 - $34,999	11%	12%	13%	8%	11%	12%
% Households: $35,000 - $49,999	14%	16%	16%	12%	15%	15%
% Households: $50,000 - $74,999	21%	21%	21%	18%	20%	19%

% Households: $75,000 - $99,999	14%	13%	12%	14%	13%	11%
% Households: $100,000 - $149,999	14%	11%	9%	17%	12%	9%
% Households: $150,000 - $199,999	4%	3%	2%	7%	3%	2%
% Households: > $200,000	3%	2%	1%	8%	3%	1%
Median Household Income	$57,413	$49,135	$45,108	$71,796	$52,213	$42,059
Mean Household Income	$70,206	$60,573	$55,677	$92,888	$64,735	$53,224
EARNINGS & INCOME (2007 – 2016)						
% families with earnings	78%	74%	72%	79%	76%	72%
% of families with Social Security	33%	36%	39%	31%	34%	36%
% of families with Supplemental Security Income	4%	5%	6%	3%	5%	7%
% of families with cash public assistance program	2%	3%	3%	2%	3%	5%
% of families with Food Stamp/SNAP benefits	7%	10%	12%	5%	11%	17%
Median family income	$68,012	$59,291	$54,497	$88,572	$64,561	$52,813
Mean family income	$80,552	$70,201	$64,142	$110,173	$76,391	$63,027
Per capital income	$27,200	$24,139	$22,480	$36,316	$26,523	$22,560
POVERTY						
Poverty Rate for All Groups (2016)	8%	12%	14%	6%	14%	20%
Poverty Rate for Children < 18, (2016.)	10%	17%	21%	8%	20%	32%
INSURANCE (2012 – 2016)						
% Children < 18, with Health Ins (2016)	96%	93%	93%	96%	97%	96%
% Children < 18, without Health Ins (2016)	4%	7%	7%	4%	3%	4%
% Working Age Adults with Health Ins (2016)	92%	89%	87%	87%	93%	89%
% Working Age Adults without Health Ins (2016)	8%	11%	13%	13%	7%	11%
ESTABLISHMENTS & PAYROLL (2007 – 2016)						
Average # of Establishments	269	285	165	961	858	722
Average # of workers	3,722	3,962	2,153	16,015	15,783	11,518
Average I Quarter Payroll	$30,427	$30,885	$17,159	$182,027	$168,548	$103,985
Average Annual Payroll	$126,464	$129,945	$72,515	$730,062	$682,854	$435,496
EMPLOYMENT & LABOR FORCE (2007 – 2016)						
Mean Working Age Population	13,638	13,128	9,948	28,274	38,161	21,768

Average % in Labor Force	64%	60%	58%	66%	64%	61%
Average % in Labor Force (Employed)	93%	93%	92%	94%	92%	90%
Average % in Labor Force (Unemployed)	6%	7%	8%	6%	7%	9%
Average % Females in Labor Force	46%	46%	46%	47%	48%	49%
Average % Females in Labor Force (Employed)	43%	43%	42%	45%	45%	45%
Average % Working with Children (< 6 years)	12%	12%	13%	12%	13%	14%
Average % Work with Children, all parents in labor force	8%	8%	8%	8%	9%	10%
COMMUTING TIME (2007 – 2016)						
Average % Labor Force Commuting to Work	92%	91%	90%	92%	90%	88%
Average % Commuting using Public Transport	0.39%	0.42%	0.29%	3%	3%	3%
Average Travel Time to Work (Minutes)	26.54	25.47	26.41	25.45	24.44	23.67
OCCUPATIONS (2007 – 2016)						
% Labor Force in Mgmt, Busi, Sci & Arts	32%	28.9216	25.8947	43.874	32.5588	27.8245
% Labor Force in Service Occupations	16%	17.4558	17.9725	13.7448	17.6387	20.9121
% Labor Force in Sales and Office Occupations	23%	22.7774	21.5907	25.2713	25.7968	25.7258
% Labor Force in Natural Resources, Construction & Maintenance Occupations	12%	12.2221	13.6774	7.0423	8.8016	8.6466
% Labor Force in Production, Transportation & Material Moving Occupations	16%	18.541	20.8367	9.9836	15.1414	16.8764
% Labor Force in Agriculture, Forestry, Fishing & Hunting, and Mining Industry	3%	3.28268	4.53063	0.84626	1.00198	0.79363
% Labor Force in Construction Industry	8%	8%	8%	6%	6%	6%
% Labor Force in Manufacturing	15%	15%	16.%	12%	14%	13%
% Labor Force in Wholesale Trade	3%	2%	2%	3%	3%	3%
% Labor Force in Retail Trade	12%	12%	12%	11%	12%	13%
Note: Economic Indicators are all from US Census Bureau using the American Community Survey series through the American FactFinder in https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Details are in Appendix 1.						

Table 13 presents the results of the correlation analysis of overweight students and economic indicators. Correlation measures were estimated for the rural and urban sub-groups and also for the entire dataset. For rural school districts, mean gross rent and median gross rent are both significantly and strongly negatively correlated with the percentage of overweight students. Besides these two variables, none of the other indicators are strongly correlated with the percentage of overweight students for rural districts.

Both mean gross rent and median gross rent are also significant and negative for urban school districts. Besides these two indicators, labor force participation rates in Management, Business, Science, and Arts, and Sales and Service are also significantly correlated with the percent of overweight students. While the participation rate in Management, Business, Science and Arts is negatively associated with overweight status, the correlation with the participation rate in Service is positive.

Table 12 indicated that as income levels rise, the percent of students in school districts with High overweight status initially increases, and then declines at higher income levels. Related to this feature, Table 13 also presents an interesting relation between income levels and the incidence of overweight. For urban school districts and for the overall grouped data, there is a significant negative correlation between overweight status and income, particularly at higher income levels, namely for the last three upper-income groups. That is, as income increases above $100,000, the incidence of overweight falls in urban school districts, echoing the findings from Table 12.

Table 13: Correlation between Economic Indicators and Percent of Overweight Students

Economic Indicators	**Rural**	**Urban**	**Overall**
LABOR FORCE			
Average % in Labor Force	Weak (-)	Weak (-)	Weak (-)
Average % in Labor Force (Employed)	Weak (-)	Weak (-)	Weak (-)
Average % in Labor Force (Unemployed)	Weak (+)	Weak (+)	Weak (+)
Average % Females in Labor Force	Weak (-)	Weak (+)	No
Average % Females in Labor Force (Employed)	Weak (-)	Weak (+)	Weak (-)
Average % Working with Children (< 6 years)	Weak (+)	Weak (+)	Weak (+)
Average % Work with Children, all parents in labor force	Weak (+)	Weak (+)	Weak (+)
COMMUTING TIME			
Average % Labor Force Commuting to Work	Weak (-)	Weak (-)	Weak (-)
Average % Commuting using Public Transport	Weak (-)	Weak (-)	Weak (-)
OCCUPATIONS			
% Labor Force in Mgmt, Busi, Sci & Arts	Weak (-)	Yes (-)	Yes (-)
% Labor Force in Service Occupations	Weak (+)	Yes (+)	Weak (+)
% Labor Force in Sales and Office Occupations	Weak (-)	Weak (+)	Weak (-)

% in Natural Resources, Construction & Maint Occup	Weak (+)	Weak (+)	Weak (+)
% in Agri, Forestry, Fishing & Hunting, & Mining Industry	Weak (+)	Weak (+)	Yes (+)
% Production, Transportation & Material Moving	Weak (+)	Weak (+)	Weak (+)
% Labor Force in Construction Industry	No	Weak (+)	Weak (+)
% Labor Force in Manufacturing	Weak (+)	Weak (+)	Weak (+)
% Labor Force in Wholesale Trade	Weak (-)	Weak (-)	Weak (-)
% Labor Force in Retail Trade	No	Weak (-)	Weak (+)
INCOME & BENEFITS			
% Households < $10,000	Weak (+)	Weak (+)	Weak (+)
% Households: $10,000 - $14,999	Weak (+)	Weak (+)	Weak (+)
% Households: $15,000 - $24,999	Weak (+)	Yes (+)	Yes (+)
% Households: $25,000 - $34,999	Weak (+)	Yes (+)	Weak (+)
% Households: $35,000 - $49,999	Weak (+)	Weak (+)	Weak (+)
% Households: $50,000 - $74,999	Weak (-)	Weak (+)	Weak (+)
% Households: $75,000 - $99,999	Weak (-)	Weak (-)	Weak (-)
% Households: $100,000 - $149,999	Weak (-)	Yes (-)	Yes (-)
% Households: $150,000 - $199,999	Weak (-)	Yes (-)	Yes (-)
% Households: > $200,000	Weak (-)	Yes (-)	Yes (-)
EARNINGS & INCOME			
% families with earnings	Weak (-)	Weak (-)	Weak (-)
% of families with Social Security	Weak (+)	Weak (+)	Weak (+)
% of families with Supplemental Security Income	Weak (+)	Weak (+)	Weak (+)
% of families with cash public assistance program	Weak (+)	Weak (+)	Weak (+)
% of families with Food Stamp/SNAP benefits	Weak (+)	Yes (+)	Weak (+)
RENT			
Median Gross Rent (2016)	Yes (-)	Yes (-)	Weak (-)
Mean Gross Rent (2016)	Yes (-)	Yes (-)	Weak (-)
POVERTY			
Poverty Rate for All Ages (2016)	Weak (+)	Weak (+)	Weak (+)
Poverty Rate for Children, < 18 years (2016)	Weak (+)	Weak (+)	Weak (+)
% families below poverty line (2007 - 2016 data)	No	Weak (+)	Weak (+)
% families below PL with child < 18 years (2007 - 2016)	Weak (+)	Weak (+)	Weak (+)
% families below PL, female HOH (no husband present)	No	Weak (+)	Weak (+)
% fam below PL, female HOH (no husband) with children	Weak (+)	Weak (+)	Weak (+)
INSURANCE			
% Children with Health Insurance (2016)	No	No	No
% Children without Health Insurance (2016)	No	No	No
% Working Adults with Health Insurance (2016)	Weak (-)	Weak (-)	Weak (-)
% Working Adults without Health Insurance (2016)	Weak (+)	Weak (+)	Weak (+)

% Civilian Pop with Coverage (2012-2016)	Weak (-)	Weak (-)	Weak (-)
% Civilian Pop without Coverage (2012 - 2016)	Weak (+)	Weak (+)	Weak (+)
% Civilian Pop < 18 years without Coverage (2012 - 16)	Weak (+)	Weak (+)	Weak (+)
% Civilian Pop, Employed Adults without Coverage	Weak (+)	Weak (+)	Weak (+)
% Civilian Pop, Unemployed, Adults without Coverage	Weak (+)	Weak (+)	Weak (+)

"Yes" refers to the economic indicators that are significantly and strongly correlated with the overweight status. Indicators are strongly correlated with the overweight status if the correlation statistic is greater than or equal to 0.6. "Weak" refers to the economic indicators that are significantly but weakly correlated with the overweight status. A weak correlation means that the coefficient of correlation is less than 0.6. "No" refers to the indicators that are not significantly correlated at the 0.05 level.
Note: Economic Indicators are all from the U.S. Census Bureau using the American Community Survey series through the American FactFinder in https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Details are in Appendix 1.

Table 14 presents the results of ANOVA, which test the difference between the economic indicators in Low, Medium and High districts and the percent of overweight students. ANOVA has been applied separately to the rural and urban data sub-groups and to the overall grouped data. With the exception of variables related to commuting time, all the indicators differ significantly for urban districts and also for the overall data. ANOVA applied to the rural subgroup data indicates that the following indicators are not significantly different between school districts: commuting time, the percent of households in the $50,000 - $74,999 income group, and the percent of the labor force employed in Agriculture, Forestry, Fishing and Hunting, and Mining. Overall, the ANOVA results indicate that most of the economic indicators differ significantly in rural and urban districts. This is an important result, because it suggests that there are pertinent economic indicators that are closely associated with the overweight distribution in these school districts.

Table 14: ANOVA: Economic Indicators and the Percent of Overweight Status

Economic Indicators	**Rural**	**Urban**	**Overall**
LABOR FORCE (2007 – 2016)			
Average % in Labor Force	Yes	Yes	Yes
Average % in Labor Force (Employed)	Yes	Yes	Yes
Average % in Labor Force (Unemployed)	Yes	Yes	Yes
Average % Females in Labor Force	Yes	Yes	Yes
Average % Females in Labor Force (Employed)	Yes	Yes	Yes
Average % Working with Children (< 6 years)	Yes	Yes	Yes
Average % Work with Children, all parents in labor force	Yes	Yes	Yes
COMMUTING TIME (2007 – 2016)			
Average % Labor Force Commuting to Work	No	No	No
Average % Commuting using Public Transport	No	No	No
OCCUPATIONS (2007 – 2016)			
% Labor Force in Mgmt, Busi, Sci & Arts	Yes	Yes	Yes

% Labor Force in Service Occupations	Yes	Yes	Yes
% Labor Force in Sales and Office Occupations	Yes	Yes	Yes
% in Natural Resources, Construction & Maint Occup	Yes	Yes	Yes
% in Agri, Forestry, Fishing & Hunting, & Mining Industry	No	Yes	Yes
% Production, Transportation & Material Moving	Yes	Yes	Yes
% Labor Force in Construction Industry	Yes	Yes	Yes
% Labor Force in Manufacturing	Yes	Yes	Yes
% Labor Force in Wholesale Trade	Yes	Yes	Yes
% Labor Force in Retail Trade	Yes	Yes	Yes
INCOME & BENEFITS (2007 – 2016)			
% Households < $10,000	Yes	Yes	Yes
% Households: $10,000 - $14,999	Yes	Yes	Yes
% Households: $15,000 - $24,999	Yes	Yes	Yes
% Households: $25,000 - $34,999	Yes	Yes	Yes
% Households: $35,000 - $49,999	Yes	Yes	Yes
% Households: $50,000 - $74,999	No	Yes	Yes
% Households: $75,000 - $99,999	Yes	Yes	Yes
% Households: $10,000 - $149,999	Yes	Yes	Yes
% Households: $150,000 - $199,999	Yes	Yes	Yes
% Households: > $200,000	Yes	Yes	Yes
EARNINGS & INCOME (2007 – 2016)			
% families with earnings	Yes	Yes	Yes
% of families with Social Security	Yes	Yes	Yes
% of families with Supplemental Security Income	Yes	Yes	Yes
% of families with cash public assistance program	Yes	Yes	Yes
% of families with Food Stamp/SNAP benefits	Yes	Yes	Yes
RENT			
Median Gross Rent (2016)	Yes	Yes	Yes
Mean Gross Rent (2016)	Yes	Yes	Yes
POVERTY (2007 – 2016)			
Poverty Rate for All Ages (2016 data)	Yes	Yes	Yes
Poverty Rate for Children, < 18 years (2016 data)	Yes	Yes	Yes
% families below poverty line (2007 - 2016 data)	Yes	Yes	Yes
% families below PL with child < 18 years (2007 - 2016)	Yes	Yes	Yes
% families below PL, female HOH (no husband present)	Yes	Yes	Yes
% families below PL, female HOH (no husband) with children	Yes	Yes	Yes
INSURANCE (2012 – 2016)			
% Children with Health Insurance (2016)	Yes	Yes	Yes
% Children without Health Insurance (2016)	Yes	Yes	Yes
% Working Adults with Health Insurance (2016)	Yes	Yes	Yes
% Working Adults without Health Insurance (2016)	Yes	Yes	Yes

% Civilian Pop with Coverage (2012-2016)	Yes	Yes	Yes
% Civilian Pop without Coverage (2012 - 2016)	Yes	Yes	Yes
% Civilian Pop < 18 years without Coverage (2012 - 2016)	Yes	Yes	Yes
% Civilian Pop, Employed Adults without Coverage	Yes	Yes	Yes
% Civilian Pop, Unemployed, Adults without Coverage	Yes	Yes	Yes
"Yes" refers to the economic indicators that are significantly different between the districts with low, medium and high percentages of overweight status, at the 0.05 level "No" represents indicators that are not statistically significant at 0.05 level Note: Economic indicators are all from the U.S. Census Bureau using the American Community Survey series through the American FactFinder in https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Details are in Appendix 1.			

For the rural districts in the study, mean gross rent and median gross rent are the only two variables that are significantly and negatively correlated with the percentage of overweight students. In other words, the percentage of students who are overweight declines as rent increases.

For urban districts, labor force participation rates in Management, Business, Science and Arts, and Services are also strongly and significantly correlated. Further, the percent of overweight students is positively correlated to the proportion of SNAP participants in urban school districts. Hence, the percentage of students who are overweight increases as the percent of families with SNAP benefits increases.

Importantly, the incidence of overweight is negatively correlated with income at the upper end of income distributions. In other words, as income increases, the incidence of overweight decreases.

For both urban and rural districts, there are significant differences in almost all economic indicators. In particular, for the rural and the urban sub-group data, and for the overall data, the ANOVA results indicate that there are important economic forces that are closely related to the distribution of overweight status within rural and urban school districts.

Obesity and School District Indicators

Table 15 presents the descriptive statistics of five main school district indicators and their differences across rural and urban school districts based on the overweight classification.

The average enrollment per district is 1,865 in rural school districts and 4,438 in urban school districts. The ratio of students to professionals is almost identical. However, over the study period, rural school buildings had 112 fewer students, on average, than urban school buildings. The educational outcome measures, in terms of PSSA scores, indicate that, in urban school districts, there is a larger percent of students scoring in the Advanced category for Math and Reading.

In both the rural and urban school districts, the dropout rate is lowest in the Low overweight group and increases in the Medium and High groups. The dropout rate for schools in the Medium and High overweight category is greater in urban school districts. For instance, within schools falling in the High overweight category, 1.2 percent of rural students dropped out of school, compared to 1.94 percent of urban students.

Table 15 also indicates that, in both rural and urban school districts, the violence incident rate (total incidents per student) during the sample period increases as the percent of overweight students increase. Further, the incident rates in the Medium and High overweight categories are greater in urban school districts. Rural school districts have a slightly higher bullying-incident rate (bullying incidents divided by total incidents reported), particularly in the Medium and High overweight categories. Interestingly, the bullying-incident rate is higher in the Low urban district group.

Finally, participation in the Free and Reduced Lunch Programs is slightly higher in rural school districts than in urban districts. During the sample period, the average participation rate in the programs was about 32 percent in rural districts and about 37 percent in urban districts.

Table 15: Differences between School District Characteristics of Rural & Urban School Districts by Percent of Overweight Status

SCHOOL DISTRICT CHARACTERISTICS	RURAL DISTRICTS			URBAN DISTRICTS		
	Low Districts	Medium Districts	High Districts	Low Districts	Medium Districts	High Districts
SCHOOL DISTRICTS						
# SDs	10	140	85	112	122	30
ENROLLMENT						
Average Enrollment per District	2,184	2,007	1,405	4,918	5,023	3,374
Average # K-12 Enrolled (2016)	2,631.75	2,280.55	1,563.69	5,537.54	6,299.58	3,988.88
Average % in Public Schools (2016)	88%	88%	91%	86%	88%	90%
Average % in Private Schools (2016)	12%	12%	9%	14%	12%	10%
Average # Students (2006-07)	2,489.09	2,221.84	1,614.08	4,824.4	5,657.82	3,767.49
Average # Students (2012-13)	2,326.8	2,044.93	1,469.62	4,811.17	5,514.61	3,641.77
Average # Students (2016-17)	2,219.2	1,944.03	1,384.44	4,803.67	5,476.87	3,602.87
Average # Classroom Teachers (2016-17)	151.083	133.578	98.693	309.930	301.419	215.063
Average Students per Classroom Teacher	14.727	14.314	13.508	15.452	16.206	15.553
Average % Graduates (2014 - 15)	93%	91%	90%	95%	85%	82%
Average % Graduates (2015 - 16)	92%	91%	91%	95%	87%	81%
Average % Graduates (2016 - 17)	94%	92%	91%	95%	88%	85%
ATHLETIC EXPENDITURES (2012 – 2016)						
Athletic Expenditures Per Student	$103.21	$130.24	$176.92	$83.28	$94.10	$112.02
FREE & REDUCED LUNCH (2005 – 2016)						
Free and Reduced Lunch	20.98	34.21	41.04	17.21	39.00	55.11
STAFF/TEACHER RATIO (2007 - 2016)						
Average # Professional Staff Per District	108	179	141	232	312	313
Ratio of Students to Professional Staff	15.15	14.44	13.52	16.85	15.99	15.32
STUDENT/BUILDING RATIO (2006 - 2016)						
Average # Buildings Per District	4	4	4	6	7	6
Ratio of Buildings to Students	612.47	511.33	444.13	696.93	617.77	590.25

TEST SCORES (2005 - 2016)						
Math: Grade 1 to Grade 6						
Advanced	45%	41%	39%	53%	37%	31%
Average and Proficient	47%	49%	50%	41%	48%	51%
Math: Grade 6 to Grade 12						
Advanced	42%	36%	33%	49%	36%	28%
Average and Proficient	45%	47%	47%	39%	45%	45%
Reading: Grade 1 to Grade 6						
Advanced	30%	26%	23%	37%	23%	18%
Average and Proficient	60%	62%	63%	56%	61%	62%
Reading: Grade 6 to Grade 12						
Advanced	41%	36%	31%	49%	35%	27%
Average and Proficient	52%	44%	57%	45%	54%	57%
AID RATIOS (2005 – 2016)						
Market Value/Personal Income Aid Ratio	0.49	0.60	0.66	0.35	0.57	0.70
Market Value Aid Ratio	0.48	0.59	0.64	0.35	0.58	0.72
Personal Income Aid Ratio	0.51	0.61	0.67	0.33	0.56	0.67
Market Value (in millions)	990	0.70	400	2560	1639	717
Personal Income (in millions)	370	258	160	1,068	695	337
Weighted Average Daily Membership (WADM)	2,823	263,430	1,827	5,517	6,545	4,259
MV per WADM	359,993	263,460	231,323	447,254	275,782	176,267
PI per WADM	13,088	103,405	86,771	193,664	116,818	193,664
DROPOUT RATE (2007 - 2016)						
Dropout Rate	0.77	1.04	1.20	0.50	1.37	1.94
BULLYING & OTHER INCIDENTS (2005 – 2016)						
Incident rates	1.90	2.52	3.42	1.70	4.24	4.54
Bullying-Incident ratio	3.56	6.04	6.63	6.15	4.92	3.91
Note: Data sources are provided in Appendix 1						

Table 16 presents the results of the correlation analysis for the percent of overweight students and various school district indicators. Correlation measures were estimated for the rural and urban sub-groups and also for the entire dataset. The only variable that is strongly and positively correlated with overweight status across rural and urban districts and the overall data is student dropout rates. Athletic expenditures per student is insignificant for both rural and urban school districts. All the other variables are either weakly correlated or insignificant for the rural and urban sub-groups and for the overall data.

Although the correlation measures are weak for both rural and urban school districts, the direction of the correlation is rather interesting. For instance, the percentage of students scoring in the Advanced category for Math and Reading is significantly negatively correlated with the percent of overweight students. Likewise, the percentage of students scoring either Basic or Below Basic is significantly positively correlated with the overweight status. Student incident rates are positively but weakly correlated in both urban and rural districts.

Table 16: Correlation: School District Indicators and Percent of Overweight Students

School District Indicators	Rural	Urban	Overall
Free and Reduced Lunch	Weak (+)	Weak (+)	Weak (+)
Athletic Expenditure per student	No	No	Weak (-)
PSSA Scores			
Math (Advanced)	Weak (-)	Weak (-)	Weak (-)
Math (Proficient)	No	Weak (+)	Weak (+)
Math (Basic)	Weak (+)	Weak (+)	Weak (+)
Math (BB)	Weak(+)	Weak (+)	Weak (+)
Reading (Advanced)	Weak (-)	Weak (-)	Weak (-)
Reading (Proficient)	Weak (+)	Weak (+)	Weak (+)
Reading (Basic)	Weak (+)	Weak (+)	Weak (+)
Reading (BB)	Weak (+)	Weak (+)	Weak (+)
AID RATIOS (2005 – 2016)			
Market Value/Personal Income Aid Ratio	Weak (+)	Yes (+)	Yes (+)
Market Value Aid Ratio	Weak (+)	Yes (+)	Yes (+)
Personal Income Aid Ratio	Weak (+)	Yes (+)	Yes (+)
Market Value (in million)	Weak (-)	Weak (-)	Weak (-)
Personal Income (in million)	Weak (-)	Weak (-)	Weak (-)
Weighted Average Daily Membership (WADM)	Weak (-)	Weak (-)	Weak (-)
MV per WADM	Weak (-)	Yes (-)	Weak (-)
PI per WADM	Weak (-)	Yes (-)	Yes (-)
Dropout Rate			
Student Dropout Rate	Yes (+)	Yes (+)	Yes (+)
Student-Staff Ratio			
Student-Staff Ratio	Weak (-)	Weak (-)	Weak (-)
Student-Building Ratio	Weak (-)	Weak (-)	Weak (-)
Violent Incidents			
Incidence Rate	Weak(+)	Weak (+)	Weak (+)
Bullying-Incidence Ratio	No	No	No

"Yes" refers to the economic indicators that are significantly and strongly correlated with overweight status. Indicators are strongly correlated with overweight status if the correlation statistic is greater than or equal to 0.6. "Weak" refers to the economic indicators that are significantly but weakly correlated with overweight status. A weak correlation means that the coefficient of correlation is less than 0.6. "No" refers to the indicators that are not significantly correlated at the 0.05 level. Data sources are provided in Appendix 1.

Table 17 presents the results of ANOVA, which tested the difference between school district indicators in the Low, Medium and High categories, and the percent of overweight students. ANOVA was applied separately to the rural and urban data sub-groups and to the overall grouped data. Almost all of the indicators are significantly different in rural and in urban districts, and in the overall grouped data, with the exception of the bullying-incidents ratio. The student-staff ratio is not significant in both rural and urban district subgroups. However, participation in free and reduced lunch and athletic expenditures per student revealed significant differences in rural and urban school districts. For rural districts, the only insignificant indicator was the percentage of students who were proficient in Math. Besides these few exceptions, the ANOVA analysis indicates that there are key school district indicators that are significantly different across the overweight categories in rural and urban school districts.

Table 17: ANOVA: School District Indicators and the Percent of Overweight Status

School District Indicators	Rural	Urban	Overall
Free and Reduced Lunch	Yes	Yes	Yes
Athletic Expenditure per student	Yes	Yes	Yes
PSSA Scores			
Math (Advanced)	Yes	Yes	Yes
Math (Proficient)	No	Yes	Yes
Math (Basic)	Yes	Yes	Yes
Math (BB)	Yes	Yes	Yes
Reading (Advanced)	Yes	Yes	Yes
Reading (Proficient)	Yes	Yes	Yes
Reading (Basic)	Yes	Yes	Yes
Reading (BB)	Yes	Yes	Yes
AID RATIOS (2005 – 2016)			
Market Value/Personal Income Aid Ratio	Yes	Yes	Yes
Market Value Aid Ratio	Yes	Yes	Yes
Personal Income Aid Ratio	Yes	Yes	Yes
Market Value (in million)	Yes	Yes	Yes
Personal Income (in million)	Yes	Yes	Yes
Weighted Average Daily Membership (WADM)	Yes	No	Yes
MV per WADM	Yes	Yes	Yes
PI per WADM	Yes	Yes	Yes
Dropout Rate			
Student Dropout Rate	Yes	Yes	Yes
Student-Staff Ratio			
Student-Staff Ratio	No	No	Yes
Student-Building Ratio	Yes	Yes	Yes
Violent Incidents			
Incidence Rate	Yes	Yes	Yes
Bullying-Incidence Ratio	No	No	No
"Yes" refers to the indicators that are significantly different between the districts with low, medium and high percentages of overweight status, at the 0.05 level. "No" represents indicators that are not statistically significant at 0.05 level. Data sources are provided in Appendix 1.			

For rural and urban districts in the study, several school district indicators are weakly correlated with the percentage of overweight students. The bullying-incident ratio, athletic expenditures per student, and dropout rate indicators are not correlated with the overweight distribution status.

However, for both urban and rural districts, with a few exceptions, there are significant differences in almost all school district indicators. In particular, for the rural and the urban sub-group data, and for the overall data, the ANOVA results indicate that there are important school district characteristics that may be associated with the distribution of overweight status within rural and within urban school districts.

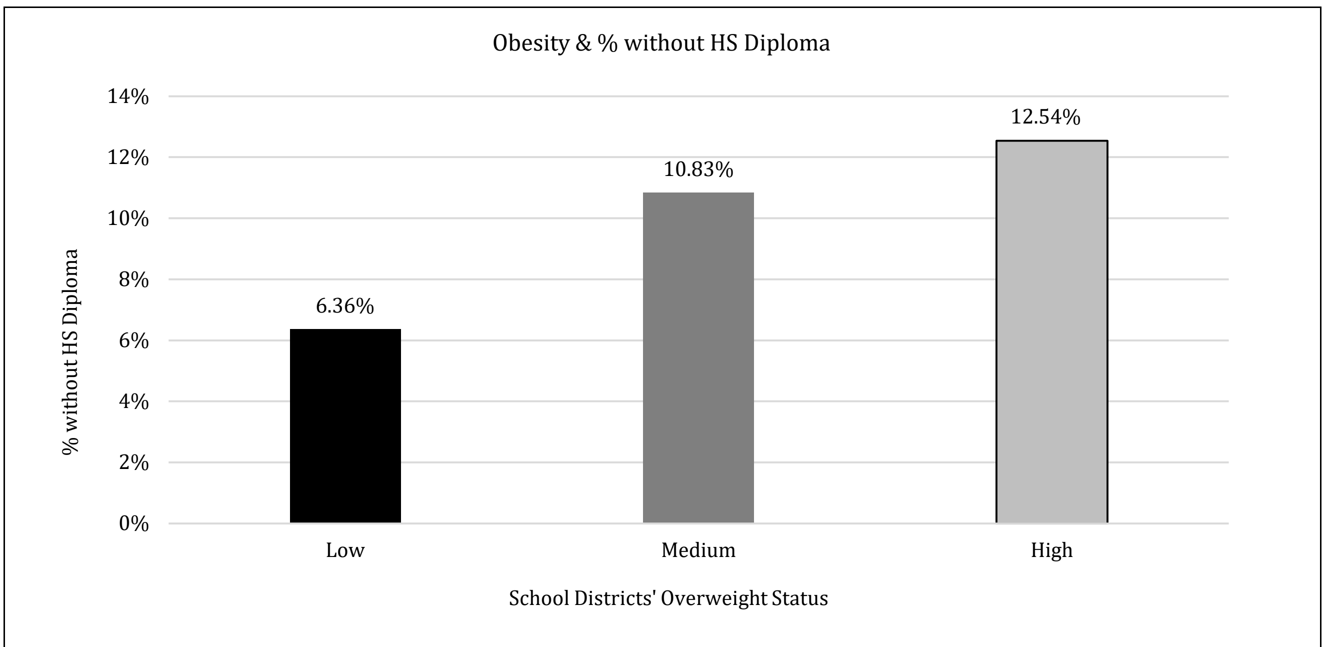
Overall Findings

The research indicated that there are demographic, economic and school district characteristics that influence the variation in the distribution of overweight students in both rural and urban districts.

Overweight and Education

Figure 6 indicates that districts with a higher percentage of the population without a high school diploma have higher percentages of overweight students.

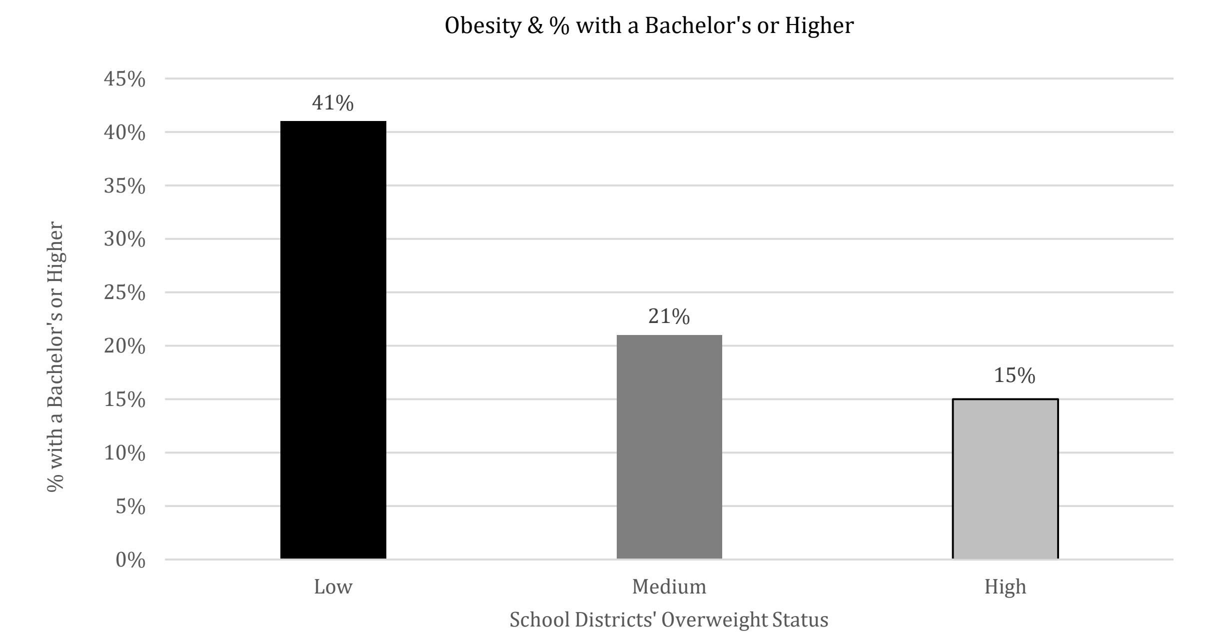
Figure 6: Obesity and the Percentage of Population without a High School Diploma



Notes: School districts overweight status refers to Low Districts (with <16% overweight students), Medium Districts (with 16% to 21% overweight students) and High Districts (with >21% overweight students). The bar graph represents the percentage of the population without a high school diploma across the different school district categories. Data source: Data on education status reflecting the percent of population with different educational attainment are available for the year 2016 from the U.S. Census Bureau using the American Community Survey series through the American FactFinder in https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

Figure 7 indicates that districts with a higher percentage of the population with a bachelor’s degree or higher have a lower percentage of overweight students.

Figure 7: Obesity and the Percentage of Population with a Bachelor’s Degree or Higher



Notes: School districts overweight status refers to Low Districts (with <16% overweight students), Medium Districts (with 16% to 21% overweight students) and High Districts (with >21% overweight students). The bar graph represents the percentage of the population with a college degree across different school districts. Data Source: Data on education status reflecting the percent of population with different educational attainment are available for the year 2016 from the U.S. Census Bureau using the American Community Survey series through the American FactFinder in https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

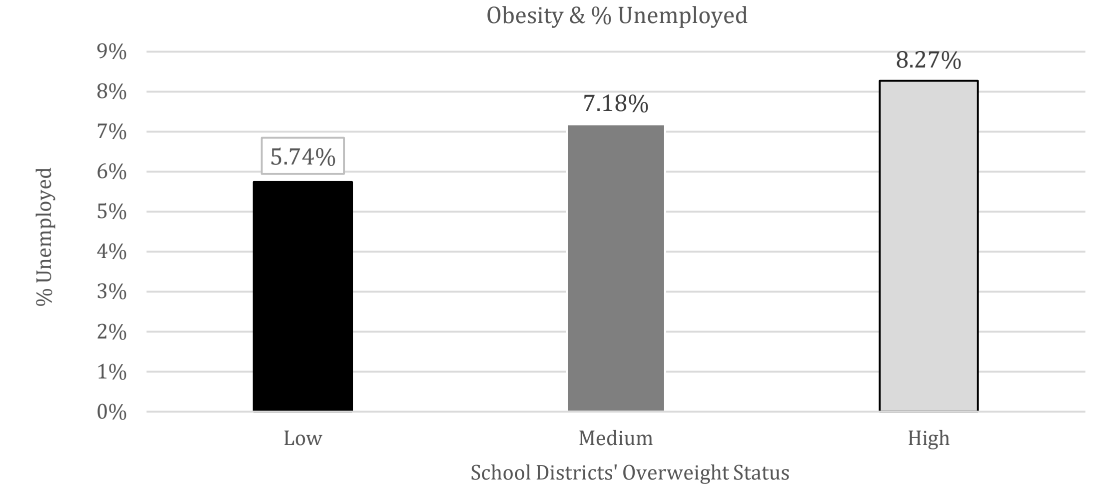
Overweight and Economic Outcomes

Figure 8 indicates that districts with a higher percentage of the population that is unemployed have higher percentages of overweight students.

Figure 9 indicates that districts with lower market values of taxable properties per capita have higher percentages of overweight students.

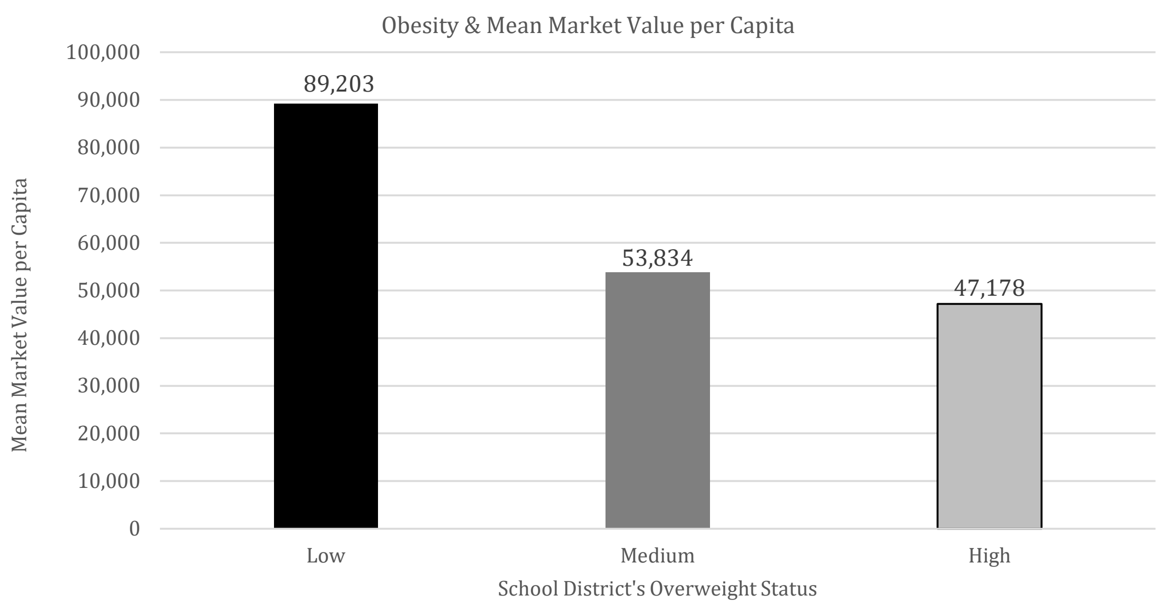
Taken together, Figures 8 and 9 suggest that unemployment and property values are closely associated with the observed differences in student overweight status.

Figure 8: Obesity and Percent Unemployed



Notes: School districts' overweight status refers to Low Districts (with <16% overweight students), Medium Districts (with 16% to 21% overweight students) and High Districts (with >21% overweight students). The bar graph represents the percentage of unemployment across school districts. Data Source: Labor force data and the percentage of civilian labor force unemployed at the county level (2007 – 2016) are from the U.S. Census Bureau using the American Community Survey series through the American FactFinder in https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

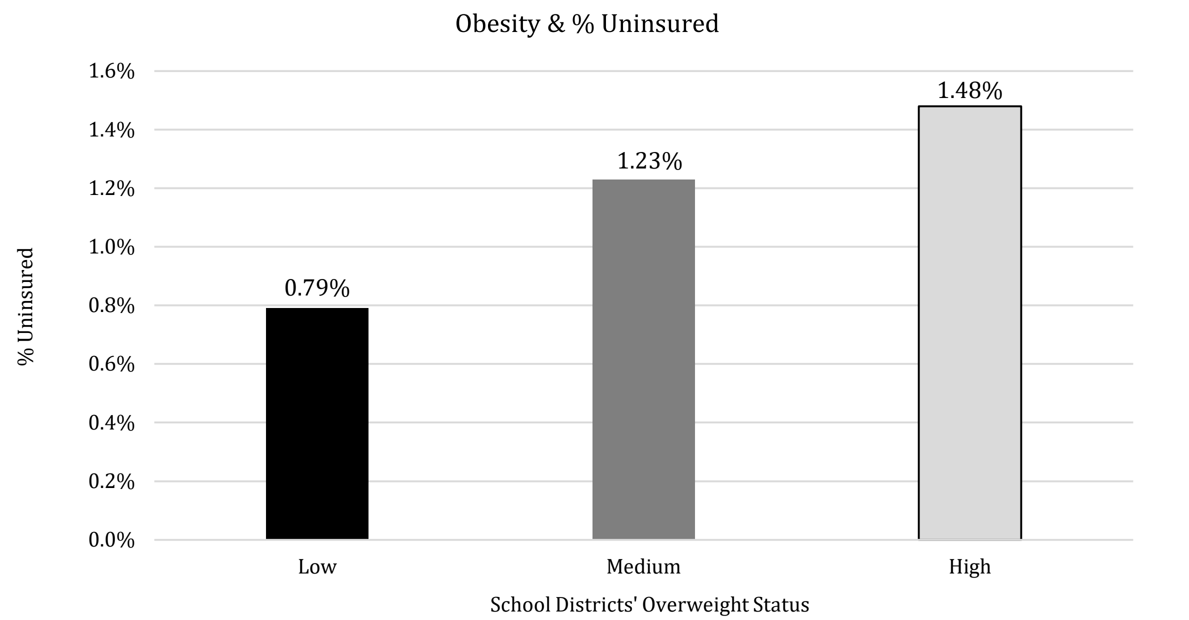
Figure 9: Obesity and Per Capita Market Values



Notes: School districts' overweight status refers to Low Districts (with <16% overweight students), Medium Districts (with 16% to 21% overweight students) and High Districts (with >21% overweight students). The bar graph represents per capita market value of taxable properties across school districts. Data Source: Per Capita Market Values are from the Financial Data Elements site within the Pennsylvania Department of Education (2005 to 2016) and are from https://www.education.pa.gov/Teachers%20-%20Administrators/School%20Finances/Finances/FinancialDataElements/Pages/default.aspx.

Figure 10 indicates that districts with a higher percentage of the population that is uninsured have higher percentages of overweight students.

Figure 10: Obesity and Percentage Uninsured

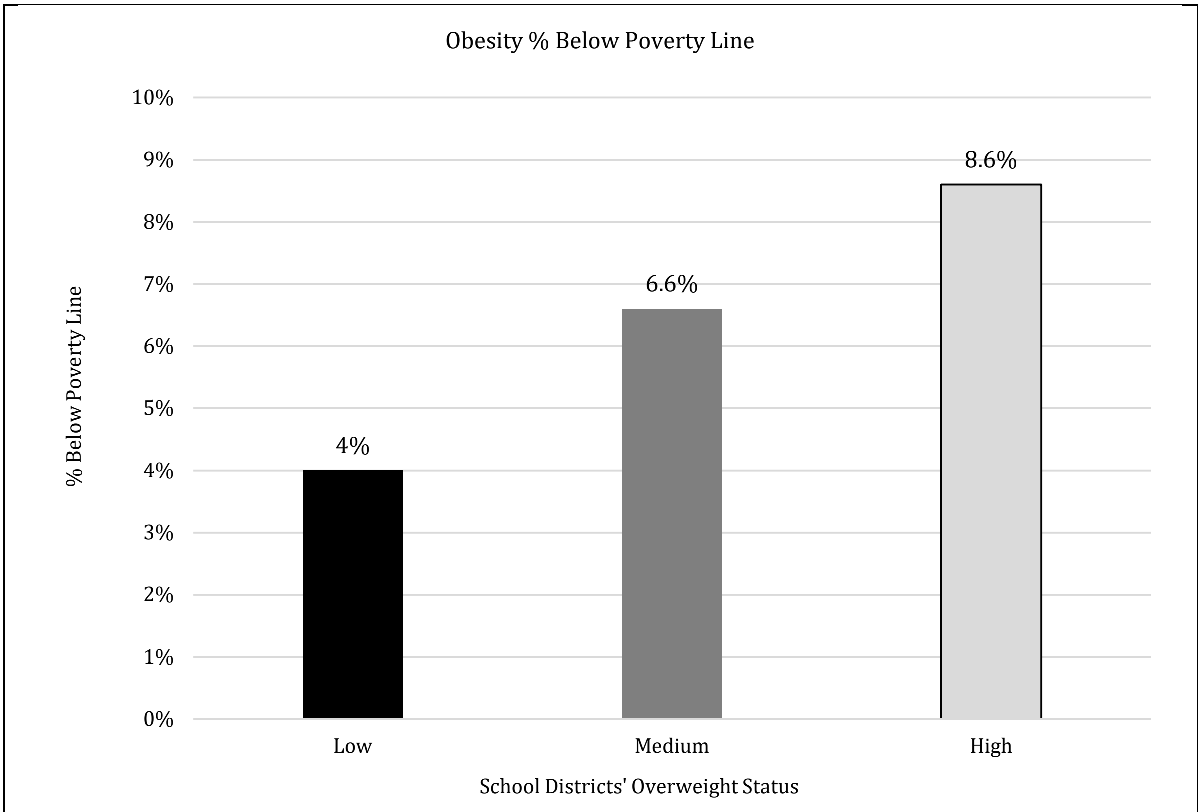


Notes: School districts' overweight status refers to Low Districts (with <16% overweight students), Medium Districts (with 16% to 21% overweight students) and High Districts (with >21% overweight students). The bar graphs represent the percent of civilian population without insurance across different school districts.
Data Source: Percent of families without health insurance (2012 – 2016) are at the county level from the U.S. Census Bureau using the American Community Survey series through the American FactFinder in https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

Figure 11 tracks the percentage of households below the poverty line and the distribution of overweight students.

Figure 12 shows the percent of households in different income quintiles and the distribution of overweight students. Income quintiles were constructed for each district, and the average percent of households within each quintile was computed for each district category (Low, Medium and High).

Figure 11: Obesity and the Percentage Below Poverty

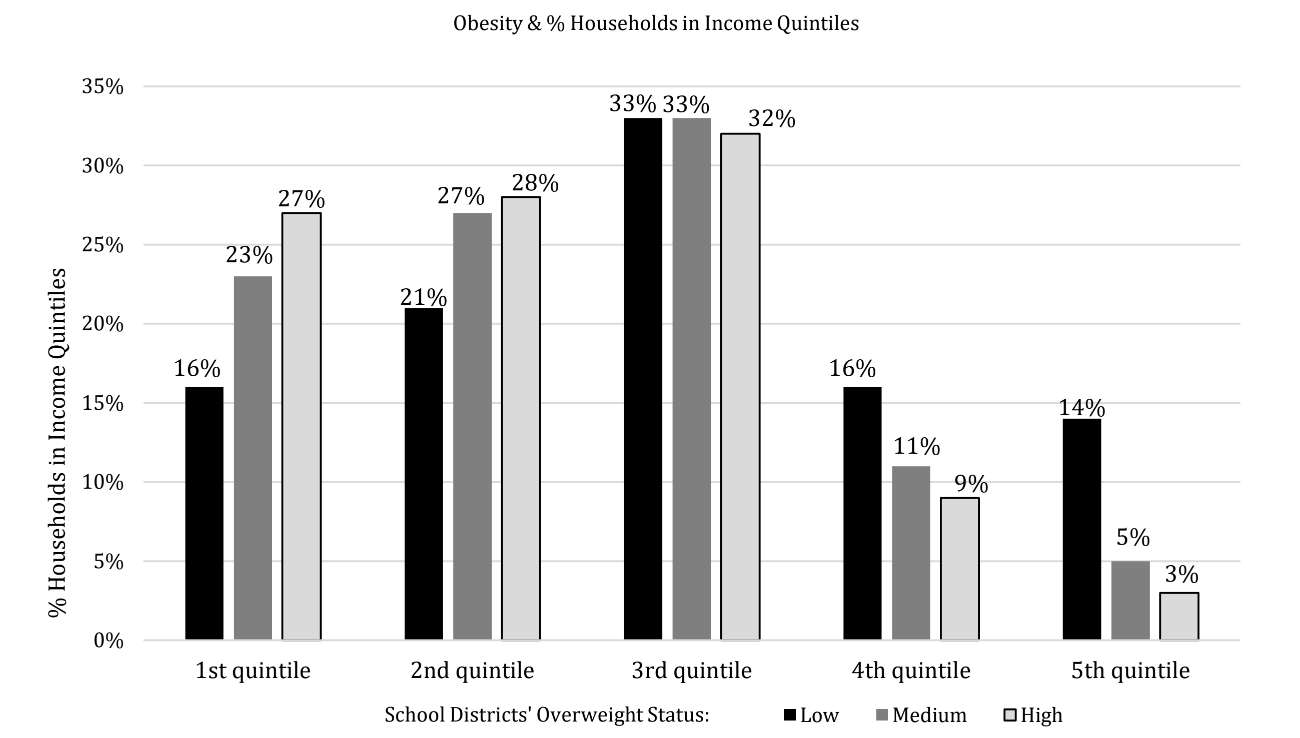


Notes: School districts overweight status refers to Low Districts (with <16% overweight students), Medium Districts (with 16% to 21% overweight students) and High Districts (with >21% overweight students). The bar graphs represent the percent of families whose incomes in the most recent 12 months is below the poverty level across different school districts. Data Source: Percent of families below poverty (2007 – 2016) are at the county level from the U.S. Census Bureau using the American Community Survey series through the American FactFinder in https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

Taken together, Figures 11 and 12 indicate that underlying differences in student overweight distributions are closely connected to economic considerations. Figure 11 indicates that the incidence of obesity increases as the percentage of households in poverty increases.

Figure 12 presents another aspect of the relationship between income distribution and the incidence of obesity. The percent of households in the three overweight categories is roughly the same across all districts in the median income quintile, or the 3rd quintile. However, the percent of households in the High overweight categories is relatively higher than those in the Low overweight categories in the 1st and 2nd income quintiles. Conversely, the percent of households in the Low overweight categories are relatively higher than those in the High overweight categories in the 4th and 5th income quintiles.

Figure 12: Obesity and Percent of Households by Income Quintiles

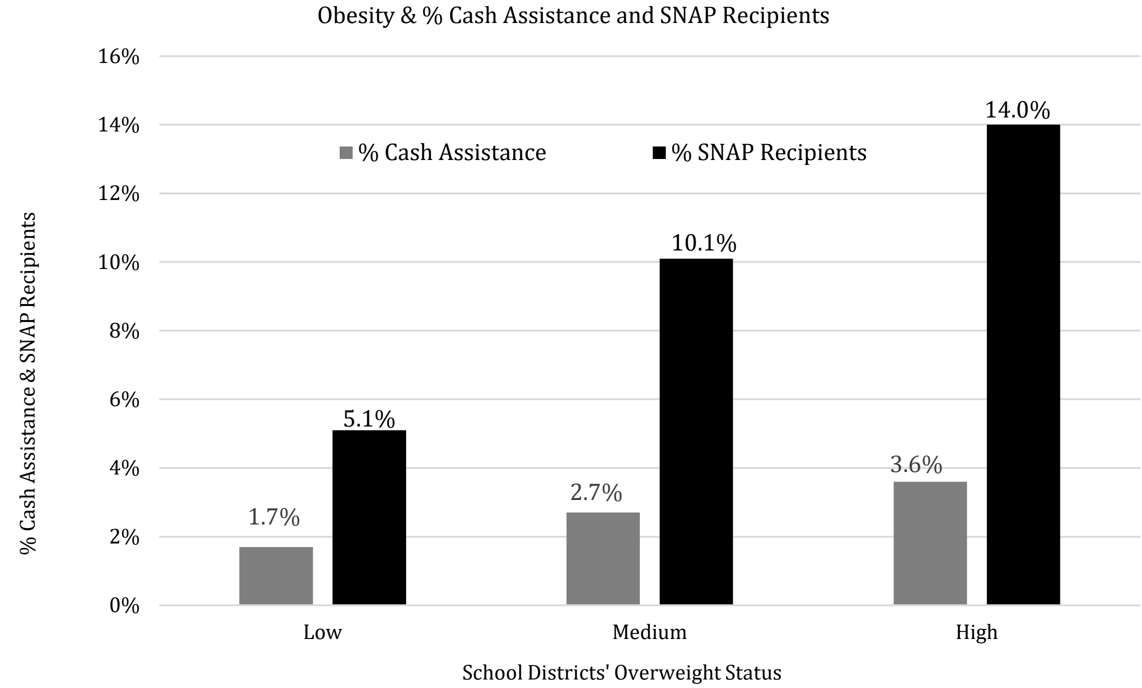


Notes: School districts overweight status refers to Low Districts (with <16% overweight students), Medium Districts (with 16% to 21% overweight students) and High Districts (with >21% overweight students). The bar graphs represent the average percent of families whose incomes fall within the respective income quintiles within the districts.
Income Quintiles are constructed as follows:
1st quintile: % of households with income < $25,000
2nd quintile: % of households with income between $25,000 and $50,000
3rd quintile: % of households with income between $50,000 and $100,000
4th quintile: % of households with income between $100,000 and $150,000
5th quintile: % of households with income > $150,000
Data Source: Percent of families within different income quintiles are at the county level from the U.S. Census Bureau using the American Community Survey series through the American FactFinder in https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

Figures 13 and 14 capture the underlying relationship between overweight distribution and two specific economic characteristics. Figure 13 shows that the incidence of overweight is higher in districts where a larger percentage of families receive cash assistance and SNAP.

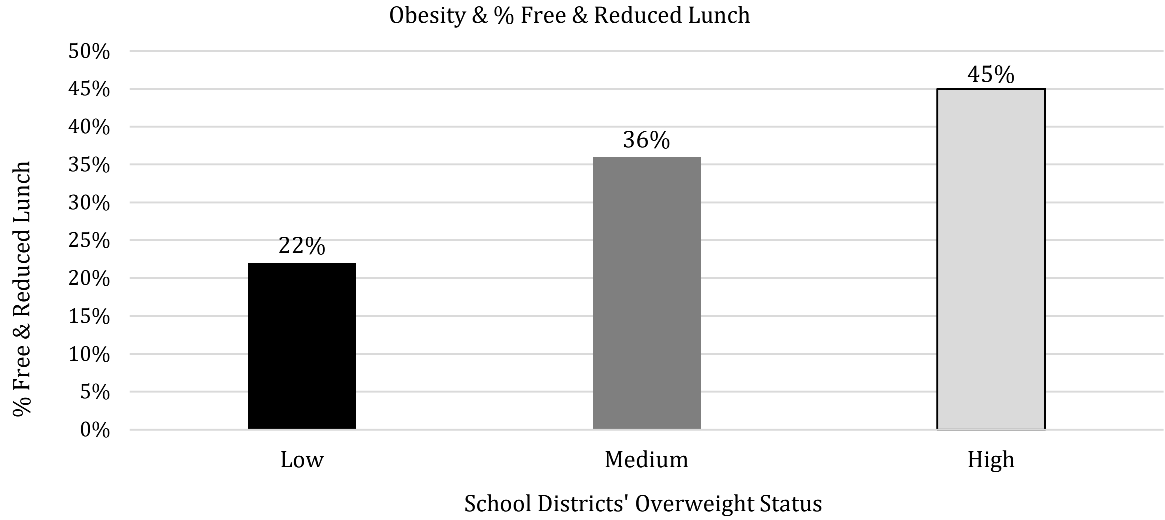
Figure 14 illustrates the relationship between the percent of students in the free and reduced lunch programs across districts and overweight distribution. It shows that the incidence of overweight is higher in districts where a larger percentage of students participate in the free and reduced lunch programs.

Figure 13: Obesity and Percent Receiving Cash Assistance & SNAP Benefits



Notes: School districts overweight status refers to Low Districts (with <16% overweight students), Medium Districts (with 16% to 21% overweight students) and High Districts (with >21% overweight students). The bar graphs represent the percent of families receiving cash assistance and SNAP across different school districts.
Data Source: Percent of families with the cash assistance program and SNAP benefits (2007 – 2016) at the county level are from US Census Bureau using the American Community Survey series through the American FactFinder in https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

Figure 14: Obesity and Percent of Students in Free & Reduced School Lunch Program



Notes: School districts overweight status refers to Low Districts (with <16% overweight students), Medium Districts (with 16% to 21% overweight students) and High Districts (with >21% overweight students). The bar graphs represent the percent of students receiving Free and Reduced Lunch across different school districts. Data Source: Percent of students Receiving Free and Reduced Lunch is from National School Lunch Program Reports (2005 to 2016) for each school within every district within the Food & Nutrition page from the PA Department of Education, and is from https://www.education.pa.gov/Teachers%20-%20Administrators/Food-Nutrition/Pages/National-School-Lunch-Program-Reports.aspx.

Overweight and Academic Outcomes

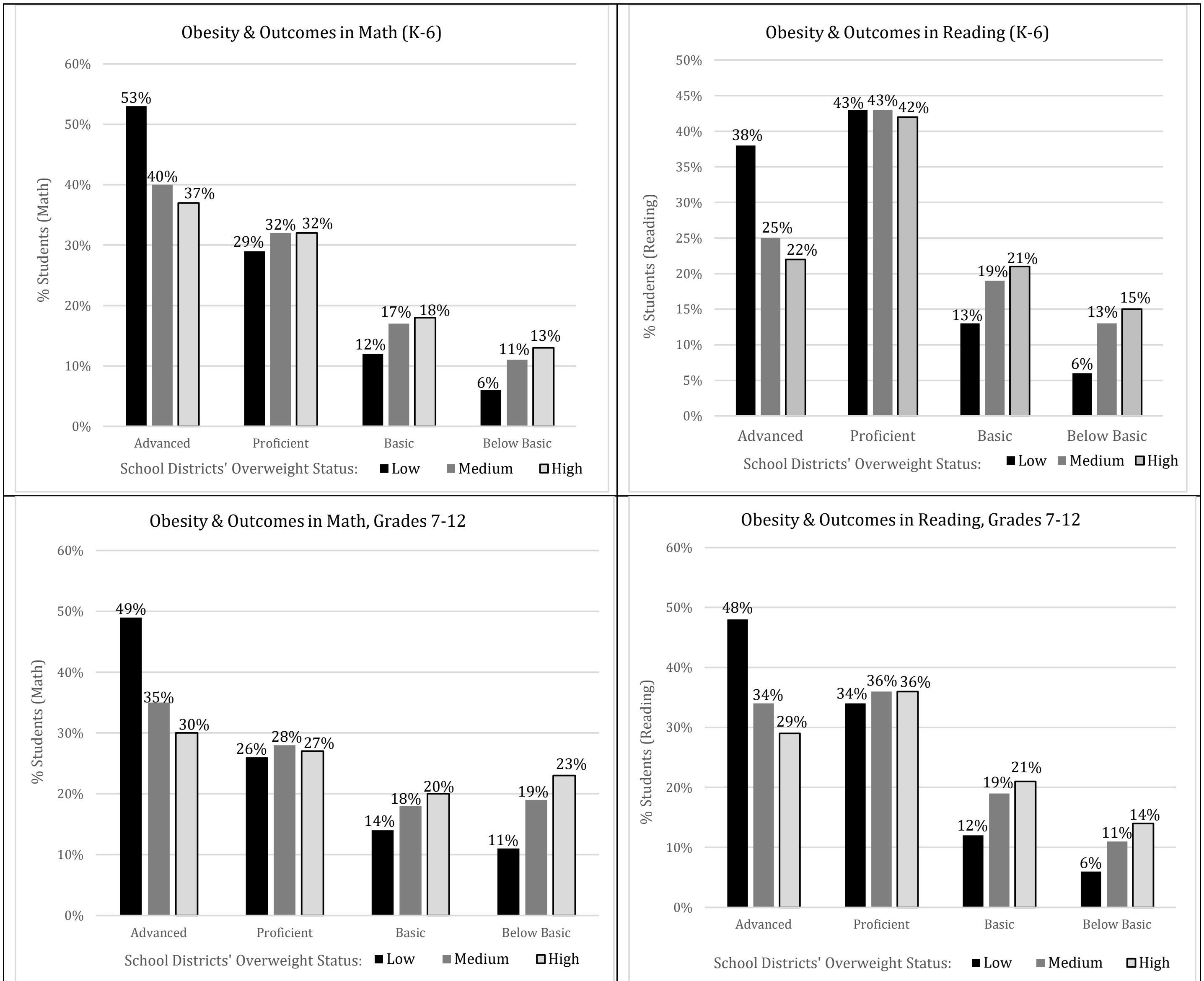
Students receive grades in PSSA Reading and Math tests that place them in one of four grading scales: Advanced, Proficient, Basic, and Below Basic. Figure 15 presents the percent of students in each of these grading scales for Reading and Math and overweight categories. Further, the grade distribution is presented separately for Grades 1 - 6, and Grades 7 - 12.

Student outcomes in Math show that in both grade groups, the percent of students scoring Advanced is higher in the Low overweight category. Further, the percent of students scoring Below Basic is higher in the High overweight category.

Student outcomes in Reading also mirror the results for Math. The percent of students scoring Advanced in Reading is higher in the Low overweight category. Conversely, the percent of students scoring Below Basic is higher in the upper-end of the overweight distribution.

Taken together, Figure 15 indicates that student outcomes are closely linked to overweight distribution, and student performance decreases with a higher incidence of overweight students.

Figure 15: Obesity and Student Outcomes in PSSA Math and Reading



Notes: School districts overweight status refers to Low Districts (with <16% overweight students), Medium Districts (with 16% to 21% overweight students) and High Districts (with >21% overweight students). The bar graphs represent the percent of students who scored in the various grading scales in PSSA Math and Reading from K-6 and Grades 7 to 12 across all school districts. Legend details: The four panels present the percent scored in Reading and Math in different grades. Based on the PSSA score, each student is ranked as Advanced, Proficient, Basic and Below Basic, in Math and Reading. Data Source: PSSA rankings across districts have been compiled from the Pennsylvania Department of Education website under Data & Statistics in https://www.education.pa.gov/Data-and-Statistics/PSSA/Pages/default.aspx (2005 to 2012).

The previous analysis has provided two important findings:

1. Economic forces are strongly related to the incidence of obesity. Employment, education, poverty, and safety nets, such as health insurance, free and reduced lunch participation, cash assistance and SNAP, are important economic characteristics that are closely tied to obesity rates.

2. Student outcomes in Math and Reading are also tied to obesity rates, as student outcomes tend to be better in districts with lower obesity rates.

Survey Design and Implementation

The study compiled a list of 500 superintendents in 66 counties across Pennsylvania using EdNA (Education Names and Addresses) from the Pennsylvania Department of Education. The email addresses of the superintendents were retrieved from EdNA, school district websites, or, in cases where they were missing, through a telephone call to the district.

The initial email to the superintendents included a link to a QUALTRICS survey and was sent in May 2018. The superintendents were requested to complete the survey, and then forward the link to their respective public school principals to request their participation in the survey. Of the 500 initial emails sent, 11 were returned undeliverable. The undeliverable email addresses (in one case the individual was on authorized leave and the email was redirected to another contact person) were identified, corrected and resent. Two individuals responded to the initial email and asked to be eliminated from the survey. There was a subsequent follow-up with a second email and survey link in June 2018, and a third email and survey link in September 2018.

The online survey gathered 113 responses (response rate equal to 22.6 percent); 64 percent of the respondents were principals, 29 percent were superintendents, and 7 percent were in the “other” category. While the online survey generated 113 survey responses, only 99 valid responses were found for the question that requested the respondent’s school’s county location. Of the 99 valid responses for the location of the school’s county, 33 responses were from urban counties, and 66 were from rural counties.

Survey Responses

The survey solicited responses on three broad topics, with questions within each topic. The specific questions and the percentage of response types are presented in Table 18.

Results from the survey indicate that the majority of respondents feel that student obesity is an important issue in their schools, and that obesity affects academic performance and is positively related to bullying. While a majority of schools have vending machines that supply soft drinks and chips, most schools have also adopted USDA’s and PDE’s guidelines in vending machines, and most schools have adopted age-appropriate menu labeling systems. Most schools have also incorporated nutritional education programs, and include similar information in menu-labeling systems.

Table 18: Survey Responses

Topic	Questions	Yes	No	Don't know	n
I	**Obesity in Schools**				
1.	Student obesity is an important issue in my school	70% (0.114)	7% (n.a)	22% (0.104)	107
2.	Student obesity affects student academic performance in my school	63% (0.121)	11% (0.079)	26% (0.11)	107
3.	Student obesity is related to bullying in my school	60% (0.12)	16% (0.09)	24% (0.10)	107
II	**Vending Machines in Schools**				
1.	Does your school have vending machines with pop, soda, chips, candy	77% (0.106)	23% (0.106)	0% (n.a)	107
2.	Does your school have food and beverages that meet USDA and PDE's guidelines in vending machines	59% (0.128)	33% (0.122)	8% (n.a)	98
3.	Does your school implement age-appropriate menu and labeling systems in vending machines	38% (0.127)	45% (0.131)	18% (n.a)	96
III	**Menu Labeling in Schools**				
1.	Does your school implement age-appropriate menu labeling systems in cafeterias	64% (0.12)	15% (0.08)	21% (0.10)	107
2.	Are menu labeling systems made available through educational materials in grades K-12	50% (0.12)	15% (0.08)	35% (0.12)	107
3.	Are menu labeling systems available through nutritional-educational programs	54% (0.12)	14% (0.08)	32% (0.11)	107

Notes: The table presents the percentage of responses for each survey question, where "n" represents the number of valid responses. The figures in the parenthesis below each percentage response represent the margin of error computed at 99% confidence level.

Table 19 presents the ANOVA results that tested for differences in the survey responses between urban and rural county respondents. In seven out of nine questions posed in the survey, the responses from urban and rural schools were not statistically different.

However, there were differences for the questions, “Student obesity is an important issue in my school,” and, “Student obesity is related to bullying in my school.” For both questions, more rural respondents answered “yes” than urban respondents.

The survey responses show that most respondents consider obesity to be an issue in their school district, and have tried to address the problem through appropriate corrective measures, wherever possible. The responses from the open-ended survey questions are also important, as these help to identify the underlying difficulties in approaching obesity, and also to gather a few best-practice policy methods.

Table 19: Rural versus Urban ANOVA Test Results

Topic	Questions	ANOVA
I	**Obesity in Schools**	
1.	Student obesity is an important issue in my school	Yes
2.	Student obesity affects student academic performance in my school	No
3.	Student obesity is related to bullying in my school	Yes
II	**Vending Machines in Schools**	
1.	Does your school have vending machines with pop, soda, chips, candy	No
2.	Does your school have food and beverages that meet USDA and PDE's guidelines in vending machines	No
3.	Does your school implement age-appropriate menu and labeling systems in vending machines	No
III	**Menu Labeling in Schools**	No
1.	Does your school implement age-appropriate menu labeling systems in cafeterias	No
2.	Are menu labeling systems made available through educational materials in grades K-12	No
3.	Are menu labeling systems available through nutritional-educational programs	No

“Yes” refers to those responses that are significantly different (at 0.05 level) between the respondents in rural and urban counties.
“No” refers to those responses that are not statistically significant (at 0.05 level) between the respondents in rural and urban counties.
Total valid responses: Rural = 66 responses, Urban = 33 Responses.

Open-ended Questions and Responses

There were two open-ended questions in the survey. The first open-ended question asked respondents: *In what ways can schools promote consumption of healthier foods and beverages and active lifestyles? Feel free to share your own experiences.*

The researchers classified the responses into the following categories: Role Modeling, Educating and Partnering with Community, Making Healthy Choices Available, and Engaging in Activity.

Examples of open-ended responses for each category are noted below.

Role Modeling

"School personnel note that adults need to model appropriate behaviors including healthy lifestyles, good eating habits, and food consumption."

"Active living should be modeled by the adults in the building; even more, adults should put kids in positions to learn about active living and, ultimately, apply active lifestyles in and outside of school."

"Educate the students on proper nutritional habits and model appropriate food consumption by the staff."

Educating and Partnering with Community

School personnel note that although healthy lifestyles are included in the curriculum, it should be more of a priority.

"Make health and wellness a mandatory class each year in school; every day as well; monies/grants tied to wellness."

"I think this would need to start at the state level and increase the amount of Physical Education classes that are required to graduate. Right now, the state only requires 2 PE courses. We require 3 at our building, but it should probably be more."

One respondent notes the impact of physical education on mental health:

"There is no doubt that students' anxiety and difficulty in classes is linked to decreasing PE classes. If the state is serious about exploring ways to help students, start with increasing PE requirements so that school districts can help students find life long, healthy ways to improve their mental functioning."

Further, schools are partnering within their organizations and receiving support within their respective communities that enhance their efforts. As noted by one participant:

"It takes real support and funding to implement many of these services. we are lucky to have community partners and a city health department."

Through internal staff efforts and community partners such as businesses, hospitals, and health departments, participants noted a number of current initiatives that target healthy eating, physical activity, and fundraising.

> “We support fitness programs with our athletic trainers and have community agencies provide nutrition programs for example - K nutrition, 3 -5 healthy food choices.”
>
> “Our school wellness committee works together to create health and wellness activities throughout the school year. For example, each year we have a "Nutrition Day" to celebrate trying new fruits and vegetables from a large buffet selection donated by teachers and staff.”
>
> “Through explicit lessons about healthy choices. We have two programs in place... Roving Chef which is led by our partnership with the food service provider in our cafeterias, and a partnership through a local hospital to provide these lessons to grades 3-5.”
>
> “We are working with students on menu items and working with local businesses. Having food items that students like and are healthy is very challenging. One product we did was work with a local pizzeria to have whole wheat pizza that meets all Federal health guidelines for students.”
>
> “We follow Smart Snacks in Schools fundraising. We work closely with the city health department as part of our district wellness committee and work to develop fun activities with our community partners. For example, we recently offered free 8-week swim lessons. . . We are setting up a summer fitness program with the local hospital's sports trainers for an elementary school. . . . We have a community partner . . . who help build and maintain gardens for the schools where the kids plant and grow vegetables and when harvested get to eat the produce. . . . Our cafeteria staff work to make sure special dietary needs are met and support our fundraising efforts with food that meets the Smart Snack guidelines.”

Making Healthy Choices Available

School personnel note that healthy and delicious foods, including nutritional information, are/or should be available in schools. As one respondent notes, “Provide fresh fruits and vegetables. Kids will eat what is available.”

> “As for food, I think we need to do a better job of breaking away from the boring foods we serve, and revamp menus that are not only delicious, but nutritious. School lunch could be an amazing opportunity to introduce students, particularly those in under-served and/or rural regions, to diverse and healthy food choices, which also meet the government's nutritional expectations.”

In some instances, healthy options are available:

> “The district follows USDA and PDE guidelines. There are no vending machines and healthy fruits and foods are promoted.”
>
> “The district promotes water and other healthy drinks and food products at breakfast and lunch;” and,

"Our cafeteria is all whole grain and low fat. The extra snacks are baked rather than normal chips. We only allow healthy snacks in the classroom, at one snack time during the day. . ."

In other instances, the need for change was expressed:

"First, we need to be able to address what can and cannot be served for school lunches, and we also need increased awareness and funding so we can offer healthy AND delicious meals to our students."

"We should get rid of all sugary drinks. We don't have any vending machines for students, but do sell Gatorade in our Café. I think we should have nutritional information for our food. Pizza is on our menu most days. The cheese (fat and cholesterol) that clogs arteries forms plaques at a very young age. We do offer many nutritional salads, fruits, and vegetables for our students."

While some schools have vending machines and others do not, participants noted the following ideas:

"While our school has vending machines, those with food are only located in the faculty rooms. The one with drinks is not allowed to be used during the day."

"All staff vending machines should contain healthy choices."

"Provide healthy food items in our cafeterias and vending machines."

"No vending for any products except for water."

Further, there were opposing viewpoints on food and classroom celebrations or special occasions, such as birthdays. One respondent noted there is, "the tradition of pizza parties and homemade baked goods for special occasions;", while others notes that only healthy foods should be allowed, or advocated for a "no food policy."

"In our district we try to promote healthy food choices at school parties. Food is not permitted to be used as rewards. Students are not permitted to bring in food for birthdays. We try to encourage students to donate a book to the library in honor of their birthday, if they want to bring in something."

Further, some noted the significant percentage of students who qualify for school food programs and that portion size should be examined:

"I realize the importance of nutrition in education. Frankly, we are happy that the more than 60% of our students are actually getting fed something on a regular basis, following the guidelines."

"Although the cafeteria follows the nutritional guidelines set by the federal nutrition program, it seems high school kids and elem get the same amount of food - then our teens are binge eating after school before sport's practices etc., because the older kids are not being given enough...3 chicken nuggets that met the fat and salt limit are not what we should be serving kids...period."

Engaging in Activity

School personnel note the importance of daily engagement in activity through a variety of ideas and offerings such as biking, walking, running, swimming, and recess as an opportunity for activity. Further, one respondent notes that high school athletes are engaged in yoga lessons.

One respondent noted the idea of fitness for life.

> "Our gym class is in a fitness center. Students are learning fitness for life, instead of playing games they will rarely play as adults. Play is important, but lifetime fitness is more important for high school students."

In addition, respondents shared:

> "Since 2000, we have implemented the PE4Life philosophies, we have daily PE for all of our 9 - 12 grade students, daily PE for a semester for all of our middle level students; have PE every 3rd day for our 1 - 5th graders and daily PE for our 4 and 5 year olds. Our PE teachers embed nutrition facts and lessons into the PE classes. We have worked with the United Way and the YWCA to help encourage parent educational opportunities about nutrition and daily physical activities. We work with our medical community for "Can Do Lists" rather than having students sit out of PE for weeks on end if they break an arm for example."

> "We have also not eliminated our Physical Education requirements as some schools have done. We also partner with the YMCA to provide free memberships for our sixth graders and have an annual health fair and recess each day at the Elementary level."

> "The elementary schools have sponsored family nights where they biked, walked, kayaked, dodge-ball etc."

> "We have an after-school running club (in the fall) for our older elementary school kids, and we use special activities (show shoeing, hiking, games in gym) as incentives for students."

The second open-ended question invited respondents to share additional thoughts on the issue.

The researchers classified the responses into the following categories: Mass and Social Media, Home Life and Health Literacy, and Poverty.

Examples of the open-ended responses for each category are noted below.

Mass and Social Media

Respondents, recognizing the complexity of the healthy lifestyles issue, suggested that technology maybe both the problem and the solution.

> "Every social issue cannot be dumped on the schools and made the fault of the schools. This is a societal issue which must be addressed globally not just with band aid approaches."

> "We need awareness through mass media and social media to address issues in the home. We are combating an epidemic of kids/families that are swamped with ads promoting unhealthy foods and lifestyles."

On the other hand, respondents identified problems with technology:

> “I have more and more students each year connected to their phones and video games and spending less time involved in physical activity. I believe this also leads to increased levels of anxiety and lack of affect, which also directly impacts health and ability to control weight.”
>
> “Taking a standpoint of having a healthier diet is a one-sided perspective. Healthy diets must be balanced with an active lifestyle. Until integration of both healthier eating and promotion of more physical activity happens, you will only ever be looking through one lens of your binoculars. In addition, integration of technology into our society has led to a more sedentary society. Because of this, we have students parked in front of computers or computer games which is a contributing factor of students being overweight.”

Home Life and Health Literacy

Some respondents expressed the importance of educating and supporting parents in healthy eating and behaviors through “website[s,] social media, and parent meetings,” and specific guidelines for social welfare programs such as food stamps and WIC.

> “Parents need to be the focal point of education when i[t] comes to healthy lifestyles, healthy eating and physical activity. Students can only do so much on their own. Parental education is a must to try to change the trends with childhood obesity and engaging in healthy lifestyle changes.”
>
> “More must be done to include parents and families in this discussion. Teaching families how to budget their food dollars, how to cook with low cost food items and what impacts obesity has on children are all important topics that must be addressed.”
>
> “This is not just a school issue. Parents are the child's primary caregiver and need supported and educated as well. Social welfare programs such as food stamps and WIC should REQUIRE the purchase of fresh foods, quality meats and produce. They also should require some type of training in cooking techniques using quality foods. Most of our kids get great food at school and then spend evenings, weekends and summers gorging on junk!”
>
> “Food Stamps should not be allowed to be used on fast food at Sheetz and other like stores. Kids who live in poverty are seen daily eating this high fat fast food. Our weekend food backpack programs that assist kids at risk are filled with preservative laden "quick" microwavable food. I realize the necessity of these programs but we are encouraging unhealthy foods. We need to teach kids by showing them...practice what we preach....and the best first step is to ensure the food we serve in school is healthy, appropriate and edible. Currently for most schools...it is not. Just check social media of the food pictures kids post that is served to them in their school.”

Other respondents expressed parental accountability, personal responsibility and choice:

"Although schools play a major role in fighting obesity, it starts at home; parents model the behaviors their children ultimately acquire."

"In my experience we attempt to promote both healthy diets and lifestyles; however, this message is not being reinforced in homes. At what point do we focus on education and require parents to parent?"

"I believe in personal responsibility and choice. We can educate our students, as we do, on healthy life style choices, but I am not a fan of regulating how a parent decides to feed and raise their child. As long as a family and child is educated on the consequences of poor eating and exercise habits, then they should be free to choose."

More specifically, three respondents noted the BMI healthy initiative and its impact:

"BMI was reported as part of a statewide healthy child initiative. Parents did not understand it. It had no impact."

"Mandating students receive BMI from school cause significant disruptions to the educational process. The intent of this was good but the practice is very poor for our students. Most of our athletes have BMI of obese (with the exception of runners) this causes anxiety for parents and students. They are upset with the school when we have to do this."

"Obesity is calculated through BMI or Body Mass Index. Several years ago the entire varsity volleyball team shared their BMI calculations and they were obese. These calculations do not consider muscle mass and these athletes did not appear to be obese with my understanding of the definition of obese. The athletes have active lifestyles, eat healthfully (during season per coach instructions), and they do not drink carbonated beverages. The athletic team is taught how to eat healthfully and they are part of a rigorous conditioning program. Due to their hard work in the gym and lifestyle changes if they are not role models due to obesity there is something wrong with the system."

Poverty

Respondents identified the issue of poverty, and its related challenges on families, as it fuels competition and prioritization of healthy lifestyles choices:

"It is complex - we have more than half of our population living in or near poverty. Quality food choices are not as important as safety within the house (at home), or living without stress & conflict (at home)."

"In my opinion the issue isn't with the schools. For the six or so hours 180 days per year we have them they get exercise, are fed healthy foods and have opportunities to learn about health and nutrition. The issue is with the home lives and families who are living in poverty. They must buy cheaper, more processed foods to live within their budgets. Family education, nutrition training and supports for how they can live within their budgets needs to happen but getting these families to come to the schools for their kids academic and athletic events is hard enough...I can't imagine many would come to the school for a health and nutrition event."

"Schools have made tremendous progress in this area. However, we don't seem to have made much progress with our families living in poverty. They buy what they can afford at Walmart. Cheap food typically is not nutritional food. While they could include cheaper in season vegetables and fruits, they typically don't, because they are too busy to prep these foods."

"The school can support the programs and implement fun activities and policies that limit food in school but the cost of healthy food often is too great for families and for deserts in sections of the city make it difficult for parents."

The survey responses provide some supporting evidence to the findings from the previous sections. Overall, a vast majority of respondents indicated that obesity is an important issue in their districts. Many of the respondents also indicated that their districts follow menu-labeling guidelines and other stipulations from USDA. School districts are also actively involved with engaging the students with community partners to increase awareness and tackle the obesity issue. Best-practice methods involve role modeling, educating and increasing Awareness, partnering with community and engaging the students in different activities, and finally, in allowing students to make healthy choices.

The survey respondents also provide supporting anecdotal evidence indicating the influence of poverty and lack of awareness as critical drivers of obesity. Overall, it is clear from the responses that obesity is a multi-faceted issue, and combating obesity requires the support of many community partners including parents, and public health officials, and targeted information campaigns.

Conclusions

This research indicated that the percent of overweight students and students who are at-risk of being overweight in Pennsylvania has been roughly steady at 32.6 percent, on average, over the 10-year period of 2005-2016. The percent of students in the at-risk category is 15.7 percent, on average, and the percent of students in the overweight category is 17 percent, on average.

The percent of overweight and at-risk students in K-6 is similar to the aggregate trend (average of 16 percent in the at-risk category, and 17.6 percent in the overweight category). Likewise, the percent of overweight students in grades 7-12 is larger than the overall trend, (about 19 percent in the overweight category, and close to 17 percent in the at-risk category). Almost 36 percent of students in the higher grade levels are either overweight or at-risk of being overweight. Further, the percent of students in rural school districts in the overweight category consistently exceeded those from urban districts. These results indicate that youth obesity is a serious issue in Pennsylvania, particularly in rural districts.

The correlation analysis between overweight status and demographic variables revealed that, for urban districts, educational status (such as not having a high school diploma, and having a Bachelor's degree or higher), the market values of taxable properties, and the density of SNAP retailers are strongly and significantly correlated with overweight status. None of the demographic indicators for the rural districts in the study appeared to be strongly and significantly correlated with the distribution of overweight students.

The ANOVA tests suggested that, for both the urban and rural districts, there are significant differences in the distribution of the percentage of overweight students in educational indicators (the lack of high school diploma or the prevalence of college degrees), property values, and the sources of revenues between districts.

In terms of economic indicators, labor force participation rates in Management, Business, Science and Arts, and Services are strongly and significantly correlated with students' overweight status in urban districts. Further, in urban districts, the percent of students who are overweight increases as the percent of families who received SNAP benefits and cash public assistance benefits increases. Importantly, in urban districts, as income increases, the incidence of overweight decreases, particularly, at higher income brackets.

For rural districts, mean gross rent and median gross rent are the only two variables that are significantly and negatively correlated with the percentage of overweight students. In other words, the percentage of students who are overweight declines as rent increases.

The ANOVA results indicated that, for both the urban and rural districts there are important economic forces that are closely related to the distribution of overweight status in rural and within urban school districts.

Several of the school district indicators are weakly correlated with the percentage of overweight students in both rural and urban districts. However, for the rural and the urban sub-group data, and for the overall data, the ANOVA results indicated that there are important school district characteristics that may be associated with the distribution of overweight status in rural and urban school districts.

Results from the survey indicated that school officials are aware of the issue of obesity and have adopted recommendations from USDA in terms of food and nutrition policies.

Overall, compared to rural districts, there are many more demographic, economic, and school district indicators that are strongly correlated with overweight status in urban districts. A primary reason for the lack of strong correlates in rural districts is the level of homogeneity in rural districts. There is very little variation in population composition, employment outcomes, and income distribution. Urban districts, in contrast, are more diverse and reveal more variation across all indicators.

Appendix 1: Data Sources

Data Sources for Table 1 and Figure 1, Table 2 and Figure 2, Table 3 and Figure 3
Data are from the Pennsylvania Department of Health. Data contain information on the number of students screened in grades K-6 and 7-12. The data also contains information on the number and percentage of students within different BMI percentiles (< 5^{th}, 5^{th}-85^{th}, 85^{th}-95^{th} and > 95^{th}). Data span 2005-2016 across all school districts, grouped by counties and districts. Table 1 presents the total number of percent of at-risk and overweight students. Only a few school districts reported the BMI values in 2005.

Data Sources for Table 4 and Figure 4, Table 5 and Figure 5
Data are from the Pennsylvania Department of Health. Data contain information on the number of students screened in grades K-6 and 7-12, and percentage of students falling within different BMI percentiles. Data spans 2005-2016 across all school districts, grouped by counties and districts. Rural and urban counties were identified by using the Center for Rural Pennsylvania's rural-urban definition. The information was linked to the BMI information across school districts within the rural-urban county data.

Data Sources for Table 6, Table 7 and Table 8
Data are from the Pennsylvania Department of Health. School districts with less than 16 percent of overweight students are classified as Low School Districts (SDs). Districts where the percentage of overweight students ranges from 16 percent to 21 percent are classified as Medium SDs. High SDs are those districts where more than 21 percent of the students are overweight.

Data Sources for Tables 9, 10 and 11
Demographic Indicators
Data on demographic variables (percentage of minorities, age distribution, family size and status, education status reflecting the percent of the population with different educational attainment levels, government revenues and expenditures) are from the 2016, 5-year average, American Community Survey, U.S. Census Bureau.
Bicycle/Pedestrian Crashes (for years 2011 to 2015) are from the Pennsylvania Department of Transportation (PennDOT) Open Data (crash data) and Small Area Income and Poverty Estimates, U.S. Census Bureau (population data) in https://data-pennshare.opendata.arcgis.com/ and in https://www.census.gov/programs-surveys/saipe.html.

Information is provided on the number of vehicle crashes from 2011 to 2015 that involved bicycles and pedestrians per capita. PennDOT provides the longitudes and latitudes for each crash. This information was entered into a GIS system, and linked to the school district boundary files. The number of crashes in each district was then summed using the intersect command. Average Crash Rate was obtained by dividing the number of crashes by the total population from 2011 to 2015. Bicycle/Pedestrian crashes may elicit a particular behavioral response from the parents, namely, that parents may be less likely to have their children walk or bike to school districts if there is a high number of bicycle/pedestrian crashes. Given risk-averse parents, it is possible that children get less exercise, which may lead to higher rates of obesity.
Data on number of acres of local parks, state parks, and biking trails per capita are for 2015 and are from the Pennsylvania Department of Conservation and Natural Resources GIS shapefiles on Pennsylvania Local Parks (2015), Pennsylvania State Park Boundaries (2017), and Explore PA Trails (lines) (2017). Data were downloaded from Pennsylvania Spatial Data Access (PASDA) and http://www.pasda.psu.edu/uci/SearchResults.aspx?originator= Pennsylvania+Department+of+Conservation+and+Natural+Resources and in https://www.census.gov/programs-surveys/saipe.html. The following three steps were used in compiling this variable. Step 1: The shapefile for local parks and state parks was downloaded into a GIS program and then combined into one shape file. This data was overlaid with the school district boundary files. The number of acres of parkland in each district was calculated and then summed. Step 2: The shapefile on PA Trails was downloaded into a GIS program. Only trails suitable for biking were used. The data were overlaid with the school district boundary files. Then the total linear miles for each school were calculated. Based on internet searches, it was estimated that the standard width of each trail was 10 feet, or 0.001894 miles. This number was multiplied by the number of linear miles to produce the square miles of bike trails for each district. The number of square miles was then converted to acres Step 3: The number of acres of parkland and bike trails were added together and divided by the school district population. In general, a reasonable hypothesis that links the recreational area to obesity is: the more land that is available for recreation, the lower the incidence of obesity among the youth.
Data on SNAP Retailers were from the Food and Nutrition Service, USDA, https://www.fns.usda.gov/snap/retailerlocator and from https://www.census.gov/programs-surveys/saipe.html. The information provided here has been used to compute the number of food retailers per capita by school districts. The Food and Nutrition Service

provides the longitudes and latitudes for each retailer that access SNAP payments. The data were entered into a GIS system. The data were overlaid with the school district boundary files. The number of retailers in each district was then summed using the intersect command. The rate of retailers per 100,000 people was obtained by dividing the number of retailers was then divided by the total population for 2015. In general, it is hypothesized that the more stores prevalent in a location is directly related to the incidence of youth obesity.

Data Sources for Tables 12, 13 and 14
Economic Indicators
Economic Indicators including labor force (participation percentages), income and benefits (income distribution percentage), earnings and income (percentage of families under the distribution, median and mean family incomes and per capita income), poverty (percentage of families below the poverty line, and percentages below the poverty line with female head of the households, with and without children), insurance (percentage with different insurance coverage), commuting time (percent of labor force commuting, and percent commuters using public transport) and occupations (percent of labor force in different occupations) are were obtained from the U.S. Census Bureau using the American Community Survey series through the American FactFinder in https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Data are available for labor force, commuting time, occupation distribution, distribution of income & benefits, earnings & income, and poverty rates at the school district level for the years 2007 to 2016. Insurance coverage is presented for years 2012 to 2016. Data on the number of firms or establishments and payroll information for the years 2005-16 are from County Business Patterns and are also available in the American Fact Finder. The data are available at the 5-digit Zip code level taken for NAICS code 00, or the total for all sectors. The Zip code information was used to link the data to the BMI data based on the location of the school districts. Data on housing characteristics, poverty rate for all ages, and poverty rates for children less than 18 years are for 2016 and are from Small Area Income and Poverty Estimates Program, U.S. Census Bureau (https://www.census.gov/programs-surveys/saipe.html).

Data Sources for Tables 15, 16 and 17
School District Indicators
Percent of students participating in the Free and Reduced School Lunch Programs: Information is from National School Lunch Program Reports, within the Food & Nutrition page from the Pennsylvania Department of Education. Data are available for the years 2005 to 2016, on the number and percent of students eligible for the free and reduced lunch programs. Data are presented for each school within every district and can be obtained from https://www.education.pa.gov/Teachers%20-%20Administrators/Food-Nutrition/Pages/National-School-Lunch-Program-Reports.aspx. Data are presented for elementary schools, middle schools and high schools in each district, and the data were linked to the BMI data using school district information. The percent of students eligible for free and reduced lunch at the elementary and middle schools was computed by dividing the number of students eligible by the total enrollment in these schools, and linked to the BMI data for the K-6 observations. The data on high school students' eligibility information were linked to the BMI data for grades 7-12.
Athletic expenditures per student: Effective July 2012, schools are required to disclose all Interscholastic Athletic Opportunities for students in grades 7 to 12 to the Pennsylvania Department of Education, and this information is available in https://www.education.pa.gov/Teachers%20-%20Administrators/Interscholastic%20Athletic%20Opportunity/Pages/default.aspx. Athletic expenditures are available for each school within each district for years 2012-13 to 2016-17. From the data, the total annual expenditures by district was computed, and athletic expenditures per student ratios were derived by dividing the expenditure amounts by enrollment for each district from 2012 to 2016.
PSSA scores: PSSA test scores have been compiled from different excel worksheets taken from the Pennsylvania Department of Education website under Data & Statistics in https://www.education.pa.gov/Data-and-Statistics/PSSA/Pages/default.aspx. Data are provided for the years 2005 to 2012 for students taking the tests from the 3rd grade to 11th grade, and for students from 3rd to 8th grade for years 2005 to 2016. Data are provided for the number of students in each grade taking the test in Mathematics and English. Students are ranked into four categories based on their scores in these two subjects: Advanced, Proficient, Basic and Below Basic. Data are available for the percent of students in each of these scoring categories. The percentages were used to compute the actual number of students in each scoring category for each district for each year. The students in grades 3 to 6 were grouped together and

this information was linked to the BMI data corresponding the K-6 group. Likewise, the PSSA score information for grades above 7 was linked to students above the 6th grade in the BMI data. The PSSA scoring categories, "Advanced", "Proficient", "Basic" and "Below Basic" were used to classify students according to their performance, and link the percentages to overweight status based on the BMI data.
Aid ratios: Aid ratios are from the financial data elements site within the Pennsylvania Department of Education and are available from 2005 to 2016. Aid ratio refers to three terms: Market Value Aid Ratio (MV AR), Personal Income Aid Ratio (PI AR) and Market Value/Personal Income Aid Ratio (MV/PI AR). The MV/PI ratio measures the relative wealth, captured by market value and income, in relation to the state average, for each pupil in a school district. Data are available in https://www.education.pa.gov/Teachers%20-%20Administrators/School%20Finances/Finances/FinancialDataElements/Pages/default.aspx.
Student dropout rates: Dropout rates for each school district were obtained from the data-and-statistics section under Pennsylvania Department of Education for the years 2007-08 to 2016-17 for each school district, and can be obtained from https://www.education.pa.gov/Data-and-Statistics/Pages/Dropouts.aspx. The dropout rate represents the percent of students who dropout during a school year and is computed by dividing the number of dropouts by total enrollment for every district for each year.
Student-staff ratios: Professional and individual staff data are under professional-and-support-personnel portion under the data and statistics portion listed in the Pennsylvania Department of Education site in https://www.education.pa.gov/Data-and-Statistics/Pages/Professional-and-Support-Personnel.aspx. Data are available for all active professional teachers and staff for each school district and the data spans 2007 – 2016. The total number of staff members was computed for each school district for each year, and the student-staff ratio was computed using enrollment figures.
Student-building ratios: The above NSLP reports within the food & nutrition page from the Pennsylvania Department of Education, for the years 2006 – 2016, in https://www.education.pa.gov/Teachers%20-%20Administrators/Food-Nutrition/Pages/National-School-Lunch-Program-Reports.aspx. It also presents the number of buildings in each school district based on each school's location for each year. This information was linked to the enrollment data and the student-building ratio was computed and reflected the student occupancy rate per building per district for each year in the sample.

Incident rates and bullying-incident ratios:

Information on bullying is from the Pennsylvania Department of Education at https://www.safeschools.state.pa.us/(S(1xgjxc4itsukymqoomto3bne))/Main.aspx?App=6a935f44-7cbf-45e1-850b-e29b2f1ff17f&Menu=dbd39a1f-3319-4a75-8f69-d1166dba5d70&res. It provides data on various incidents such as aggravated assaults, drug possession, etc. Data span 2005 to 2016 for every school within the district. All schools within a district were aggregated to arrive at the district-level observation for each year. Incident rates for each district for each year is defined as the total number of reported incidents divided by enrollment, or the number of incidents per student. The bullying-incident ratio is the number of bullying incidents divided by total incidents, and this ratio is computed for every year for every school district.

Appendix 2: USDA and PDE guidelines

Nutrition guidelines under the Smart Snacks in Schools by the USDA in https://www.fns.usda.gov/school-meals/tools-schools-focusing-smart-snacks cover all programs including requirements concerning labeling and marketing for foods and beverages sold in vending machines in schools. More information about this program is also in http://www.schoolnutritiontoolbox.org/snt-v3/images/smart-snacks-in-school/PDE-Q-and-A-about-Smart-Snacks-in-School-2017-update.pdf with details about nutrition standards based on caloric content and serving sizes. Information is also available on the compliance requirements for foods in vending machines, pertaining to labeling, product specifications and Smart Snack requirements.

The Pennsylvania Department of Education (PDE) website also provides nutritional standards for competitive foods in Pennsylvania schools at http://www.asppears.ed.state.pa.us/forms/files/PDE181.pdf. Finally, *Snack Foods and Beverages in Pennsylvania Schools* (Jan 2015), from The Pew Charitable Trust and the Robert Wood Johnson Foundation, presents a detailed comparison of Pennsylvania's standards with USDA's Smart Snacks in School standards.

Appendix 3: Glossary of Terms

BMI & BMI Percentile

The Centers for Disease Control and Prevention (CDC) defines Body Mass Index (BMI) as a person's weight in kilograms divided by the square of height in meters. For children and teens, BMI is specific to age and sex. A high BMI is usually considered to be an indicator of high body fat. BMI is based on a person's height-weight compatibility, and is computed as a ratio of weight to height (weight in kilograms divided by height in meters squared).

After BMI is calculated for children and teens, it is expressed as a percentile, which relate a child's BMI relative to other children of the same age and sex. Obesity is defined as a BMI at or above the 95th percentile for children and teens of the same age and sex. For example, a 10-year-old boy of average height of 56 inches, who weighs 102 pounds, would have a BMI of 22.9 kg/m^2. This would place the boy in the 95th percentile for BMI, and he would be considered obese. This means that the child's BMI is greater than the BMI of 95% of 10-year-old boys in the reference population.

BMI Percentile Range and the Weight Status Category

The CDC adopted the BMI-for-age percentile growth charts, and has developed the following BMI-for-age weight status categories:

Underweight: BMI-for-age is less than the 5th percentile

Appropriate Weight: BMI-for-age lies between the 5th percentile and the 85th percentile

At risk of becoming overweight: BMI-for-age lies between the 85th to less than the 95th percentile

Overweight: BMI-for-age is at or equal to or greater than the 95th percentile.

Classifying School Districts based on the percentage of overweight students

The current study classified school districts into three types (Low, Medium and High), based on the following distribution of the average percentage of students who are in the overweight category:

Low: School districts that have less than 16% overweight students

Medium: School districts where the percentage of overweight students ranges from 16% to 21%

High: School districts that have more than 21% overweight students.

Rural and Urban School Districts

The current study used the Center for Rural Pennsylvania's definition of rural and urban school districts: school districts with a population density below the statewide average of 284 persons per square mile are "rural," and those at or above 284 persons per square mile are "urban."

Correlation Analysis

A statistical technique that indicates how closely two indicators are related to each other. The coefficient of correlation between two different indicators, for example, the percent of overweight students, and the percent of unemployed, may be positive or negative. If the coefficient is positive, then it implies that the two indicators move in the same direction, up or down. Conversely, if the correlation is negative, then the two indicators move in opposite directions; if one goes up, the other goes down. Correlation measures the degree of association between any two indicators. A high correlation, usually a coefficient value of 0.6 or higher, implies that the two indicators are very closely related. Correlation analysis provides an idea about the degree of association between two indicators, and does not specify any causal linkage. In the current study, the coefficient of correlation has been computed between different socioeconomic and school district indicators and the percent of overweight students across rural and urban districts.

Analysis of Variance (ANOVA)

A statistical technique to determine, whether the means of a particular indicator are different within and between two or more groups. In the current study, ANOVA has been applied to each of the socioeconomic and school district indicators to test whether the means differ between and within rural districts, between and within urban districts, and for the overall sample.

Statistical Significance

A term that signifies the importance of a result in statistical terms. If the coefficient of correlation is significant at 0.05 level, this means that there is a 95% chance that the said two indicators are closely associated. If a computation of correlation does not possess statistical significance, this means that the association between the two variables has less than a 95% chance of being closely associated.

Margin of Error

A margin of error (MOE) usually accompanies survey responses. A margin of error always arises in survey analysis, because too often, either researchers do not survey the entire population, or not all those surveyed respond in a timely manner. Consequently, it is useful to know by how much the sample results are expected differ from those of the actual population. The formula to compute the margin of error is: $MOE = z_{0.01}\sqrt{\frac{p(1-p)}{n}}$ where *p* represents the percent of the respondents who have a specific attribute, and *n* total sample size, and $Z_{0.01} = 2.58$, or the appropriate z-value representing 99% confidence. If $n = 600$ responses received from a survey of parents, of which 312 (or 52%) responses indicate that obesity is a serious issue in the district. This implies that $p = 0.52$, and $(1-p) = 0.48$, and applying the formula yields $MOE = 0.052$, leading to the inference that with 99% confidence, 52% of all parents think that obesity is a serious issue in the district.

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The Center for Rural Pennsylvania
625 Forster St., Room 902
Harrisburg, PA 17120
Phone: (717) 787-9555
www.rural.palegislature.us
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