The Effect of Nutrition and Physical Education on Student Achievement: Evidence from Traverse City Area Public Schools

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Abstract

The Physical Education and Nutrition Education Working Together (PE-Nut) program was evaluated to determine the impact nutrition and physical education has on students' academic performance. Administrative data was collected from 8 Traverse City Michigan Area Public Schools (TCAPS), four schools that administered PE-Nut (treatment) and four schools that did not administer PE-Nut (control). Regression analysis was utilized to identify the treatment effect of PE-Nut on students' academic performance. Overweight and obese students that participated in PE-Nut were 12% and 9% more likely to be proficient in reading. For math and writing, overweight and obese students that participated in PE-Nut were 22% and 13% more likely to be proficient at math, and 14% and 13% more likely to be proficient in writing. Implications from these results are nutrition and physical education programs can have a positive spillover effect on students' academic performance. The estimated economic impact of students participating in PE-Nut suggests that participants can improve their future wages by nearly $10,000.

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Introduction

Childhood obesity is a recognized public health problem in the United States. Approximately 17% or 12.7 million children and adolescents aged 2-19 years are obese (CDC 2015). Childhood obesity is more prevalent among lower-income families (CDC 2015; Singh, Siahpush, and Kogan 2010). The prevalence of obesity is particularly high among Hispanic and black children and adolescents (CDC 2014a). A third of obese preschool children, and about half of obese school-age children, becomes obese adults (Cawley 2010).

In 1998, the overall medical cost of obesity was estimated to be as high as $78.5 billion, with roughly half financed by Medicare and Medicaid. In 2008, the medical costs of obesity had risen to $147 billion per year, almost 10% of all medical spending (Eric A. Finkelstein et al. 2009). The direct cost of childhood obesity including annual prescription drugs, outpatient and inpatient costs is about $14.3 billion (Trasande and Chatterjee 2009; Cawley 2010). Between 2010 and 2030, it is projected that the combined medical costs associated with treatment of obesity related diseases are estimated to increase by $48–66 billion per year in the USA (Wang et al. 2011).

The estimated direct and indirect medical costs for obese individuals are higher compared to normal weight Americans (Eric A. Finkelstein et al. 2009; Cawley and Meyerhoefer 2012). It is estimated that the average cost of care for obese Americans was $1,429 more than normal weight Americans (Eric A. Finkelstein et al. 2009). Incremental lifetime medical cost of an obese child was estimated to be $19,000 more relative to a normal weight child (Eric Andrew Finkelstein, Graham, and Malhotra 2014).

Obesity is related to increased absenteeism (Hammond and Levine 2010; Andreyeva, Luedicke, and Wang 2014) and decreased productivity of employees while at work (presenteeism) (Gates et al. 2008; Ricci and Chee 2005). The cost of presenteeism in obese workers is an additional $506 annually in lost productivity per worker compared to normal weight workers (Gates et al. 2008). Overall, the US average cost of absenteeism per obese employee was predicted at $260 per year (Andreyeva, Luedicke, and Wang 2014). Obesity-attributable absenteeism among American workers costs the nation an estimated $8.65 billion per year (Andreyeva, Luedicke, and Wang 2014).

Multiple studies have shown that childhood obesity negatively affect students' overall academic performance (Booth et al. 2014; Gable, Krull, and Chang 2012; Datar and Sturm 2006; Crosnoe and Muller 2004; Cohen et al. 2013; Jenny Caird et al. 2011). Although, the mechanism of how obesity negatively impacts academic attainment is still uncertain (Booth et al. 2014). Childhood obesity has been linked to lower grades (Crosnoe and Muller 2004), worse math and reading scores on standardized tests (Gable, Krull, and Chang 2012; Booth et al. 2014; Datar and Sturm 2006), and increased absenteeism (Pan et al. 2013; Geier et al. 2007). Childhood absenteeism has also been associated with productivity loss among their parents (Bramley, Lerner, and Sames 2002).

To combat the childhood obesity epidemic, many interventions have been made in US schools and have focused on increasing physical activity and nutrition education among youth (Eric A. Finkelstein et al. 2013). This increase in school-based nutrition/physical education programs, has led to an increasing body of literature looking at the effect that physical/nutrition education intervention programs have on students health outcomes (Waters et al. 2011; Robinson-O'Brien, Story, and Heim 2009; Marcus et al. 2009; Gentile et al. 2009; Sbruzzi et al. 2013). There is also a growing body of literature examining the effect physical/nutrition education intervention programs have on students' academic performance (James F. Sallis et al. 1999; Ahamed et al. 2007; Coe et al. 2006; Hollar et al. 2010; Ericsson 2008; Budde et al. 2008).

The objective of this study is to determine the academic and economic impact PE-Nut has on students' compared to the control group. This study will analyze what effect the program has on the student's state-administered examination test scores in the following subjects: math, reading, and writing. This study will also analyze the effect PE-Nut has on students' attendance records and estimate the economic benefit to the individuals who participated in PE-Nut.

This article will add to the body of literature examining the impact of nutrition/physical education programs on student's academic performance. Also, this is the first evaluation of PE-Nut's effect on students' academic performance. This article also, utilizes unique longitudinal administrative data from TCAPS to estimate the impact of PE-Nut on students' academic performance. Finally, this is one of few articles that attempt to measure the economic impact of nutrition/physical education programs.

Background

Obesity and Student Performance

Multiple studies have shown that obesity negatively affects students' overall academic performance (Booth et al. 2014; Gable, Krull, and Chang 2012; Datar and Sturm 2006; Crosnoe and Muller 2004). Also, increased wages has been linked to higher cognitive ability and academic performance of workers (Heckman, Stixrud, and Urzua 2006).

Cohen et al. (2013) and Caird et al. (2011) performed systematic reviews on the effect obesity has on education attainment. The latter systematic review focused on childhood obesity while the former focused on obesity at all age levels. Cohen et al. (2013) main finding was studies that were conducted in high-income countries; an inverse relationship was more commonly found between education attainment and obesity.

Looking specifically at studies that focus on childhood obesity and educational attainment Caird et al. (2011) found that 29 of the studies included in the review suggested that higher weight is weakly associated with lower educational attainment among children and adolescents. Also, the systematic review concluded that little of the variation in academic achievement was explained by weight status alone. Half of the studies reviewed found that other factors, such as socio-economic status (SES), can better explain much of the negative association between weight status and attainment.

The majority of studies used observational study design (Jenny Caird et al. 2011; Jennifer Caird et al. 2014; Cohen et al. 2013) to identify the effect obesity has on students' academic performance. Some studies used primary data (Huang, Goran, and Spruijt-Metz 2006; Cottrell, Northrup, and Wittberg 2007; Chomitz et al. 2009), but the majority of the studies in this area used secondary datasets to perform the analysis (Jennifer Caird et al. 2014). The National Longitudinal Study of Adolescent Health (ADDHealth), the Early Childhood Longitudinal Study, Kindergarten Class (ECLS-K), National Longitudinal Survey of Youth 79 and 97 (NLSY79/NLSY97), and Third National Health and Nutrition Examination Survey (NHANES III) are just a few of existing datasets that researchers have used to analyze this topic (Jennifer Caird et al. 2014; Cohen et al. 2013). Regression analysis was the most commonly employed statistical analysis. Other types of statistical analysis included analysis of variance (ANOVA), multivariate analysis of variance (MANOVA) and analysis of co-variance (ANCOVA). To account for unobserved heterogeneity and endogeneity issues that may bias the estimation, several articles used Fixed Effects (FE) and Instrumental Variables (IV) regression models (Jenny Caird et al. 2011; Jennifer Caird et al. 2014; Averett and Stifel 2010).

When looking at the effect childhood obesity has on students' grades Crosnoe and Muller (2004) found a negative correlation between childhood obesity and student grades. The authors estimated that students who are at risk for obesity had one-tenth lower grade point averages then non-obese students.

Race and gender have been found to be strongly associated both with being overweight and with academic and school outcomes (Judge and Jahns 2007). Multiple studies have shown that students who were overweight or became overweight over time between Kindergarten and 5th grade did worse on standardized math tests than students who were normal weight. The results were even more pronounced for girls than boys (Gable, Krull, and Chang 2012; Datar and Sturm 2006).

Booth et al. (2014) and Datar and Sturm (2006) found that students who were overweight or obese did worse on reading tests than normal weight students. Booth et al. (2014) using data on roughly 6000 participants from the University of Bristol Avon Longitudinal Study of Parents and Children (ALSPAC), showed that females who were obese at age 11 did statistically worse on their English test scores at ages 11, 13, and 16 then normal weight students. This finding was not statistically significant for males, although there was an inverse relationship for obesity and English performance. Using the National Center for Education Statistics (NCES) ECLS-K dataset, Datar and Sturm (2006) were able to show similar results for students in kindergarten-3rd grade.

Averett and Stifel (2010) used data from the NLSY79 cohort to investigate childhood obesity effect on relative cognitive development. They found that overweight, Caucasian boys have lower math and reading scores compared to normal weight children. Also, overweight Caucasian girls have lower math scores, whereas overweight African American boys and girls have lower reading scores.

The association between childhood obesity and student absenteeism have been mixed. Several studies have shown a negative relationship between students' health and student absenteeism (Datar and Sturm 2006; Pan et al. 2013; Geier et al. 2007). While, data from Baxter et al. (2011) were not able to find any association between childhood health and school absenteeism. Datar and Sturm (2006) show that boys who are obese had statistically significant higher number of absences compared to normal weight students. These effects were not significant for girls. Using data from the 2009 National Health Interview Survey (NHIS) Pan et al. (2013) found overweight and obese adolescents had 36% and 37% more sick days, respectively, than adolescents of normal weight.

The mechanism of how obesity negatively impacts academic attainment is still uncertain (Booth et al. 2014), although many mechanisms have been hypothesized (Datar A and Sturm R 2004; Kamijo et al. 2012; Maccann and Roberts 2013; Smith et al. 2011). It is hypothesized that negative effects of childhood obesity can lead to physical and mental health problems, which can lead to absenteeism (Booth et al. 2014; Kamijo et al. 2012). More rigorously designed studies are still needed to determine the casual relationship (K.K. Pucher, N.M.W.M. Boot, and N.K. De Vries 2013; Rasberry et al. 2011).

Furthermore, researchers hypothesize that excess weight might affect cognition and have a negative effect on learning and academic attainment (Kamijo et al. 2012). Studies have shown that both boys and girls who are overweight or obese are more likely to experience internalizing behavior problems. Datar A and Sturm R (2004) were able to show that girls had 54% greater odds of internalizing behavior problems reported by teachers and 49% greater odds reported by parents. Boys and girls differ on externalizing behavior problems. Girls have an 81% greater odds of teacher reported externalizing behavior problems (Datar A and Sturm R 2004). While, boys who were or became obese showed statistically significant lower externalizing behavior problems reported by their teachers (Datar and Sturm 2006). Datar and Sturm (2004) hypothesized psychological problems to be among the most serious consequences of children being overweight. Overweight children and adolescents may be teased and ridiculed or may experience social marginalization, leading to low self-esteem.

Diet, Physical Activity, and Student Performance

An extensive body of literature has shown that poor dietary behavior negatively impacts the performance of students in school (Symons et al. 1997; Taras 2005; Florence, Asbridge, and Veugelers 2008; Rampersaud et al. 2005). Florence, Asbridge, and Veugelers (2008) surveyed 5,200 5th grade students in Nova Scotia, Canada, and their parents as part of the Children's Lifestyle and School-performance Study. In the survey information on the students' dietary intake, height, weight, sociodemographic and their standardized test scores were collected. The Harvard Youth/Adolescent Food Frequency Questionnaire (YAQ) was used to collect dietary intake information of the students. Then that questionnaire was used to calculate the Diet Quality Index—International (DQI-I), a composite measure of diet quality. Multilevel regression analysis was used to examine the association between indicators of diet quality and academic performance while adjusting for gender and socioeconomic characteristics of parents and residential neighborhoods. The study found that students with decreased overall diet quality were significantly more likely to perform poorly on the standardized tests. Also, girls performed better than boys, as did children from socioeconomically advantaged families. This also applied to children who attended better schools and lived in wealthier neighborhoods.

Taras (2005) performed an extensive literature review on different aspects of children nutrition and student performance. Taras finds that iron deficient children and/or food insufficient populations perform worse academically then there non-iron deficient/ food insufficient counterparts. Also, school breakfast programs are positively related to attendance rates and academic performance of students.

To estimate the association of school-based physical activity and academic performance several studies have used either experimental (Budde et al. 2008; J F Sallis et al. 2001), quasi-experimental (Tremarche, Robinson, and Graham 2007; Ericsson 2008), or analysis of secondary data designs (Carlson et al. 2008; Tremblay, Inman, and Willms 2000). Rasberry et al. (2011) systematic review on the subject conclude that physical activity is either positively related or no relationship exists with academic performance. The results also suggest adding physical activity to the school day does not detract and may enhance students' academic performance (Rasberry et al. 2011).

Nutrition/Physical Education Programs Effects on Student Performance

Several studies have shown a positive relationship between students participation in school-based health promotion intervention (SHPI) programs and academic performance (James F. Sallis et al. 1999; Ahamed et al. 2007; Coe et al. 2006; Hollar et al. 2010; Ericsson 2008; Budde et al. 2008). Similar to Physical Education and Nutrition Education Working Together (PE-Nut), all of the studies had interventions whose curriculum focused on improving the nutrition intake of participants and increasing their physical activity levels.

PE-Nut is a nutrition and physical education program that uses a whole-school approach to motivate students, parents and educators to eat healthier and be physically active. PE-Nut uses a CDC award winning curriculum that teaches physical education while incorporating nutrition messages (CDC 2015b). The Nutrition education program materials for this study were taught in kindergarten, 2nd and 4th grade. In kindergarten and 2nd grade, PE-Nut consist of eight nutrition-based lessons incorporating 27 activities, and in 4th grade ten nutrition-based lessons incorporating 32 actives are taught to students (Michigan Fitness Foundation 2015). Trained guest nutrition educators teach the nutrition lessons to the students. More detailed information on the components of PE-Nut can be found at Michigan Fitness Foundation website (http://www.michiganfitness.org/pe-nut).

To estimate the effect the interventions had on students' academic performance the studies employed either an experimental (Coe et al. 2006; Budde et al. 2008) or quasi-experimental (James F. Sallis et al. 1999; Ahamed et al. 2007; Ericsson 2008; Hollar et al. 2010) design. All of the articles utilized a two-sample t-test to compare differences in means in the demographic variables between the control and intervention groups. ANOVA (James F. Sallis et al. 1999; Ahamed et al. 2007; Coe et al. 2006; Hollar et al. 2010; Budde et al. 2008), ANCOVA (James F. Sallis et al. 1999), and Repeated Measures ANOVA (Hollar et al. 2010) were used to analyze the effect the interventions had on academic performance.

School Breakfast Programs (Murphy J et al. 1998; Meyers 1989), a school-based mental health counseling services (Gall et al. 2000), and a school-based respiratory and asthma prevention program (Clark et al. 2004) have been analyzed on what effect these programs have on students' absenteeism. Three of the studies reported a decrease in the number of absences among students participating in the interventions (Meyers 1989; Meyers 1989; Murphy J et al. 1998; Gall et al.

2000), and the other study saw no statistical difference in number of absences from participation (Clark et al. 2004).

Data

Administrative data was collected from Traverse City Area Public Schools (TCAPS). Data was collected from eight schools in TCAPS, four schools that administered PE-Nut (treatment) and four schools that did not administer PE-Nut (control). The schools were selected on similar enrollment size and percentage of free/reduced lunch recipients at the schools.

The dataset is an unbalanced panel dataset from the school years 2008-2009 to 2012-2013 school years. Students who were in kindergarten, 2nd, and 4th grade between 2008 and 2012 in the eight schools in this study were included in the dataset. The dataset included student level anthropometric (height, weight), education outcome (standardized test scores), attendance records, demographic, zip codes of students' residency and other data.

The student's zip code data was used to link the American Community Survey (ACS) five year estimates. Individual level socio-economic status (SES) information was not included in the dataset, hence, community level SES data was included to proxy students' SES following the approach by Sanigorski et al. (2008) and Oakes (2016). The ACS is a yearly survey administered by the Census Bureau. ACS 5 year estimates from 2008-2012 for median income level, percentage of high school and college graduates, median house and population size were used.

Measures
<u>Michigan Education Assessment Program (MEAP)</u>: MEAP is a 44 year old paper based test that measures the performance of students in the state of Michigan (Michigan Department of Education 2015a). MEAP was developed to measure what Michigan educators believe all students should know and be able to achieve in five content areas: mathematics, reading, science, social studies, and writing. MEAP was the only common measure given statewide to all students before 2014. The test serves as a measure of accountability for Michigan schools (Michigan Department of Education 2015b). The raw scores on MEAP were not provided by TCAPS, only the category level of the student subject area was provided. To create the category level, a raw score is created for each student who takes a particular test subject. From that raw score the student is placed in one of the levels of comprehension: level 1 - student is advanced in that subject; level 2 - student is proficient; level 3 - student is partially proficient; and level 4 - student is not proficient at a given subject.

Math and reading tests are taken in grades 3rd -8th, science is taken in grades 5th and 8th, social studies is taken in grades 6th and 9th, and writing is tested in 4th and 7th grade. Due to the small number of scores received for science and social studies only math, reading, and writing MEAP scores are analyzed in this article. Finally, using level 2 (proficient) and level 3 (partially proficient) as the cutoff point, the MEAP categorical variables were transformed into dummy variables where 1 indicates that the student is proficient in the subject.

<u>Attendance</u>: The attendance data includes information on the students' total number of excused/unexcused tardy and absences each school year. An excused absence and tardy is when

a parent/guardian has given the school verification of a student's absence due to one of the reasonable excuses deemed by the school district (e.g. illness, appointment, religious holiday, etc.). An unexcused absence and tardy is when a parent/guardian has notified the school of a student's absence with a reason not considered a reasonable excuse. Students up to one hour late for school are marked tardy. Also, an early departure with more than an hour left in school is recorded as tardy. The school will send a letter to the student's home after ten (10) absences of any kind. A second letter will be sent to the student's parent/guardian at the principal's discretion or after twenty absences of any kind with a copy forwarded to the Truancy Intervention Center ("TCAPS Elementary Handbook" 2014).

Treatment variable: The treatment variable indicates the effect the PE-Nut program had on individual students that participated in the program. PE-Nut is a treatment variable that indicates individual level student participation in the program. A student participate in PE-Nut when the student attends one of the four schools that offer PE-Nut between 2008 and 2012 and is in kindergarten, 2nd, or 4th grade during that school year.

Weight Categories: Students height, weight, sex, and age information was used to calculate student's BMI-z score. Then the Center for Disease Control and Prevention (CDC) cutoff points were used to categorize student's weight as underweight, normal weight, overweight, or obese. Table lists the percentiles (z-score) values that correspond to the weight categories and the corresponding percentile is in parentheses.

Table 1: Weight Status Category Cutoff Points Based on BMI-z Scores

Weight Status Category	**Percentile Range (Z-score)**
Underweight	Less than the 5th percentile (-1.64)
Normal or Healthy Weight	5th percentile (-1.64) to less than the 85th percentile (1.04)
Overweight	85th (1.04) to less than the 95th percentile (1.64)
Obese	Equal to or greater than the 95th percentile (1.64)

Source: http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.htm

Descriptive Statistics

Table 2 lists the variables included in this article and their definition by school assignment. The variables that are dichotomous, the percentage for 2008 and 2012 are reported. The mean for 2008 and 2012 are reported for the continuous variables. Also a mean comparison t-test was calculated to see if there were any statistically significant differences between the control and treatment schools. All dependent variable averages were statistically significantly different between the control and treatment groups. The average number of absences and tardy from school for students that went to a school that did not have PE-Nut was less than the treatment schools. The mean for the test subjects indicate the proportion of students that are proficient in math, reading, and writing were statistically higher at the control schools than the treatment schools, but the proportion of students who are proficient at math and reading did increase between the five year period.

The independent variables age, normal weight, obese, and non-white, the means of the control and treatment groups were statistically significantly different. Roughly 16% of the students were obese in the treatment group versus 12% of the students in the control group. This is similar to the 17% of adolescents who are categorized as obese in America according to the CDC (CDC 2015). Finally, the community level SES variables for the treatment group were less and statistically different from the control group.

Table 2: Descriptive Statistics by Year and Assignment

VARIABLE	DEFINITION	Percentage			
Dichotomous		**2008**		**2012**	
		Treatment	**Control**	**Treatment**	**Control**
Female	Student is female	45.73	47.67	49.07	47.64
Normal Weight	Student is normal weight	63.27	69.11***	64.65	66.07
Overweight	Student is overweight	17.70	15.83	16.03	15.71
Obese	Student is obese	16.19	12.39**	16.58	13.68*
Non-White	Student is non-white	13.10	9.50***	11.64	8.58***
PE-Nut	Participated in PE-Nut	54.82		28.66	
Reading (0-1)	Proficient at reading	47.71	68.53***	64.33	73.93***
Math (0-1)	Proficient at math	14.48	28.78***	25.18	30.07**
Writing (0-1)	Proficient at writing	37.61	57.03***	38.17	56.03***
Continuous		**Mean**			
Absences	Number of Absences	15.62	11.55***	14.18	11.63***
Tardy	Number of days Tardy	5.33	3.99***	4.90	3.94***
Reading Score^	MEAP Reading Score	2.66	2.32***	2.37	2.19***
Math Score^	MEAP Math Score	3.49	3.13***	3.24	3.12***
Writing Score^	MEAP Writing Score	2.68	2.44***	2.68	2.36***
Age	Age of student	6.71	7.25***	8.66	9.70***
Community-level information					
Median Income	Median Income ($)	50384.80	52599.18***	50817.97	52554.80***
Population	Population of zip code area	23220.00	31185.60***	26013.10	30804.30***
High School	Proportion of high school graduates	92.45	93.55***	92.75	93.52***
College	Proportion of college graduates	26.48	32.35***	28.01	32.25***
Median House Value	Median House Value	8108.80	8236.76	7919.26	8303.70***

* Implies mean comparison test is significant at the 0.10, ** at the 0.05 level and *** at the 0.01 level

^MEAP Score has 4 values: 1 indicates that a student is advanced ; 2 indicates that a student is proficient; 3 indicates that a student is partially proficient; 4 indicates that a student is not proficient

Empirical Framework

A quasi-experimental design was created to measure the effect PE-Nut has on students' academic performance. Regression analysis is used to identify the treatment effect of PE-nut on students' academic performance. Average Treatment Effect (ATE) analysis has been used in policy analysis to estimate the effectiveness of various programs. Economos et al. (2007), Sanigorski et al. (2008), and Hoelscher et al. (2010) are studies that used regression analysis specifically mixed models (random intercept models) to find the ATE of nutrition education on participant's health and education outcomes. Wooldridge (2010), Caliendo and Kopeinig (2008), and Meyerhoefer and Yang (2011a) provide more formal discussions on the Rubin Casual Model (RCM) framework and ATE analysis.

The analysis is to look at the effect of PE-Nut on student achievement. The treatment variable $PE\text{-}Nut_{it}$ indicates students' participation in the program between 2008 and 2012. Also, the treatment variable follows Wooldridge (2005) setup of program evaluation with panel data. The equation below is the reduced form model. The estimated Average Partial Effect (APE) for the treatment variable will indicate the differences in students' achievement, between students who participated in PE-Nut versus non-PE-Nut students.

$$Y_{it} = \alpha + \beta_1 PE\_Nut_{it} + Z_{it}\Pi + T_t\Lambda + \varepsilon_{it}$$

Where,

Y_{it} = Academic Outcomes, Z_{it} = Other explanatory variables, T_t = time dummy variables, c_i = unobserved effect, ε_{it} = error term

Due to how schools were selected to participate in PE-Nut it is likely that there is selection bias in the data. For a school to be eligible for PE-Nut the school must have at least 50% or more of the students receiving free/reduced lunch[1]. Once, a school reaches this threshold, the Intermediate School Districts (ISD) or local community organizations must complete a request for proposals and go through a competitive review process for potential funding. If funded, MFF staff will work with that organization to support their implementation of the program at the qualifying schools.

This selection process can lead to an oversampling of relatively low-income students compared to the control schools. Propensity score techniques have been utilized in controlling for selection bias in the estimation of the treatment effect. Unfortunately, these techniques cannot be estimated. Since, the children are not deciding if they participate in the program then performing a propensity score weighted regression on student participation is useless. Also, a propensity score regression cannot be performed based on school participation because of the eight schools included in the study there is no overlap of the schools that received PE-Nut.

There may also be some endogeneity issues in the estimation of the treatment effect of PE-Nut. Unobservable traits like innate ability, motivation, and capacity to concentrate are just a few individual unobservable traits that affect student achievement that is not control for with the covariates in this article (Behrman 1996). Without the ability to control for these unobservable

[1] The National School Lunch Program (NSLP) is a federally funded meal program operating in public and nonprofit private schools. NSLP provides low-cost or free lunches to children each school day (USDA 2016).

traits this will lead to omitted variable bias in the estimation of the treatment effect. Due to issues of endogeneity reduced form equation is estimated by Fixed Effects (FE), which accounts for the individual heterogeneity, where the students in the program are compared to themselves.

Since, the attendance dependent variable is continuous those reduced form equations are estimated by Ordinary Least Squares (OLS) and Fixed Effects (FE). Due to the categorical nature of the test score dependent variables those reduced form equations are estimated by OLS, FE and logit.

Results

Table 3 displays the OLS and FE estimation of the effect of participating in PE-Nut on students' attendance. The estimated coefficient for PE-Nut is the treatment effect of participating in PE-Nut on students' academic performance. This estimated coefficient indicates the effect the program had on individuals who participated in PE-Nut between years 2008-2012 versus individuals who did not participate in the program during that time period.

Interpreting the significant variables in Table 3, age is positively related to students' attendance. Thus as students become older they are going to be absent from school and be late to school more often. Non-white was also positively related to attendance. Students who are non-white are absent from school and late to school about one day more than white students.

The estimated overall effect of being obese was significant and positively related to attendance. Obese students are absent from school about 1.3 days more and tardy 1 day more than normal weight students. Analyzing the FE estimated coefficients, which uses the within variation of students for identification, the overall effects of being obese on attendance disappear.

The OLS estimates for the treatment variable overall effect was positive for students' absences, while no effect was found for their tardy. Students that participated in PE-Nut were likely to be absent from school 1 day more than students who did not participate in PE-Nut. When comparing students to themselves, the FE model estimates were similar to the OLS estimations.

Table 4 displays the OLS, logit, and FE estimations for the effect PE-Nut had on students' MEAP reading test scores. The same analysis was performed for MEAP math and writing test scores, whose output can be found in the appendix. Age, female, non-white, obese, and underweight was the significant demographic and weight category variables. Age was positively related to the MEAP reading and math tests and negatively related to the writing test. Being a female student was inversely related to math and positively related to reading and writing. Also, female students were roughly 5% less likely to be proficient at math compared to boys. Female students were also 9% more likely to be proficient in reading compared to boys and 17% more likely in writing. The overall effect of being non-white was negatively correlated with students' tests scores, and all of the estimated coefficients were significant at the 5% critical level. Non-white students were about 12% less likely in reading and math, and 9% less likely in writing to be proficient compared to Caucasian students.

Being overweight was negatively related to math scores, while no statistically significant relationship was found between reading and writing tests. Students that were overweight were roughly 4% less likely to be proficient at math compared to normal weight students. Obese was negatively related to reading and writing scores, while no statistically significant relationship was found for math scores. Students that were obese were roughly 5% less likely to be proficient at reading compared to normal weight students and 6% less likely in writing.

The OLS and logit estimated coefficients for the treatment variable showed an inverse relationship on the MEAP reading, math, and writing tests and were significant at the 10% critical value. The overall effect of students who participated in PE-Nut were 4% less likely to be proficient in reading, 6% less likely in math, and 7% less likely in reading. This negative effect did not hold for all individuals that participated in PE-Nut. In table 3, the interaction terms estimated that overweight and obese students that participated in PE-Nut were roughly 12% more likely and 9% more likely to be proficient in reading. Similar results were estimated for the math and writing sections. Overweight and Obese students that participated in PE-Nut were 22% and 13% more likely to be proficient at math. For writing overweight and obese students were 14% and 13% more likely to be proficient. This result is similar to Hollar et al. (2010), which estimated higher Florida Comprehensive Achievement Test (FCAT) math scores for obese students that participated in the nutrition/physical education program. In the OLS and logit regressions, a statistically significant negative relationship was estimated for the treatment variable and MEAP test scores, but the FE estimation shows no statistical difference in reading and writing proficiency. The FE models also show that students who participate in PE-Nut are only 4% less likely to be proficient in math.

Table 3: Effect of PE-Nut on Students' Attendance

	Absences				Tardy			
VARIABLES	OLS		Fixed Effects		OLS		Fixed Effects	
PE-Nut	0.870***	0.866	0.833***	0.810**	0.232	-0.052	0.049	-0.262
	(0.323)	(0.542)	(0.277)	(0.322)	(0.193)	(0.288)	(0.160)	(0.185)
Age	-0.758***	-0.757***	1.035***	1.034***	-0.412***	-0.412***	0.316***	0.316***
	(0.065)	(0.065)	(0.046)	(0.046)	(0.042)	(0.042)	(0.030)	(0.030)
Female	0.044	0.079			-0.018	-0.018		
	(0.280)	(0.278)			(0.171)	(0.175)		
Overweight	0.030	-0.212	-0.084	-0.115	0.161	0.019	-0.219	-0.338*
	(0.327)	(0.319)	(0.297)	(0.305)	(0.190)	(0.194)	(0.187)	(0.195)
Obese	1.384***	1.571***	0.002	0.084	0.920***	0.846***	-0.239	-0.380
	(0.408)	(0.424)	(0.459)	(0.465)	(0.268)	(0.275)	(0.323)	(0.331)
Underweight	0.710	0.708	0.665	0.347	0.710	0.752	-0.422	-0.490
	(0.673)	(0.663)	(0.634)	(0.597)	(0.475)	(0.490)	(0.550)	(0.541)
Non-white	1.044**	1.003*			0.800***	0.719**		
	(0.507)	(0.536)			(0.297)	(0.307)		
Underweight* PE-Nut		0.021		2.249		-0.248		0.495
		(1.832)		(1.810)		(1.459)		(1.316)
Overweight*PE-Nut		1.711*		0.298		1.019*		0.876*
		(0.915)		(0.794)		(0.523)		(0.473)
Obese*PE-Nut		-1.120		-0.531		0.482		0.901**
		(0.915)		(0.770)		(0.544)		(0.430)
Female*PE-Nut		-0.235				-0.009		
		(0.630)				(0.364)		
Nonwhite*PE-Nut		0.317				0.495		
		(1.001)				(0.606)		
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SES Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,557	14,557	14,638	14,638	14,557	14,557	14,638	14,638
R-squared	0.234	0.234	0.228	0.228	0.124	0.125	0.090	0.091

* Implies significance at the 0.10, ** at the 0.05 level and *** at the 0.01 level
Robust standard errors reported above

Table 4: Effect of PE-Nut on Students' MEAP Reading Test

	Reading					
VARIABLES	OLS		Logit		Fixed Effects	
PE-Nut	-0.041*	-0.090**	-0.040*	-0.087**	0.030	0.030
	(0.021)	(0.037)	(0.021)	(0.036)	(0.020)	(0.027)
Age	0.024***	0.024***	0.024***	0.025***	0.047***	0.047***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Female	0.088***	0.086***	0.088***	0.087***		
	(0.016)	(0.016)	(0.016)	(0.016)		
Overweight	-0.008	-0.020	-0.009	-0.021	-0.004	-0.008
	(0.020)	(0.020)	(0.020)	(0.021)	(0.027)	(0.028)
Obese	-0.050**	-0.060***	-0.050**	-0.060***	-0.083**	-0.080*
	(0.021)	(0.022)	(0.021)	(0.022)	(0.040)	(0.041)
Underweight	-0.132***	-0.135***	-0.135***	-0.139***	-0.049	-0.048
	(0.047)	(0.048)	(0.047)	(0.048)	(0.047)	(0.048)
Underweight* PE-Nut		0.046		0.046		-0.021
		(0.136)		(0.105)		(0.126)
Non-white	-0.161***	-0.152***	-0.117***	-0.152***		
	(0.028)	(0.029)	(0.023)	(0.029)		
Overweight*PE-Nut		0.140**		0.119***		0.040
		(0.056)		(0.042)		(0.044)
Obese*PE-Nut		0.098*		0.086**		-0.028
		(0.055)		(0.042)		(0.053)
Female*PE-Nut		0.026		0.016		
		(0.042)		(0.039)		
Nonwhite*PE-Nut		-0.082		-0.068		
		(0.068)		(0.066)		
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes
SES Variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,831	5,831	5,831	5,831	5,846	5,846
R-squared	0.037	0.039			0.030	0.030
Pseudo R-squared			0.029	0.0310		

* Implies significance at the 0.10, ** at the 0.05 level and *** at the 0.01 level
Robust standard errors reported above

Economic Impact

This section used the estimation of the effect of PE-Nut on students' attendance to calculate the economic impact of PE-Nut on participants' future earning outcomes. The linear projections of the absences model were used to estimate the future wages of PE-Nut participants could gain from their participation in the program. The average work day productivity gained per year, total benefits, cost per participant, net benefit and the present value of the net benefits are calculated.

The assumptions that were used to calculate the benefits of participating in PE-Nut: 1) Individuals will maintain their BMI after the last observation is recorded in this study; 2) Students begin participation in the workforce at age 21 and leave at age 65. 3) Average daily wage per eight hour workday was based on the American Community Survey average hourly wage for Traverse City, MI (Bureau 2016). Average Total Individual Benefit = Work day Productivity Loss Saved per year x Average Daily Wage per 8 hour workday x # of Years of Work.

To calculate cost per participant the 2016 total grant award plus administration costs for TCAPS were divided by the number of TCAPS students that participated in PE-Nut in 2016. Then the yearly cost per participant was multiplied by three because students are expected to participate in PE-Nut in kindergarten, 2nd and 4th grades.

Table 5 lists the estimated economic impact of participating in PE-Nut. The results suggest that students that participate in PE-Nut on average earn $11,823.56 over their lifetime compared to only $8,970.36 for non-PE-Nut students. This benefit is larger for overweight students that participated in the program. Factoring in the cost of implementing PE-Nut the Net Benefit of participating in PE-Nut is positive for 0%, 1% and 3% discount rate, but is negative when the discount rate is 5%.

Table 5: Estimated Total Individual Benefit for Participating in PE-Nut

	Projected Avg. Workday Gained per year	Avg. Total Benefits*	Net Benefit**	Scenario 1 Discount Rate =1%***	Scenario 2 Discount Rate =3%	Scenario 3 Discount Rate =5%
PE-Nut	1.46	$11,823.56	$10,168.88	$5,976.68	$1,565.72	-$272.96
Control	1.11	$8,970.36	$7,315.68	$4,135.19	$788.59	-$606.39
Overweight PE-Nut	1.94	$15,735.69	$14,081.01	$8,501.85	$2,631.27	$184.21
Overweight Control	1.23	$9,996.84	$8,342.16	$4,797.74	$1,068.18	-$486.44
Obese PE-Nut	1.09	$8,828.08	$7,173.40	$4,043.36	$749.84	-$623.02
Obese Control	1.27	$10,303.17	$8,648.49	$4,995.45	$1,151.61	-$450.64

*Avg. Total Benefit = Workday Gained per year x Average Daily Wage x # of Years of Work
**Total Cost per participant is $1,654.68. Students are expected to participate in PE-Nut for 3 years
*** Present Value = Future Value*$(1+i)^{-n}$

Conclusion

The purpose of this project was to add to the growing body of literature by examining the effect PE-Nut had on students' academic performance. Administrative data was collected from 8 Traverse City Area Public Schools (TCAPS), 4 schools that administered PE-Nut (treatment) and 4 schools that did not administer PE-Nut (control). The panel dataset included student level anthropometric (height, weight), education outcome (standardized test scores), attendance records, demographic, zip codes of students' residency and other data.

A quasi-experimental design was created to measure the effect PE-Nut has on students' academic performance. Regression analysis was utilized to identify the treatment effect of PE-Nut on students' attendance records and standardized test scores. The reduced form equations that are used to identify the treatment effect were estimated by OLS, logit, and FE.

First, looking at the effect PE-Nut had on students' attendance, the estimates showed students that participated in PE-Nut were likely to be absent from school 1 day more than students who did not participate in PE-Nut, and no difference was found for students' tardy. But when we look at the interaction term students who are obese and participated in PE-Nut they were absent from school roughly 1 day less than students that are normal weight and did not participate in PE-Nut.

An inverse relationship was estimated between the treatment variable and MEAP reading, math, and writing tests. Also the estimated coefficients were significant at the 10% critical value. The overall effect of students who participated in PE-Nut were 4% less likely to be proficient in reading, 6% less likely in math, and 7% less likely in reading. This negative effect did not hold for all individuals that participated in PE-Nut. The interaction terms estimated that overweight and obese students that participated in PE-Nut were roughly 12% more likely and 9% more likely to be proficient in reading. Similar results were estimated for the math and writing sections. Overweight and Obese students that participated in PE-Nut were 22% and 13% more likely to be proficient at math. For writing overweight and obese students were 14% and 13% more likely to be proficient. This result is similar to Hollar et al. (2010), which estimated higher Florida Comprehensive Achievement Test (FCAT) math scores for obese students that participated in the nutrition/physical education program.

The implications that can be drawn from these results are that nutrition and physical education programs can have a positive spillover effect on students' academic performance. This spillover effect was even more pronounced for obese and overweight students that attended a school that had PE-Nut or participated in the program. These results should encourage school district administrators in Michigan to implement a nutrition and physical education program like PE-Nut, which uses a whole-school approach to teach students, in more schools in the state and furthermore provide evidence that SNAP-Ed programming leads to long term impactful outcomes. Also, the results suggest that this program should expand to schools with higher populations of obese/overweight students to achieve the most effective return on student investment.

There are three limitations to this study. First, test score data was not available before 2008; therefore a Difference in Differences (DID) framework was not able to be used as an identification strategy. Second, no individual level information on students free/reduced lunch eligibility was assessable. Free/reduced lunch eligibility would have been a better predictor of students SES than using area level SES variables to proxy for students SES. Finally, the selection bias that was created from the rules used to implement the PE-Nut program. Even though, we accounted for the selection bias with the quasi-experimental design there may still exist selection bias in the estimates. In the future, it would be advantages if the threshold level of free/reduced lunch recipients were not required for a school to receive PE-Nut, but all schools in Michigan are eligible to participate in the program.

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Appendix A

Table A1: Individual Level Effect of PE-Nut on Students' MEAP Math Test

	Math					
VARIABLES	OLS		Logit		Fixed Effects	
PE-Nut	-0.060***	-0.100***	-0.065***	-0.095***	-0.041***	-0.042**
	(0.018)	(0.031)	(0.019)	(0.030)	(0.015)	(0.018)
Age	0.014**	0.014**	0.014**	0.014**	0.010	0.010
	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
Female	-0.053***	-0.052***	-0.053***	-0.051***		
	(0.016)	(0.016)	(0.016)	(0.016)		
Overweight	-0.041**	-0.055***	-0.040**	-0.053***	-0.042	-0.047*
	(0.019)	(0.019)	(0.019)	(0.018)	(0.026)	(0.026)
Obese	-0.026	-0.037*	-0.026	-0.035*	-0.024	-0.025
	(0.020)	(0.021)	(0.020)	(0.020)	(0.036)	(0.037)
Underweight	-0.030	-0.018	-0.028	-0.017	0.085	0.097*
	(0.041)	(0.044)	(0.038)	(0.040)	(0.060)	(0.058)
Non-white	-0.117***	-0.114***	-0.117***	-0.111***		
	(0.023)	(0.024)	(0.023)	(0.024)		
Underweight* PE-Nut		-0.156***		#		-0.234**
		(0.051)				(0.105)
Overweight*PE-Nut		0.166***		0.221***		0.043
		(0.054)		(0.074)		(0.039)
Obese*PE-Nut		0.103**		0.134**		-0.001
		(0.044)		(0.065)		(0.035)
Female*PE-Nut		-0.008		-0.030		
		(0.035)		(0.044)		
Nonwhite*PE-Nut		-0.029		-0.093		
		(0.041)		(0.068)		
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes
SES Variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,843	5,843	5,843	5,830	5,858	5,858
R-squared	0.025	0.027			0.023	0.025
Pseudo R-squared			0.0225	0.0241		

* Implies significance at the 0.10, ** at the 0.05 level and *** at the 0.01 level
Robust standard errors reported above
No individual who was underweight and participated in PE-Nut had a proficient score in math so it was dropped in the model because it predicts failure perfectly

Table A2: Individual Level Effect of PE-Nut on Students' MEAP Writing Test

	Writing					
VARIABLES	OLS		Logit		Fixed Effects	
PE-Nut	-0.070**	-0.140***	-0.074**	-0.159***	-0.072	-0.129
	(0.030)	(0.046)	(0.031)	(0.052)	(0.080)	(0.102)
Age	-0.077***	-0.078***	-0.076***	-0.077***	-0.172***	-0.171***
	(0.022)	(0.022)	(0.022)	(0.022)	(0.035)	(0.035)
Female	0.179***	0.174***	0.179***	0.170***		
	(0.021)	(0.024)	(0.021)	(0.023)		
Overweight	-0.034	-0.056*	-0.034	-0.054*	-0.173*	-0.208**
	(0.029)	(0.032)	(0.028)	(0.030)	(0.097)	(0.101)
Obese	-0.063**	-0.091***	-0.065**	-0.087***	-0.065	-0.062
	(0.029)	(0.032)	(0.029)	(0.031)	(0.144)	(0.142)
Underweight	-0.039	-0.055	-0.038	-0.052	0.121	0.122
	(0.059)	(0.064)	(0.058)	(0.061)	(0.151)	(0.151)
Non-white	-0.094***	-0.087**	-0.092***	-0.085**		
	(0.035)	(0.040)	(0.035)	(0.038)		
Underweight*PE-Nut		0.114		0.117		-0.699***
		(0.161)		(0.162)		(0.096)
Overweight*PE-Nut		0.138*		0.142*		0.306
		(0.076)		(0.075)		(0.243)
Obese*PE-Nut		0.139**		0.136**		0.069
		(0.067)		(0.069)		(0.142)
Female*PE-Nut		0.032		0.061		
		(0.054)		(0.059)		
Nonwhite*PE-Nut		-0.025		-0.032		
		(0.080)		(0.095)		
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes
SES Variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,239	2,239	2,239	2,239	2,246	2,246
R-squared	0.097	0.099			0.127	0.139
Pseudo R-squared			0.073	0.075		

* Implies significance at the 0.10, ** at the 0.05 level and *** at the 0.01 level
Robust standard errors reported above