

# Childhood Obesity and Schools: Evidence From the National Survey of Children's Health

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## ABSTRACT

**BACKGROUND:** The international prevalence of childhood obesity and obesity-related diseases has received increasing attention. Applying data from the Centers for Disease Control and Prevention, we explore relationships between childhood obesity and school type, National School Lunch Program (NSLP) and School Breakfast Program (SBP) eligibility, membership in sports clubs and other sociodemographic, and household factors.

**METHODS:** Nonlinear regression models with interaction terms were developed to investigate the effects of school type, physical activity, and NSLP/SBP, etc, on children's body mass index (BMI). Probit models then examine the probability of a child being overweight.

**RESULTS:** Though clinically small, statistically significant effects on BMI were found for children from households eligible for the NSLP/SBP, attending public schools. They have a mean BMI value 0.401 higher than counterparts attending private schools ( $p < .05$ ). If the child both attends public school and is eligible for the NSLP/SBP, then his or her BMI is 0.725 higher ( $p < .001$ ). Children taking part in the NSLP or SBP have a 4.5% higher probability of being overweight ( $p < .001$ ).

**CONCLUSIONS:** Regardless of household socioeconomic status, children attending public schools have higher BMI than those attending private schools. Eligibility for free or reduced-cost lunch or breakfast programs at public schools is positively correlated with children's BMI. Children attending public schools are more likely to be overweight. In lower socioeconomic status households, school type does not have a significant effect on the probability of being overweight. Policy recommendations for factors to address childhood obesity are discussed.

**Keywords:** childhood obesity; body mass index (BMI); school type; physical activity; National School Lunch Program (NSLP); School Breakfast Program (SBP).

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## INTRODUCTION

The international prevalence of childhood obesity and obesity-related diseases has received increasing attention.<sup>1,2</sup> Individual physical and psychological health, and social and economic development are significantly impacted by personal weight.<sup>3-7</sup> Recent decades have seen an increasing prevalence of childhood obesity. In the United States, childhood obesity is on the rise; the percentage of obese children aged 6 to 11 more than doubled in the past two decades, increasing from 6.5% in 1980 to 17.0% in 2006. The percentage of obese adolescents aged 12 to 19 more than tripled, going from 5% to 17.6% during the same period.<sup>8</sup> Similar trends have been seen in other countries. For example, in England, the level of overweight and obesity for children aged 7 to 11 was less than 10% in the mid 1970s, but it exceeded 20% for girls and 15% for boys in 1998.<sup>9</sup> The percentage of obesity for children aged 2 to 6 increased from 1.5% in 1989 to 12.6% in 1997 in Chinese urban areas.<sup>10</sup> Childhood obesity is now a global challenge.

Childhood obesity is more than a problem in children; it is linked to adult obesity and is accompanied by adverse health status.<sup>11</sup> Overweight and obese children are increasingly diagnosed with type 2 diabetes and heart disease.<sup>5</sup> Obesity not only impacts individual physical and psychological health, but also exerts a burden on social and economic development. Economic costs linked to obesity are high and are expected to continue to rise. One estimate suggests that the direct and indirect cost of obesity in the United States was about \$139 billion in 2003.<sup>12</sup>

Childhood obesity has been studied broadly, and schools have frequently been identified as a key context for childhood obesity research. For example, high school students in the United States were surveyed to examine race, ethnicity, and gender-specific differences in the association between television viewing and overweight.<sup>13</sup> Public school children in the northeastern United States were surveyed to study the relationship between physical fitness and academic achievement in a diverse, urban public school population. Results suggest a statistically significant positive relationship between fitness and academic achievement.<sup>14</sup> There are also studies examining the impact of local school-based policy to increase physical activity.<sup>15,16</sup>

The role of the National School Lunch Program (NSLP) has been studied in part by considering high school students' food choices for labeled foods comparing the nutrient density of NSLP and competitive foods in the cafeteria.<sup>17</sup> Another study examined the influences of participation in the NSLP and food insecurity on child well-being. Results showed that families' economic status, cultural and attitudinal factors were associated with participation

in the NSLP, but found no evidence of benefits of NSLP participation on child well-being.<sup>18</sup> Among this research, either school type was not differentiated, or public schools alone were investigated. This article explores the influences of public and private schools on childhood obesity at a national level. In addition, most studies have attempted to investigate this issue applying various limited perspectives. We employ a more comprehensive viewpoint, integrating multiple school-related elements to explore their effects on childhood obesity.

In this study, the relationships between childhood obesity and family, school, and community factors are examined. Considering such multidimensional perspectives surrounding a child's life, we explore effects on body mass index (BMI) as a measure of childhood obesity. In the following sections, a nonlinear regression model is first applied to survey data to study key relationships. To investigate the effects of NSLP and School Breakfast Program (SBP), 3 model specifications are constructed. Two probit models analyze the impacts of various factors on the probability of being overweight.

## METHODS

### Subjects

Data used in this article are drawn from the National Survey of Children's Health (NSCH) conducted by the Centers for Disease Control and Prevention (CDC) in 2003 and 2004. This survey investigated the physical and psychological health status of children aged from 0 to 17 years old using the State and Local Area Integrated Telephone Survey Program. When selecting households, a pool of nonbusiness telephone numbers was selected and a screening question of the presence of children under age 18 years in the household employed. The survey was conducted by CDC's National Center for Health Statistics (NCHS). Abt Associates Incorporated and its subcontractors conducted all interviews for the project. In this study, we investigate childhood obesity through the value of BMI. Data for children aged from 6 to 11 years old and adolescents from 12 to 17 are extracted. A total of 62,880 observations of children from different households are explored. Children were selected based on a random selection process. Households identified as having children less than 18 years of age were eligible for the NSCH interview. If there was only 1 child, that child is the selected child. If there was more than 1 child, 1 of these children was randomly selected by the interviewer.

### Instruments

To analyze the influence of various factors of interest on childhood obesity, information about

**Table 1. Variable Definitions**

Variable	Definition
AGE	Age of selected child (SC) in the household
GENDER	= 1 if male, 0 if female
EDUM	Highest level of education of child's parents, = 1 if high school, = 0 if not
EDUH	Highest level of education of child's parents, = 1 if college and above, = 0 if not
LANG	Primary language spoken at home, = 1 if Spanish, = 0 if English
SCHOOL	Current school enrolled, = 1 if public, = 0 if private
SPORTS	During the past 12 months, was SC on a sports team or taking sports lessons after school or on weekends, = 1 if yes, = 0 if no
ORGA	During the past 12 months, did SC participate in any clubs or organizations after school or on weekends, such as Scouts, a religious group, or boy/girl's club, = 1 if yes, = 0 if no
COMPUTER	On an average school day, hours of SC's using a computer for purposes other than schoolwork
TV	On an average school day, hours of SC's usually watching TV or videos, or playing video games
EXERPAR	During the past month, did either of the SC's parents regularly exercise or play sports hard enough to make her breathe hard, make (your/her) heart beat fast, or make her sweat for 20 minutes or more, = 1 if yes, = 0 if no
SMOKE	Anyone in household using cigarettes, cigars, or pipe tobacco, = 1 if yes, = 0 if no
EMPLOY	Anyone in the household employed at least 50 weeks out of the past 52 weeks, = 1 if yes, = 0 if no
SES	Coded as 1 when the household has a poverty level below 300% and eligible for NSLP or SBP; coded as 0 when the household income is above 300% of the poverty level using the derived poverty level of this household based on Department of Health and Human Services guidelines
LUNCH	During the past 12 months, did anyone in the house receive free or reduced-cost breakfasts or lunches at school, = 1 if yes, = 0 if no

**Table 2. Descriptive Statistics (Sample Size: 62,880)**

Variable	Mean	Standard Deviation	Minimum	Maximum
AGE	11.988	3.423	6	17
EDUM	0.206	0.404	0	1
EDUH	0.764	0.425	0	1
EMPLOY	0.918	0.274	0	1
SCHOOL	0.882	0.323	0	1
GENDER	0.515	0.500	0	1
LANG	0.041	0.198	0	1
SPORTS	0.640	0.480	0	1
ORGA	0.575	0.494	0	1
EXERPAR	0.585	0.493	0	1
SMOKE	0.323	0.467	0	1
COMPUTER	1.038	1.877	0	24
TV	1.611	1.680	0	24
SES	0.523	0.499	0	1
BMI	20.906	5.044	7.105	77.895
LUNCH	0.549	0.498	0	1

schools, community, parents, and the children's daily activities are extracted from NSCH. These variables are defined in Table 1. Table 2 presents descriptive statistics of the variables. Based on the data, we first estimate the influence of various socioeconomic, school, household, and environmental characteristics on the dependent variable BMI. Sociodemographic variables include the child's age, gender, parents' highest education level, the primary language spoken at home, and the derived poverty level of the household, used to measure socioeconomic status (SES). Whether the household is eligible or not eligible for the NSLP and SBP is determined by its poverty level. Chomitz et al<sup>14</sup> used NSLP eligibility as an indirect measure of family SES. Here we use the standard set in the NCHS with variable SES coded as 1 when the

household has an income below 300% of the poverty level and eligible for NSLP or SBP, and SES is coded as 0 when the household income is above 300% of the poverty level (ineligible for NSLP or SBP). Variable SCHOOL describes whether the child was attending a public school (1) or private school (0). The number of hours a child spent using a computer on a regular weekday is reflected by variable COMPUTER, and the number of hours watching television or playing videos by variable TV. For the child's parents, their smoking practices (SMOKE), exercising time (EXERPAR), and employment status (EMPLOY) are all included in the model. The variable SPORTS describes whether the child was on a sports team or took sports lessons after school or on weekends during the past 12 months. The variable ORGA explains whether during the past 12 months, the child participated in any clubs or organizations after school or on weekends, such as scouts, a religious group, or boy/girl's club (1 for yes, 0 for no).

The dependent variable BMI is a common measure evaluating obesity. It is defined as weight in kilograms divided by height in meters squared. Generally, it is calculated as weight in pounds divided by height in inches squared and multiplied by 703. Bhargava<sup>19</sup> proposed a likelihood ratio test to determine if height and weight should be combined as BMI when used as independent variable(s). However, this test is not appropriate here as BMI is used as the dependent variable. Although there are problems using BMI in children who are still developing, it still provides a reasonable measure evaluating the weight of children and adolescents.<sup>20</sup> In addition, it is a widely used index to measure physical development by healthcare professionals. CDC developed new growth charts using BMI in 2001.<sup>21</sup>

## Procedure and Data Analysis

We first use a nonlinear regression model to estimate the influence of various socioeconomic, school, household, and environmental characteristics on children's BMI. Considering the possible association between SES and school type, an interaction term across variables (SCHOOL) and (SES) is included in the model.

The NSLP is a federally assisted meal program operating in public and nonprofit private schools, and residential child care institutions. It provides low-cost or free lunches to children each school day. The SBP operates in the same manner, and offers free or reduced price breakfasts to eligible children. We consider three model specifications to explore the impact of the NSLP and SBP on children's BMI values. The first contains variable SCHOOL, the second variable LUNCH, and the third both variables and their interaction term. As the NSLP and SBP are available only to households with low SES, these 3 models only use data for eligible households.

Childhood obesity and overweight is most appropriately an age- and gender-specific determination not always captured by BMI. Thus, we introduce a binary dependent variable BMIBI which better accounts for life stage. CDC developed BMI-for-age percentile charts for boys and girls respectively. If the child's BMI-for-age is between the 85th and 95th percentile, then she/he is classified as at risk of overweight, and if it is greater than or equal to the 95th percentile of the age- and gender-specific BMI, then the child is regarded as overweight. Based on this standard, BMIBI is determined by comparing the child's actual BMI with the 85th percentile value for that child's corresponding age and gender. If the actual BMI is larger than the 85th percentile value, then  $BMIBI = 1$ , otherwise it is 0.

As the dependent variable BMIBI is binary, a probit model is used in this analysis. Using maximum likelihood estimation, the model generates consistent and asymptotically normal parameter estimates for large sample sizes.<sup>22</sup> In initial estimations of a model containing an interaction term of SCHOOL and SES, the parameter estimate was not significant, so we use a probit model without the interaction term.

## RESULTS

Table 3 reports the estimated coefficients and related statistics for the variables from the nonlinear regression model. The results show that a child's age and gender have significant effects on BMI, which validates CDC's age- and gender-specific BMI reference values for children and adolescents. School type appears to play a role on BMI. Among the children from households with higher SES not qualifying for the NSLP or SBP, children attending public schools have a mean BMI 0.150 higher than counterparts attending private

Table 3. Estimation Results of Nonlinear Regression Model (Sample Size: 62,880)

Variable	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	16.604	0.164	101.21	<.0001
AGE	0.421	0.006	75.52	<.0001
GENDER	0.640	0.038	16.82	<.0001
EDUM	-0.517	0.119	-4.35	<.0001
EDUJH	-1.279	0.117	-10.95	<.0001
LANG	0.680	0.099	6.84	<.0001
SCHOOL	0.150	0.074	2.03	.0419
SPORTS	-0.751	0.041	-18.24	<.0001
ORGA	0.061	0.040	1.53	.1264
COMPUTER	-0.012	0.010	-1.18	.2376
TV	0.148	0.012	12.9	<.0001
EXERPAR	-0.199	0.039	-5.11	<.0001
SMOKE	0.500	0.042	11.95	<.0001
EMPLOY	-0.294	0.071	-4.15	<.0001
SES	0.334	0.116	2.87	.0042
SCHSES	0.251	0.123	2.04	.0409
R-squared	0.123	F value	Pr > F	
Adjusted R-Sq.	0.123	589.89	<.0001	

schools. However, if his/her household has a lower SES qualifying for the NSLP or SBP, then those children attending public schools have a mean BMI value 0.401 higher than counterparts attending private schools. No matter whether households have high or low SES, children attending public schools have higher BMI values than those attending private schools. The effect of school type is larger for lower SES households.

Whether a parent regularly exercises or plays sports has a negative and significant effect on their child's BMI. Children of physically active parents have mean BMI values 0.199 lower than inactive parents' children. Active parents appear to impart the importance of exercise and health on their children. As seen from the estimate of variable SPORTS, BMI of children who take part in a sports team or sports lessons after school or on weekends is 0.751 lower than those who do not. The variable measuring whether the child participates in a club or social organization activity such as Scouts, a religious group, or boy/girl's club is not statistically significant. Notice that such organizations are different from sports clubs, with less emphasis on physical activities. Regardless, joining such clubs may still be beneficial both to the child's emotional development and to the community. Of course, it is possible that high BMI children are not interested in sports, so they may turn to other organizations (nonathletic, etc) to fill a socialization need. This result does not explore such *causation*, merely associations between variables.

Parents' education level is negatively associated with the child's BMI; parents with a high school education level are associated with an average reduction in BMI of 0.517 in the child's BMI value compared to children whose parents' education level

is lower than high school. Parents with college and above education level are linked to a 1.279 reduction in the child's BMI value. The variable LANG suggests that in households where Spanish is the primary language, the mean value of BMI is 0.680 higher than in corresponding households where English is the primary language. The estimation of variable EMPLOY implies that whether a parent or caregiver is employed is associated with a 0.294 decrease in the child's BMI. In addition, either parent's smoking behavior has a positive association on the child's BMI, a mean 0.500 higher than a nonsmoking parent's child.

The hours spent watching TV or playing video games are positively associated with the BMI value. A 1-hour increase in watching TV increases a child's BMI by 0.148 on average. Previous research suggested that watching TV was associated with being overweight among White female and male students, and Hispanic female students in US high schools.<sup>13</sup> It is important to notice that the question in the CDC survey asks about

the hours spent on a regular school day, not on the weekend.

The estimation results of the 3 model specifications are shown in Table 4. In model 1, the results suggest that if the child attends a public school, then his/her BMI value is 0.398 higher on average than a child attending a private school. Model 2 tells us that children eligible for the NSLP or SBP have a BMI 0.41 higher than those not eligible. After considering the interaction term between SCHOOL and LUNCH, the results suggest that if the child both attends public school and is eligible for the NSLP/SBP, then his/her BMI value is 0.725 higher than children attending private schools or being eligible for the NSLP/SBP. So for public school students, NSLP/SBP has a statistically significant positive association with BMI. Although such programs provide necessary nutrition to children from low-income families, they may contain unhealthy food choices which could lead

Table 4. Estimation of the Association Between NSLP and BMI Value\* (Sample Size: 62,872)

Variables	Specification 1: SCHOOL		Specification 2: LUNCH		Specification 3: Interaction Term	
	Estimated Parameter	p-Value	Estimated Parameter	p-Value	Estimated Parameter	p-Value
Intercept	17.364 (0.212)	<.0001	17.335 (0.195)	<.0001	17.262 (0.232)	<.0001
AGE	0.396 (0.009)	<.0001	0.4 (0.009)	<.0001	0.401 (0.009)	<.0001
GENDER	0.532 (0.058)	<.0001	0.528 (0.058)	<.0001	0.526 (0.058)	<.0001
EDUM	-0.466 (0.138)	.0007	-0.415 (0.138)	.0027	-0.413 (0.138)	.0028
EDUH	-1.223 (0.136)	<.0001	-1.152 (0.137)	<.0001	-1.133 (0.137)	<.0001
LANG	0.852 (0.122)	<.0001	0.794 (0.122)	<.0001	0.776 (0.122)	<.0001
SPORTS	-0.834 (0.06)	<.0001	-0.818 (0.06)	<.0001	-0.806 (0.06)	<.0001
ORGA	0.045 (0.06)	0.4515	0.043 (0.06)	.4753	0.046 (0.06)	.4491
COMPT	-0.016 (0.016)	0.3051	-0.015 (0.016)	.3423	-0.015 (0.016)	.3481
TV	0.135 (0.017)	<.0001	0.134 (0.017)	<.0001	0.132 (0.017)	<.0001
EXERPAR	-0.159 (0.059)	.0065	-0.149 (0.059)	.0109	-0.146 (0.059)	.0124
SMOKE	0.496 (0.061)	<.0001	0.491 (0.061)	<.0001	0.477 (0.061)	<.0001
EMPOY	-0.383 (0.087)	<.0001	-0.311 (0.088)	.0004	-0.305 (0.088)	.0005
SCHOOL	0.398 (0.11)	.0003			0.05 (0.145)	.7303
LUNCH			0.41 (0.06)	<.0001	-0.268 (0.212)	.2061
SCHLUN					0.725 (0.221)	.001
F value (p-value)	251.69	(<.0001)	254.55	(<.0001)	222.17	(<.0001)

\*The numbers in parentheses are the standard error.

Table 5. Probit Model Estimation Results (Sample Size: 62,880)

Variable	Parameter Estimate	Marginal Effect	t Value	Pr >  t
Intercept	-0.067		-1.77	.0765
EDUM	-0.069	-0.025	-2.17	.0303
EDUH	-0.248	-0.092	-8.02	<.0001
LANG	0.135	0.05	5.09	<.0001
SCHOOL	0.04	0.015	2.45	.0144
SPORTS	-0.153	-0.057	-13.93	<.0001
ORGA	-0.025	-0.009	-2.32	.0201
COMPUTER	-0.022	-0.008	-7.63	<.0001
TV	0.037	0.014	11.91	<.0001
EXERPAR	-0.049	-0.018	-4.64	<.0001
SMOKE	0.128	0.047	11.38	<.0001
EMPLOY	-0.053	-0.02	-2.81	.005
Log likelihood	-40,703			

to higher levels of BMI. The NSLP has been criticized for providing meals high in fat.<sup>23</sup>

The estimates of the probit model are shown in Table 5. The results suggest that children attending public school are more likely to be overweight than those attending private schools. Participating in a sports team or attending sports classes decreases the probability of overweight for children by 5.7%. Children who take part in organized social activities have a 0.9% lower chance of being in the overweight classification than those who do not. Regularly exercising parents decrease the chance of their child being overweight by 1.8%.

The marginal effects of variables EDUM and EDUH imply that the children of higher educated parents are less likely to be overweight than those of less educated parents. Income effects may influence this result. Alternatively, higher educated parents may be better informed about the risks of childhood overweight. Every additional hour of computer use decreased the probability of being overweight by 0.08%, and every additional hour of TV watching or playing videos game increased the chance of being overweight by 1.4%. These results are similar to the results of the previous nonlinear regression.

To investigate the influence of NSLP/SBP on the likelihood of being overweight among children from eligible households, a second probit model is applied. These estimation results are presented in Table 6. The analysis suggests that in lower SES households, school type does not have a significant effect on the probability of being overweight. It is confirmed that involvement in a sports team or sports classes after school or during the weekend decreases the probability of being overweight by 6.2%, which is higher than the percentage estimated for all households. Children participating in organized activities have a 0.3% lower chance of being overweight than those who do not, but this effect is not significant. Children eligible for NSLP or SBP have a 4.5% higher probability of

Table 6. Probit Model Estimation Results—NSLP (Sample Size: 32,872)

Variable	Parameter Estimate	Marginal Effect	t Value	Pr >  t
Intercept	-0.151		-3.26	.0011
EDUM	-0.034	-0.013	-1.03	.3031
EDUH	-0.167	-0.064	-5.09	<.0001
LANG	0.104	0.04	3.55	.0004
SCHOOL	0.039	0.015	1.43	.1522
SPORTS	-0.162	-0.062	-11.18	<.0001
ORGA	-0.007	-0.003	-0.47	.6416
COMPUTER	-0.021	-0.008	-5.45	<.0001
TV	0.026	0.01	6.5	<.0001
EXERPAR	-0.024	-0.009	-1.7	.0889
SMOKE	0.102	0.039	6.97	<.0001
EMPLOY	-0.019	-0.007	-0.87	.3825
LUNCH	0.116	0.045	7.98	<.0001
Log likelihood	-21,257			

being overweight compared to children not eligible. This finding further indicates the positive association between the NSLP/SBP and child weight. Regularly exercising parents decrease the chance of their child being overweight by 0.9%, which is lower than the percentage estimated using all households.

## DISCUSSION

This study examines how socioeconomic, school, household, and environmental variables affect children’s BMI and likelihood of being overweight. Regardless of the household socioeconomic status, children attending public schools are associated with higher BMI than those attending private schools. The effect of school type on a child’s BMI is much larger for lower SES households. In addition, if the child both attends public school and is eligible for the NSLP/SBP, then his or her BMI is higher than other children. Use of free or reduced-cost lunch or breakfast programs at public schools is positively correlated with children’s BMI. Children attending public school are also more likely to be overweight than those attending private schools. However, in lower SES households, school type does not have a significant effect on the probability of being overweight. Children taking part in the NSLP or SBP have a higher probability of being overweight. This finding further indicates the positive association between the NSLP/SBP and weight. Those children participating in a sports team or sports lessons have lower BMI and are less likely to be overweight.

The research results provide additional support to current efforts of government, schools, and communities. The government has strengthened its support of elementary and secondary physical education through various measures. The Omnibus Appropriations Act of 2009 allocated \$78 million for the Carol M. White Physical Education Program, a

\$2 million increase over fiscal year 2008. This program initiates, expands, or improves physical education and after-school activities for students in kindergarten through 12th grade by offering funds to schools and community-based organizations.<sup>24</sup> Participating schools include public schools, private nonprofit elementary schools, and secondary schools. The grants can be used to purchase relevant equipment to get students actively involved in physical education as well as to provide teacher training.<sup>25</sup>

The Omnibus Appropriations Act also allocated \$183 million for the Safe Routes to School program, which aims to provide safer access to schools through bike lanes, trails, and sidewalks.<sup>26</sup> The reauthorized State Children's Health Insurance Program (SCHIP) developed a comprehensive and systematic model for reducing childhood obesity with a \$25 million grant from the federal government. Eligible activities include establishing after-school and weekend community activities; forming partnerships with day-care facilities to establish programs, planning and implementing a healthy lifestyle curriculum in schools, etc. Wellness and Prevention Funding provisions in the economic stimulus package included \$650 million for community obesity prevention programs.

The School Physical Education Program is also searching for ways to fight childhood obesity. The solutions start in the classroom and go beyond. For example, a local school in Kansas City is launching a physical education for life campaign.<sup>27</sup> Students voluntarily use fitness equipments on a daily basis. One school in Maryland offers a workout army program before the start of school, employing an intensive 30-minute workout.<sup>28</sup>

Not-for-profit community service organizations are also focusing efforts on childhood obesity. The YMCA in Blue Springs, MO, is offering a new program called "Kids in Action" which combines old school games with fitness exercises targeting children between the ages of 9 and 13.<sup>29</sup> In Washington, DC, CareFirst BlueCross BlueShield and the local YMCA initiated a "Physical, Healthy, Drive" (PHD) program to educate District youth about the potential harm of childhood obesity and to encourage lifelong healthy behaviors.<sup>30</sup>

### Limitations

Our models examine the nonlinear relationship between the dependent variables (BMI and BMIBI) and independent variables (school type, sports club, NSLP/SBP, etc). Such relationships have been demonstrated using various measures of statistical significance, such as F statistics, p-values, and likelihood ratio index values. However, this study has limitations. The CDC survey was designed to investigate the overall health condition of children at a national level. More detailed surveys with additional exploratory questions

can offer other richer information relevant to the study of childhood weight and health concerns. For example, the number of hours devoted to particular types of sports, and quality of access to parks and recreation facilities could be gathered. In addition, our models may be refined in terms of complexity, and other models may help explain the overweight and obesity problem.

### IMPLICATIONS FOR SCHOOL HEALTH POLICY

Schools as a major setting of student life need to become actively involved in developing obesity prevention programs. Our analysis has important implications for school health policy. For example, school health practitioners need to collaborate with physical activity organizers to provide necessary health care support and to track children's BMI change, following the implementation of exercise and nutrition awareness programs. Fighting childhood obesity should be a school-wide campaign. Teachers in both public and private schools need to expand efforts to encourage physical activities and to promote healthy lifestyles through innovative curriculum developments. Teachers should also set a good example for children through their own diet and exercise patterns. Enhanced communications between teachers and parents should be encouraged to promote frequent dialogues about the importance of children's eating and physical activities.

School superintendents can collaborate with agents from local governments and various community organizations such as the American Association of School Administrators and National School Boards Association to implement innovative policies and programs, which help prevent and reduce childhood obesity. The combined efforts and collective strength of schools, families, and communities are needed to reverse obesity trends.

In general, based on the results, public schools need to take further steps to reduce childhood overweight and obesity. Designing and implementing wellness curricula through collaborations between communities, nongovernmental organizations, and government agencies are critical in cultivating healthy eating and exercising habits. Providing additional safe and easy access to physical exercise facilities and assisting sports organizations are within schools' capabilities to enable youth to have more opportunities to participate in aerobic activities. One recent school-based obesity prevention study implies such intervention through physical activity, and healthy snacks can result in a significant reduction in percent body fat.<sup>31</sup>

In addition, the findings of this study could be used as a guide to direct clubs and organizations' programs targeting those children who do not undertake physical activity regularly. It is possible that children with

high BMI are less likely to participate in sports. Therefore, the role of clubs or organizations needs to be fully exploited, and may be facilitated by schools or communities. On the one hand, school sports clubs and community organizations can offer more health education programs concerning overweight and obesity, targeting children who do not exercise regularly. Further, creating additional types of school sports clubs could attract high BMI children and adolescents to enjoy physical activities and healthy lifestyles. Alternatively, clubs and organizations play different and possibly synergistic roles in fighting childhood overweight and obesity. It is possible that high BMI children prefer to participate in nonsporting organizations rather than sporting clubs. Further outreach efforts must target these organizations providing additional health information to such groups of children. This will permit the organizations to provide an extra channel for health and wellness information, and may help encourage children to take part in physical activity.

The positive association between both children's BMI and the probability of being overweight and participating in the NSLP or SBP among those households with less than 300% poverty level deserves further attention. In research by Delores et al.<sup>32</sup> elementary school students expressed intense dislike and distrust of school meals. Improving school meals by including more fresh fruits and vegetables would likely be beneficial. Such an update of the NSLP and SBP would likely impact children's BMI values.

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