Do State Physical Education Requirements Reduce Youth Body Weight?

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Abstract

State physical education requirements have been adopted with the policy goal of increasing exercise among students and reducing the prevalence of youth obesity. Using pooled cross-sectional data from the National and State Youth Risk Behavior Surveys (YRBS) from 1999 to 2011, we use within-state variation in state physical education requirements to identify their effects on in-school and overall youth physical activity, as well as body weight. We find that the imposition of a binding PE requirement is associated with a 35.1 to 36.8 increase in minutes per week spent by youths exercising in school. Moreover, we find that binding PE requirements reduce body mass index (BMI), particularly for young males. We conclude that state physical education requirements may be an important tool for fighting obesity among youths.

Keywords: physical education requirements; exercise; youth obesity

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Extended Abstract

Motivation. State physical education requirements have been adopted with the policy goal of increasing exercise among students and reducing the prevalence of obesity of youths. This objective is important for a number of reasons. The obesity rate among 12- through 19-year-olds in the United States tripled between 1974 and 2004 (Ogden and Carroll 2010), and while the adolescent obesity rate appears to have peaked in the mid-2000s (Ogden et al. 2010; Madsen et al. 2010), the consensus view among health professionals is that too many young Americans are at risk of asthma, menstrual abnormalities, sleep apnea, and type 2 diabetes because of their weight.

In addition to the adverse health consequences of youth obesity, there are also human capital-related reasons to be concerned about rising rates of obesity. Students who are overweight or obese are prone to being teased and bullied (Eisenberg, Neumark-Sztainer and Story 2003; Janssen et al. 2004; Neumark-Sztainer and Eisenberg 2005; Wang, Iannotti and Luk 2010**),** (Falkner et al. 2001; Crosnoe 2007; Sabia 2007; Ding et al. 2009), suffer from psychological harm (Rees and Sabia 2014), and perform more poorly in school (Puhl and Brownell 2001; Latner, Stunkard and Wilson 2005; Crosnoe 2007).

An intriguing study by Cawley, Meyerhoefer, and Newhouse (CMN 2007) examined the relationship between state physical education (PE) requirements and student physical mobility. Using data from the National Youth Risk Behavior Survey (NYRBS) from 1999 to 2003 and cross-state policy variation for identification, CMN

found that PE requirements were associated with a 31-minute increase in time spent physically active in PE class. Using PE laws as an instrument for PE exercise time, the authors find that PE time is associated with increased total exercise for women, but no change in the probability of overweight for either boys or girls. Their finding could be explained by adolescents' substituting time away from some types of physical activities outside of gym class in response.

In describing their findings, CMN note an important limitation of their empirical strategy:

> "[W]e do not observe a random assignment of PE policies; states choose their policies. For this reason, policy endogeneity may bias the results." (p. 1289)

To address policy endogeneity, CMN carefully control for a number of observables that could be correlated with state PE laws and youth exercise, including state obesity rates, socioeconomic status, and state education resources. However, it is also possible that difficult-to-measure characteristics of states—such as pro-health sentiment—lead to biased estimates.

In this study, we will build on the work of CMN by exploiting state policy changes in PE requirements and estimate a difference-in-difference model of the effects of these policies on minutes spent exercising inside and outside physical education classes and the resultant impacts on body weight. In addition, we will examine the sensitivity of our difference-in-difference estimates to controls for state-specific time trends as well as controls for state-specific time-varying measures of youth health sentiment. Finally, we will conduct falsification tests on older young adults for whom school physical education requirements should not be binding.

Data and Methods. Our analysis will pool data individual-level cross-sectional data from the 1999 to 2011 National and State Youth Risk Behavior Surveys (YRBS). While the National YRBS is well-known and used widely in the literature, individual-level State YRBS data has been used by fewer scholars. The State YRBS, while coordinated by the Centers for Disease Control and Protection and sampling US high school students, is administered by state education and health agencies. An important advantage of the SYRBS is that, unlike the NYRBS, these data contain hundreds and often thousands of observations per state-year. The augmentation of national with state YRBS data has been employed in a number of recent studies examining the effects of a number of state-level public policies on youth behaviors, including cigarette taxes (Hansen et al. 2014), medical marijuana laws (Anderson et al. 2014), parental involvement laws for abortion (Sabia and Anderson 2014), and minimum wages (Sabia et al. 2014).

We will begin by estimating a baseline model similar to CMN:

$$PEMinutes_{ist} = \beta_0 + \beta_1 PE_{ist} + \beta_2' \mathbf{X}_{ist} + \beta_3' \mathbf{Z}_{st} + \tau_t + \varepsilon_{ist} \quad (1)$$

where $PEMinutes_{ist}$ measures minutes (in 100s) per week spent physically active in PE class (not just minutes spent in class, whether active or not) in of individual *i* residing in state *s* in year *t*; PE measures the state binding PE unit/credit requirement; **X** is a vector of demographic controls (age, gender, race/ethnicity, region, urbanicity); $\mathbf{Z}_{st}$ is a vector of state-level observables (per-capita income, obesity rates, national school lunch participation per capita, average teacher salary and student : teacher ratio); τ_t is a year

fixed effect and ε_{ist} the error term. The means of all of our key variables are shown in Table 1. The coefficient of interest, β_1, measures the partial effect of binding PE requirements on minutes spent in exercise. However, given the possibility of policy endogeneity due to differences across states in health sentiment that could be correlated with the adoption of stricter PE requirements and with student exercise, we next move on to a difference-in-difference approach, which will control for time-invariant state-level unmeasured heterogeneity. Specifically, we estimate a difference-in-difference (DD) model of the following form:

$$PEMinutes_{ist} = \beta_0 + \beta_1 PE_{ist} + \beta_2' \mathbf{X}_{ist} + \beta_3' \mathbf{Z}_{st} + \tau_t + s_s + \varepsilon_{ist} \quad (2)$$

where s_s is a state fixed effect. Adding more years allow us to employ the within-state changes in PE requirements for identification. Specifically, the identifying variation in equation (2) comes from Florida, Michigan, Mississippi and South Dakota, where pre- and post-law change data are available in the YRBS (See Table 2 for a complete list of states that change their PE requirements between 1999 and 2011). We content that this model provide a more credible identifying variation.

We continue by employing state PE requirements as instruments for PE minutes in an IV framework, and estimate the effects of plausibly exogenous changes in PE minutes (driven by within-state policy changes) on youth physical activities and BMI using the equation:

$$Y_{ist} = \beta_0 + \beta_1 \widehat{PEmins_{ist}} + \beta_2' \mathbf{X}_{ist} + \beta_3' \mathbf{Z}_{st} + \tau_t + s_s + \varepsilon_{ist} \quad (3)$$

where Y_{ist} measures the number of days the student spent physically active (including time spent outside gym class) in light activities, vigorous activities, strength building activities, and predicted values of *PEMinutes* are generated from the policy change in the first-stage. Ordinary least squares (OLS) models are used in equations (1) and (2), and two stages least squares (2SLS) models in equation (3). Standard errors are corrected for clustering on the state.

Preliminary Findings. Our preliminary results appear in Tables 3 through 4 below. We estimate models for the pooled sample of high school students, as well as separately for males and females who may be differentially affected by state physical education policies.

In Panel I of Table 3, we replicate the CMN results using our enhanced State and National YRBS data over a longer sample period than the original authors (1999-2003 vs 1999-2011). The results are very similar to what the original authors found: a binding PE requirement is associated with a 30.1 to 35.6 increase in minutes per week spent in physical education classes exercising. Importantly, in Panel II, we find that when we limit the identifying variation to within-state changes in policy, we continue to find that binding PE requirements increased time spent physically active in PE. Difference-in-difference estimates suggest that the imposition of a binding PE requirement is associated with a 33.6 to 36.8 percent increase in minutes spent physically active in PE class. These results suggest that the findings of CMN cannot be explained by time-invariant state characteristics associated with the adoption of PE requirements and with student exercise,

such as pro-health sentiment. Preliminary unreported results suggest that the estimates in Panel II are robust to the inclusion of state-specific linear time trends.

The estimates in Panel II of Table 3 can be thought of as the first-stage of a two-stage least squares regression. In Table 4, we present the second-stage of our instrumental variables (IV) model (equation 3). Our findings suggest that policy-induced increases in PE minutes increase the number of days spent in vigorous exercise (Panel I), number of days of light activity (Panel II), and number of days of strength building activity (Panel III) for both males (column 2) and females (column 3). These results suggest that there could be some positive spillover effects of in-school exercise outside of school.

CMN found little evidence that PE-induced increases in physical exercise had a beneficial effect on overall body weight. We continue to find such a result for females (Panel IV, column 3). However, for males, we find strong evidence that binding PE requirements lead to a 0.83-point decline in body mass index (Panel IV, column 2). This result suggests that strong state PE requirements may be an effective policy tool for fighting youth overweight and obesity.

In the full version of this paper, we will examine overweight and obesity thresholds (as defined by the Center of Disease Control) to examine whether state PE requirements affect the probability of crossing these thresholds. In addition, we will explore potential mechanisms through which PE might affect boys' and girls' BMI differently, perhaps through compensatory eating habits. We will also explore the use of negative binomial IV models of the type used by CMN to refine the estimates presented in Panels I-III of Table 4. Finally, we will conduct falsification tests on (i) older young

adults in the Behavioral Risk Factor Surveillance Survey (BRFSS) and (ii) adolescents in the YRBS attending grades in which the PE requirement change is not binding, to further test the credibility of the identifying assumption of our difference-in-difference model.

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Table 1. Means of Selected Variables, 1999-2011

Variable	Pooled (1)	Males (2)	Females (3)
BMI	22.92 (5.048) [328,778]	23.37 (5.165) [159747]	22.49 (4.896) [169,031]
No. days light activity	2.659 (2.496) [284,365]	2.803 (2.598) [137,891]	2.524 (2.389) [146,474]
No. days strength-building activity	2.910 (2.458) [165,226]	3.433 (2.479) [79,767]	2.422 (2.334) [85,459]
No. days vigorous exercise	3.660 (2.481) [286,004]	4.188 (2.452) [138,652]	3.163 (2.405) [147,352]
PE minutes per week (100s)	0.767 (1.011) [328,778]	0.909 (1.084) [159,747]	0.633 (0.918) [169,031]
Binding PE credit requirement	0.365 (0.481) [328,778]	0.364 (0.481) [159,747]	0.365 (0.482) [169,031]
Age 15	0.255 (0.436)	0.249 (0.433)	0.259 (0.438)
Age 16	0.269 (0.444)	0.269 (0.443)	0.270 (0.444)
Male	0.486 (0.500)	1.000 (0.000)	0.000 (0.000)
White	0.628 (0.483)	0.631 (0.483)	0.625 (0.484)
Black	0.144 (0.351)	0.138 (0.345)	0.151 (0.358)
Per capita income (000s of 2003$)	30.36 (4.793)	30.39 (4.816)	30.34 (4.771)
Percentage with BA degree	26.48 (4.223)	26.48 (4.217)	26.47 (4.229)
NSLP per capita	10.09 (1.927)	10.08 (1.924)	10.09 (1.930)
Teacher salary	46.23 (7.732)	46.23 (7.728)	46.23 (7.736)
Pupil : teacher ratio	15.01 (2.386)	15.01 (2.383)	15.02 (2.389)
Obesity prevalence-males	24.35 (3.770)	24.35 (3.778)	24.35 (3.762)
Obesity prevalence-females	23.31 (3.783)	23.30 (3.791)	23.32 (3.775)
N	328,778	159,747	169,031

Note: Standard deviations are in parentheses and sample sizes are in brackets.

Table 2. States that Changed PE Requirements between 1999 and 2011

State	Year of Law Changed	Contributing to Identifying Variation	Binding Grade
Florida	2007	Yes	Freshmen
Michigan	2007	Yes	Freshmen
Mississippi	2007	Yes	Freshmen
South Dakota	2010	Yes	Sophomore
Tennessee	2010	No	No Data Before & After in YRBS
Texas	2010	No	No Data Before or After in YRBS

Table 3. Estimates of the Effects of PE Requirements on PE Minutes

	Pooled (1)	Boys (2)	Girls (3)
Panel I: Estimate of Equation (1)			
Binding PE Credit Requirement	0.329***	0.301***	0.356***
	(0.038)	(0.034)	(0.047)
	[74.48]	[77.62]	[58.22]
N	159,933	77,862	82,071
Panel II: Estimates of Equation (2)			
Binding PE Credit Requirement	0.351***	0.336***	0.368***
	(0.039)	(0.031)	(0.051)
	[82.63]	[114.7]	[51.27]
N	328,778	159,747	169,031

Notes: **,*** indicates statistical significance at 5% and 1% level respectively. Standard errors are in parentheses and F-statistics in brackets. All models include the full set of controls described in the text and listed in Table 2. Standard errors are clustered by states.

Table 4. Estimates of the Effects of PE-Requirements-Induced Changes on Youth Physical Activities and BMI, 1999-2011

	Pooled (1)	Males (2)	Females (3)
Panel I:No. days vigorous exercise			
PE Minutes	0.614***	0.528***	0.697***
	(0.079)	(0.083)	(0.096)
N	286,004	138,652	147,352
Panel II: No. days light activity			
PE Minutes	0.163**	0.140	0.188**
	(0.064)	(0.077)	(0.077)
N	284,365	137,891	146,474
Panel III: No. days strength-building activity			
PE Minutes	0.728***	0.626***	0.841***
	(0.128)	(0.133)	(0.159)
N	165,226	79,767	85,459
Panel IV: BMI			
PE Minutes	-0.283**	-0.829***	0.205
	(0.122)	(0.195)	(0.111)
N	328,778	159,747	169,031

Notes: **,*** indicates statistical significance at 5% and 1% level respectively.
Standard errors are clustered by states