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The impact of physical education on obesity among elementary school children

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ABSTRACT

In response to the dramatic rise in childhood obesity, the Centers for Disease Control (CDC) and other organizations have advocated increasing the amount of time that elementary school children spend in physical education (PE) classes. However, little is known about the effect of PE on child weight. This paper measures that effect by instrumenting for child PE time with the state's mandated minimum number of minutes of PE, using data from the Early Childhood Longitudinal Study, Kindergarten Cohort (ECLS-K) for 1998–2004. Results from IV models indicate that PE lowers BMI *z*-score and reduces the probability of obesity among 5th graders. This effect is concentrated among boys; we find evidence that this gender difference is partly attributable to PE being a complement with other physical activity for boys, whereas they are substitutes for girls. This represents some of the first evidence of a causal effect of PE on youth obesity, and thus offers at least some support for the assumptions behind the CDC recommendations. We find no evidence that increased PE time crowds out time in academic courses or has spillovers to achievement test scores.

1. Introduction

The prevalence of obesity among elementary schoolchildren in the United States nearly quadrupled between 1965 and 2000 (Ogden et al., 2002).[1] As of 2009–2010, 32.6% of American youths aged 6–11 years are overweight, and 18.0% are obese (Ogden et al., 2012). The U.S. Surgeon General has declared childhood obesity to be an "epidemic" with significant adverse health consequences, including vascular disease and Type 2 diabetes (U.S. D.H.H.S., 2010), that significantly raise health care costs for youth (Trasande and Chatterjee, 2009; Trasande et al., 2009).

The U.S. Surgeon General attributes the rise in childhood obesity, in part, to school cutbacks in physical education (PE) and urges all school systems to mandate daily PE that totals at least 150 min/week for elementary schoolchildren (U.S. D.H.H.S., 2010). Other organizations concur, including the American Academy of Pediatrics (AAP), Centers for Disease Control and Prevention (CDC), Institute of Medicine (IOM), and National Association of State Boards of Education (NASBE) (see, e.g., IOM, 2012; AAP, 2006). However, as of 2006, only 3.8% of elementary schools were in compliance with the recommendation of 150 min of PE/week (Lee et al., 2007).

Despite the recommendations of the Surgeon General, CDC, and others, there is little evidence of a causal effect of PE on youth obesity. There are several reasons that additional PE may not lower weight or the risk of obesity. First, PE classes may not involve much physical activity. Studies using direct observation or accelerometers have documented that elementary schoolchildren spend only

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[1] For children, overweight is defined as a body mass index (BMI) above the 85th percentile of the BMI distribution from historic CDC surveys of the 1960s and 1970s (i.e., prior to the rise in overweight and obesity) for youth of the same age and gender, and obesity is defined as a BMI above the historic 95th percentile (Barlow and Expert Committee, 2007). BMI is calculated as weight in kilograms divided by height in meters squared.

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9–42% of PE time engaged in moderate to vigorous physical activity (Pate et al., 2011). A second issue is that students may offset any additional physical activity during PE by decreasing physical activity outside of school, with little net impact on physical activity or weight (King et al., 2007).

This paper contributes to the literature by estimating the causal effect of PE time on the weight of elementary schoolchildren. A large number of studies have reported the correlation of PE with student weight (see Pate et al., 2011, for a review). However, the correlation may be a badly biased estimate of the causal effect for several reasons. First, if enrollment is optional then there may be selection bias; physically fit students may be more likely to enroll. Second, the amount of required PE and enrollment in PE in a school may be correlated with the area's socioeconomic status (SES); e.g. higher-SES schools may require more PE, or may offer more or better PE courses, and may also have more physically fit students because of their higher SES. Alternatively, higher-SES schools may devote more time to academic subjects and less to PE.

A small number of studies estimate the causal effect of PE on youth weight.[2] Cawley et al. (2007) estimate the effect of PE time on the physical activity and weight of high school students, using variation in PE requirements across states as an instrument. Their IV models indicate that PE increases self-reported physical activity but has no detectable effect on the weight of high school students. Datar and Sturm (2004) study the effect of the increase in PE that results from the progression from kindergarten to first grade, and find that an additional hour of PE time/week is associated with lower BMI in overweight or obese girls, but results in no change in BMI for healthy weight girls or for boys.

This paper examines the effect of PE on elementary schoolchildren (specifically, those in kindergarten through fifth grade). We analyze data from the Early Childhood Longitudinal Study, Kindergarten Cohort (ECLS-K). Our methods for identifying causal effects are described in the next section.

2. Methods and data

The objective of this paper is to measure the causal effect of PE time on the weight of elementary schoolchildren. If PE time was randomly assigned, then one could regress child weight W on time spent in PE (PE), controlling for a vector of relevant observables X:

$$W = \alpha + \beta PE + \delta' X + \varepsilon$$

and interpret the coefficient on PE time, β, as the causal impact of PE on weight.

However, PE time is not randomly assigned. Physically fit students may be more likely to choose PE, and the PE requirements and offerings of individual schools may be correlated with local SES. As a result, the error term ε is likely correlated with the regressor of interest PE, and thus an OLS estimate of the coefficient of interest β is likely biased.

In order to measure the causal impact of PE on weight, one needs to find a natural experiment that creates exogenous variation in PE time without directly affecting student weight (i.e. the instrument should be highly correlated with PE but uncorrelated with ε). The natural experiment that we exploit is variation in state requirements for PE for elementary schoolchildren. Using these state policies as instruments, we estimate models of instrumental variables in order to measure the causal effect of PE time on child weight.

[2] There are also studies that involved randomized experiments of innovative PE curricula (for reviews, see Katz, 2009; Brown and Summerbell, 2009), but these studies are not informative about the effect of PE as it currently exists.

We do not use ECLS-K sample weights in the regression analysis, on the grounds that the sampling probability is a function of the explanatory variables (Solon et al., 2013) and thus using survey weights decreases efficiency (see, e.g. Deaton, 1997).[3] We cluster standard errors at the state level in all of our models because the instrument varies at the state level.

2.1. Data: state PE policies

Our source for state policies regarding elementary school PE by year is the LexisNexis database of state statutes. These laws were cross-referenced with the Shape of the Nation Reports in 1993, 2001, and 2006, the Trust for America's Health (TFAH) annual reports that began in 2004, and the State School Health Policy database maintained by the National Association of State Boards of Education; we used these sources to determine when PE was first mandated if historical statues were unavailable in LexisNexis.[4]

There is significant variation across states in how the legislated mandates are written. For example, some states only require that PE be offered, but do not require that students enroll in it. States also differ in whether they recommend or require a minimum number of minutes/week that students spend in PE; some states specify both a recommended and required number of minutes. The instrument we use is the *required* number of minutes of PE/week (states that mandate PE but do not specify a required number of minutes/week are coded as requiring 0 min of PE/week).[5] We use this as an instrument because the requirement is mandatory and specific, leaving no leeway or room for interpretation; thus, it is expected to be a powerful predictor of actual time that youth spend in PE. (However, as we show later in the paper, compliance with mandated minutes is less than perfect.) Appendix Table 1 (available for download from the journal website) contains details of the relevant laws by state. The states that had a minutes requirement each year that applied to the relevant grade for the ECLS-K panel between 1999 and 2004 were: Georgia and New York. The states that added a minutes requirement based on the year and relevant grade for the ECLS-K panel between 1999 and 2004 were: Alabama, Arkansas, California, Louisiana, Missouri, New Jersey, North Dakota, Rhode Island, and Texas. The 39 states not listed in either of the previous categories never had a minutes requirement that applied to the relevant grade for the ECLS-K panel between 1999 and 2004. Appendix Table 2 (available for download from the journal website) lists the number of required minutes of PE by state and year.

2.2. Data: Early Childhood Longitudinal Study, Kindergarten Class of 1998–1999 (ECLS-K)

The Early Childhood Longitudinal Study, Kindergarten Class of 1998–1999 (ECLS-K) is a nationally representative survey of children entering kindergarten in the 1998–1999 school year conducted by the National Center for Educational Statistics of the U.S.

[3] As a robustness check, we re-estimated the regression models of this paper using the ECLS-K sample weights; the results are substantively similar, but the absolute magnitude of the estimate of the effect of PE time on BMI z-score increases (from −.0016 to −.0027 in the second stage) and the estimate is less precise (significant at the 10% rather than the 1% level), as would be expected given the decrease in efficiency predicted by Deaton (1997).

[4] The District of Columbia is excluded from this analysis because its statute was not available on LexisNexis and the Shape of the Nation and TFAH reports were inconsistent.

[5] If we include as an additional instrument whether a state has a mandate at all (which may not involve a minimum number of minutes), we find extremely similar results in the 1st and 2nd stage of IV.