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Associations between the home and school environments and child body mass index

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ABSTRACT

This paper examined associations between various aspects of home and school environments and child body mass index (BMI) in the Early Childhood Longitudinal Study – Kindergarten cohort, a panel dataset of US children collected from 1998 to 2004. Using three-level growth curve modeling with a sample of approximately 11,400 children, it assessed whether these aspects were related to initial BMI and to the rate of growth of BMI over the period from kindergarten to fifth grade, independent of a large number of controls. A number of home and school factors were associated with initial BMI and the growth of BMI. Greater hours of sleep by children, more lunches eaten at school, and the adequacy of their school cafeterias and the adequacy of their school gymnasiums were all significantly associated with lower initial levels of BMI. More breakfasts typically eaten per week with their families and greater minutes of recess (free time for activity at school) were each associated with decreases in the rate of BMI growth over time, while more television watched, greater average hours of weekly maternal employment, more school lunches and school breakfasts eaten, and the adequacy of children's gymnasiums were associated with faster rates of BMI growth over the study period. The study adds to the existing literature on environmental influences on child BMI by illustrating the utility and necessity of examining multiple influences within a single analytic framework. Further research and policy efforts should continue to acknowledge the multi-etiological manner by which the environment can affect rates of child obesity.

Introduction

The obesity epidemic among children and adolescents is one of the major public health issues of the current generation. The most recent nationally representative American data show that in 2007–2008, 14.8% of children aged 2–19 years were overweight, while 16.9% were obese (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). Although rates of overweight and obesity have showed no significant increase recently (Ogden et al., 2010), their current levels represent considerable and significant increases since the early 1980s (Ogden et al., 2006).

In the U.S., overweight in children and adolescents is defined as having a body mass index (BMI) (kg/m^2) ≥85th and <95th age- and gender-specific percentiles, while obesity is defined as a BMI ≥ 95th percentile. Although the most serious health risks are associated with obesity, both overweight and obesity are of concern because of their relationship to concurrent comorbidity (Davis et al., 2007; Weiss et al., 2004) and their demonstrated link to overweight and obesity in adulthood (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Indeed, the dramatic increases in overweight and obesity over the past decades have prompted some to predict a decrease in life expectancy for the current generation of children, a first in modern times (Olshansky et al., 2005).

Research has shown that environmental factors are at the root of the obesity epidemic (Lobstein, Baur, & Uauy, 2004; Wardle, Carnell, Haworth, & Plomin, 2008). Although BMI is highly heritable (Wardle et al., 2008), increased rates of overweight and obesity are likely due to the interplay between genetics and the environment, whereby underlying susceptibility for excess weight is triggered by environmental stimuli (Barsh, Farooqi, & O'Rahilly, 2000; Lobstein et al., 2004). Indeed, one review (Allison, Matz, Pietrobelli, Zannolli, & Faith, 1999) suggested that only approximately 10% of the population would be overweight in environments that did not stimulate weight gain. Given the importance of the environment to child overweight and obesity, the identification of the full set of environmental factors related to increases in BMI is an important task for current research.

Bronfenbrenner's (1986) Bioecological Model suggests that outcomes such as child obesity are the product of multiple, reciprocal relationships between a child and his or her developmental contexts. Previous work extending this model to the topic of child obesity (Budd & Hayman, 2008; Davison & Birch, 2001) has highlighted the

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importance of both the home and school contexts (among others) to the development of child obesity. Although many previous studies have examined how aspects of homes and schools are related to child obesity outcomes, none has examined a multitude of potential influences from both in the same study, which is important in helping to discern the relative role of each on child BMI (Davison & Birch, 2001). In addition, previous research has tended not to examine changes in BMI longitudinally, which is important since the trajectory of BMI is important for predicting child overweight and obesity.

To address shortcomings in previous work, this study uses growth curve modeling with a longitudinal, prospective cohort study of American children to investigate the role of the home and school environments. This analysis improves upon and complements previous research in at least two ways. For one, data for this study were collected between 1998 and 2004, in the midst of rapid increases in overweight and obesity among children. As such, the data provide an important opportunity to study how environmental factors are associated with contemporary changes in children's weight. Also, unlike other analyses, which have focused on a small number of possible contributors to children's BMI, this study jointly considers the role of numerous school and home factors independent of a wide array of control variables.

To this end, the analysis models the associations between BMI and groups of variables belonging to the home and school environments that have been identified in previous research as related to child BMI or overweight and obesity. The paper proceeds with a discussion of the study sample, before describing the pertinent variables available in the Early Childhood Longitudinal Study – Kindergarten Cohort (ECLS-K) in the context of previous literature and then analytic methods and results.

Data and methods

Data

Data come from the ECLS-K, which began in the 1998–1999 school year with a nationally representative sample of over 21,000 American kindergartners, who at the time of analysis had been followed longitudinally until 5th grade. An essential characteristic of the ECLS-K is its sampling method, which collects data on children within schools. The ECLS-K has collected detailed direct assessment information on children but has also directly surveyed parents, teachers, and school administrators. Thus, the ECLS-K provides an ideal source to study how both the home and school environments are related to BMI. This study makes use of data from four waves: the springs of kindergarten, first, third and fifth grades when children in the analytic sample were 6.24, 7.25, 9.26, and 11.23 years old on average, respectively. The final sample consists of approximately 11,400 children from around 1700 schools (sample sizes are rounded as per data license restrictions). The reduction in sample size from 21,000 to 11,400 is largely a consequence of sample attrition as the ECLS-K did not follow about 8000 of the children who moved schools after kindergarten (approximately 75% of all movers) (Tourangeau et al., 2006). On average, those children remaining in the sample were of significantly higher socioeconomic status, were more likely to be White, non-Hispanic, and were less likely to live in a single parent home. While no longer nationally representative, the sample size far exceeds that of many other national surveys. This research was approved by the Columbia University Morningside Heights Institutional Review Board.

Measures

Body mass index

The outcome measure for this study is child BMI. A recent expert panel in the U.S. reaffirmed the use of BMI as an appropriate anthropometric tool to assess excess body weight, noting its correlation with body fat and other health risks (Barlow & The Expert Panel, 2007). In addition, a recent review of its validity indicated that high BMI has moderately high sensitivity and high specificity as a measure of excess body fat (Freedman & Sherry, 2009).

One advantage of the ECLS-K is the careful process used to collect information on child weight and height. At each survey point interviewers measured children's weight and height twice using a digital scale and Shorr board respectively. Height measures differing by less than 2 inches (5.08 cm) and weight measures differing by less than 5 pounds (2.27 kg) were averaged and recorded; otherwise, the value of height and weight closest to the national median was kept. Using these recorded measures, the ECLS-K created a variable for BMI, which was used as the dependent variable for this study.

Home variables

The ECLS-K includes a number of variables that have been conceptualized here as belonging to the home environment, and which have been identified in previous literature as associated with BMI or associated with caloric intake or expenditure. In all, six were selected. Table 1 provides detail on all variables included in the analyses, indicates the reporting source (parent, teacher, administrator, or ECLS-K created variable) for each, as well as the range for each variable in the pooled sample, and means and standard deviations by grade.

The first variable was a child's typical hours of sleep per night, which has been linked in previous studies to child BMI (Chen, Beydoun, & Wang, 2008; Patel & Hu, 2008). Although the exact mechanisms by which sleep and obesity are related are not clear, theory and research suggest that low levels of sleep may negatively impact children's caloric intake and expenditure as well as hormone levels, in turn leading to energy imbalance (Chen et al., 2008).

The group of home variables also included two variables indicating how many breakfasts and dinners children typically ate together with their families in a given week. Research has linked the number of meals a family eats together with improved nutrient intake and better dietary habits in young people (Gillman, Rifas-Shiman, Frazier, Rockett, Camargo, Field et al., 2000; Neumark-Sztainer, Hannan, Story, Croll, & Perry, 2003). The analysis also included a variable measuring the average hours of television a child watched daily, which has been identified as a cause of obesity (Gortmaker, Must, Sobol, Peterson, & Dietz, 1996; Proctor et al., 2003), both because of its sedentary nature, but also because children tend to consume more calories while watching television (Crespo et al., 2001).

Two variables were included that measured mothers' and fathers' average weekly hours of work. A number of studies have found a link between maternal employment and child BMI or risk for overweight or obesity (Anderson, Butcher, & Levine, 2003; Hawkins, Cole, Law, & The Millennium Cohort Study Child Health Group, 2008; Phipps, Lethbridge, & Burton, 2006). Maternal work is included here as a function of the home environment because previous research has suggested that it may impact child BMI by affecting household routines (such as meal preparation, opportunities for activity, or television watching (Anderson et al., 2003)), for which mothers typically bear the largest responsibility in the household division of labor. It is likely for this reason that previous research has found no association for fathers' (or partners') work (Hawkins, Cole, & Law, 2008; Phipps et al., 2006). However, no study has explored a link between fathers' work and child BMI, while controlling for the full range of factors in this analysis. To ensure that all families were included in the analyses, dummy variables indicating whether a family was headed by a single mother or single father were included, and the variables for mothers' and fathers' employment were set equal to zero in these cases.