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From Kindergarten Through Second Grade, U.S. Children's Obesity Prevalence Grows Only During Summer Vacations

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Additional Supporting Information may be found in the online version of this article.

Abstract

Objective

To assess the relative importance of school and nonschool risk factors, this study estimated whether overweight and obesity prevalence grows faster during the school year or during summer vacation.

Methods

In the Early Childhood Longitudinal Study, Kindergarten Class of 2010–11, a nationally representative complex random sample of 18,170 U.S. children was followed from the fall of kindergarten in 2010 through the spring of second grade in 2013. Children's weight and heights were measured in schools each fall and spring. A multilevel growth model was used to estimate growth in mean BMI, overweight prevalence, and obesity prevalence during each summer and each school year.

Results

From the fall of kindergarten to the spring of second grade, the prevalence of obesity increased from 8.9% to 11.5%, and the prevalence of overweight increased from 23.3% to 28.7%. All of the increase in prevalence occurred during the two summer vacations; no increase occurred during any of the three school years.

Conclusions

The risk of obesity is higher when children are out of school than when they are in school.

Introduction

A fundamental question about child obesity is whether its causes lie primarily inside or outside of schools. If obesity originates primarily inside schools, then we may hope to substantially reduce obesity through policies affecting school meals [1], competitive foods [2], physical education [3], and other programs affecting the school environment [4]. But if obesity originates primarily outside of schools, then school-based programs must try to shape out-of-school behaviors, and we must further emphasize out-of-school interventions to reduce screen time [5], limit child-directed food marketing [6], promote out-of-school activities such as summer school [7] and summer camp [8], and educate parents about nutrition [9].

One way to compare in-school and out-of-school influences is with a *seasonal* design that compares growth in body mass index (BMI) when children are in school during the academic year and when school is out for summer vacation. If BMI grows fastest during the school year, then school environments would appear to be the major cause of obesity. But if BMI grows fastest during summer vacation, then it would appear that the major risk factors lie outside of schools.

The most common finding of seasonal research is that BMI increases faster during the summer than during the school year [10, 11], but some studies have not reported faster summer BMI growth, even in high-risk groups such as Native Americans [12, 13], and nearly all seasonal studies have relied on local convenience samples. Only one seasonal study has used nationally representative data [14], and that study was limited to a single summer—the one after kindergarten—and a single cohort of children who started kindergarten in 1998 and are now 22 to 23 years old.

This article offers the second nationally representative analysis of seasonal BMI gain. The data describe a recent cohort that started kindergarten in 2010, and the data cover three school years and two summers from the start of kindergarten through the end of second grade.

Methods

Sample and design

The Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (ECLS-K:2011) [15] is a complex probability sample from the population of U.S. children who attended kindergarten in the fall of 2010. The ECLS-K:2011 followed a multistage design, sampling children within schools and schools within primary sampling units; each primary sampling unit was a large county or a group of adjacent and demographically similar small counties. The ECLS-K:2011 was stratified into public and private schools. Asian/Pacific Islander children were over-sampled. Sample weights compensate for over-sampling and nonresponse.

The complete ECLS-K:2011 consists of 18,170 children in 970 schools and 90 primary sampling units. After excluding children with missing covariates and children from year-round schools, which have short summer vacations, we had an analytic sample of 13,006 children in 846 schools.

The ECLS-K:2011 measured height and weight on six occasions—once in the fall and spring of each school year from the fall of kindergarten in 2010 through the spring of second grade in 2013. On average, the ECLS-K:2011 took fall measurements 5 to 7 weeks after the first day of school and took spring measurements 8 weeks before the last day of school. On two occasions—the falls of first and second grade—the ECLS-K:2011 took measurements only in a 30% random subsample of schools. Subsampling did not introduce bias since the subsample was random; however, the reduction in sample size does reduce power on the affected measurement occasions.

On each occasion, height and weight were measured twice, using a Shorr board stadiometer and a Seca Bella 840 flat electronic scale. Children were asked to remove shoes, hats, and jackets. Comparing the two BMI measurements, we calculated that the standard error of measurement was 0.187 kg/m^2. Unfortunately, the data do not include other obesity-relevant measures such as waist circumference or skinfold thickness.

Statistical analysis

We estimated mean BMI and the prevalence of overweight and obesity [by the CDC definition [16]] on each measurement occasion. Our estimates accounted for survey strata, clusters, and sample weights. We used the *svy* commands in Stata software, version 13.

Next, using HLM software, version 7, we fit multilevel growth models to estimate rates of growth during each school year and summer [17]. We estimated mean growth rates, the variation of growth rates between children and schools, and the association of growth rates with demographic covariates including the child's gender, race/ethnicity, and age at the start of kindergarten; the square root of family income and mother's education level; and indicators for whether the mother was employed or the child lived with a single parent. Details of the growth model are given in the Online Supporting Information.

Results

Figure 1 plots mean BMI, obesity prevalence, and overweight prevalence on each measurement occasion from the fall of kindergarten through the spring of second grade. Although mean BMI grows in every period, it grows faster during the summers than during the school years. Overweight and obesity prevalence grow only

during summer vacations, not during the school years.

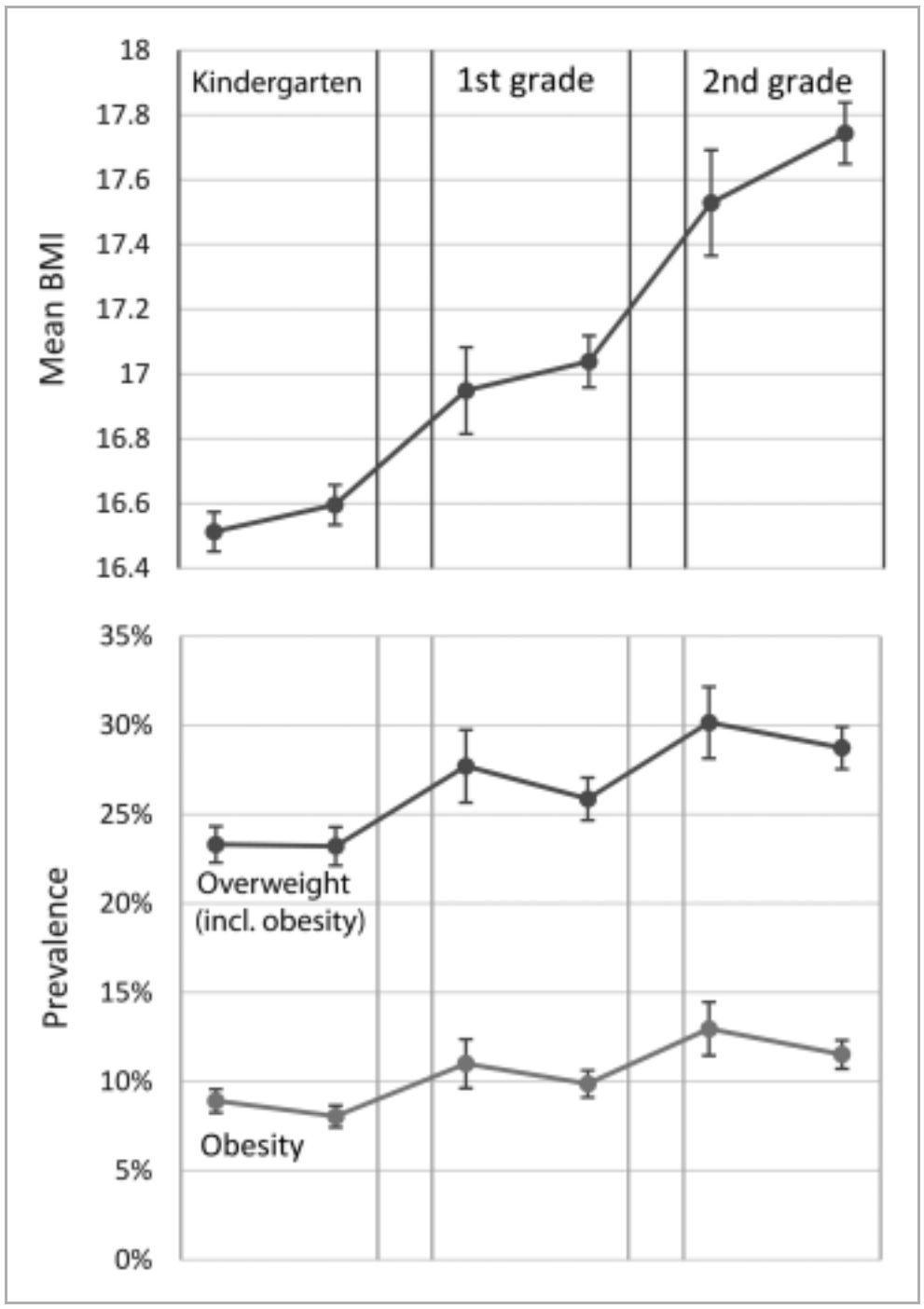

Figure 1.

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Mean BMI, overweight prevalence, and obesity prevalence in the fall and spring of each school year.

The upper rows of Table 1 estimate growth in overweight and obesity prevalence. At the start of kindergarten, the prevalence of overweight was approximately 23% and the prevalence of obesity was approximately 9%. During summer 1 and summer 2, both overweight prevalence and obesity prevalence increased by approximately 1 percentage point per month (pp/m). These were significant increases (all P s < 0.001), which over the 2.6 to 2.7 months of an average summer vacation added up to an increase of 2 to 3 percentage points in overweight and obesity prevalence.

Table 1. Monthly rates of growth in BMI, percent overweight, and percent obesity

		Monthly growth rates

	Start of kindergarten	Kindergarten	Summer 1	First grade	Summer 2	Second grade
Percent overweight	23.02*** (22.16 to 23.89)	0.03 (−0.05 to 0.12)	0.95*** (0.54 to 1.35)	−0.01 (−0.14 to 0.13)	1.09*** (0.68 to 1.51)	−0.01 (−0.15 to 0.12)
Percent obesity	8.84*** (8.27 to 9.42)	−0.12*** (−0.17 to −0.07)	0.81*** (0.56 to 1.05)	−0.01 (−0.09 to 0.08)	0.88*** (0.59 to 1.18)	−0.11* (−0.21 to −0.01)
Mean BMI	16.46*** (16.41 to 16.51)	0.02*** (0.01 to 0.02)	0.07*** (0.05 to 0.09)	0.03*** (0.03 to 0.04)	0.08*** (0.06 to 0.11)	0.05*** (0.04 to 0.06)
BMI random effects: child level						
SD	2.40*** (2.37 to 2.43)	0.17*** (0.17 to 0.17)	0.51*** (0.50 to 0.52)	0.18*** (0.17 to 0.18)	0.57*** (0.55 to 0.58)	0.22*** (0.21 to 0.23)
Correlations						
Start of kindergarten		−0.25***	0.26***	0.07***	0.13***	0.03*
Kindergarten growth rate			−0.56***	0.06***	−0.02*	0.02*
Summer 1 growth rate				−0.47***	0.27***	−0.04**
First grade growth rate					−0.49***	0.06***
Summer 2 growth rate						−0.55***
BMI random effects: school level						
SD	0.44*** (0.37 to 0.50)	0.04*** (0.04 to 0.04)	0.10*** (0.07 to 0.12)	0.03** (0.02 to 0.04)	0.12*** (0.09 to 0.15)	0.03 (0.00 to 0.06)
Correlations						
Start of kindergarten		−0.10	0.07	0.49**	−0.06	0.17 to 0.10
Kindergarten growth rate			−0.48**	0.06	0.28*	−0.19
Summer 1 growth rate				−0.17	−0.10	0.17
First grade growth					−0.56*	0.42

rate	
Summer 2 growth rate	−0.55

Point estimates (with 95% CIs).

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

During the school years, overweight prevalence did not increase at all, and obesity prevalence actually decreased by approximately 0.1 pp/m during both kindergarten and second grade (but not during first grade). The kindergarten and second grade decreases in obesity prevalence are statistically significant (both Ps < 0.001), but over the 9.3 to 9.4 months of an average school year they only add up to a 1 percentage point decrease in obesity prevalence—not enough to reverse the 2 to 3 percentage point increases that occur during each summer vacation.

The next rows of Table 1 estimate growth in mean BMI. On average, BMI growth rates were faster during the summers than during the school years. Average BMI grew at 0.02 kg/m^2 per month during kindergarten, accelerated to 0.07 kg/m^2 per month during summer 1, slowed to 0.03 kg/m^2 per month during first grade, accelerated to 0.08 kg/m^2 per month during summer 2, and slowed to 0.05 kg/m^2 per month during second grade. According to a planned contrast, the average of the two summer growth rates exceeded the average of the three school year growth rates by 0.04 kg/m^2 per month (95% CI 0.02–0.06 kg/m^2 per month, $P <$ 0.0001).

The rest of Table 1 summarizes the random effects. The standard deviations (SDs) of the random effects show that BMI growth is more variable during the summer than during the school year. At both the child level and the school level, the SD of BMI growth is approximately three times greater during the two summers than during the three school years. This pattern suggests that the common school environment may reduce differences between children's BMI growth rates.

Child-level correlations among the random effects show that initial BMI is more positively correlated with summer BMI growth than with school year BMI growth. These correlations may suggest that out-of-school factors affect initial BMI and summer BMI growth, but have less effect on school year BMI growth.

Table 2 estimates the association of BMI and BMI growth with demographic covariates, and the Online Supporting Information estimates the association between demographic covariates and growth in overweight and obesity prevalence. Although most of the covariates are significantly associated with initial BMI, none is significantly associated with summer growth. The lack of demographic variation in summer growth is consistent with results from a southeast Texas school district [18], but differs from the results of the previous national study [14], where summer BMI growth was faster for black and Hispanic children.

Table 2. Association of BMI and BMI growth with mean-centered covariates

		Monthly growth rate				
	Start of kindergarten	**Kindergarten**	**Summer 1**	**First grade**	**Summer 2**	**Second grade**

Mean	16.460*** (16.414 to 16.507)	0.016*** (.012 to 0.020)	0.065*** (0.046 to 0.084)	0.034*** (0.027 to 0.040)	0.081*** (0.058 to.105)	0.053*** (0.045 to 0.061)
Female	−0.168*** (−0.251 to −0.084)	0.007* (0.001 to 0.013)	0.003 (−0.028 to 0.034)	0.007 (−0.004 to 0.018)	0.017 (−0.021 to 0.055)	−0.007 (−0.020 to 0.006)
Age at start of kindergarten	0.020*** (0.011 to 0.029)	0.001** (0.000 to 0.002)	0.001 (−0.003 to 0.005)	0.001 (−0.001 to 0.002)	0.003 (−0.001 to 0.008)	0.000 (−0.002 to 0.001)
Race/ethnicity						
Black	0.168* (0.020 to 0.316)	0.016** (0.004 to 0.028)	−0.011 (−0.074 to 0.052)	0.024* (0.001 to 0.047)	−0.001 (−0.078 to 0.076)	0.005 (−0.022 to 0.033)
Hispanic	0.460*** (0.328 to 0.593)	0.015** (0.005 to 0.026)	0.019 (−0.025 to 0.062)	−0.002 (−0.018 to 0.014)	0.043 (−0.016 to 0.103)	−0.001 (−0.021 to 0.019)
Asian	−0.105 (−0.270 to 0.060)	0.001 (−0.013 to 0.015)	0.025 (−0.039 to 0.089)	−0.011 (−0.032 to 0.010)	0.019 (−0.060 to 0.098)	−0.001 (−0.030 to 0.028)
Native American	0.659* (0.114 to 1.205)	0.019 (−0.018 to 0.056)	0.038 (−0.119 to 0.194)	0.050* (0.001 to 0.100)	−0.066 (−0.258 to 0.126)	0.047 (−0.026 to 0.120)
Other race	0.113 (−.077 to 0.303)	0.005 (−0.008 to 0.018)	0.012 (−0.056 to 0.080)	0.006 (−0.018 to 0.031)	−0.012 (−0.115 to 0.092)	0.012 (−0.025 to 0.049)
Mother's education						
< High school	0.429*** (0.246 to 0.612)	0.013 (−0.001 to 0.026)	−0.019 (−0.075 to 0.038)	0.025* (0.006 to 0.044)	0.007 (−0.073 to 0.088)	0.000 (−0.028 to 0.028)
High school	0.307*** (0.205 to 0.410)	0.003 (−0.005 to 0.011)	−0.012 (−0.051 to 0.027)	0.017* (0.003 to 0.030)	−0.004 (−0.051 to 0.042)	0.010 (−0.006 to 0.026)
Single parent	0.108 (−0.012 to 0.229)	0.003 (−0.006 to 0.011)	−0.032 (−0.071 to 0.006)	0.003 (−0.011 to 0.016)	0.003 (−0.050 to 0.057)	−0.003 (−0.022 to 0.016)
Mother employed	0.229*** (0.141 to 0.317)	−0.002 (−0.009 to 0.004)	−0.002 (−0.036 to 0.033)	0.011 (−0.002 to 0.024)	0.000 (−0.042 to 0.043)	0.008 (−0.006 to 0.023)

Family income	−0.035 *** (−0.052 to −0.019)	0.000 (−0.001 to 0.001)	−0.003 (−0.010 to 0.004)	−0.001 (−0.003 to 0.002)	−0.001 (−0.008 to 0.007)	−0.001 (−0.004 to 0.001)

Point estimates (with 95% CIs).

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Discussion

Between kindergarten and second grade, U.S. children's overweight and obesity prevalence increase only during summer vacations. This finding suggests that the major risk factors for child obesity lie outside of schools. Schools may reduce risk in the relative sense that they prevent overweight prevalence from increasing during the school year as it does during the summer. Schools may even reduce risk in an absolute sense, since obesity prevalence slightly declines during kindergarten and second grade.

What behavioral changes explain the acceleration of BMI growth during the summer? It is not clear whether children consume more food energy in the summer [19], but they do sleep less [20], and they watch more television [21]. In addition, children in hot climates are less physically active during summer, although children in cool climates are more active [22]. While these behaviors are suggestive, it is challenging to correlate them with seasonal BMI patterns, because seasonal measures of BMI and the relevant behaviors have not been collected on the same children.

It is plausible that some out-of-school risk factors affect children not just during the summer, but also after school and on weekends. However, our data do not permit us to estimate weekend or after-school BMI gains.

The question arises: if obesity prevalence increases only during summer, how much more can schools do to reduce obesity? Many school-based interventions have had little effect, and effective school-based interventions tend to be those that do not just alter the school environment but also involve parents [4] and try to change out-of-school behaviors such as watching television [23]. There may also be underexploited potential in out-of-school interventions such as summer camps [8], summer learning programs [7], parent nutrition education [9], reductions in screen time [5], and reductions in child-directed food marketing [6].

» Supporting Information

» References

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