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Changes in the Incidence of Childhood Obesity

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Abstract

OBJECTIVES: Examine childhood obesity incidence across recent cohorts.

METHODS: We examined obesity incidence and prevalence across 2 cohorts of children in the United States 12 years apart using the Early Childhood Longitudinal Studies, parallel data sets following the kindergarten cohorts of 1998 and 2010 with direct anthropometric measurements at multiple time points through fifth grade in 2004 and 2016, respectively. We investigated annualized incidence rate and cumulative incidence proportion of obesity (BMI z-score $\geq 95_{th}$ percentile based on Centers for Disease Control and Prevention weight-for-age *z*-scores).

RESULTS: Among children who did not have obesity at kindergarten entry, there was a 4.5% relative increase in cumulative incidence of new obesity cases by end of fifth grade across cohorts (15.5% [14.1%–16.9%] vs 16.2% [15.0%–17.3%]), though annual incidence did not change substantially. The risk of incident obesity for children who had normal BMI at kindergarten entry stayed the same, but the risk of incident obesity among overweight kindergartners increased slightly. Social disparities in obesity incidence expanded: incidence of new cases during primary school among non-Hispanic Black children increased by 29% (95% confidence interval, 25%–34%), whereas risk for other race–ethnic groups plateaued or decreased. Children from the most socioeconomically disadvantaged households experienced 15% higher cumulative incidence across primary school in 2010 than 1998.

CONCLUSIONS: Incidence of childhood obesity was higher, occurred at younger ages, and was more severe than 12 years previous; thus, more youths may now be at risk for health consequences associated with early onset of obesity.

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Obesity in early life remains a leading public health challenge because it is linked with long-term poor physical and mental health.[1–5] The prevalence of childhood obesity in the United States is among the highest in the world.[6,7] Although some data suggested that increases in the prevalence of obesity among primary school children had stalled in the early 2000s,[8] recent studies report that the prevalence of obesity among children and adolescents has continued to increase.[9]

To understand how the public health challenge of childhood obesity is evolving, and consequently the long-term prospects for population health, it is important to investigate temporal changes in incidence at the national level. Evidence from incidence can uncover patterns not observed from prevalence data. For example, earlier research indicated that, although the prevalence of childhood obesity in the United States was increasing with age, the incidence of new cases decreased with age, and that the children at highest risk of experiencing incident obesity by adolescence were those who had entered kindergarten overweight.[10] Prevalence estimates help us understand the proportion of the population affected by obesity and its health and psychosocial consequences; it also guides policy and programs for treatment and for long-term health care needs of the population. On the other hand, to inform prevention efforts, for example, the population groups at greatest risk if incidence and the ages when new cases are most likely to occur, we need age-specific incidence estimates. Furthermore, to monitor whether the force of disease is changing in the population and to evaluate whether prevention efforts are working, we must understand how the incidence of new cases is changing over time.

With this information, we can understand the risk of developing obesity and how the epicenter of new obesity cases may be changing. We can also assess whether the differences in prevalence of obesity over time that have been reported in the literature are simply glitches, shifts in risk groups, or temporary stalls, or whether they portend coming improvements or worsening in health.

In this article, we examine changes in the incidence of obesity among cohorts of US children growing up 12 years apart, going through the same developmental stages at different points in time: 1 cohort in the late 1990s to early 2000s, the other in the 2010s. We used 2 parallel nationally representative kindergarten cohorts with direct anthropometric measurements at multiple points from average age 6 years to 11 years.

METHODS

The Early Childhood Longitudinal Studies–Kindergarten are observational cohort studies conducted by the National Center for Education Statistics (NCES) of the U.S. Department of Education. They are nationally representative of the United States cohorts entering kindergarten in 1998 and 2010, thus approximately the birth cohorts of 1993 and 2005, respectively. Through a school-based, multistage sampling strategy, 21 069 kindergartners were enrolled in 1998 and 17 937 in the 2010 cohort. From each cohort, respectively 9796 and 8542 were retained and had follow-up at every data wave through the fifth grade, and we use this longitudinal sample for our analysis. Most attrition resulted from random selection for nonsampling because of survey costs of children who moved to different schools. The NCES constructed longitudinal weights and survey adjustments to maintain the representativeness of the analytic sample to the US population of children who entered kindergarten in 1998 and 2010.[11,12]

Data on the first cohort were collected 6 times between kindergarten entry (average age 5.7 years) and end of fifth grade (average age 11.2 years); data from the second cohort were collected 9 times using similar sampling and data collection methods. A visualization of the survey waves is shown in Supplemental Fig 3.

All study procedures were approved by the NCES ethics review board; parents provided written informed consent and children assented to participate. The analysis in this report was submitted to the institutional review board of our institution, but deemed not applicable because it is a secondary data analysis of deidentified, public-use data.

Trained interviewers took anthropometric measurements at each data wave using a ShorrBoard to measure height and a digital scale to measure weight. We used these measurements to compute BMI *z*-scores by age and sex, with reference to growth charts developed by the Centers for Disease Control and Prevention.[13] Following standard recommendations, we defined normal weight as BMI z-score <85th percentile, overweight as 85th percentile ≤ BMI *z*-score <95th percentile, and obesity as BMI *z*-score ≥95th percentile. We additionally distinguished between moderate obesity, calculated as BMI *z*-score ≥95th percentile to <120% of the 95th percentile and severe obesity as BMI *z*-score ≥120% of the 95th percentile.[14–16]

For each cohort, we calculated the distribution, prevalence, and incidence of obesity across data waves. We calculated obesity prevalence as the percentage of children with obesity at a given point in time. We then calculated annual obesity incidence rates as the annualized risk of developing obesity between data waves, calculated by dividing the number of new obesity cases in the wave by the number of person–years of follow-up contributed by children when they were nonobese.[10] For each individual, the follow-up period was defined as half of the time between each survey wave and the following wave for an incident case, or the entire time between these 2 waves if the child remained without obesity. This approach makes the implicit assumption that the obesity threshold was crossed at the midpoint between 2 data waves.

It could be that having more frequent data waves in the more recent cohort could allow us to observe more events of incident obesity that turn out to be fleeting, which would affect estimates of incident cases. Therefore, we estimated all incidence rates for the 2010–2011 cohort using the same waves of data as the 1998–1999, thus, using a balanced panel. The estimates, including all data waves available, are shown for reference in Supplemental Fig 4.

We calculated cumulative obesity incidence as the proportion of children who developed obesity by the end of fifth grade, among children who did not have obesity at kindergarten entry. To examine the risk of obesity for demographic groups, we stratified cumulative incidence estimates by gender (boys or girls) and parent-reported race and ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and other race, which includes Asian American, Pacific Islander, American Indian, and multiracial). To measure whether there were changes in socioeconomic patterning of obesity, we stratified cumulative incidence by household socioeconomic status (SES) quartiles at baseline (1 being the most disadvantaged households and 4 the most socioeconomically advantaged) and by school location at baseline (city, urban fringe and large town, small town and rural area). To consider importance of prenatal growth, we stratified by birth weight (low birth weight: <2500 g; normal birth weight: 2500–3999 g; high birth weight: ≥4000 g).

BMI was missing for <5% of observations in every full sample wave. However, some survey waves were designed as representative subsamples of the full cohorts to reduce survey costs, so some children were not measured at all data waves by design. When an observation was missing a BMI value at the first or last observation, we used the value from the closest available wave to avoid making estimates outside the available range. For observations with missing BMI values at other waves, the missing value was linearly interpolated. This is a reasonable assumption because the time between measurements was fairly short; the alternative method, multiple imputation, has been found to yield little difference in conclusions for within-person trajectories.[17] Missing data on demographic and socioeconomic variables was generally <1%, with the exception of SES in 1998 (5.9%) and urbanicity in 2010 (8.3%). We used listwise deletion for each subgroup analysis. Information on birth weight was missing for 17.2% in 1998 and 27.1% in 2010, so we show associations with weight status for those with missing birth weight.

Analyses were performed with R (version 3.5.1).[18]

RESULTS

Table 1 shows children by BMI categories in each of the 2 cohorts. When the birth cohorts of 1992/93 entered Kindergarten in 1998, 72.9% (95% confidence interval 71.2%–74.6%) had normal BMI, whereas 15.1% (13.6%–16.5%) had overweight and 12% already had obesity: 9.2% (8.1%–10.2% had moderate obesity and 2.9% had severe obesity (2.2%–3.5%). Twelve years later, when the birth cohorts of 2004 to 2005 entered kindergarten in 2010, the percentage of children starting school with a normal BMI had decreased to 69% (67.6%–70.5%). The percentage entering kindergarten with overweight in 2010 had not changed substantially, at 15.7% (14.6%–16.7%), but the percentage that already had obesity increased to 15.3%. Thus, unhealthy BMI levels shifted to younger ages between children growing up in the 1990s and those growing up in the 2000s as evidenced by increase in prevalence at kindergarten entry; in the more-recent cohort, obesity already affected 1 in 6 children before they entered school.

At kindergarten entry, at average age 6 years, not only had a higher proportion of children in the more recent cohort already entered overweight and obesity, but a higher proportion had already reached severe obesity: 3.9% (3.3%–4.5%) in 2010, compared with 2.9% (2.2%–3.5%) in 1998. In both cohorts, the prevalence of severe obesity increased with increasing age. Additionally, the age-specific prevalence of severe obesity was greater at every age point in the 2010 as compared with 1998–1999 cohort. For example, in fifth grade (~ age 11), the prevalence of severe obesity was 5.6% (4.8%–6.4%) in the 1998–1999 cohort versus

7.2% (6.4%–8.0%) in the 2010–2011 cohort. Thus, obesity was more severe in the recent cohort.

Fig 1 shows that the prevalence of obesity during primary school was higher in the 2010 cohort at all ages, with the largest differences being at kindergarten entry.

Fig 2 shows the annualized incidence rate of obesity during primary school. The annual incidence of obesity was highest during kindergarten for the 1998 cohort, at 5.12 (4.01–6.22) per 100 person–years, and lower thereafter, oscillating around 3 per 100 person–years. In the 2010 cohort, annual incidence was somewhat lower during kindergarten but peaked in first grade at 4.12 (3.15–5.09) per 100 person–years and remained higher than for the 1998 cohort thereafter, reaching the largest difference in fifth grade at 3.86 (3.44–4.28) per 100 person–years, compared with 2.83 (2.35–3.31) per 100 person–years in the 1998 cohort.

Table 2 shows the cumulative incidence proportion (eg, “risk”) of obesity by age 11 among children who entered kindergarten nonobese for the 1998 and 2010 kindergarten cohorts. Among all children who did not already have obesity when they entered kindergarten, cumulative incidence of obesity between kindergarten entry and the end of fifth grade (ages 6 and 11 years) was 16.2% (15.0–17.3) in 2010; this is a 4.5% relative increase over the cumulative incidence of 15.5% for children over the same age span 12 years earlier.

When further stratified by BMI category at kindergarten entry, differences emerge. There was no change between the 2 cohorts in the risk of developing obesity for children who entered with normal BMI (9.8% cumulative incidence for both cohorts). However, the risk of developing obesity for children who entered kindergarten overweight increased slightly from 42.9% (38.0–47.9) to 44.3% (41.3%–47.3%) in the later cohort. These patterns suggest that the cumulative risk of developing obesity during primary school was higher for the 2010–2011 kindergarten entrants than for new kindergartners 12 years earlier for children who already had overweight at average age 6 years.

Table 2 shows 5.5-year cumulative incidence proportion of obesity stratified by sociodemographic groups. Boys had higher risk of developing obesity than girls in each cohort, but only boys experienced an increase in risk in 2010 to 2011 (17.7% [16.1%–19.4%]) as compared with 1998 to 1999 (16.2% [14.2%–18.3%]), with a relative risk of 1.09 (1.08–1.11).

Non-Hispanic Black kindergartners were 29% (risk ratio [RR] 1.29, 95% confidence interval 1.25–1.34) more likely to develop new onset obesity by fifth grade in the 2010–2011 cohort compared with non-Hispanic Black children in the 1998–1999 cohort. Although in the late 1990s, Hispanic children were experiencing the highest incidence of obesity during primary school (19.9% [16.1–23.8]), they were surpassed by non-Hispanic Black children in the 2000s. Thus, there were widening disadvantages in obesity for non-Hispanic Black children compared with all other groups. The risk of incident obesity during primary school plateaued for Hispanic and Non-Hispanic White children, though at a higher level for Hispanic (19.9%) than for White children (13.6%). Children in other race groups, which includes Asian American, Pacific Islander, and American Indian, had a 16% reduction in risk of developing obesity during primary school between the 2 cohorts (RR 0.84 [0.80–

0.87]); thus, they surpassed non-Hispanic White children as the group with lowest incidence in the 2010–2011 cohort (13.4% [10.1%–16.7%]).

The risks of developing obesity stayed similar for children in the middle of the socioeconomic spectrum across the 2 cohorts, but increased by 15% for children from the least advantaged households (RR 1.15 [1.12–1.17]), from 17.7% (14.6%–20.8%) to 20.3% (18.0–22.6)) and from the most advantaged households (RR 1.15 [1.14–1.17]). The socioeconomic gradient of obesity incidence was maintained and the disadvantages in terms of unhealthy weight increased for the most socioeconomically disadvantaged children relative to all other SES groups.

The risks of developing obesity were similarly distributed across urban, suburban, and rural schools in 1998, though the lowest risks were in suburban schools. Children in suburban schools and large towns had the largest increases in incidence, leading to even more similarity across environments for the 2010 cohort (RR 1.13 [1.11–1.15]).

To consider intergenerational transmission of risk, Table 2 presents obesity incidence in relation to birth weight. These preliminary data indicate that incidence of obesity in primary school increased linearly with birth weight in the early 2000s but followed a J-shape a decade later because of large relative increases in risk for children born with low birth weight and high birth weight.

DISCUSSION

Previous studies reporting on the prevalence of childhood obesity have shown continued increases in obesity during the past decade, with plateauing of obesity prevalence among some age groups.[9] This study contributes by identifying how the incidence of new cases has changed between recent cohorts.

Compared with children born in the early 1990s, those born in the mid-2000s experienced obesity with higher incidence, at younger ages, and at more severe levels. In 2010, a higher proportion of children arrived at kindergarten with moderate or severe obesity, compared with the cohort of children passing through this age group 12 years earlier. This pattern suggests earlier onset of elevated BMI in the more-recent cohort occurring during the preschool years. Increases in BMI across the 2 cohorts and higher proportions reaching severe obesity indicate temporal trends to more children having elevated BMI and severely high levels of BMI.

Across the 2 cohorts, social disparities in unhealthy weight increased. Most markedly, the risk of developing obesity during primary school increased significantly for non-Hispanic Black children, surpassing that of Hispanic children. During this period, other race and ethnic groups experienced plateauing or even decreasing incidence of obesity. Recognizing that the obesity risks faced by Black children are continuing to increase highlights the need to identify factors that may underlie their vulnerability to develop more successful prevention efforts.[19] Although extensive public health efforts have been directed toward childhood obesity since 2010, such as the Let’s Move! campaign and the Healthy, Hunger-Free Kids Act, these policies have had no impact on reducing population-level obesity.[20]

The heterogenous risk of obesity by race–ethnicity, coupled with the lack of impact of interventions, highlights the need for public health policies to be tailored to counterbalance obesogenic factors. Notably, we identified increasing heterogeneity in incidence of obesity across schools in urban, suburban, and rural areas because all locations converged toward higher obesity incidence.

That children from both the highest and lowest socioeconomic households were more likely to develop obesity in the 2010s is a reminder that children of all walks of life are at risk for obesity. At the same time, the socioeconomic gradient of obesity has persisted because children from the most disadvantaged households experienced increases in incidence higher than other children; thus, their disadvantages in terms of long-term health continue to grow. Boys experienced increases in incidence of obesity during primary school but girls did not, suggesting the importance of psychosocial, behavioral, and epigenetic factors beyond those originating from race, ethnic, and socioeconomic circumstances.

Among these factors, the intergenerational transmission of obesity may offer insights into changes in obesity across cohorts. Specifically, obesity has been increasing among women of reproductive ages,[9,21,22] and maternal obesity predisposes children to develop obesity[23–25]; consequently, more children in recent cohorts may be predisposed to developing obesity. Information on mothers' health was not collected in the Early Childhood Longitudinal Study, so we cannot assess this proposition directly. To attempt to capture some prenatal factors, we examined associations between birth weight and obesity incidence. The proportion of children born with low and high birth weight was similar across the 2 cohorts (6.3% and 6.7% low birth weight and 8.9% and 6.6% high birth weight), but the incidence of obesity for children who were born small or large was substantially higher in the more-recent cohort. These patterns show mixed support for the possibility that childhood obesity incidence is increasing because of changing maternal and prenatal exposures; because of the high proportion of children missing data on birth weight, this hypothesis should be examined with other data sets.

In light of the observed higher incidence of obesity across primary school, more children in the recent cohort will be at risk for the health consequences that can develop with obesity, including diabetes, cardiovascular conditions, and mobility limitations. Data from the SEARCH for Diabetes in Youth (SEARCH) and Treatment Options for type 2 Diabetes in Adolescents and Youth (TODAY) studies, among others, indicate that children with obesity have 5 times higher risk of diabetes in childhood, which in turn is associated with cardiovascular complications, lower quality of life, and mortality.[26–29]

Given the observed younger onset of obesity and severe obesity, more-recent cohorts will be exposed to obesity at more developmental periods and for longer durations. Obesity is difficult to reverse, even in childhood, and tends to endure into adolescence and even adulthood.[10,30–35] Earlier onset of obesity is associated with higher risk of severe obesity in adulthood and type 2 diabetes.[25,36–38] It will be important for studies to quantify the implications for health of age of onset and duration of childhood obesity.

The short-term and long-term consequences of obesity are most strongly associated with severity, including in children.[39,40] Children with severe obesity have more cardiovascular risk factors than children with moderate obesity; these include elevated blood pressure, atherosclerosis, and cardiac abnormalities.[4,5] They also have higher prevalence of metabolic syndrome, sleep apnea, nonalcoholic fatty liver disease, and musculoskeletal problems.[39–42] With more children experiencing severe obesity in the recent cohort, we can expect higher risks of these comorbidities in today's high-schoolers and future adults. As these youths reach childbearing years, maternal obesity could increase intergenerational transmission of obesity for children born in the 2030s and 2040s.

This study has limitations. The cohorts examined here are representative of children who entered kindergarten in the United States in 1998 and in 2010, and may not reflect the experiences of even more-recent cohorts. However, these are the currently available nationally representative cohort studies of children and represent today's teens and young adults. These cohorts experienced periods of time when obesity was high and also experienced health interventions that are still being used or considered today. We are comparing cohorts of children only 12 years apart. These data allow us to observe trends over contemporary cohorts, but, in a period of just >1 decade, population-level changes that can be observed will be small. We did not account for the fact that children who had obesity at 1 time point might have subsequently lost weight and transitioned to overweight or to normal BMI. We also do not have information on growth patterns before kindergarten, so we cannot track incidence of obesity across childhood, nor identify the age at which children who entered kindergarten with overweight or obesity had first developed excess BMI. Lacking data before and after the period of observation, called left and right censoring, is common in studies of disease incidence. Observational data do not allow us to assess possible causal pathways, but they are the only option for identifying trends over time at the national level.

CONCLUSIONS

Approximately 40% of today's high school students and young adults experienced obesity or overweight before leaving primary school. Young people who were born in the 2000s experienced obesity incidence at even higher levels, at younger ages, and at higher severity during the developmentally important stages of childhood, compared even with the cohort 12 years earlier; this was despite the fact that they were exposed to more intensive efforts to prevent obesity than had earlier cohorts. These data have several implications for policies and prevention. First, they point to hitherto insufficient knowledge about susceptibility to childhood obesity to make substantial progress in obesity prevention. The data provide strong justification to focus efforts on research and policies aimed at preschool children. With advances in molecular and analytic technologies, integrative research connecting the biological factors and social determinants of early onset of obesity is warranted. Such approaches may shed light on childhood weight phenotypes and point to more precise interventions in terms of strategy and timing. We speculate that prevention programs need to look beyond simple solutions to obesity, including addressing the substantial changes in physical activity and in food environments that have progressed in recent decades, as well as the epigenetic and neuro–psycho–behavioral pathways to obesity. Ongoing surveillance is required to monitor changes in health at population levels. There are no national longitudinal studies of health for today's children; such data will be necessary to map the changing incidence of obesity across age, gender, social and economic factors, and geographies.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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ABBREVIATIONS

NCES	National Center for Education Statistics
RR	risk ratio
SES	socioeconomic

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WHAT'S KNOWN ON THE SUBJECT:

The prevalence of childhood obesity in the United States is high, and obesity in early life is linked with long-term poor physical and mental health.

WHAT THIS STUDY ADDS:

The age-specific incidence of childhood obesity during primary school has grown higher during the 2000s compared with a decade earlier, is occurring at younger ages, and is reaching more severe levels, indicating the need for more comprehensive programs.

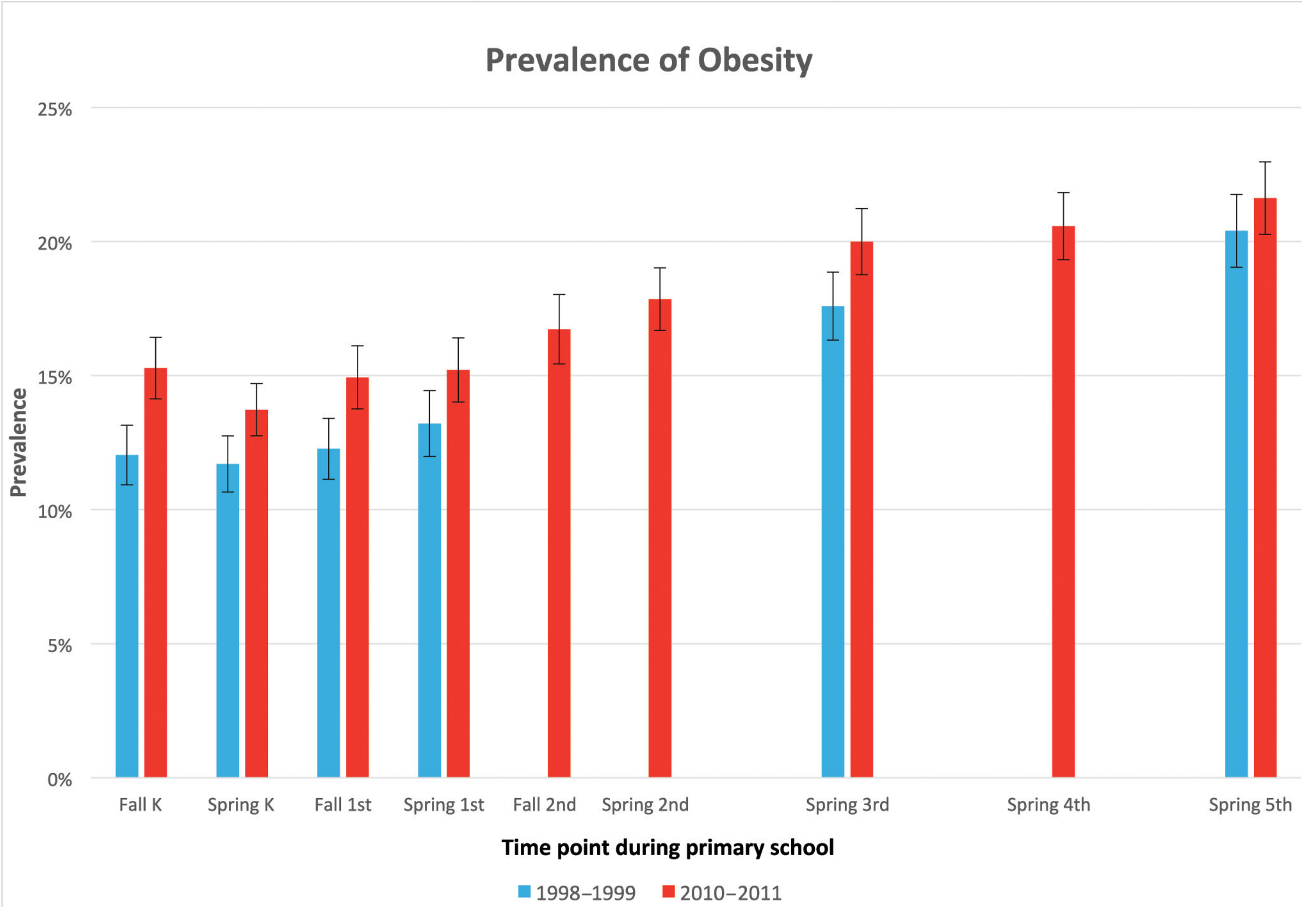

FIGURE 1.

Prevalence of obesity between kindergarten and fifth grade for the 1998 and 2010 kindergarten cohorts. Notes: Prevalence of obesity is shown for the cohorts of US children who entered kindergarten in 1998 and in 2010, followed yearly until the end of fifth grade. Whiskers indicate 95% confidence intervals. Data: Early Childhood Longitudinal Study–Kindergarten cohorts of 1998 and 2010.

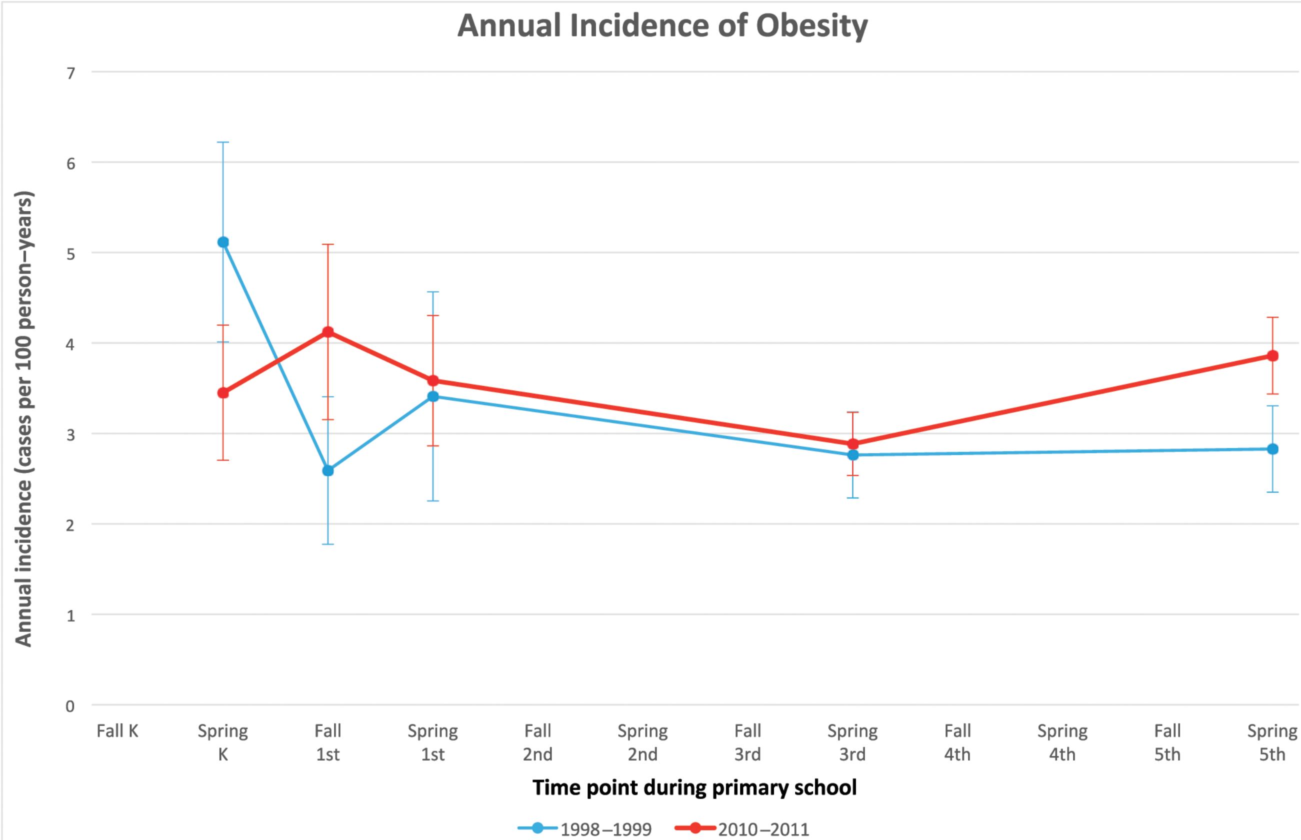

FIGURE 2.

Annualized incidence of obesity between kindergarten and fifth grade for the 1998 and 2010 kindergarten cohorts. Notes: Annualized incidence of obesity is calculated using balanced measurement waves, with person–years at risk in the 2010 cohort calculated after excluding the spring second-grade, fall third-grade, and spring fourth-grade waves, for which no parallel measure was taken in the 1998 cohort. Children with obesity at any previous wave were excluded from calculations for subsequent waves because they were not eligible for incident obesity. Whiskers indicate 95% confidence intervals. Data: Early Childhood Longitudinal Study–Kindergarten Cohorts of 1998 and 2010.

TABLE 1

National Prevalence of Normal, Overweight, Obesity, and Severe Obesity BMI Between Kindergarten and Fifth Grade for the 1998 and 2010 Kindergarten Cohorts

	Kindergarten, Fall Semester		**First Grade, Spring Semester**		**Third Grade, Spring Semester**		**Fifth Grade, Spring Semester**	
	Prevalence	**95% CI**	**Prevalence**	**95% CI**	**Prevalence**	**95% CI**	**Prevalence**	**95% CI**
1998 kindergarten cohort								
Mean age	5.7	5.5–5.9	7.2	7.0–7.4	9.3	9.1–9.4	11.2	11.0–11.4
BMI category								
Normal weight	72.9%	71.2%–74.6%	73.0%	71.3–74.8%	66.3%	64.5%–68.1%	61.0%	58.5%–53.4%
Overweight	15.1%	13.6%–16.5%	13.7%	12.3%–15.2%	16.1%	14.7%–17.4%	18.6%	16.7%–20.5%
All obesity	12.0%	10.9%–13.1%	13.2%	12.0%–14.4%	17.6%	16.3%–18.9%	20.4%	19.0%–21.8%
Moderate obesity	9.2%	8.1%–10.2%	9.4%	8.3%–10.5%	12.9%	11.7%–14.0%	14.8%	13.6%–15.9%
Severe obesity	2.9%	2.2%–3.5%	3.8%	3.0%–4.6%	4.7%	4.0%–5.5%	5.6%	4.8%–6.4%
2010 kindergarten cohort								
Mean age	5.6	5.4–5.9	7.1	6.9–7.4	9.1	8.9–9.3	11.1	10.9–11.3
BMI category								
Normal weight	69.0%	67.6%–70.5%	69.8%	68.5%–71.0%	62.0%	60.6%–63.5%	60.5%	59.0%–62.0%
Overweight	15.7%	14.6%–16.7%	15.0%	14.2%–15.8%	17.4%	16.5%–18.3%	17.9%	16.8%–18.9%
All obesity	15.3%	14.1%–16.4%	15.2%	14.0%–16.4%	20.6%	19.3%–21.8%	21.6%	20.3%–23.0%
Moderate obesity	11.4%	10.3%–12.4%	10.7%	9.6%–11.8%	14.0%	13.0%–15.0%	14.4%	13.5%–15.3%
Severe obesity	3.9%	3.3%–4.5%	4.5%	4.0%–5.1%	6.6%	5.8%–7.4%	7.2%	6.4%–8.0%

Note: Prevalence of obesity is shown for the cohorts of United States children who entered kindergarten in 1998 and in 2010, followed yearly until the end of fifth grade. Other survey waves omitted for brevity. Percentages may not sum because of rounding. Data: Early Childhood Longitudinal Study–Kindergarten cohorts of 1998 and 2010. Normal weight, <85th percentile; overweight, ≥85th to <95th percentile; all obesity, ≥95th percentile; moderate obesity, ≥95th percentile to <120% of the 95th percentile; severe obesity, ≥120% of 95th percentile. CI, confidence interval.

TABLE 2

Cumulative Incidence Proportion of Obesity From Kindergarten Through Fifth Grade Across Sociodemographic Groups and Risk Ratios Comparing the US 1998 and 2010 Kindergarten Cohorts

	1998 Kindergarten Cohort		2010 Kindergarten Cohort		RR for Obesity, 2010 vs 1998	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Overall	15.5%	14.1%–16.9%	16.2%	15.0%–17.3%	1.04	1.03–1.05
Baseline BMI status						
Normal in kindergarten	9.8%	8.7%–11.0%	9.8%	8.7%–10.9%	0.99	0.98–1.00
Overweight in kindergarten	42.9%	38.0%–47.9%	44.3%	41.3%–47.3%	1.03	1.00–1.06
Sex						
Males	16.2%	14.2%–18.3%	17.7%	16.1%–19.4%	1.09	1.08–1.11
Females	14.8%	12.8%–16.8%	14.5%	13.2%–15.9%	0.98	0.97–1.00
Race						
White, non-Hispanic	13.7%	12.0%–15.4%	13.6%	12.3%–14.9%	0.99	0.98–1.00
Black, non-Hispanic	17.3%	13.3%–21.3%	22.4%	18.2%–26.7%	1.29	1.25–1.34
Hispanic	19.9%	16.1%–23.8%	19.9%	17.6%–22.1%	1.00	0.97–1.02
Other race groups	16.1%	11.7%–20.5%	13.4%	10.1%–16.7%	0.84	0.80–0.87
Socioeconomic status						
Quartile 1 (lowest)	17.7%	14.6%–20.8%	20.3%	18.0%–22.6%	1.15	1.12–1.17
Quartile 2	18.1%	15.3%–21.0%	18.6%	16.1%–21.1%	1.03	1.00–1.05
Quartile 3	16.0%	12.7%–19.2%	14.7%	12.6%–16.8%	0.92	0.90–0.94
Quartile 4 (highest)	10.3%	7.8%–12.8%	11.9%	10.2%–13.6%	1.15	1.14–1.17
Urbanicity						
City	16.6%	14.5%–18.6%	17.3%	15.5%–19.3%	1.05	1.02–1.07
Urban fringe/large town	14.5%	12.5% –16.5%	16.3%	14.1%–18.5%	1.13	1.11–1.15
Small town/rural	15.7%	11.7%–19.8%	16.3%	14.5%–18.0%	1.03	1.02–1.05
Birth weight						
Low birth weight	11.6%	6.9%–16.2%	19.6%	15.4%–23.7%	1.69	1.65–1.73
Normal birth weight	15.8%	14.1%–17.6%	14.9%	13.6%–16.2%	0.94	0.93–0.95
High birth weight	16.2%	10.8%–21.7%	21.2%	16.7%–27.3%	1.35	1.30–1.41
Missing birth weight	15.4%	11.7%–19.1%	16.8%	14.6%–18.9%	1.09	1.07–1.11

Note: Number of incident cases of obesity per 100 person–years between the time the children entered kindergarten and when they completed fifth grade are shown for the cohorts of United States children who entered kindergarten in 1998 and in 2010. Children with obesity in kindergarten are excluded from this table because they were not eligible for incident obesity. Race or ethnic group was reported by parents of the children or collected from school records. The category designated as “other” includes Asian American, Pacific Islander, American Indian, and multiracial background. Data: Early Childhood Longitudinal Study–Kindergarten cohorts of 1998 and 2010. CI, confidence interval.