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Entrenched obesity in childhood: findings from a national cohort study

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ABSTRACT

Purpose: Given the high levels of obesity among U.S. children, we examine whether obesity in childhood is a passing phenomenon or remains entrenched into adolescence.**Methods:** Data are from the prospective nationally representative Early Childhood Longitudinal Study, Kindergarten Class of 1998–1999 (analytic sample = 6600). Anthropometrics were measured six times during 1998–2007. Overweight and obesity were defined using CDC cut-points. Entrenched obesity was defined as obesity between ages 5–9 coupled with persistent obesity at ages 11 and 14.**Results:** Almost 30% of children experienced obesity at some point between ages 5.6 and 14.1 years; 63% of children who ever had obesity between ages 5.6 and 9.1 and 72% of those who had obesity at kindergarten entry experienced entrenched obesity. Children with severe obesity in kindergarten or who had obesity at more than 1 year during early elementary were very likely to experience obesity through age 14, regardless of their sex, race, or socioeconomic backgrounds.**Conclusions:** Prevention should focus on early childhood, as obesity at school entry is not often a passing phenomenon. Even one timepoint of obesity measured during the early elementary school years may be an indicator of risk for long-term obesity.

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Introduction

Childhood obesity has become a major concern for individual and population health. With 12% of children in the United States already having obesity by the age of 5 years [1], the implications of long-term obesity are indeed serious, given the associations between obesity and health problems such as diabetes and CVD [2–4].

An important question about obesity in childhood is whether it is a fleeting or entrenched health problem. That is, children grow at different rates, and a brief period of obesity may not be a reason for major worry for parents and pediatricians. On the other hand, if obesity becomes entrenched, that is, firmly established and difficult to reverse, this is indeed a major concern, as it entails that the child is likely to continue having obesity into adulthood, with the major health consequences of long-term exposure to obesity [5–7].

Several studies have suggested that people tend to maintain their weight trajectories as they age, and that, to the extent that

weight changes, it increases [1,8–13]. While many individuals with normal weight in childhood first developed overweight or obesity in adulthood, few children who had overweight or obesity eventually achieve normal weight [12–15]. In urban Greenland, schoolchildren with obesity tended to retain obesity: of children with obesity at school entry, 10% achieved normal weight by age 15 years [10]. In a nationally representative British cohort followed from ages 3 to 11, an obese trajectory was already distinct by age 3 and an overweight trajectory diverged from normal-weight trajectories around age 5 [16]. In rural U.K., less than 2% of 7-year-olds with obesity had normal weight at age 11 years, while among normal-weight children, less than 1% developed obesity [12]. In one nationally representative U.S. study, children with obesity at age 5 years had a 47% probability of obesity at age 14 years [1]. Regional data from longitudinal studies of adults in the United States showed that individuals who had overweight or obesity in childhood or adolescence were more likely to have obesity in adulthood [7,17–20].

Most of the evidence on weight tracking comes from studies from outside the United States or from subnational studies in the United States. This study presents nationally representative data on

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entrenched obesity based on a recent cohort of children in the United States, the Early Childhood Longitudinal Study (ECLS-K). Using multiple direct anthropometric measurements between the ages of 5 and 14 years, we assess the extent to which obesity in early childhood becomes entrenched, the ages of greatest risk, and which children are at highest risk, if ever they do developed obesity, to retain obesity into adolescence. While previous papers have focused on the incidence or prevalence of obesity, the contribution of this article is to describe what happens after an incident case—to understand whether childhood obesity is a temporary or absorbing state, and what characteristics are associated with staying in the obese state.

Material and methods

Data

We analyzed data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998–1999 (ECLS-K), developed by the National Center for Education Statistics (NCES) of the U.S. Department of Education to study children's development and experiences from kindergarten through the eighth grade. The ECLS-K is a nationally representative cohort selected with multistage probability sampling. The primary sampling units (PSUs) were counties or groups of counties, the secondary stage of selection was schools within the sampled PSUs, and the third stage unit was students within schools [21]. The ECLS-K enrolled 21,260 children around the country in Fall 1998 (mean age 5.6 years), with 6600 (all numbers are rounded to the nearest 10, per NCES restricted use data agreement), followed with complete data through study waves in Spring 1999 (mean age 6.1 years), 2000 (mean age 7.1 years), 2002 (mean age 9.1 years), 2004 (mean age 11.1 years), and 2007 (mean age 14.1 years).

The primary source of attrition from the original kindergarten sample resulted from random selection for nonsampling due to survey costs. That is, the attrition bias was minimized because the ECLS-K followed a random subsample of half the movers in each wave before the fifth grade and all the movers between grades 5 and 8 [21]. Appropriate weights for adjusting for attrition and nonresponse were created by ECLS-K staff and we used these for all analyses. Children with missing follow-up data were more likely to be Black and of lower socioeconomic status relative to those with complete data, but no substantial differences have been found between respondents and nonrespondents, and nonresponse bias is addressed by the use of weights [22].

Trained assessors measured height and weight for all participants twice per wave. Height was measured in inches to the nearest 0.25 inch using a Shorr Board and weight was measured in pounds using a digital scale [23]. Primary caregivers were asked about the child's health at birth, including birth weight, during the baseline interview, and invited to add details at subsequent waves. Primary caregivers were asked detailed questions about child characteristics and about household social and economic circumstances and family characteristics at each wave of data collection.

Analysis

The analytic cohort consists of children with complete data over 9 years of follow-up on height and weight, age, sex, and race/ethnicity ($n = 6600$). We used longitudinal weights and survey adjustments constructed by NCES to account for attrition and to make nationally representative inferences.

We use the 2000 CDC Growth Reference to calculate each child's BMI z-score, standardized to the reference population for the child's age and sex [24]. Children were categorized as having normal weight, overweight, or obesity at each data wave using CDC

cut-points of the 85th percentile for overweight and the 95th percentile for obesity. For some analyses, to distinguish between levels of obesity, we followed the commonly used approach of measuring severe obesity as the lower of BMI >120% of the 95th percentile or a BMI >35.

Entrenched obesity was defined as having or developing obesity between kindergarten entry (average age 5.6 years) and third grade (age 9.1 years) and retaining obesity between the fifth grade (average age 11.1 years) and the eighth grade (average age 14.1 years). Thus, entrenchment considers not only the occurrence of obesity in early childhood, but the extent to which it then persists through middle childhood and early adolescence. The age span of 11 to 14 years encompasses a long period during early adolescence which is an important stage of development for body weight [25]. Obesity at these ages is a strong indicator of subsequent obesity and morbidity [26]. Also, as the incidence of new cases of obesity drops to low levels between the fifth and eighth grades [1], it is reasonable to consider this period of childhood as a “steady state” period for identifying entrenched obesity.

We defined three other terms to help identify the nature of the early onset of entrenched obesity. We have two measures of “ever obesity” to indicate whether the child was ever measured at or above the 95th BMI percentile between kindergarten and third grade and between kindergarten and eighth grade. The third is “consistent obesity” indicating prevalent obesity at kindergarten entry or incident obesity any time until third grade and obesity at all waves following the first obese observation within that period.

We examined entrenched obesity from three perspectives. First, we measure the prevalence of and risk factors for entrenched obesity among the total population. Second, we estimate the risk of entrenched obesity among a set of kids who had even fleeting obesity between kindergarten and third grade. Third, we show the risks of entrenched obesity among children with consistent obesity within the first 4 years of elementary school.

We calculated unadjusted and adjusted risk ratios from multivariable logistic regression models. To understand variation in children's risks of entrenched obesity, models were adjusted for child's sex (male, female), family socioeconomic status quintile in kindergarten, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, Other), birthweight (<2500, 2500–3999, 4000+ grams), weight at kindergarten entry (normal weight [z-score <85th percentile], overweight [85th $\geq$ z-score <95th percentiles] obesity [95th $\geq$ z-score <99th percentiles] and severely obesity [the lower of BMI >120% of the 95th percentile or a BMI >35]) and BMI change during kindergarten, modeled as a continuous variable and reported as specific contrasts (e.g., –0.5, –0.25, 0.25, 0.5 relative to 0). Effect estimates for children with changes in BMI of –0.5 and +0.5 represent approximately the 25th and 75th percentile of change among all children. Z-scores are most appropriate for assessing children's weight at 1 point in time, while BMI change is a better measure for assessing change in an individual child because the variability of z-scores is lower for the heaviest children [27]; results were consistent in alternative models using change in BMI z-score instead.

Analyses were conducted using SUDAAN 10.1 (Research Triangle Park, NC). The Institutional Review Board of Emory University reviewed this data analysis project before its commencement and determined it to be exempt.

Results

Timing and entrenchment of childhood obesity

Table 1 shows the timing and persistence of obesity between ages 5 and 14 years. Nearly three-fourths (70.3%, 95% confidence

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