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Child physical development in the UK: the imprint of time and socioeconomic status

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ABSTRACT

Objectives: Social health inequalities remain a key policy challenge. The existing literature has not presented a synthetic view on the evolution of inequalities in physical development across childhood. We examine social disparities as children grow older using a range of different outcomes.

Study design: Population-based secondary data analysis.

Methods: We employ longitudinal data on British children aged 9 months to 12 years from the Millennium Cohort Study (n = 13,811–18,987) and focus on multiple child physical measures: weight, body mass index (BMI), overweight, fat mass and waist circumference.

Results: Higher family income is associated with lower BMI (for females), less body fat and a smaller likelihood of overweight (for both genders) on average throughout childhood. When income is multiplied by 3, the probability of overweight decreases by 2.8 (95% CI −0.041 to −0.016) percentage points for females and by 2.7 (95% CI −0.038 to −0.016) percentage points for males. Social inequalities in weight, BMI, overweight and body fat significantly widen as children grow older, for both genders. For instance, for females, when income is multiplied by 3, the probability of overweight decreases by 1.6 (95% CI −0.032 to −0.000) percentage points at ages 2–3 years, but by 8.6 (95% CI −0.112 to −0.060) percentage points at ages 10–12 years.

Conclusions: The trajectory of social inequalities, which may reflect the cumulative effect of family socioeconomic status, is a precursor of inequalities in adulthood.

Introduction

Family socioeconomic status (SES) is associated with an increased risk of overweight and obesity in childhood.[1–6] But little is known about the emergence and evolution of inequalities in physical outcomes as children grow older. Because physical measures develop over long periods, we may expect that the effect of SES be cumulative, which would mean that association between SES and development would strengthen with age. However, it is possible that inequalities remain stable or even decrease during childhood, for instance if the effect of peers at school, youth culture and social norms cut across the influence of the family.[7,8] Knowing the ages at which the slope of gradient changes is important because it suggests an optimal age at which policies tackling inequalities should be implemented. The current analysis contributes to this line of research by examining the evolution of the

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gradient in child physical development across childhood in the UK.

Evidence on the shape of the development gradient is limited and results are inconsistent. In British cohort data (from the Avon Longitudinal Study of Parents and Children—ALSPAC) that follows children from birth to age 15 years, the maternal education gradient in total fat mass remains flat across childhood, whereas the gradient in height increases with age, for both females and males.[9] Using French cross-sectional and longitudinal data for children aged 0–17 years, a recent article finds that the trajectory of the family SES (parents' education, household income) gradient in body mass index (BMI) and overweight follows an inverted U-shape: inequalities increase from birth to age 8 years, and decrease between 8 and 17 years.[10] Results for the US seem somewhat contradictory. Indeed, employing cross-sectional data on children aged 2–19 years, a study finds that the association between income (measured by the poverty-to-income ratio) and obesity is stable with age,[11] whereas using longitudinal data on children aged 6 to 14 years, another article suggests that the impact of (the log of) income on BMI decreases with age.[12] Finally, in a US cohort of individuals transitioning from early to middle adulthood, the maternal education gradient in offspring BMI and obesity widens with age for both females and males.[13]

The trajectory of the physical development gradient across childhood thus remains unclear. Differences between study findings may be explained by differences in countries (social norms and healthcare systems in particular) and child age ranges, but also by differences in methods. Indeed, some studies do not disentangle the cohort effect (i.e. the effect related to the year of birth) from the age effect, so that the estimated 'age effect' is obscured by cohort effects. In addition, these studies do not use the same development outcomes and SES variables, which could also explain why they reach different conclusions. On a related matter, most articles do not take a unified approach on the shape of the development gradient, since they employ a limited number of physical development outcomes and SES variables.

Our goal here is to provide a general view of the evolution of socioeconomic differences in physical development with age in the UK. We rely on cohort data that follows the lives of children born in 2000–2002. For this reason, the age effects we capture are not obscured by cohort effects. We focus on a number of physical measures, more precisely the gender- and age-adjusted weight, BMI, overweight, fat mass and waist circumference. We employ several SES variables, namely family income in the main analysis, and maternal and paternal education in the sensitivity analysis.

Methods

Data

The Millennium Cohort Study (MCS) is a research project following a sample of around 19,000 children born in the early 2000s in the UK.[14] Births happened over 12 months from 1 September 2000 in England and Wales and from 1 December 2000 in Scotland and Northern Ireland. The data are representative of all four UK countries. There have been five waves of the study so far, at 0–1 year, 2–3 years, 4–5 years, 6–8 years and 10–12 years. We use all available waves, and the analysis sample contains children who have data at, at least, one point in time. The impact of attrition on the findings is discussed below.

Child physical development measures

The MCS contains information on the following physical development variables: weight, height, body fat mass and waist circumference. Body fat mass is a measure of overall fat, whereas waist circumference, of central fat in the body. The measures are taken by trained interviewers. Weight and percentage fat mass are measured using the Tanita HD-305 or BF–522W scales, height using a Leicester stadiometer, and waist circumference using a SECA tape calibrated in millimetres. Weight is measured at each wave, but the other outcomes are not: body fat is measured in waves 4 and 5, and waist circumference in waves 3 and 4. BMI is calculated using the height and weight measures and is available in waves 2 to 5.

Using these pieces of information as well as child gender and age in months, we derive the gender- and age-adjusted weight-, BMI-, body fat-, and waist-for-age z-scores, employing the 'zanthro' Stata function with the British 1990 growth chart.[15] This enables us to obtain comparable values across sexes and ages. We complement these variables with a dichotomic variable for whether the child is overweight (including obese). This dummy is created using the 'zbmicat' Stata function, which employs the BMI cutoffs recommended by the Childhood Obesity Working Group of the International Obesity Taskforce.

Socioeconomic status

Our main SES measure is weekly family income. Income is adjusted for household size and composition using the modified Organisation for Economic Cooperation and Development equivalence scale.[a] Income is also adjusted for inflation using the consumer price index available from the Office for National Statistics.[b] We use the logarithm of income to account for non-linearities. Our conclusions are robust to sensitivity analysis for different SES variables (maternal of paternal education).

Statistical methods

We estimate several regression models to examine the average slope of the gradient during childhood, the gradient at each age, and the evolution of the gradient across childhood. First, to quantify the mean level of inequalities during childhood, we regress physical development outcomes on SES (the logarithm of income) and control variables. The model is adjusted for the following variables: a series of dummies for child age (in months),[c] dummies for whether the child is from a multiple birth (twins and triplets), the mother's age, a dummy for the

[a] The scale weights the first adult as 0.67, the second adult and each child over 14 as 0.33, and each child under 14 as 0.20.

[b] 2015 is our reference year. See http://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/d7bt.

[c] Given that the evolution of physical outcomes is non-linear across childhood, using age dummies is more appropriate than entering age as a continuous measure.