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Heterogeneity in predictive power of early childhood nutritional indicators for mid-childhood outcomes: Evidence from Vietnam

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ABSTRACT

We utilize longitudinal data on nearly 1800 children in Vietnam to study the predictive power of alternative measures of early childhood undernutrition for outcomes at age eight years: weight-for-age (WAZ8), height-for-age (HAZ8), and education (reading, math and receptive vocabulary). We apply two-stage procedures to derive unpredicted weight gain and height growth in the first year of life. Our estimates show that a standard deviation (SD) increase in birth weight is associated with an increase of 0.14 (standard error [SE]: 0.03) in WAZ8 and 0.12 (SE: 0.02) in HAZ8. These are significantly lower than the corresponding figures for a SD increase in unpredicted weight gain: 0.51 (SE: 0.02) and 0.33 (SE: 0.02).

The heterogeneity of the predictive power of early childhood nutrition indicators for mid-childhood outcomes reflects both life-cycle considerations (prenatal versus postnatal) and the choice of anthropometric measure (height versus weight). Even though all the nutritional indicators that involve postnatal nutritional status are important predictors for all the mid-childhood outcomes, there are some important differences between the indicators on weight and height. The magnitude of associations with the outcomes is one aspect of the heterogeneity. More importantly there is a component of height-for-age z-score (at age 12 months) that adds predictive power for all the mid-childhood outcomes beyond that of birth weight and weight gain in the first year of life.

1. Introduction

Studies on the importance of early-life anthropometry for later human capital development recently have become prominent. Behrman and Rosenzweig (2004), Black et al. (2007), Victora et al. (2008), Rosenzweig and Zhang (2013), and Figlio et al. (2014) find birth weight to have significant associations with long-run adult health, education and earnings. Gupta et al. (2011) and Krishna et al. (2016) are the most relevant previous studies for the birth weight-related contents in our study.[1] Gupta et al. (2011) use data from the Danish Longitudinal Survey of Children (DALSC), which followed children born in 1995 with surveys in 1996, 1999, 2003 and 2007. For mid-childhood outcomes, their findings imply that the associations of low birth weight (2.5 kg or lower) with weight and height are statistically significant, but not the associations with behavioral outcomes. The data used in Krishna et al. (2016) are from Young Lives, which is described in the next section. They find that prenatal conditions, reflected in birth weight, are more strongly associated with height trajectories than postnatal factors; they do not consider weight and educational outcomes.

A number of child health and nutrition researchers have focused on the concept of a critical window for investing in early childhood nutrition during the first 1000 days after conception (Martorell et al., 1994; Victora et al., 2008, 2010; Prentice et al., 2013; Lundeen et al., 2014). Stunting at age 2–3 years, which is indicated by deficits of two standard deviations or more below the median height-for-age for a well-nourished reference population, has become an important policy concern (Engle et al., 2007, 2011;

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[1] Both papers present Ordinary Least Squares associations.

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Grantham-McGregor et al., 2007; UNICEF, 2013; Richter et al., 2016).

Inadequate prenatal nutrition results in low birth weight and inadequate postnatal nutrition results in low weight and height gains in early childhood. There have been few studies that focus on the impacts of infant weight gain and height growth. Even fewer studies investigate the relative importance for predicting later development of weight gain versus height growth. Huang et al. (2013) reviews the limited literature on the predictive power of infant weight gain and height growth and reports substantial variety in the findings. Li et al. (2004) find that height growth during the postnatal period (birth to age 2 years) is the only variable predictive of Guatemalan women's educational achievement and weight gain is not statistically significant. Corbett et al. (2007) find in UK data that “postnatal weight gain in the first 2 years of life is at most weakly related to cognitive and education attainment at age 10. In contrast, birth weight is clearly associated with cognitive and educational attainment at age 10 . . . ” (2007: 62). There is, however, an issue that may affect Corbett et al's results: factors such as birth order, maternal education and family environment are not included in their analysis. More recently, Huang et al. (2013) evaluated the relative associations of birth weight and postnatal growth (weight gain, height growth, or head circumference growth) with cognition and behavioral development in over 8000 Chinese children. They find that, for full-term children, both birth weight and postnatal growth are associated with child's IQ at age 4–7 years, but the sizes of the associations are small.

While Huang et al. (2013) used up to seven years for their postnatal period, we consider the postnatal period of the first year, which is within the usually-emphasized critical window. We study the nexus of the early childhood undernutrition with anthropometric and educational outcomes in mid childhood. There are many studies that use height-for-age z-scores to predict longer-run outcomes and many that use birth weight (e.g., Crookston et al., 2013; Victora et al., 2008). While height-for-age is often interpreted to measure the nutritional status over the whole period from conception to measurement, weight-for-age is expected to have an advantage in capturing the effect of recent health shocks before the survey, such as diarrhea in the few months before the survey. In the same vein, weight gain after birth might be relevant in addition to birth weight and weight-for-age. The timing of the impact is important because of the debate on the “critical period” during which brain development is most sensitive to poor nutrition. Dobbing (1976), for example, argues that the period from birth to six months is the most critical. For other authors, such as Doyle et al. (2009), the prenatal period is more important.

To separate the pre- versus postnatal influences of nutrition status, we apply two-stage procedures in which we derive indicators of unpredicted nutritional changes. We define the unpredicted weight gain (height growth) in the first year of life as the component of weight-for-age (height-for-age) z-score at age 12 months that is unpredicted based on what is known at birth, including birth weight. Further, we define the *conditionally* unpredicted height-for-age as the component of the unpredicted height growth that is uncorrelated with weight-for-age at age one year. The conditionally unpredicted height-for-age is useful for comparison of predictive powers of the indicators on height growth versus that of weight gain in the first year of life.

The sample of children we work with in this study differs from those in the aforementioned studies on birth weight in a number of dimensions. Our data contain no twins, so the distribution of birth weight differs from that in the papers that use data on twins since the distribution of birth weights for twins is to the left of the distribution of birth weights for singletons.[2] In part because our data do not have twins, less than five percent of children in our sample have birth weight under 2.5 kg (the standard cutoff for low birth weight), even though we use a semi-purposeful pro-poor sample from Vietnam. Also the age patterns of undernourishment are very different than reported for other contexts in previous studies. In the first decade of the 21st century, for Vietnamese under-5 years old moderate and severe stunting rates were as high as those for West and Central Africa, while the Vietnamese percentage of low birth weights was the same as for high-income countries (UNICEF, 2009).

We examine different combinations of variables for birth weight, weight-for-age, height-for-age, unpredicted weight gain (height growth) and conditionally unpredicted weight-for-age (height-for-age), together with a set of controls, to estimate their associations with mid-childhood outcomes. We find that a standard deviation higher unpredicted weight gain (height growth) in the first year of life generally is more associated with positive outcomes in mid-childhood than are the adverse outcomes associated with a standard deviation lower birth weight. This suggests that for most of the children, the adverse outcomes related to being born low weight may be partially or totally avoided by weight gain (height growth) in the first postnatal year. In addition to the question of prenatal versus postnatal timing, we also investigate another aspect of heterogeneity of the relationships of the early childhood nutrition indicators and mid-childhood outcomes: the difference between height and weight. We find that height-for-age z-score at age one year contains a component that adds explanatory power for the variation of all the mid-childhood outcomes, beyond that of birth weight and weight gain in the first year of life.

2. Methods

2.1. Young lives data for Vietnam

The sample is part of Young Lives, which is an international comparative study of child poverty. Since 2002, Young Lives has been following ~12,000 children in Ethiopia, India, Peru and Vietnam. The Young Lives sample consists of two cohorts: ~8000 children born in 2001–2 and ~4000 children born in 1994–5. The Vietnamese Younger Cohort sample, which we use in this study, consists of 20 commune-based clusters in Northern Uplands, Red River Delta, Central Coast, and Mekong Delta. The subsamples for each of these regions contain four rural clusters, except that for the Central Coast, which consists of four urban clusters in the city of Da Nang and four rural ones in the province of Phu Yen. The children in this study were on average 11.6 months old in Round 1, with the youngest being 5 months old and the oldest being 18 months old. Consistent with the design of the Young Lives study, we limit consideration to children in the age range from 6 to 17.9 months and therefore exclude 21 observations.[3] Furthermore, following the same method as in Lundeen et al. (2014) and Schott et al. (2013), we

[2] Behrman and Rosenzweig (2004) and Rosenzweig and Zhang (2013) primarily use twins and present birth weight distributions for twins that are significantly to the left of those for singletons in the same populations. Most of the other studies mentioned above use both singletons and twins in proportions roughly representative of the populations studied.

[3] There were 8 children older than 17.9 months and 13 children under 6 months in Round 1.