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Childhood obesity among the poor in Peru: Are there implications for cognitive outcomes?

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ABSTRACT

This paper exploits three rounds of panel data provided by the Peruvian dataset of the Young Lives study to investigate the relationship between child cognition and obesity status among the poor. Child weight status is measured by a full distribution of child weight, from severely thin to obese, using data from a z-score for body mass index and cognition is measured by the Spanish version of the Picture Peabody Vocabulary Test (PPVT). This relationship is studied at age five and age eight (school age), and disaggregated across socioeconomic factors of gender, urban/rural setting and indigenous/nonindigenous status. The initial results suggests that *obese* children have higher cognitive scores and that this result is driven by those who are female, non-indigenous and live in an urban region. However, after correcting for possible bias due to unobservable heterogeneity, there is little evidence of this relationship. The one exception is for a weakly significant relationship between *obese* female children and higher cognition, a relationship which tends to weaken between the ages of five and eight. On the other end of the weight distribution, indigenous children who are *severely thin* or *thin* have significantly lower cognitive scores, a relationship that holds after correcting for possible bias and appears to strengthen between ages of five and eight. This paper contributes to a very small set of literature on child cognition and obesity, points to the importance of controlling for unobserved heterogeneity in estimation, and is the first of its kind to study this relationship in a developing country.

1. Introduction

Globally, the prevalence of child malnutrition is transitioning from a declining state of high prevalence of stunting to increasing prevalence of overweight children.[1] According to the World Health Organization (WHO), between 1990 and 2014 stunting prevalence declined by 96 million children to 24%, while the prevalence of overweight children grew by about 10 million children to 6% (WHO, 2014). Further, by 2013 there were over 42 million children under the age of five who were overweight and roughly 31 million of them live in developing countries. By the year 2025, the WHO (2014) estimates that the prevalence of overweight children under age 5 will rise to 11% worldwide.

Peru is no exception to the growing problem of childhood obesity. Recent data from the Peruvian dataset of Young Lives (YL) study indicate that 11% of children were overweight/obese by age one, and 28% were overweight/obese by age eight (9% were obese). Young Lives is an international study on childhood poverty following 12,000 children in four countries (Ethiopia, India, Peru and Vietnam) over 15 years. In Peru, Young Lives followed a child who was about one years old in Round 1 (2002), about five years old in Round 2 (2006) and about eight years old in Round 3 (2009).[2]

The growth of childhood obesity among the poor raises questions about implications for learning. For example, it is well known that early childhood malnutrition (measured by stunting between ages 0–3) is linked to poor cognitive development and academic achievement (Alderman et al., 2006; Glewwe and King,

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[1] *Stunting* refers to a child who is too short for his/her age and reflects chronic, long run malnutrition (WHO, 2014). Stunting is measured by the child's height-for-age z-score. Z-scores express the anthropometric value as a number of standard deviations (SD) below or above the mean of a reference population All z-scores were calculated by Young Lives using the World Health Organization growth standard (WHO, 2014). A child is considered stunted if their height-for-age z-score is <-2SD. *Overweight* refers to a child who so too heavy for his/her height and results from expending too few calories for the amount consumed. The WHO defines overweight for a child between the ages of 0–5 as a weight-for-height z-score > 2SD. For children over the age of five, *overweight* is a Body Mass Index, BMI-for-age z-score $\geq$ 1SD and *obese* is a BMI-for-age z-score $\geq$ 2SD.

[2] This cohort of children in the Peru Young Lives study was known as the young cohort. Young Lives also followed an older cohort who was about age 7–8 in Round 1.

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2001; Grantham-McGregor et al., 2007; Glewwe and Miguel, 2008; Barham et al., 2013). In this paper, a similar question is raised: What is the relationship between childhood malnutrition, measured by obesity, and cognition? More generally, this paper studies the relationship between cognition and the full weight distribution from severely thin to obese.

Unfortunately little is known about the relationship between child obesity and cognition.[3] Nyaradi et al. (2013) provides the only literature review on the relationships between child obesity and cognition (as opposed to academic achievement); it is from the public health literature and includes only three studies, all from the U.S. and Canada. Li et al. (2008) finds that obesity among 8–16 year old American children is associated with decreased cognitive functioning, even after controlling for parental socioeconomic status. However, neither Palermo and Dowd (2012) who study children age 5–19 in the U.S., nor Bisset et al. (2012) who study children age 4–7 in Canada find an association between obesity and cognition. Nyaradi et al. (2013) concludes that the findings are inconclusive because of the complex socioeconomic factors underlying these outcomes.

Indeed, two recent studies using the Peruvian YL dataset note distinct cognitive differences across different socioeconomic groups. In particular, both urban and nonindigenous (Spanish speaking) children have higher cognitive test scores than rural and indigenous children.[4] To explain indigenous/nonindigenous differences in cognition, Arteaga and Glewwe (2014) apply a decomposition method and find that by age five (Round 2) almost all cognitive differences between indigenous and nonindigenous children were due to the communities they live in, as opposed to child or household characteristics. However, by age eight (Round 3), household characteristics played the major role. Castro and Rolleston (2015) use the same data to measure the contribution of school and early childhood influences on the urban/rural differences in cognitive development observed in Round 3. Their results suggest that 35–40% of the gap in cognitive skills between urban and rural children is related to differences in school inputs and a roughly equal percent is related to differences in the learning and care environment a child experiences through age five, including the prevalence of child stunting.

Given the scant evidence from the literature on the relationship between child obesity and cognition, this paper has three goals: one, to be the first (to this author's knowledge) to examine in a developing country context the linkage between cognition and a full distribution of child weight, from severely thin to obese; two, to study this relationship before and at school age when the child is about age five and eight; and three, to understand what socioeconomic factors including child gender, urban/rural setting and indigenous/nonindigenous status may influence any results.

To accomplish these goals, this paper exploits three rounds of panel data provided by the Peruvian dataset of the Young Lives study. The child's weight status is measured in Rounds 2 (age five) and 3 (age eight) using a z-score for body mass index (bmi) for the child's age (bmi-for-age z-score) and cognition is measured by the Picture Peabody Vocabulary Test (PPVT).

The initial results suggests that *obese* children have significantly higher cognitive scores and that this result is driven by those who are female, non-indigenous and live in an urban region. However after correcting for possible bias due to unobservable heterogeneity, there is little evidence of this relationship. The one exception is for a weakly significant relationship between *obese* female children and higher cognition, a relationship which tends to weaken between the ages of five and eight. On the other end of the weight distribution, initial results suggest that rural and indigenous children who are *severely thin* or *thin* have significantly lower cognitive scores, even after controlling for stunting. In these cases of low weight, the significant relationship still holds after correcting for possible bias due to unobserved heterogeneity. Further this relationship tends to strengthen between the ages of five and eight.

The rest of this paper is organized as follows: Section 2 provides an estimation strategy, Section 3 describes the data, Section 4 presents the results, and the conclusions are in Section 5.

2. Estimation strategy

2.1. Framework

To appreciate the construction of the estimated model, consider a three period framework where each period corresponds to a survey round in the YL dataset. Period 1 represents the child from birth through about age one (Round 1). Period 2 represents the child after age one and through about age five, before formal schooling (Round 2). In period 3, the child has reached school age of about eight years (Round 3). The following represents a standard production function of cognitive skills produced in period 3, as a function of inputs provided in periods 1–3:

$$A_{i3} = A_3(S_{i3}, Q_{i3}, C_{it}, H_{it}, I_{it}, N_{it}, \mu_i), \quad t = 1, 2, 3 \tag{1}$$

This simple production function illustrates the relationship between cognitive skills (A_{i3}) for child *i* in period 3 as a function of the following inputs: years of schooling (S_{i3}), the quality and quantity of inputs provided by the school (Q_{i3}), child characteristics (C_{it}), household characteristics (H_{it}), educational inputs chosen by the parent (I_{it}), child health status (N_{it}) and the child's innate ability, which is time invariant (μ_i). Eq. (1) is a structural equation between cognitive skills and the inputs that have a direct effect on these skills.

The input of interest is the vector of variables in child health status (N_{it}). Of these, our key variable is child weight measured by the child's bmi-for-age z-score and a set of dummy variables to indicate this z-score status using WHO cutoffs (e.g. *overweight* 1SD > z-score ≥ 2SD and *obese* > 2SD).[5] A similar model can be written for period 2 to study the production of cognitive skills by age 5. Doing so eliminates S_{i3} and Q_{i3}, as the child has not yet reached school age in period 2.

[3] In contrast, there are relatively more studies on the impact of child obesity and educational outcomes or school achievement (as opposed to cognition). Taras and Potts-Datema (2005) reviewed nine studies and find a negative, but inconsistent, association between obesity and academic achievement. Kaestner and Grossman (2009) find only three based studies (Datar and Sturm, 2006; Averett and Stifel, 2007; Edwards and Grossman, 1979), all of which suggests that obesity has an adverse effect on educational achievement. In their own study using data from the US National Longitudinal Survey of youth (1997 children cohort), Kaestner and Grossman (2009) find that children age 5–12 who are overweight or obese have achievement test scores that are about the same of children with average weight. Also Gurley-Calvez and Higginbotham (2010) find that obesity among American 5th grade students is negatively associated with reading test scores, but only in high poverty school districts. However, these limited findings are difficult to interpret because, as pointed out by Sigfusdottir et al. (2007) school performance is confounded by school attendance, mental health and depression that are also often associated with child weight.

[4] In the Peru YL data, indigenous and nonindigenous is defined by language used at home; nonindigenous people speak Spanish, as opposed to other languages (Quechua, Aymara, Ashaninka and other indigenous languages).

[5] Also included is a long run indicator of child health and nutrition, height-for-age z-score. Also, while it is well know that ages 0–36 months is a critical period for stunting (low height-for-age z-score) to impact child cognitive development, there is not yet any research guidance for a critical period for the impact of overweight/obesity to impact cognition.