Economics and Human Biology 15 (2014) 67–80

Contents lists available at ScienceDirect

Economics and Human Biology

journal homepage: http://www.elsevier.com/locate/ehb

Early-life environment and adult stature in Brazil: An analysis for cohorts born between 1950 and 1980☆

Victor Hugo de Oliveira [a], Climent Quintana-Domeque [b,*]

[a] IPECE, Brazil
[b] University of Oxford, United Kingdom

ARTICLE INFO

Article history:
Received 1 March 2014
Received in revised form 6 July 2014
Accepted 7 July 2014
Available online 22 July 2014

JEL Classification Codes:
I12
O54

Keywords:
Infant mortality
Income
Measured adult height
Fixed effects estimator
Lagged dependent variable estimator

ABSTRACT

We study the relationship between environmental conditions at birth (GDP per capita and infant mortality rate) and adult stature using cohort-state level data in Brazil for the period 1950–1980. We find that GDP per capita, whose annual percentage growth rate was 4.8% during this period, not infant mortality rate, is a robust correlate of population stature in Brazil. Our results are robust to a battery of robustness checks. Using a useful bracketing property of the (state) fixed effects and lagged dependent variables (heights) estimators, we find that an increase in GDP per capita of the magnitude corresponding to that period is associated with 43–68% of the increase in adult height occurring in the same time span. Income, not disease, appears to be the main correlate of Brazilian population heights in the second half of the 20th Century.

1. Introduction

Over the past three centuries humans in the developed world have become taller and live longer than ever before (Floud et al., 2011). The relationship between adult stature and life expectancy has been established in numerous studies (Batty et al., 2009; Jousilahti et al., 2000; Kock, 2011; Leon et al., 1995; Waaler, 1984), along with the link between environmental conditions in the year of birth for a given population, as measured by its disease environment and/or available resources, and its adult stature (Bozzoli et al., 2009; Peracchi and Arcaleni, 2011). Height is a marker of health and nutrition during the critical periods of growth in early life (particularly from conception to age 3), and taller individuals exhibit superior outcomes in a wide range of measures, from happiness or life satisfaction to wages or productivity (Case and Paxson, 2008; Deaton and

☆ We thank Pedro Albarran, Carlos Bozzoli, Lola Collado, Jaume Garcia, John Komlos, Asier Mariscal, Catia Nicodemo, Sonia Oreffice, Vladimir Ponczek, Francesco Serti and four anonymous referees for helpful comments and suggestions. Oliveira acknowledges financial support from the Instituto de Pesquisa e Estratégia Econômica do Ceará (IPECE). Quintana-Domeque acknowledges financial support from the Spanish Ministry of Science and Innovation (ECO 2008-05721 and ECO 2011-29751). This is a substantially revised version of a previous paper, "Infant disease, economic conditions at birth and adult stature in Brazil", that circulated as a working paper (FEDEA DT 2009-33 and IPECE Texto para Discussão n.75 November/2009). Any errors contained in the paper are our own.

* Corresponding author at: University of Oxford, Department of Economics, Manor Road Building, Manor Road, Oxford OX1 3UQ, United Kingdom. Tel.: +44 (0)1865 281452
E-mail address: climent.quintana-domeque@economics.ox.ac.uk (C. Quintana-Domeque).

http://dx.doi.org/10.1016/j.ehb.2014.07.001
1570-677X/

Arora, 2009; Lundborg et al., 2014; Schultz, 2003). Not surprisingly, understanding the determinants of the changes in body size represents a key part of a comprehensive theory of development, and is of interest to a wide spectrum of researchers, from human biologists and historians to demographers and economists.

Leaving the role of genes aside, individual stature is a function of net nutrition, which depends on gross nutrition minus the demands exerted on it, mainly through disease, but also through physical exercise. At the population level, however, the role of genes appears to be less important than that of environmental conditions in determining stature (Silventoinen, 2003). For this reason, studies have focused on gross nutrition (typically proxied by GDP per capita) and disease burden (usually proxied by infant mortality or postneonatal mortality rates).[1] Bozzoli et al. (2009) unveiled evidence that across a range of European countries and the United States there is a strong inverse relationship between post-neonatal (defined as the period from one month to one year of age) mortality and the mean adult height of those infants in the same birth cohort who survived into adulthood.[2]

A very intriguing finding is that disease, not income, has been the constraining factor on human growth in developed countries at least after 1950 (Bozzoli et al., 2009; Quintana-Domeque et al., 2011). As pointed out by Bozzoli et al. (2009), and recently emphasized by Coffey (2013), this does not rule out the possibility that income (or nutrition related) constraints were important before 1950 or even nowadays in the more developing world. Indeed, this possibility echoes the work by Komlos (1998), who argues that the decline of average stature in Europe and North America during historical periods of economic growth[3] was associated primarily with economic processes and structural changes (e.g., increase in income inequality, increase in relative price of nutrients) than a deterioration of the disease environment. It is also entirely consistent with Fogel's research on the links between income and height. In this paper, we explore the relationship between early-life environment, as measured by income and infant mortality in the year of birth, and the stature of the population in Brazil, a large developing country.[4]

In Brazil, researchers have used data from the Pesquisa de Orçamentos Familiares (POF) to document positive correlations between stature and education, and stature and wages (Curi and Menezes-Filho, 2009), but also to investigate the determinants of individual height. Monasterio et al. (2010) show the average state GDP per capita of each individual up to 15 years old is one of the main correlates of individual adult stature, controlling for per capita family income, years of education, demographic characteristics, and income distribution. While their results indicate a positive (concave) relationship between adult stature and the mean GDP during 0–15 years after birth, they do not account for the burden of disease in the year of birth, a potential determinant of adult height which is correlated with GDP. Neglecting the (potential) influence of disease exposure during childhood on adult stature can be problematic, not only because of previous research documenting the effects of infant mortality rate (IMR) in the year of birth on adult height, but also given the findings in Alves and Belluzzo (2004) that a rise in education, sanitation and per capita income contributed to the decline of infant mortality in Brazil during the period 1970–2000, and the sizeable correlation coefficients between average adult stature and environmental measures (IMR and per capita GDP) in the year of birth across Brazilian states.[5]

In this paper we put forward an answer to the question "What are the forces behind the Brazilian human growth in the second half of the 20th Century?" focusing on the role of both income and disease (and its potential interactions) in explaining population heights. Collapsing height data from the POF at the state and year-of-birth level and combining it to data on GDP, IMR and other socioeconomic indicators at the state-year level, we find that income, not disease, is a robust correlate of population stature in Brazil during the period 1950–1980. Using a useful bracketing property of the (state) fixed effects and lagged dependent variables (heights) estimators (Guryan, 2001; Angrist and Pischke, 2009), we find that an increase in GDP per capita of the magnitude corresponding to that period is associated with 43–68% of the increase in adult height occurring in the same time span. Finally, we also show that per capita income five years before birth is *not* associated with adult height, whereas per capita income during the first five years of life is an important correlate of it.

The paper is organized as follows. Section 2 describes the data sources. Section 3 summarizes the evolution of height, GDP and IMR in Brazil during the period 1950–1980. Section 4 contains the main regression results. Section 5 provides several robustness checks. Section 6 concludes.

2. Data sources

Height data come from the Brazilian Household Budget Survey 2002–2003 (Pesquisa de Orçamentos Familiares - POF) of the Brazilian Institute of Geography and Statistics

[1] Infant mortality rate is measured as the number of infants who die in their first year of life per 1000 live births. Post-neonatal mortality rate is measured as the number of infants who die between their first month and their first year of life per 1000 live births.

[2] More recently, Quintana-Domeque et al. (2011) find that, in Spain, a reduction in the infant mortality rate of 30 individuals per 1000 is associated with an increase in average height of about 2.7 cm, about 70% of the gain in average adult stature during the period 1961–1980. In Italy, Peracchi and Arcaleni (2011) find that economic conditions appear to matter more than disease burden for height for cohorts of men born between 1973 and 1978.

[3] Second half of the eighteen century in Europe and the 1930s and the 1940s in both Europe and North America.

[4] Clearly, there is a large practical and epistemological gap between the core intentions of our analysis and the data employed (in particular with regards to proxying gross nutrition by GDP per capita). The reader must be aware of the very general character of the correlations presented in this paper.

[5] The correlation between IMR and adult height is −0.65 ($p-$value = 0.0000), between log of real per capita GDP and height is 0.79 ($p-$value = 0.0000), and between IMR and log of real per capita GDP is −0.77 ($p-$value = 0.0000). These pair-wise correlations conform to the existing empirical evidence coming from other studies, in terms of both signs and magnitudes. Section 2 provides the data sources.