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Inferring the economic standard of living and health from cohort height: Evidence from modern populations in developing countries

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ABSTRACT

Average adult height is a physical measure of the biological standard of living of a population. While the biological and economic standards of living of a population are very different concepts, they are linked and may empirically move together. If this is so, then cohort heights can also be used to make inferences about the economic standard of living and health of a population when other data are not available. We investigate how informative this approach is in terms of inferring income, nutrition, and mortality using data on heights from developing countries over the last 50 years for female cohorts born 1951–1992. We find no evidence that the absolute differences in adult height across countries are associated with different economic living standards. Within countries, however, faster increases in adult cohort height over time are associated with more rapid growth of GDP per capita, life expectancy, and nutritional intake. Using our instrumental variable approach, each centimeter gain in height is associated with a 6% increase in income per capita, a reduction in infant mortality of 7 per thousand (or an 1.25 year increase in life expectancy), and an increase in nutrition of 64 calories and 2 grams of protein per person per day relative to the global trend. We find that increases in cohort height can predict increases in income even for countries not used in the estimation of the relationship. This suggests our approach has predictive power out of sample for countries where we lack income and health data.

1. Introduction

In addition to genetic heritage, individual adult height depends on physical growth during childhood and adolescence, which in turn depends on childhood nutrition, energy use, and experience of disease. Evidence on the genetic component of height come from twin studies and Genome-Wide Association meta-analysis (Jelenkovic et al., 2011; Lango Allen et al., 2010; Soranzo et al., 2009). Studies have estimated the effects of early childhood environmental conditions, such as income, nutrition, and disease on adult heights (Steckel, 1986, 1995, 2008; Fogel, 1994; Alderman et al., 2006; Akachi and Canning, 2007). The sensitivity of adult height to childhood living conditions has led to the use of height as a measure of the "biological standard of living" in economic history when studying populations for which more conventional measures of living standards are absent (Komlos and Baten, 2004). Data on adult heights are sometimes available from historical sources for populations for which height was measured

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and recorded, and height can also be estimated from skeletal remains (Steckel et al., 2002).

In addition, heights can be used to compare living standards between modern populations in different countries such as those between the two Koreas and two Germanys (Pak, 2004; Komlos and Kriwy, 2003; Komlos, 2001) or within countries over time (Steckel and Floud, 1997; Komlos, 1993; Lopez-Alonso and Condey, 2003) and to study inequality and the relative living standards of subgroups within countries (Moradi and Baten, 2005; Deaton, 2008; Margo and Steckel, 1982). Pak (2004) for example, shows that while both South Korea and North Korea had similar adult height for cohorts born in 1940, the adult height in North Korea has stagnated while that of South Korea has increased by 6 cm since then. Steckel (2013) provides a recent survey of the field. This approach uses adult height as an independent indicator of the standard of living that is thought to be correlated with, but different from, income per capita and other measures of living standards.

Nevertheless, if adult height and other measures of the standard of living are correlated, we can potentially make inferences about income per capita, nutrition, and disease burdens in populations from observations of adult height alone when direct evidence on these variables is not available. Baten and Blum (2012) estimate a relationship explaining income per capita with adult height data for decade averages in a large panel of countries over more than a century, finding a positive relationship. This suggests that tall adults are associated with a higher level of income per capita. Their approach takes income per capita as the dependent variable, and adult height as the independent variable, in a regression analysis which reverses the usual approach and assumed direction of causality.

Can we use variations in height to draw inferences about changes in health, nutrition, and income levels? Komlos (1993, 2001) has stressed that height is a proxy for the "biological standard of living," and is different from measures of the economic standard of living; while it is different it may still provide valuable information on economic living standards when other data is not available. The contribution of this paper is that by focusing on the second half of the 20th century, we enable comparisons of adult height to measures of the economic standard of living and health such as income, nutrition, infant mortality rate, and life expectancy for developing countries and therefore study how well we can infer these indicators from height data alone. Reliable sources of data only became available for the last several decades in the panel data format, and we provide evidence that average cohort height can be used to infer income and other indicators of interest when direct evidence on economic living standards and health are missing.

2. Data

The data sources for our cohort height variable are Demographic and Health Surveys (DHS). For each country, we use the latest available DHS. The typical DHS dataset measures the height of women from age 15 to 49. Not every DHS dataset includes height of all women as some have no data on heights while others only have height of mothers (women who have given birth in the last five years). Including surveys with only mothers would create a sample selection problem; for example, if height is positively linked, while fertility is negatively linked, to socioeconomic status, mothers will be shorter than average. We do not use data from surveys where only mothers' height is measured. It could be argued that the bias introduced by including countries with height measurements only for women who have given birth in the last five years is small. Moradi (2010) shows that in the DHS samples from 16 sub-Saharan African countries, around 59% of women aged 20–50 have given birth in the last 5 years. Based on countries where there is complete data, constructing height estimates only from these mothers does lead to a downward bias. This bias is very small, and could be regarded as negligible. Nevertheless, our study also includes countries from Latin America and Asia, where the fertility rates have been substantially lower, and more rapidly changing, than in sub-Saharan Africa. Across the countries considered, these empirical relationships might well vary if they are at different stages of demographic transition. It may be that the selection effect in these regions is both larger and time varying. We prefer to exclude these mother only samples from our analysis rather than risk the potential selection bias.

Each survey is checked country by country, and all available DHS dataset with height of all women are included in the analysis. This gives us a sample of 38 countries. These countries are listed in Table 1. We use the latest survey available in each country to provide our primary dataset. We extract heights of women only from age 20 and above on the grounds that at age 20, physical development has likely ceased. After age 50 a decline in physical stature is likely to occur with aging (Fernihough and McGovern, 2013). The number of observations in a typical DHS dataset is around 4000, though there is variation in sample size by age within a survey as well as across countries and time. Height, without shoes, is measured in DHS surveys by the interviewer, using a headboard. While this is an objective measure (rather than a self-report), there may still be measurement error in individual observations. Extreme heights (defined as below 100 cm and above 250 cm) were excluded from the sample as well as a small portion of missing observations. Our calculation of cohort height also has error due to the fact that it is based on a sample rather than the whole population. Though our data are nationally representative samples, the probability of being sampled is usually unequal for different observations, and we use the sampling weights provided in the survey to construct estimates of average adult height for each country by birth year.

We also list, where available, the data from an earlier survey for these countries in which the heights of all women in the age range (not just mothers) was measured. These earlier surveys are usually about 5 years before the latest survey and provide similar height data for overlapping cohorts. Since each DHS survey draws a different random sample of the population, these earlier surveys give height estimates for some of the same cohorts with sampling error that is independent of that found in the latest survey. We use these independent cohort height