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# Towards an anthropometric history of latin America in the second half of the twentieth century

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ABSTRACT

We examine the evolution of adult female heights in twelve Latin American countries during the second half of the twentieth century based on demographic health surveys and related surveys compiled from national and international organizations. Only countries with more than one survey were included, allowing us to cross-examine surveys and correct for biases. We first show that average height varies significantly according to location, from 148.3 cm in Guatemala to 158.8 cm in Haiti. The evolution of heights over these decades behaves like indicators of human development, showing a steady increase of 2.6 cm from the 1950s to the 1990s. Such gains compare favorably to other developing regions of the world, but not so much with recently developed countries. Height gains were not evenly distributed in the region, however. Countries that achieved higher levels of income, such as Brazil, Chile, Colombia and Mexico, gained on average 0.9 cm per decade, while countries with shrinking economies, such as Haiti and Guatemala, only gained 0.25 cm per decade.



## 1. Introduction

In this article we introduce what we believe is the most comprehensive and updated evidence on the evolution of adult heights in Latin America in the second half of the twentieth century. The dataset allows us to trace trends by five-year periods that rely on comparable health surveys from the DHS program and from national agencies that used similar methodologies. Our dataset includes twelve Latin American countries for which we could obtain at least two health surveys: Bolivia, Brazil, Chile, Colombia, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, and Peru. By using more than two surveys in each country we were able to assess and control survey differences and hence obtain more reliable estimates. Altogether, these countries represent close to 80 percent of the population throughout the period; in terms of income per capita, both the average and the range represent well the characteristics of the entire region. The earliest survey dates from 1977 (in Brazil), and the latest from 2013 (in Dominican Republic). Since we report the average height of adults by birth cohort, our dataset tracks changes in biological wellbeing from the late 1940s to the end of the century.

Latin America provides an excellent laboratory to study the history of biological wellbeing. There are significant differences in environmental conditions as well as multiple ancestries, providing a wide range of possible responses to socioeconomic forces. Moreover, the countries share striking similarities in their economic and political configurations, as well as in their cultures. Given the strong contacts and common historical experiences, they share institutions, norms and policies (Bértola and Ocampo 2013; Bulmer-Thomas, 1995). The cycles of strong economic growth rarely served to lift the economic welfare of the poor due to devastating crises, high inequality and a skewed political system (Thorp, 1998). Still, in other facets of human development, progress is undeniable due to increased school enrolment and improvements in infant mortality and life expectancy (McGuire, 2010; Prados de la Escosura, 2015).

We used a total of forty-nine national health surveys from the previously-mentioned twelve Latin American countries. All surveys drew samples representative of the national population and followed similar protocols to select cases, code variables, and instruct technicians on how to measure height, weight, and other anthropometric data. We obtained most of them from the US Aid-funded DHS Program (http://dhsprogram.com) and some from national health agencies and the Global Health Data Exchange (http://ghdx.healthdata.org). The surveys diverge in some ways in their purposes and the subpopulations they tracked, but they remain largely comparable particularly given the high-quality

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stratified sampling and the expansion factors (sample weights) provided in each survey. The Demographic and Health Surveys (DHS) are the most common source of our data, with thirty-eight studies in total. They focus on children and their caregiver mothers and are primarily geared to obtain information on disease, malnutrition, caregiving practices and reproductive health. Most of these surveys include anthropometric data for mothers between 15 and 49 years old. DHS surveys are a common source in studies of adult heights in the twentieth century (Acosta and Meisel, 2013; Baltzer and Baten, 2008; Baten and Blum, 2012; Blum, 2013; Bozzoli et al., 2009; Deaton, 2007; Moradi, 2010; Morales et al., 2004). The DHS surveys are organized in phases or waves. Over time, the sample sized increased, and so did the questionnaire, but the core of the survey and the sampling design are comparable (Moradi and Baten, 2005). The major difference among waves is that the first ones collected information for mothers of small children in the household, while later waves included all women of reproductive age. In addition to these DHS surveys, we used eleven comprehensive health surveys that focus on the nutritional and/or health characteristics of individuals of all ages and sex. For all practical purposes, their questionnaire and techniques are similar to the DHS surveys, but they sample all the population, as the later DHS. Finally, Honduras' 2004 Living Conditions Survey (ENCOVI 2004) relied on self-reported statures and was retained as the trends conformed to the other sources.[1]

Data availability was the main reason to select adult women, rather than men or children, as the population for this analysis. Most of our surveys do not have information on adult men or the number of cases is very limited. Female physical growth is less responsive to nutritional and disease factors than in the case of males (Camara, 2015; Cole, 2003); hence, the variations we show here are most likely the lower band of change across time in each country. In order to retain the largest possible number of cases, we made the decision to include women of a wide age range, from 15 to 59 years of age, using controls by age to model height gain and loss due to age.

Ultimately, this information was summarized in five-year national age-standardized averages through a procedure involving two steps. First, we created single-country datasets organized by year of birth and survey built from the microdata. We eliminated heights below 130 centimeters and above 200 centimeters, since they represent in all likelihood errors in measurement and create a bias in the annual averages. The standard deviation of heights within the surveys ranged from 5.6 to 7.2 cm and conformed to the normal distribution. Using the expansion factors (weights), provided in each survey, we created height averages per birth year and survey of each country. The variables included:

- Survey (panel)
- Birth-year cohort (time unit)
- Height average in mm
- Standard Deviation in mm
- Average age at time of measurement
- Number of cases

Among all countries, we had 1781 survey-birth year observations. The average number of cases in each birth-year cohort is 266 cases; 79 percent of the panel cells are based on at least 100 cases, and 94 percent on more than 25 cases. For the same birth cohort and country, most differences between DHS surveys were less than 0.6 cm, although we noticed a downward bias in the earlier waves (II and III) close to 1 cm. The earlier versions of the DHS sampled mothers in care of small children; hence they biased the sample toward the poorer groups of society. Non-DHS surveys tended to show heights 1.3 cm higher on average. The only outlier (3.6 cm, relative to a DHS in the same country and period) was the 2004 Honduras survey based on self-reported stature. In all, the differences between surveys are predictable and can be controlled with fixed effects.

In the second step we created a panel dataset of five-year national height averages based on the annual tabulations per survey of the previous step. We used country-specific regressions to remove the effects of height gain and loss among the young and the old, as well as the differences in averages among surveys. The following equation indicates the parameters of the regression:

$$\text{Average Height}\,(i,t) = \alpha(i) + \beta 1(t) + \beta 2 \text{ x (Squared Young Age)} + \beta 3 \text{ x (Squared Old Age)} + u(i,t)$$

The subindexes 'i' and 't' denote the panel and time units, which are the surveys and year of birth, respectively.[2] $\alpha(i)$ identifies fixed effects for each survey, and $\beta 1(t)$ is a vector that corresponds to one dummy variable per five-year period. The use of five-year periods eliminates the variability caused by random variation between smaller annual samples and increases the number of cases on which the average is based which makes it possible to have more reliable estimates.[3] $\beta 2$ and $\beta 3$ apply the height gain and loss corrections. Between ages 21–40, height does not significantly change as a function of age. The variable for young (old) age is set to zero if age is in the 21–40 range, otherwise it is the squared difference of 21 (40) minus the age of the annual birth cohort. That is, women of ages 19, 30 and 45 have young-age values of 4, 0 and 0, and old-age values of 0, 0 and 25. The squared value efficiently captures the gain and loss of height and was not significantly different from a model that used age dummies. In all countries, the $\beta 2$ parameter was negative and significant; $\beta 3$ was typically negative, but it was positive (but not significant) in some surveys that covered the population through age 49.[4] The resulting dataset is an unbalanced panel where the group is the country and the time unit is the five-year period. The height averages and frequencies are shown in Table 1.

Compared to most anthropometric studies, our method makes use of heights from a wider range of ages. The trends obtained from our data are very similar to other male and female height series for Latin American countries from the 1940s to the 1980s. The R squared of our data and similarly constructed series for males in Brazil ( Monasterio et al., 2010) and Mexico (López-Alonso and Vélez-Grajales, 2015) are 0.96 and 0.99 respectively. For Ríos and Boggin (2010), estimated a decadal series based on a rural sample of identification cards, instead of a national random sample; the R squared is smaller (0.59), but still significant. In these comparisons, dimorphism, the gap between male and female heights, is within an expected range (10 to 13 cm), while the overall growth in heights is also comparable. The correlations with other female height series are similarly high. Meisel and Vega's series for Colombia is based on millions of identification cards that are broadly representative of young women (2007). Our average is about three centimeters lower because surveys of mothers of young children are often among

[1] On self-reported versus measured heights, see Camara (2015) and Unikel-Santoncini et al. (2009) and Zambrano-Ruiz (2009).

[2] This approach yields similar results to a random-effects panel regression that considers fixed effects for each general type of survey.

[3] This is common practice in similar studies: Acosta and Meisel (2013); Baltzer and Baten (2008); Blum (2013); Camara (2015); López-Alonso and Vélez Grajales (2015); Moradi and Baten (2005).

[4] A positive coefficient on the old age variable is not surprising since the loss of stature after 40 is moderate, and it becomes more pronounced only after the age of 50. Even more, in some countries with low life expectancy, we can expect that women who reached 40 years old are healthier and, hence taller (on average) than those who did not survive (Bozzoli et al., 2009). In all our statistical analysis, we confirmed that the results we present here also held for the subset of those in the 21–39 age range, which is more common in other anthropometric studies.