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JEL Classification: I15, N34, O15

Keywords: Anthropometrics, economic development, poverty, child health

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Stunting and Wasting in a Growing Economy: Biological Living Standards in Portugal during the Twentieth Century[1]

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[1] This paper previously circulated under the title "Stunting and wasting in a growing economy: biological living standards in Portugal, 1924-1994". We are thankful to Eric Schneider, Jaime Reis and speakers at several talks for helpful comments and suggestions. We thank Centro Cultural Casapiano and the Archive of Santa Casa da Misericórdia de Lisboa for access to their data. Luísa Colen from the latter institution provided us with much useful information. Nuno Palma and Renato Pistola acknowledge financial support from Fundação para a Ciência e a Tecnologia (CEECIND/04197/2017 and CEEC-IND/00991/2018/CP1541/CT0005). Alexandra L. Cermeño thanks the Jan Wallanders och Tom Hedelius foundation (P20-0037). Ethical approval to collect this data and conduct this study has been granted by the institutions that we work for. The dataset underlying this paper will be made available.

1. Introduction

Portugal's real income per capita grew by a factor of eight during the second half of the twentieth century, a period characterized by fast growth and convergence towards Western European standards of living.[2] Portugal converged from around one-third of the GDP per capita of the core of Europe's wealthiest countries in 1940 to approximately 60% in 1974, and up to about 65% in 1994 (Lains 2003). In this paper, we collect heights and weights for a new sample of 3,431 infants and children from birth to 18 years of age. We use the prevalence of stunting and wasting to document trends in biological living standards among infants and children during the twentieth century, including a period of fast economic development from around 1950. We find a dramatic secular decrease in the prevalence of stunting and wasting of children, reflecting an improvement in living standards that occurred over the period. We also use a representative sample of more than 26,000 young adults and find similar trends.

In this study, we focus on two measures of physical growth as indicators of societal changes in standard of living: stunting and wasting. Stunting refers to impaired growth, resulting in reduced height-for-age (World Health Organization, 2006). A child is stunted if their height-for-age is below two standard deviations from a reference mean height. It represents a long-term and cumulative manifestation of chronic undernutrition, recurrent infections, lack of psychosocial stimulus or increased emotional stress in childhood. It can also occur before birth during fetal development brought about by malnourishment of the mother and other pregnancy factors. In turn, wasting concerns individuals who are underweight for their height and reflect short-term changes in nutrition and disease or stress exposure (World Health Organization, 2006). We use the Center for Disease Control and Prevention (henceforth CDC) growth reference (Cole et al. 2000) to identify individuals in our sample as stunted or wasted. We then calculate the prevalence of stunting and wasting by decade, sex and age group: infants (up to 36 months of age) and children (ages 2 to 18 years).[3]

[2] Amaral (2002, 2019); Lopes (2004); Stolz et al. (2013); Costa et al. (2016); Palma and Reis (2021). Portugal has been Western Europe's poorest country since the first half of the nineteenth century (Palma and Reis 2019).

[3] We split infants from children in this way in order to respect conventional categories (as explained below), even though individuals between 24 and 36 months fall in both categories.

We find that the prevalence of stunting and wasting decreased over time as income per capita grew and access to improved nutrition, sanitation and medical care. The prevalence of stunting and wasting in the city of Lisbon fell gradually from the 1950s. The largest declines occurred before the 1970s, prior to the social changes brought by the transition from a dictatorship to a democratic political regime, including the creation of a national health service. However, progress was not only due to better nutrition – undoubtedly an important factor, as we document – but also due to gradually increased access to health and public sanitation services (Deaton 2014; Pato 2011; Saraiva et al. 2014). The evolution was impressive; for example, for both sexes, the prevalence of wasting fell from 45% in infants during the 1950s to around 15% in 1985-1994. The prevalence of stunting also showed remarkable progress, with close to 50% of infants and children stunted in the postwar period to less than 15% in 1985-1994. There were larger incidences in older children, reflecting a lag in the improvements relative to the younger generations. The observed progress must have led to enormous welfare gains, especially as we show that stunting had long-term negative health consequences for most individuals affected.

The observed drop in the prevalence of stunting and wasting occurs in tandem with the dramatic decrease in infant mortality from the early 1950s onwards (Baganha and Marques 2001, Instituto Nacional de Estatística 2001). We discuss these trends in the context of improvements in the health of children and young adults. We also compare the observed trends to the macroeconomic and infrastructure development of the time. We discuss developments in access to nutrition, health care, sanitation, and housing. Finally, we consider potential sample selection issues in detail.

2. Data

We rely on three separate archive sources for our data collection. First, records from the *Hospital de São Roque*, which belonged to the House of Mercy (*Misericórdia*) of Lisbon, created in 1943. Second, records from *Casa Pia a* home for children who lost one or both of their parents, which opened in the 1780s but offers records from the early

1900s.[4] Finally, since both prior sources cover infants and children only, we additionally study young adults through the *Livros de Recrutamento,* a military source belonging to the army.[5] Unfortunately, the latter source only allows the study of males.

Santa Casa da Misericórdia

The *Hospital de São Roque* is part of the *Santa Casa da Misericórdia de Lisboa*, founded in 1498, and historically the largest private (i.e. Catholic) charitable organization in Portugal. The hospital sample consists of 1,970 children who attended the hospital between 1945 and 1994.[6] The children in the sample lived within proximity of the hospital or were transferred there from hospitals and institutions located elsewhere. Up until 1979, when the Portuguese public universal health care system was created, the country relied largely on a private and charity-run network of hospitals and other similar facilities.[7]

Because of the charitable nature of this hospital, children from wealthy families were unlikely to attend as they sought better quality private institutions with high service fees. While a few children from well-off families are likely excluded, the sample can still be considered representative of the vast majority of the population: the middle-to-low socioeconomic segment of the city across the entire period considered.[8] Data were

[4] The Casa Pia provided shelter, food, assistance and education to these children. There have been prior studies of some of its anthropometric data, most of which in the Portuguese language, but the associated datasets are not publicly available.

[5] Our original hand-collected dataset consisted of 2,227 individuals who visited the *Hospital de São Roque* in Lisbon for medical appointments or hospital stays between 1945 and 2010, 1,566 children registered in the *Casa Pia* school/home for orphans, and more than 26,000 young adults in the military recruitment records. We restricted the sample to the period 1905 to 1994 because the number of observations for the later years was too small for prevalence measures to be meaningful. We also cleared our dataset of outliers as a result of typing errors, omissions and record-keeping issues. To make sure that our sample does not include unrealistic outliers, we used the WHO Multicenter Growth Reference Study Group (2006) criterion by which Z-scores lower than -6 and greater than 6 in terms of weight for age and weight for length were considered outliers and removed from the analysis. This resulted in a final dataset consists of 1,970 children for the *Misericórdia* dataset, 1,461 children for the *Casa Pia* dataset, and 26,412 for the military recruitment dataset.

[6] Our sample contains a comparable set of males and females. The number of surviving records with usable information decreases over time but the trend reverts during 1985-1994: as Figure A1 in the Appendix shows, most records of the children observed in the hospital pertain to the 1945-1965 and 1985-1994 periods.

[7] A few public hospitals also existed in the main cities, complemented by private clinics and co-operative health centers.

[8] A number of children were sent to the hospital from areas outside of Lisbon. After the mid- to late 1990s, this hospital's data can no longer be considered to represent a representative sample of the city of Lisbon. From 1994 onwards, not only is data more scarce but it is also the case that the clinical files progressively indicate that the children who attended the hospital were sent from shelter homes – a reflection of its increased focus on underprivileged infants and children, often those who had been subject to mistreatment by their families. Hence our dataset is truncated at 1994.

collected from the clinical file of each child that was initiated by the doctor or nurse when the child was first admitted. For each child, we collected year of observation, age of the individual (in months), sex, weight in kilograms, and height in centimeters. We also collected handwritten notes taken by the attending physician or nurse, namely the clinical diagnoses.

We divide our sample into two age groups: those between the ages of 0 and 36 months (infants); and those between 2 and 10 years of age (children). This reflects a change in the height-for-age reference from relying on supine length (infants) to standing height (children). In our dataset, 246 individuals are aged between 24 and 36 months old, meaning that they are included in both the infant and child sub-samples (Table 1).

Table 1: Number of observations by sex (Misericórdia sample)

	INFANTS (0-24 MONTHS)	CHILDREN (3-10 YEARS)	OVERLAP (24 – 36 MONTHS)	TOTAL
MALES	796	157	135	1,088
FEMALES	610	161	111	882
TOTAL	1,406	318	246	1,970

Note: for simplicity, we split the children by age following the headings of the table. Note however that the the group of children aged between 24 to 36 months (OVERLAP) is counted in both INFANTS and CHILDREN samples for calculations, following the CDC guidelines of measurement (Cole et al. 2000).

The z-score for height and weight is calculated for each child based on the CDC growth reference. The z-score is a relative measure of growth calculated in terms of standard deviations from the sex- and age-specific mean.[9] Finally, a dummy variable identifies those who are below the -2 z-score threshold (following Cole et al. 2000) and are classified as stunted and/or wasted. In the Appendix, we perform several tests to demonstrate that our results are not driven by sample selection effects.[10] Namely, we compare

[9] This facilitates analysis because individuals of different ages can be pooled together and thus overcome issues with sample size.

[10] We only collected height and weight from a subset of the records that have available data. If heights and weights were recorded more often in those children whose medical condition was more likely to affect growth, then our sample would represent a selection of the most growth-compromised children. However, our comparison shows that children who presented impaired growth or a condition likely to impair growth during the medical appointment, are not more likely to include height or weight measurements compared to the other children. Because of the lack of selection in the sample, variations in the prevalence of stunting and wasting can be taken to represent temporal changes in child well-being.

our quantitative information with an extra sample of 150 children from the same hospital where there was no biological information other than the diagnosis. We code the doctors' diagnoses into a binary growth-impairing disease variable and show that the probability of finding children with growth impairing diseases is the same in both samples.[11]

In addition, we study whether the children in the dataset are heterogenous by the nature of their interaction with the hospital during 1985-1994. This is the period for which we have records of patients that went for regular checkup appointments as well as lengthy hospital stays.[12] We check whether inpatients were more stunted or wasted than those who just went for a consultation with a doctor using a t-test of the means of the dummies stunted and wasted. We also look for significant differences in their height and weight and their individual z-scores, which control for sex and age. We reject any differences in the inpatients from those that only attended a doctor's appointment (i.e. outpatients). The differences in means on the z-scores (which adjust for sex and age) for both height and weight are not statistically significant which suggests that our main results are not subject to sample selection on observables.[13]

Casa Pia sample

The *Casa Pia de Lisboa* is a school located in Lisbon. It is still in operation. During the period which we cover in this paper, it received children from all parts of the country, including a few born in the colonies, which at the time included Angola in Africa and East Timor in Southeast Asia, among other locations. We collected data from this source for all periods.[14] This school was dedicated to receiving children who had lost at least one of their parents.[15] In Table 2, we indicate the birthplace of the children received who appear in our sample, splitting it between the Lisbon district and other regions. In the case of children who appear more than once in the source, we only use their first appearance for these results.[16]

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[11] See Tables A1 to A3 of the Appendix.
[12] There are two types of data in the archive, one concerning inpatients and the other scheduled appointments. We divided children into these two groups based on this division.
[13] See Tables A4 to A10 of the Appendix.
[14] Figure A2 of the Appendix shows the distribution of our *Casa Pia* sample over time.
[15] There was a separate school for children with cognitive limitations, which we do not consider here.
[16] Below, we consider repeated visits taking advantage of the longitudinal dimension for those who are observed more than once.

Table 2: Number of children and teenagers (7-18 years old) by birth origin (Casa Pia sample)

	MALES	FEMALES	TOTAL
BORN IN LISBON	607	261	868
BORN IN OTHER REGIONS	431	162	593
TOTAL	1,038	423	1,461

Note: All individuals were observed in Lisbon. The table refers to their birthplace. We show the number of individuals with at least one record. Data for females is available only from 1943.

We collected the *Casa Pia* data from two types of documents: the *Livros de Mensurações* – actual books which contain data from 1906 to 1913 – and the *Fichas de Admissão*, which are files of students that include data from 1914. From 1942-1943 the information becomes better organized, as it was systematically collected when students entered *Casa Pia* (i.e., the measurements were made just before the student entered *Casa Pia* or shortly after their entry).

Children's full sample

Our full sample for children (i.e., individuals below eighteen years old, including infants and teenagers) consists of the pooling together of the *Misericórdia* and *Casa Pia* samples.[17] Table 3 shows details about the contribution of each subsample to the totals, and Figure 1 shows correlations of height and weight, separated by sex and age. As expected, we observe infants (0-36 months old) to have a lower weight, height, and variability than children and teenagers (2-18 years old), for both sexes.[18]

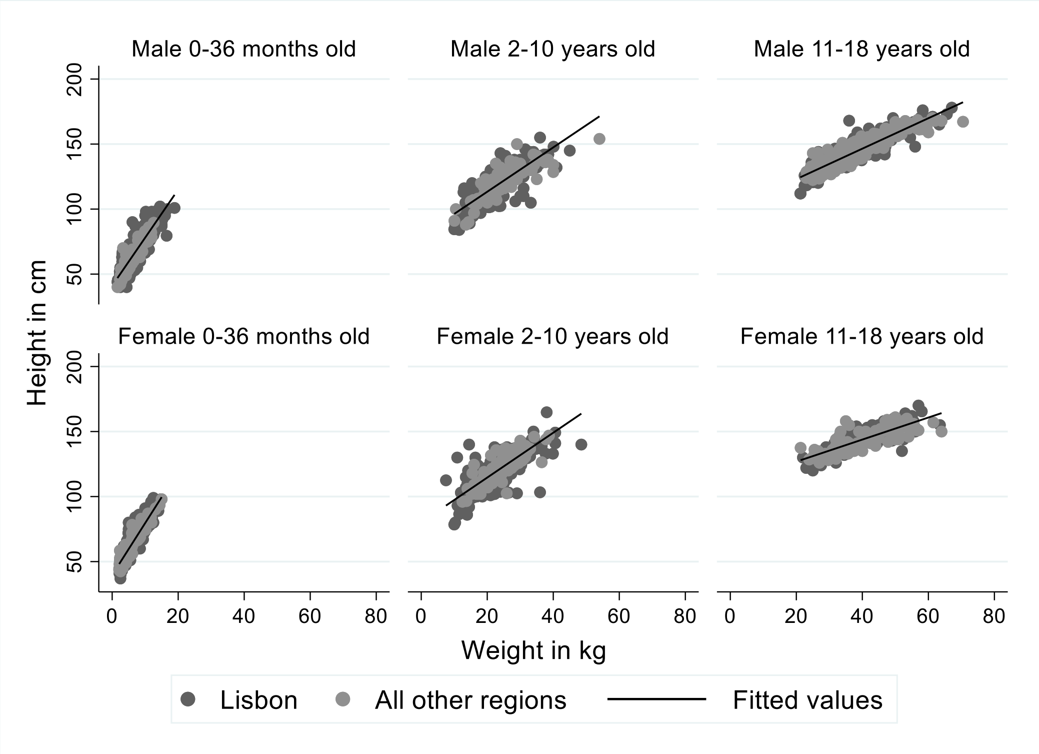
Table 3: Total children in the children full sample by decade and institution

	TOTAL	MISERICÓRDIA		CASA PIA	
DECADE		Males	Females	Males	Females
1905-1914	171	0	0	171	0
1915-1925	168	0	0	168	0
1925-1934	93	0	0	93	0

[17] In the Appendix, we show that for the main periods when the two samples overlap (1945-64), the results for each subsample are similar. See Table A11 and the surrounding discussion.
[18] We show further information about weights and heights in our sample in Tables A12 and A13 of the Appendix. Our descriptive statistics are in line with what previously existing studies reported about the heights and weights of Portuguese children or young adults for the years in which they overlap our sample (Rosa 1986, Padez 2002, 2007).

1935-1944	59	0	0	59	0
1945-1954	1,067	344	312	247	164
1955-1964	969	332	222	217	198
1965-1974	163	9	10	83	61
1975-1984	96	51	45	0	0
1985-1994	645	352	293	0	0
TOTAL N	3,431	1,088	882	1,038	423
		1,970		1,461	

Figure 1: Height on weight for infants and children of both sexes



Note: the total sample size corresponds to 1,970 individuals from the Misericórdia hospital and 1,461 observations for Casa Pia.

Young adults sample

From the archival sources of the military in Portugal (*Arquivo Geral do Exército, Livros de Recenseamento Militar*), we obtained 26,412 observations of young adults' heights from 1924 to1968. We collected a random sample which includes observations for municipalities (*concelhos*) covering all major regions of continental Portugal. This allows us to compare trends in stunting and wasting for young adults across space and time. The benefit of this source of height data is that the information was universally collected across adult 20 year-old males in Portugal, and it was drawn without sample selection (for survivors).[19] Hence, it is representative of the entire young adult male population in the country. The main disadvantage of this sample is that it is available for males only. The heights were collected during the mandatory military medical inspection that all 20 year-old males undertook. We collected the height of these individuals for several annual benchmarks (1924, 1930, 1940, 1950, 1960 and 1968) covering the entire country.[20]

Table 4: Number of young adult males (20 years old) by location

	BIRTHPLACE	**LIVING/WORKING PLACE**
LISBON	5,438	8,479
OTHER REGIONS	20,974	17,933
TOTAL	26,412	

Note: The living/working division is based on the location of the military inspection.

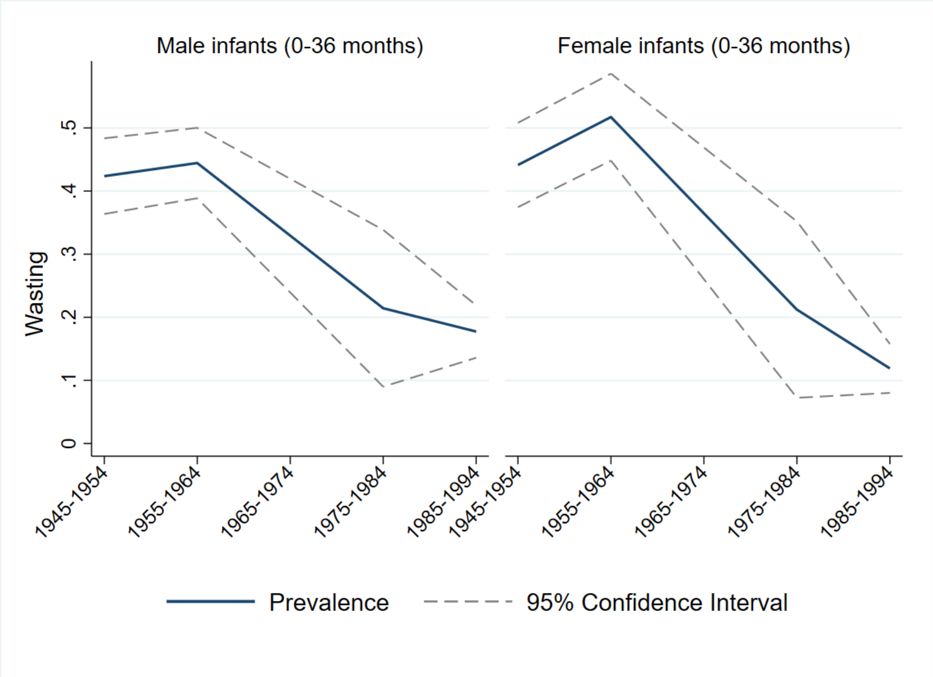
3. Wasting and stunting among infants and children

Wasting among infants

Wasting is a measure of acute malnutrition and identifies infants with at least one of the following conditions: weight-for-height z-score (WHZ) below two standard deviations and/or mid-upper arm circumference <125 mm; the presence of bilateral pitting edema. We focus on the first criteria alone since it is the only one we can measure. Wasting references are available at different ages and by sex from the CDC, but only until 103cm. Accordingly, we focus on wasting among infants only (i.e. up to 36 months).[21] Figure 1 shows that wasting among infants fell steadily from the mid-1950s.

[19] See Palma and Reis (2021) for more details about this source.
[20] The distribution of observations by municipality is listed in Table A14 of the Appendix. From 1969, the age of observation of recruits by the military changed from 20 to 18 years old, which means that further benchmarks would not be directly comparable.
[21] Table A15 of the Appendix describes the prevalence of wasting among infants over time.

Figure 2. Wasting for infants



Note: The 1965-1974 period is interpolated in this figure due to the low number of available records.

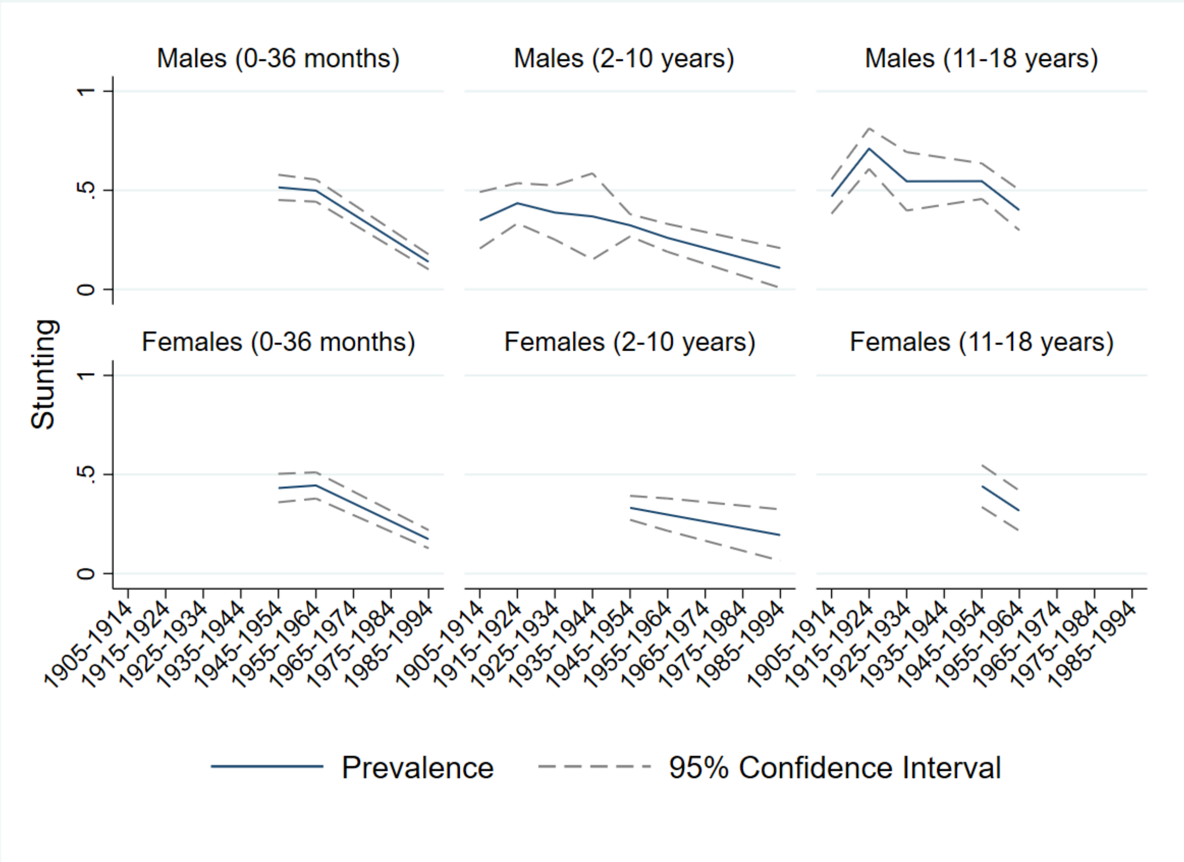
Stunting among infants and children

Child stunting refers to a reduction in growth and measures chronic malnutrition and recurrent infections (most notably leading to diarrhea). These can occur in early childhood or before birth due to inadequate fetal development brought on by a malnourished mother. The World Health Organization (WHO) defines a stunted child as one whose height-for-age is less than two standard deviations from the mean of that age taken from a Growth Reference Standard. Severe stunting is defined as height-for-age below three standard deviations.[22] There are two different height-for-age reference values for children: one for 0-36 months and another for those 2 to 20 years old. The overlap in both standards corresponds to a change in the position for taking the measurements. This paper considers children who fall in the overlapping measures in both categories, consistently with the CDC.

[22] Data available at different ages and by sex from Centres for Disease Control (https://www.cdc.gov/).

The stunting prevalence by decade and age category is shown in Figure 3.[23] Concerning infants (aged 0 to 36 months), for both males and females, around 50% suffered from stunting between 1945 and 1964. Stunting then fell steadily, to less than 15% by 1985-1994. Figure 3 also shows the results for children aged 2-10 years. For this age group, the percentage of stunting also fell steadily over time, to less than 20% by 1985-1994 (notice the lag in improvement relative to the infants, as expected). Finally, the available evidence for the 11-18 years old group is more limited but also shows improvement over time, with the expected lag.

Figure 3. Stunting by age group



Note: Except for 2 -10 years old children (central figures), the 1965-1974 period is interpolated due to the low number of available records. In the case of infants (0-36 months old), the period 1975-1984 was dropped because of a low number of available records. Please, refer to Table 3 for more information about observations by source.

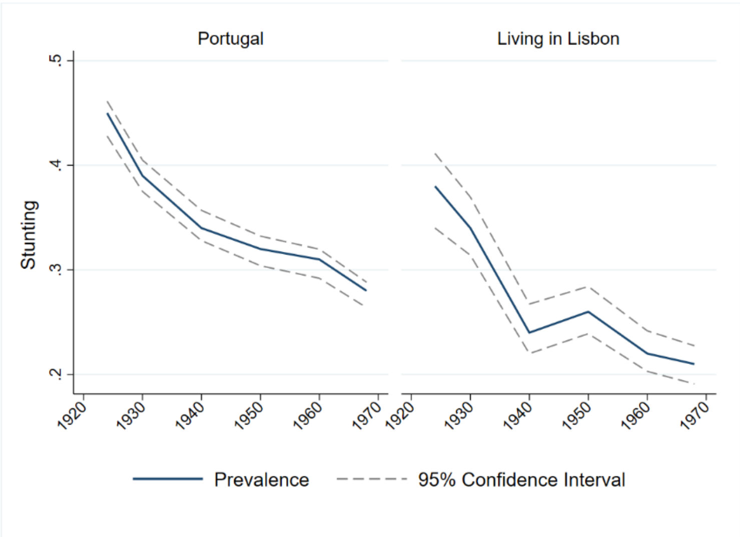
4. Stunting among young adult males

[23] For the prevalences, see Tables A16 to A18 of the Appendix.

We now move to the discussion of young adults.[24] As explained in section 2, we can only observe males due to the military nature of the source. However, our sample is representative of males who survived to the age of 20 and lived in Portugal, since the military inspection was universal, and we collected a random sample from all around the country.[25]

Figure 3 shows that the prevalence of stunting was consistently lower in Lisbon than elsewhere in the country.[26] As with infants and children, there was a decreasing trend over time: for the country as a whole, stunting decreased from around 45% of individuals in 1924 to less than 30% by 1968.[27] Progress happened earlier for those living in Lisbon: stunting decreased from more than 35% in 1924 to close to 20% by 1968. As with infants and children, health improvements began before a tax-financed national health service was created.

Figure 4. Comparison of stunting in Portugal vs. Lisbon for 20 year-old males



Source: Arquivo Geral do Exército, *Livros de Recenseamento Militar* (1924-1968).

[24] Figure A3 in the Appendix shows the number of observations over time for this database.
[25] We did not collect date beyond 1968 because from 1969 the military inspection began to happen at the age of 18 instead of 20.
[26] Our dataset includes information on the place of inspection, typically corresponding to where the individual was living and working or studying. We have alternatively used birthplace as the criteria; doing so the results are similar, and shown in the Appendix (Figure A4).
[27] The lower stunting incidence for young adult males compared with male infants for corresponding periods is likely due to survivorship bias. This levels effect is not in contradiction with the decrease in trends concerning the average effects on adults lagging those of children.

5. Interpretation

The income and health improvements in Portugal over the second half of the twentieth century led to the decreased incidence of both stunting and wasting that we have demonstrated. In this section, we provide additional context and interpretation. The proximate causes were improved nutrition and sanitation and increased availability of medical care, which have been documented to have had an impact elsewhere (Fogel 2005; Deaton 2013).[28] Infant mortality due to digestive diseases up to 3 years of age fell, and literacy levels among children rose steadily from the late 1920s onward (Palma and Reis 2021). From around 1950, infrastructure improved considerably regarding water access, sewage, and quality of dwellings (Pato 2011; Saraiva et al. 2014). This decreased the incidence of diarrhea and digestive diseases that commonly affect children. The infrastructure improvements happened earlier in urban areas, particularly in Lisbon than elsewhere in the country (Pato 2011, pp. 97-98).

Nutrition in Portugal improved considerably over the twentieth century. At least from the early 1960s, and for the country overall, per capita protein consumption from foodstuffs, including meat, eggs, and milk, increased significantly (Table 3). Progress was interrupted by a temporary breakdown related to the adverse effects of the agrarian reform and economic crisis during the initial post-revolution years (Barreto 2017) but resumed in the late 1970s.

Table 5. Per capita annual food consumption for selected staples, in kg or litres.

	1963	**1970**	**1974**	**1977**	**1980**	**1990**
WHEAT	67.9	75.2	75.2	72.9	72.6 to 93.8	95.9
RICE	14.5	14.8	37.8	16.1	17.3 to 19.8	24.8
POTATO	102.3	121.7	110.9	91.9	101.3 to 149.5	147.5
SUGAR	19.1	25.6	30.0	27.9	29.6 to 31.3	29.3
PORK	6.0	7.5	9.4	9.4	9.8 to 12.2	20.0
POULTRY	1.4	7.1	11.9	15.0	17 to 18.6	19.1
BEEF	6.8	11.2	14.3	13.4	11.4 to 12.7	16.0
COD	6.8	10.1	6.8	5.2	4.0 to 4.1	6.6
EGGS	3.7	4.4	4.5	4.4	5.0 to 5.8	7.5
MILK	30.8	51.8	57.3	59.6	60.6 to 73.9	83.5

[28] We do not find surprising that outcomes for females improved as much as those for males did, given that historical evidence suggests that Portuguese traditional social norms did not discriminate against women more systematically than was the case in other Western European regions (Palma et al. 2020).

OLIVE OIL	6.7	6.9	5.3	4.2	4.1 to 4.2	3.3
WINE	91.3	79.4	131.0	85.9	95.0	-
BEER	4.4	14.8	32.6	29.5	40.1	-

Source: Barreto et. al. (1996, p. 84), who for 1963 to 1974 rely on Campos (1980); for 1980 they also rely on Campos (1980) as well as, alternatively, on Instituto Nacional de Estatística (1984). For 1990, they rely on Instituto Nacional de Estatística (1994, p. 69).
Note: the figures refer to continental Portugal until 1980 and the entire country henceforth. The range of figures for 1980 corresponds to the information in both sources. The unit for beverages corresponds to litres, all else in kg.

In addition to improved nutrition, the incidence of stunting also reflects non-nutritional factors such as the health environment during childhood. The initial increase in the heights of the Portuguese was essentially the result of a reduction in stunting. While the most significant decrease in stunting occurred before the 1960s, most mean height increases took place afterwards (Cardoso 2008). Portuguese eighteen-year-old males were considerably taller after 1970 due to the greatest increase in mean stature of individuals born in the 1960s and later (Padez 2007). Mean height continued to increase into the early 2000s (Cardoso 2008). These changes reflect ongoing progress in socioeconomic circumstances and material living conditions, both with regards to higher incomes and more access to public goods.

We lack most Portuguese health-related data series for the period under study. The exceptions are perinatal, neonatal, and infant mortality. Analysis of these indicates a steep decrease between 1940 and 1950, which continued to decrease and then became steep again after around 1970 (Veiga et al. 2004). From the 1930s, there was a decline in the mortality rate and a decrease in the infant mortality rate (Schmidt et al. 2011). Deaths caused by infectious and parasitic diseases, usually related to poor social environment and hygiene, in turn, started to decline in the 1950s, due to improvements in living conditions, better literacy, and the progress in medical care (Palma and Reis 2019; Schmidt et al. 2011; Leão and Rodrigues 2016).

In line with the remainder of our evidence, child mortality showed enormous improvements in the period which we cover in this paper (Table 5). As the table shows, after an initial rise during the 1910s, infant mortality declined steadily.

Table 6: Perinatal, neonatal, and infant mortality (per 1000)

YEAR	PERINATAL	NEONATAL	INFANT

1910	-	-	133.9
1920	-	-	164.1
1930	-	-	143.6
1940	-	-	126.1
1950	-	-	94.1
1960	42.2	28.0	77.5
1970	38.9	25.4	55.5
1980	23.8	15.4	24.3
1990	12.4	6.9	10.9
2000	6.2	3.4	5.5

Notes: infant mortality corresponds to children less than one year of age. It was 38.9 in 1975.
Source: Perinatal and neonatal data from Instituto Nacional de Estatística (2001). Infant mortality from Rodrigues (2008, p. 426). As alternative infant mortality figures, Baganha and Marques (2001, pp. 38-42) alternatively give 131 for 1950 and 94 for 1960, while Instituto Nacional de Estatística (2001) alternatively gives 58 for 1970, and 34.4 for 1980.

The supply of tax-financed public health services increased substantially in both quantity and quality during the period under study. A reform to the Social Security system in 1945 led to greater state involvement in providing health services. As a result, more people were covered by public health insurance (*caixas de providência*) until 1971 (Campos and Simões 2012). During this period, much progress was made towards constructing a system of hospitals financed by the state, such as *Hospital de Santa Maria* in Lisbon and *Hospital de São João* in Porto. Further reforms in 1971 laid the foundation of a National Health Service, which gradually became a universal health system provided by the state, but which would only become accessible to all from 1979, following the implementation of democracy and its associated constitutional mandate (Campos 2000, p. 120). There was also an essential public national vaccination plan in the 1970s, which reduced child mortality due to communicable diseases for children 1-4 years old to less than half (Campos 2000, p. 406). There was hence a gradually increased access to health services. The percentage of the population with access to public healthcare increased from less than 10% in 1954 to 16% by 1960, 30% in 1965, 60% in 1970, and finally 78% in 1975 (Carreira 1999, p. 412).[29] In addition, from 1963 a healthcare system known as

[29] Public healthcare was often run by private providers but was nevertheless tax-financed and marginally free from the perspective of the user.

ADSE (*Assistência na Doença aos Servidores Civis do Estado*) was available to public servants. It covered as much as 8% of the population in 1975 (Carreira 1999, p. 412). The military and their families had a specific health system as well.

Longitudinal analysis

We now study long-term health effects. In the case of the Casa Pia sample, we observe many children more than once. For those children, we now consider persistence (scarring) effects. For individuals that appear in our series more than once, we consider the probability of being stunted in subsequent health inspections conditional on initial stunting. Table 7 shows a high level of attrition in the sample (there are fewer observations with a higher number of inspections). However, it also indicates that those individuals appearing in more than one inspection are not subject to selection bias: whereas the prevalence of stunting increases in groups with more health inspections, regression analysis shows that stunting is not a probable cause of subsequent visits beyond the second.[30]

Table 7: Observations of children in Casa Pia sample, number of health inspections

INSPECTION NUMBER	TOTAL N	STUNTED AND PREVALENCE	PROB. OF STUNTING IN FURTHER INSPECTIONS
FIRST	1,461	520	0.191**
		(0.36)	(0.00)
SECOND	602	237	0.04
		(0.39)	(0.38)
THIRD	123	56	0.08
		(0.46)	(0.58)
FOURTH	91	44	-0.165
		(0.48)	(0.27)
FIFTH	60	26	0.11
		(0.44)	(0.74)

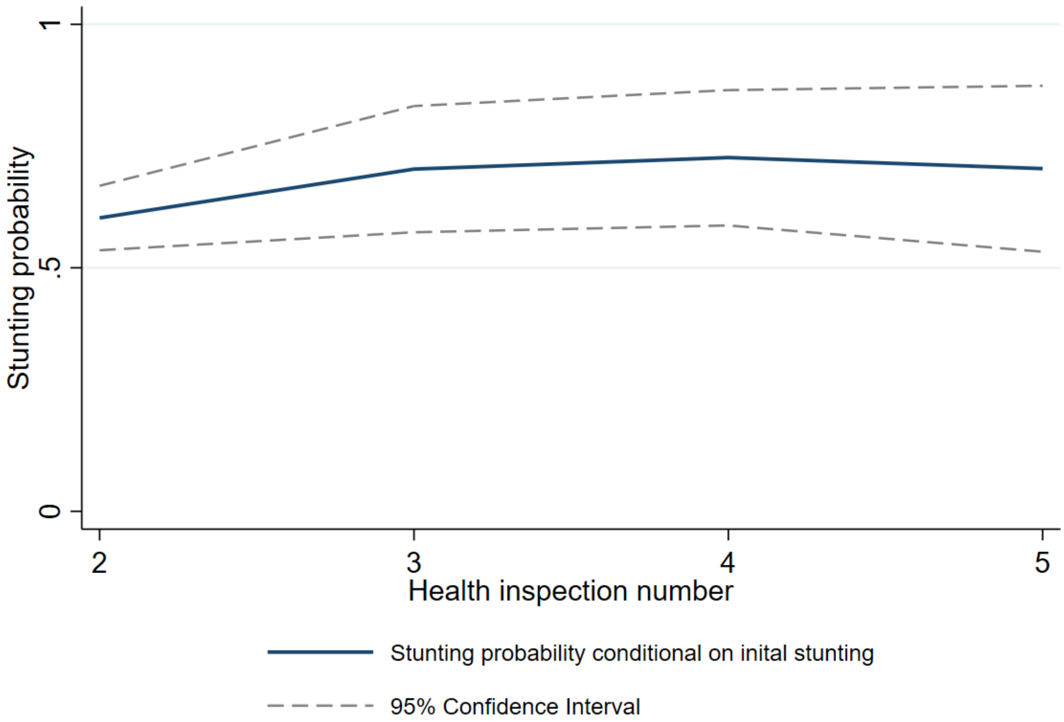
Note: This table shows the number of individuals who have 1 to 5 health inspections in our records, their stunting prevalence, and the coefficient of the regression of further visits as a consequence of stunting after controlling for age at the time of visit. Robust standard errors in parentheses, statistical significance

[30] Table A19 shows that older age motivates further visits, and a careful examination of our data shows that many of these took place on the birthday of the students.

*denoted by *** p<0.01, ** p<0.05, * p<0.1. The overall results of this regression can be found in the Appendix (Table A19).*

We perform a regression to test the probability that subsequent measures of children report stunted growth, provided that they were stunted in the first measurement, and controlling for the age of the individual.[31] The results (Figure 5) show that individuals who were stunted in their first inspection remained stunted in subsequent visits with more than 50% probability, and this did not decrease over time. This shows that initial deprivation had long-term – permanent – adverse health effects for most individuals.

Figure 5. Probability of stunting by inspection number conditional on initial stunting



Note: Data from Casa Pia, described in text. Coefficients shown in the Appendix (Table A20).

[31] See Table A20 in Appendix for details.

6. Conclusion

Portugal witnessed the fastest economic development of its history during the second half of the twentieth century. In this paper, we have documented a remarkably decreasing incidence of undernourished and stunted infants and children over that time. The progress in health outcomes affected individuals of both sexes and covered the entire country. The most noticeable changes happened during the final decades of the Estado Novo regime, before democracy and the creation of a modern tax-financed national health service. Using an additional source of military origin, we find that a similar pattern of improvement in stunting occurred for young adult males during the same period, with the expected time lag.

Our results show that the good macroeconomic performance of the Portuguese economy during the second half of the twentieth century translated into considerably better living standards for infants, children and adults. The decreases in stunting and wasting were related to increases in income, sanitation and medical improvements that gradually spread through the country despite a limited (but expanding) healthcare system. Healthcare improvements mattered, but so did better nutrition, with much-increased consumption of high-protein foodstuffs such as poultry, beef, and milk.

Our results confirm the reformist and developmental nature of the Estado Novo regime (1926/33-1974), which had been previously documented along other dimensions, including education (Palma and Reis 2021), banking (Amaral 2013, 2015), and law (Álvares and Garoupa 2020). During the postwar European golden age, despite being a dictatorship, this regime generated material gains and convergence from which most of the population benefited, as has also been documented for Spain (Prados de la Escosura et al. 2012). The macroeconomic progress that occurred was associated with considerable improvements in ordinary citizens' living standards, including infants and children. That progress then further continued under democracy. As a result of this joint progress, Portugal was transformed during the 1945-1994 half-century from a country with dismal development outcomes into a modern developed country as far as health outcomes are concerned.

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Appendix (for online publication only)

Figure A1: Percentage observations in the Misericórdia dataset by sex and year

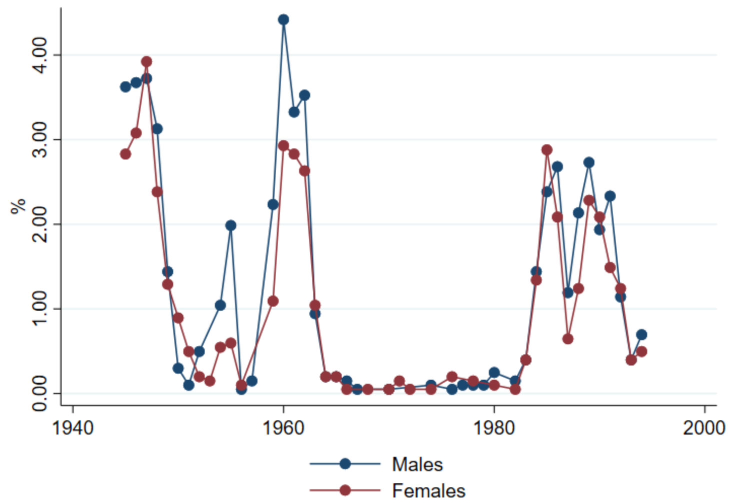


Figure A2: Percentage observations in the Casa Pia dataset by sex and year

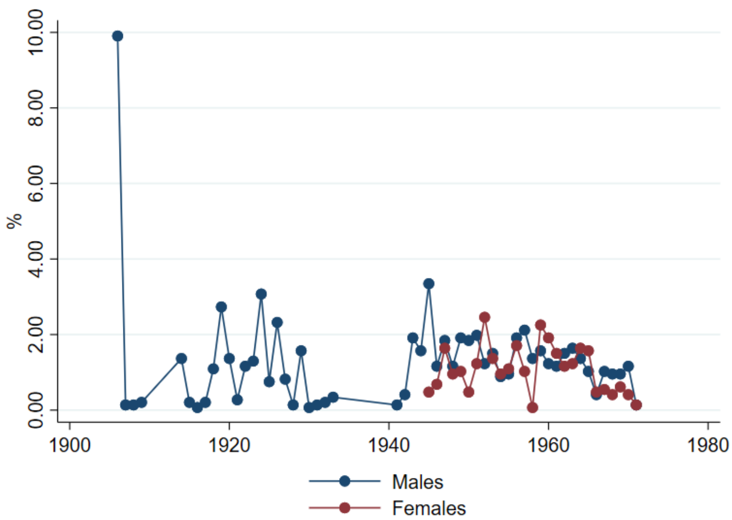


Figure A3: Total number of observations in the young adult military database

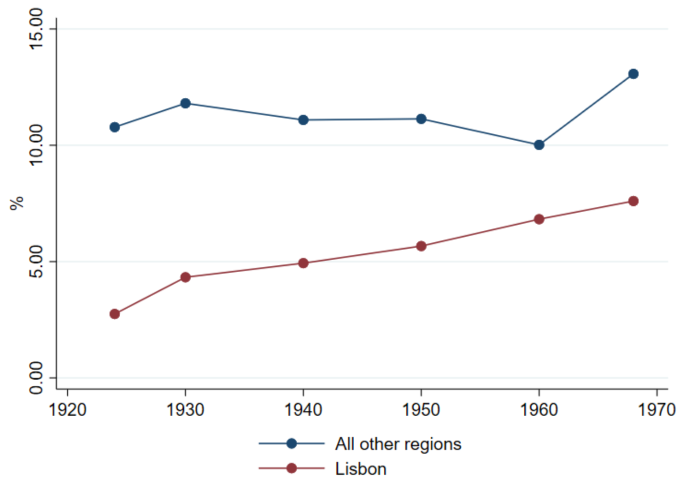
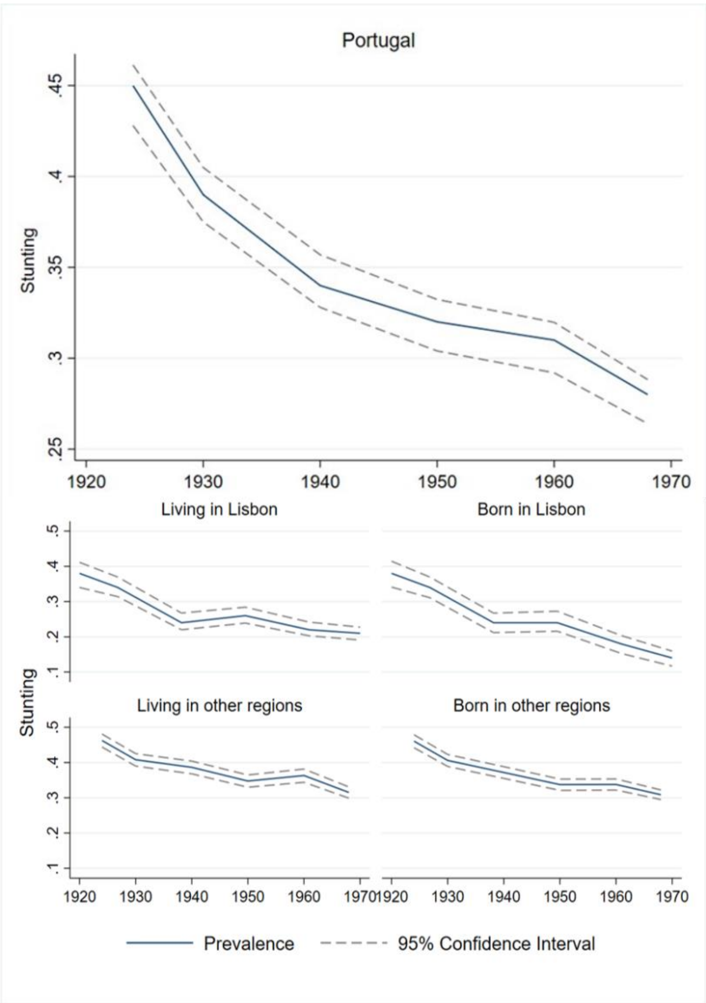


Figure A4. Stunting among young adult males



Discussion of sample representativeness

We now present evidence that our results are not driven by the selection of observables, where the weight/height information might have been observed conditional on diseases – for example, if a doctor or nurse could have made a note on this quantitative information with higher probability in situations of malnourishment. We collected 150 additional observations for the Misericórdia sample, which do not have the height or weight information, but for whom we know the medical diagnosis. We then compare this qualitative sample with our original dataset. We do not find evidence in favor of sample selection. Therefore, we argue that even though less than half the records in the archive include data on the heights and weights of children, they are representative.

The test is performed based on our extraordinary information on the doctors' diagnosis of the patients. We can use the clinical information reported by the doctors in the records to detect whether patients with diseases that can affect their weight/stature are statistically different. In practice, the classification of diseases is complicated, and disentangling causality is challenging. To simplify matters, we coded the doctors' diagnosis in a binary variable that equals 1 when the diagnosis reports at least one disease that can potentially affect long term height/growth – such as congenital malformations or an explicit diagnosis of growth delay/impairment – and 0 when there is no certainty of a growth-impairing disease.

We show that data on heights and weights are missing at random, which, as argued, increases the credibility of our main results not being driven by sample selection. In Table A1, we show the reported incidence of growth diseases coded in a "Growth Disease" dummy in the main dataset and the150 qualitative sample (random observations across decades, 25 males and 25 females for each period). The rationale behind this test is to check that the reason for recording height/weight in the hospital is not dependent on the existence of a clinical issue directly or indirectly related to a growth deficit, hence making our results endogenous, but simply a random outcome related to the current policies of the hospital or the diligence of the nurse which happened to record the patients' information.[32]

[32] The criteria that we adopted for the presence of a growth disease is given in detail below.

Table A1: Growth-impairing diseases in the total sample by decade (Misericórdia sample)

DECADE	MAIN SAMPLE	GROWTH DISEASE		QUALITATIVE SAMPLE	GROWTH DISEASE	
		=1	=0		=1	=0
1945-1954	656	257	399	50	17	33
1955-1964	554	205	349	50	23	27
1965-1974	19	10	9	0	0	0
1974-1985	96	26	70	0	0	0
1985-1994	645	176	469	50	7	43
TOTAL N	1,970	674	1,296	150	47	103

We split the analysis into both age groups (0-36 months and 2- to 10-year-olds) to study whether the information on diagnosis behaves in the same way both for the main sample and the additional qualitative sample. Tables A2 and A3 show that infants and children diagnosed with a growth impairing condition are found in the same proportion in both the qualitative and main samples.

Table A2: T-test results the binary coding of growth impairing conditions from the diagnosis of 0-36 months old infants (Misericórdia sample)

GROUP	N	GROWTH IMPARING DISEASE DUMMY (MEAN)
Qualitative sample	109	0.376 (0.047)
Main sample	1,517	0.344 (0. 012)
Diff = Mean (Qualitative) – Mean (Main)		0.033 (0.047)
T-Statistic		0.693
P-Value (Pr(|T| > |t|))		0.488

Note: this table reports the t-test statistics for the means of the dummy variables coding the growth impairing conditions from the doctor's diagnosis of children between 0 and 36 months old across decades for the main sample and the extra quantitative observations. The null hypothesis is that the sample means are equal, and we have 1,620 degrees of freedom. Standard errors are reported in brackets under the means.

Table A3: T-test results the binary coding of growth impairing conditions from the diagnosis of 2-10 year-old children (Misericórdia sample)

GROUP	N	GROWTH IMPAIRING DISEASE DUMMY (MEAN)
Qualitative sample	84	0.286 (0.050)
Main sample	521	0.352 (0. 019)
Diff = Mean(Qualitative) - Mean(Main)		-0.077 (0.054)
T-Statistic		-1.429
p-value (Pr(|T| > |t|))		0.155

Note: This table reports the t-test statistics for the means of the dummy variables coding the growth impairing conditions from the doctor's diagnosis of children between 2 and 10 years old across decades for the main sample and the additional quantitative observations. The H_0 is that the sample means are equal, and we have 609 degrees of freedom. Standard errors are reported in brackets under the means.

These tables show that infants aged 0-36 months old for whom data on height and weight has been reported are less affected by growth impairing diseases (3%). The trend is the opposite for older children, who show a higher prevalence of growth impairing diseases when their weight and height was recorded. However, we cannot reject the null that the difference of means equals zero for both age groups at conventional statistical confidence levels (p-values: 0.488 and 0.155>0.05). This is evidence that our data do not suffer from self-selection issues.

We classify the doctors' diagnoses into two groups, one for conditions that are more likely to affect growth, and another for less growth-impairing conditions. This classification was made using a single diagnosis without knowing whether these were chronic or acute afflictions, medical history, or comorbidities. As such, it is an imperfect classification that, for the most part, identified the following conditions as impacting growth potentially more than others: 1) congenital malformations; 2) heart conditions; 3) rheumatic conditions; 4) cancer; 5) chronic infections; 6) autoimmune diseases and 7) explicit diagnoses of growth delay/impairment.

In addition, we performed another test for sample selection bias: whether the infant patient went for a regular doctor's checkup appointment (outpatient) or whether he/she was interned in the hospital for days (inpatients). We coded the sample based on whether the children stayed in the hospital or just got inspected by the doctor. Table A4 shows that a change in this distribution cannot drive the observed changes between 1945-1954 and 1955-64.

Table A4: Children distribution by kind of stay in the hospital by decade (Misericórdia sample)

DECADE	INPATIENTS	OUTPATIENTS	TOTAL
1945-1954	656	0	656
1955-1964	554	0	554
1965-1974	19	0	19
1975-1984	96	0	96
1985-1994	289	356	645
TOTAL	1,514	356	1,870

Based on the classification of these criteria, we can test whether the children in the dataset are different by kind of interaction with the hospital for the sample 1985-1994, the period for which we have both kinds of patients.[33] We check whether the interned in the hospital are more stunted/wasted than those who go for a consultation with a doctor using a t-test of the means of the dummies stunted and wasted. For infants aged 0-36 months, we carry out the two-sample t-test with equal variances in Table A5.[34] We reject any differences in the interned and appointment children.

[33] There are two sources of data in the archive, one which concerns interns and the other for appointments. We divided children into these two groups based on this archival division.
[34] T-test with unequal variances leads to the same conclusions.

Table A5: T-test results on wasting and stunting prevalence differences by kind of stay in the hospital for infants between 0-36 months old (Misericórdia sample)

GROUP	N	STUNTED	WASTED
Inpatients	315	0.152	0.149
		(0. 020)	(0.201)
Outpatients	274	0.157	0.153
		(0.022)	(0.022)
Diff = Mean(Inpatients) - Mean(Outpatients)		-0.005	-0.004
		(0.029)	(0.029)
T-Statistic		-0.152	-0.138
P-Value (Pr(|T| > |t|))		0.879	0.891

Note: This table reports the t-test statistics for the means of the dummy variables stunted and wasted for the sample of children between 0 and 36 months old in 1985-1994. The H_0 is that the sample means are equal, and we have 590 degrees of freedom. Standard errors are reported in brackets under the means.

The two-tailed p-value computed using the t distribution (Pr(|T| > |t|)) is the probability of observing a greater absolute value of t under the null hypothesis. Because our p-values for the sample of 0-36 months old children between 1985-1994 are larger than 0.05, we cannot conclude that the difference in means is statistically significantly different from 0. We do not have enough evidence that stunting or wasting prevalences for infants between 0 and 36 months of age behave differently for inpatient and outpatient observations in the Misericórdia sample.

Alternatively, we can test whether there are any significant differences between children visiting the hospital under the null hypothesis that they were shorter, lighter and further from their reference group, suggesting that stunting or wasting affects inpatients more than outpatients. We test that hypothesis by looking at the average weight and height for each group and their z-scores based on the CDC guidelines by age and sex (i.e., each individual's z-score is adjusted for their age and sex). As before, we find no significant differences (Tables A6 and A7).

Table A6: T-test results on weight and sex- adjusted z-scores for weight by age by kind of stay in the hospital for infants between 0-36 months old (Misericórdia sample)

GROUP	N	WEIGHT IN KG	INDIVIDUAL Z-SCORE
Inpatients	315	6.958 (0.149)	-0.385 (0.071)
Outpatients	274	7.027 (0.160)	-0.525 (0.071)
Diff = Mean(Inpatients) - Mean(Outpatients)		-0.062 (0.219)	0.139 (0.101)
T-Statistic		-0.281	1.379
P-Value (Pr(|T| > |t|))		0.779	0.168

Note: This table reports the t-test statistics for the means of the weight and z-scores for the sample of children between 0 to 36 months old in the period 1985-1994. The H_0 is that the sample means are equal, and we have 587 degrees of freedom. Standard errors are reported in brackets under the means.

Table A7: T-test results on height and sex-adjusted z-scores for height by age by kind of stay in the hospital for infants between 0-36 months old (Misericórdia sample)

GROUP	N	HEIGHT IN CM	INDIVIDUAL Z-SCORE
Inpatients	315	65.606 (0. 620)	-0.581 (0.085)
Outpatients	274	66.204 (0.657)	-0.640 (0.087)
Diff = Mean (Inpatients) – Mean (Outpatients)		-0.598 (0.904)	-0.060 (0.121)
T-Statistic		-0.662	-0.490
P-Value (Pr(|T| > |t|))		0.509	0.624

Note: This table reports the t-test statistics for the means of the height and z-score value for the sample of children between 0 and 36 months old in the period 1985-1994. The H_0 is that the sample means are equal, and we have 587 degrees of freedom. Standard errors are reported in brackets under the means.

These tests show that, on average, 0-36 months-old inpatients are shorter and lighter than outpatients. However, p-values are too large to reject the null that the difference of means equals zero (0.509 >0.05). Hence, there is no evidence suggesting that inpatient infants were different from outpatients, which supports the universal use of this sample. The results for children between 2 and 10 years old are shown in Tables A8 to A10.

Table A8: T-test results on stunting prevalence differences by kind of stay in the hospital for children between 2 and 10 years old (Misericórdia sample)

GROUP	N	STUNTED
Inpatients	74	0.122 (0. 038)
Outpatients	40	0.200 (0.064)
Diff = Mean(Inpatients) - Mean(Outpatients)		-0.078 (0.070)
T-Statistic		-1.118
P-Value (Pr(|T| > |t|))		0.266

Note: This table reports the t-test statistics for the means of the dummy variables stunted and wasted for the sample of children between 2 and 10 years of age in the period 1985-1994. The H0 is that the sample means are equal, and we have 112 degrees of freedom. Standard errors are reported in brackets under the means.

Consistently with the test for infants, we find that the p-values are too large to reject the null that the difference of means equals zero (0.266 >0.05): we do not have enough evidence to state that the sample of inpatient children is different from the sample of outpatients. We cannot reject the null for any age for the period we can test.

Table A9: T-test results on height and sex-adjusted z-scores for weight by age by kind of stay in the hospital for children between 2 and 10 years old (Misericórdia sample)

GROUP	N	WEIGHT IN KG
Inpatients	69	15.633 (0.798)

Outpatients	40	13.065 (0.702)
Diff = Mean(Inpatients) - Mean(Outpatients)		2.568 (1.203)
T-Statistic		2.136
P-Value (Pr(|T| > |t|))		0.035

Note: This table reports the t-test statistics for the means of the weight and z-scores for the sample of children between 2 and 10 years old in the period 1985-1994. The H0 is that the sample means are equal, and we have 112 degrees of freedom. Standard errors are reported in brackets under the means.

Table A10: T-test results on height and sex-adjusted z-scores for height by age by kind of stay in the hospital for children between 2 and 10 years old (Misericórdia sample)

GROUP	N	HEIGHT IN CM	INDIVIDUAL Z-SCORE
Inpatients	74	98.568 (2.228)	-0.449 (0.194)
Outpatients	40	91.788 (2.224)	-0.710 (0.275)
Diff = Mean(Inpatients) - Mean(Outpatients)		6.780 (3.446)	-0.261 (0.336)
T-Statistic		1.968	-0.776
P-Value (Pr(|T| > |t|))		0.052	0.439

Note: This table reports the t-test statistics for the means of the heights and z-score values of the sample of children between 2 and 10 years old in the period 1985-1994. The H0 is that the sample means are equal, and we have 112 degrees of freedom. Standard errors are reported in brackets under the means.

Our goal is to find systematic differences in height and growth between children attending the hospital for different reasons. The A8 to A10 tests show that inpatients between 2-10 year-olds were 7 cm taller than outpatients. The same is true for weight, which shows a difference of around 2.5 kg across groups. However, when we account for their z-scores (see Table A10), which consider sex and age differences in the distributions (how far they are from the CDC growth guidelines), we can see that the deviation from the mean for impatient is smaller than for outpatients. This indicates a larger share of males or older patients in the group. Note how the sample size is notably smaller than in the group of 0-36 months-old infants, potentially leading to weaker results. The differences in z-score means are not statistically significant (p-values are too large to reject the null that the difference of means equals zero, 0.439>0.05), which is no different for the one-tail test. This confirms that our main results are not subject to sample selection on observables.

Poolability test

We have done several tests to ensure that the sample observations for the period 1945-1964, when both archives have observations available, are drawn from the same underlying population. Table A10 below shows the mean differences in stunting by sex and decade for both institutions. We test the null hypothesis that the differences in prevalence means are equal to zero, i.e. H_0: Mean (Stunting Prevalence Misericordia) – Mean (Stunting Prevalence Casa Pia) = 0. We do not find significant systematic differences overall. We find that overall, the *Misericórdia* sample is slightly more stunted than the Casa Pia sample and that this is driven by the differences in the female group from 1945-1954.

Table A11. Poolability test

	DECADE		**OVERALL**
Ho: Stunting Prev. % (Misericórdia - Casa Pia) = 0	1945-1954	1955-1964	
MALES 2-10	-0.191	-0.093	-0.093
	(0.205)	(0.072)	(0.068)
FEMALES 2-10	-0.204***	-0.114	-0.186**
	(0.076)	(0.294)	(0.071)
GENERAL	-0.147***	-0.067	-0.137***
	(0.052)	(0.139)	(0.005)

*Notes: The table shows the difference in prevalence by group and the p-value in parenthesis. *, **, and *** denote significance at 10, 5 and 1%.*

Table A12: Sample mean weight by age and cohort (children's full sample)

	Females				Males		
Age (years)	1945-1954	1955-1964	1985-1994		1945-1954	1955-1964	1985-1994
0	3.75	3.93	4.96		4.26	4.36	5.55
0.5	5.64	5.46	7.47		6.64	5.76	7.90
1	7.39	7.16	9.01		7.74	7.76	9.66
2	9.65	9.38	10.45		10.21	10.60	11.47
3	11.87	9.68	13.2		12.07	12.5	13.35
4	13.88	17	16.2		14.76	15.3	15.6
5	15.4	15.2	19.675		15.63	16.1	16.13
6	17	-	18.8		18.05	17.35	18.63
7	20.65	23.67	-		20.73	23.09	19.5
8	22.83	25.83	23.03		23.51	24.60	25.25
9	25.49	26.64	-		25.77	26.07	22.37
10	26.25	30.79	-		26.77	28.39	31.1
11	30.55	35.29	-		29.41	31.49	-
12	38.06	40.24	-		30.88	30.56	-
13	40.11	43.22	-		33.77	39.21	-
14	41.81	46.4	-		36.08	38.25	-
15	45.25	48.21	-		46.4	39.33	-
16	45.58	49.71	-		48.83	-	-
17	48.5	55.5	-		56.8	47	-
18	52.25	-	-		57	-	-
Average	18.89	17.89	8.04		18.90	14.87	8.02
Observations	483	428	296		599	556	355

Table A13: Sample mean height by age and cohort (children's full sample)

	Females			Males		
Age (years)	1945-1954	1955-1964	1985-1994	1945-1954	1955-1964	1985-1994
0	53.86	55.05	56.96	55.08	56.13	59.36
0.5	63.5	62.76	67.89	63.52	63.80	69.41
1	71.78	69.59	75.89	72.11	70.18	77.16
2	81.28	74.5	91	81.75	83	85.19
3	90.41	82	85.86	89.82	89	92.25
4	96.64	102	100.71	96.68	97.9	101
5	104.16	102.5	106.13	104.28	99	-
6	109.20	-	109	109.34	106	109.33
7	115.66	118.9	-	115.75	117.75	116
8	118.91	121.42	122	120.18	122.18	132.25
9	127.25	123.31	-	125.70	125.89	125.33
10	127.54	132.80	-	129.20	131.45	129
11	132.21	138.17	-	132.96	136.19	-
12	142.82	141.08	-	134.60	134.40	-
13	146.25	146.88	-	142.33	143.92	-
14	147.73	149.6	-	143.42	148	-
15	147.42	153.86	-	151.8	147	-
16	145.83	150.86	-	155.33	-	-
17	144	153	-	165.2	157	-
18	161	-	-	162	-	-
Average	102.93	93.22	69.86	103.61	89.02	69.71
Observations	483	428	296	599	556	355

Table A14: Distribution of observations by municipality, based on place of military inspection, young adult males database (Military Archives – Livros de Recrutamento dataset).

COUNTY	FREQ.	PER-CENT	CUM.
ALCOUTIM	383	1.45	1.45
AMARANTE	826	3.13	4.58
AMARES	357	1.35	5.93
ARGANIL	440	1.67	7.60
ARMAMAR	288	1.09	8.69
ARRAIOLOS	197	0.75	9.43
AVEIRO	647	2.45	11.88
BAIÃO	655	2.48	14.36
BARREIRO	436	1.65	16.01
CADAVAL	293	1.11	17.12
CANTANHEDE	646	2.45	19.57
CARRAZEDA DE ANSIÃES	350	1.33	20.89
CHAVES	931	3.52	24.42
FAFE	627	2.37	26.79
GÓIS	164	0.62	27.41
LAMEGO	885	3.35	30.76
LISBOA	8,479	32.10	62.87
LOURES	625	2.37	65.23
LOURINHÃ	374	1.42	66.65
MAFRA	759	2.87	69.52
MANGUALDE	549	2.08	71.60
MATOSINHOS	984	3.73	75.33
MAÇÃO	374	1.42	76.74
MESÃO FRIO	400	1.51	78.26
MORTÁGUA	232	0.88	79.13
MURÇA	380	1.44	80.57
NELAS	282	1.07	81.64
RIBEIRA DE PENA	474	1.79	83.44
SILVES	728	2.76	86.19
SINTRA	645	2.44	88.63
SÁTÃO	352	1.33	89.97
TAVIRA	163	0.62	90.58
VALE DE CAMBRA	353	1.34	91.92
VIDIGUEIRA	207	0.78	92.70
VILA FRANCA DE XIRA	589	2.23	94.93
VILA REAL	847	3.21	98.14
ÍLHAVO	491	1.86	100.00
TOTAL	26,412	100.00	

Table A15: Sample size, wasting and prevalence by sex and decade for children below 103 cm.

	Individuals			Wasting		
Decade	Total	Males	Females	Total	Males	Females
1945-1954	420	237	183	197 (0.45)	107 (0.45)	90 (0.42)
1955-1964	529	311	218	246 (0.44)	136 (0.43)	110 (0.50)
1975-1984	95	50	45	19 (0.22)	11 (0.22)	8 (0.18)
1985-1994	589	324	265	89 (0.17)	57 (0.18)	32 (0.12)
Total	1,633	922	711	551	313	240

Note: The table shows total and wasted individuals according to the CDC growth standards defined by the general weight-for-length distribution until 103 cm of length. We do not include the 1965-1974 period due to few observations being available. Prevalence in parenthesis under wasting count for each group.

Table A16: Sample size, stunting prevalence by sex and decade for infants (0-36 months old).

	Individuals			Stunting		
Decade	Total	Males	Females	Total	Males	Females
1945-1954	420	237	183	201 (0.48)	122 (0.51)	79 (0.43)
1955-1964	529	311	218	252 (0.48)	155 (0.49)	97 (0.45)
1975-1984	95	50	45	25 (0.26)	12 (0.24)	13 (0.29)
1985-1994	589	324	265	91 (0.16)	45 (0.14)	46 (0.17)
Total	1,633	922	711	569	334	235

Note: The table shows total and stunted individuals according to the CDC growth standards defined by the general length-for-age distribution. We do not include the 1965-1974 period due to few observations being available. Prevalence in parenthesis under the stunting count for each group.

Table A17: Sample size, stunting and prevalence by sex and decade for children (2 – 10 years old).

	Individuals			**Stunting**		
Decade	Total	Males	Females	Total	Males	Females
1905-1914	43	43	-	15 (0.35)	15 (0.35)	-
1915-1924	92	92	-	35 (0.38)	35 (0.38)	-
1925-1934	49	49	-	16 (0.33)	16 (0.33)	-
1935-1944	19	19	-	7 (0.37)	7 (0.37)	-
1945-1954	502	268	234	151 (0.30)	78 (0.29)	73 (0.31)
1955-1964	271	150	121	70 (0.26)	36 (0.24)	34 (0.28)
1965-1974	49	14	35	12 (0.24)	4 (0.29)	8 (0.23)
1985-1994	74			11 (0.15)	4 (0.11)	7 (0.19)
Total	1,099	635	390	317	195	122

Note: The table shows total and stunted individuals according to the CDC growth standards defined by the general weight-for-age distribution from 2 to 10 years old. We do not include the 1975-1984 period due to few observations being available. Prevalence in parenthesis under wasting individuals for each group.

Table A18: Sample size, stunting and prevalence by sex and decade for children (11-18 years old).

	Individuals			**Stunting**		
Decade	Total	Males	Females	Total	Males	Females
1905-1914	128	128	-	59 (0.46)	59 (0.46)	-
1915-1924	76	76	-	48 (0.63)	48 (0.63)	-
1925-1934	44	44	-	22 (0.5)	22 (0.5)	-
1935-1944	40	38	-	11 (0.28)	11 (0.28)	-
1945-1954	205	119	86	95 (0.45)	63 (0.53)	32 (0.37)
1955-1964	172	90	82	54 (0.33)	34 (0.38)	20 (0.24)
1965-1974	95	69	26	18 (0.19)	16 (0.23)	2 (0.08)
Total	760	564	194	307	251	54

Table A19: Regression coefficients for subsequent health inspections as a consequence of stunting

	Subsequent health inspections after				
	First	Second	Third	Fourth	Fifth
Stunting	0.191***	0.037	0.081	-0.165	0.114
	(0.060)	(0.096)	(0.147)	(0.148)	(0.74)
Age control	-0.002**	-0.013***	-0.041***	-0.039***	-0.321***
	(0.001)	(0.001)	(0.003)	(0.004)	(0.005)
Constant	1.838***	4.744***	11.39***	11.84***	11.64***
	(0.128)	(0.250)	(0.465)	(0.606)	(0.929)
Observations	1,461	602	123	91	50
R-squared	0.009	0.123	0.647	0.582	0.417

*Note: regression coefficients show the probability of subsequent measurements of height (dependent variable) provided that the current measurement reports stunting, controlling for the individual's ages. Robust standard errors in parentheses, statistical significance denoted by *** p<0.01, ** p<0.05, * p<0.1*

Table A20: Regression coefficients for subsequent measurements of stunting

	Stunting in subsequent inspections			
	Second	Third	Fourth	Fifth
Stunted in the first inspection	0.531***	0.560***	0.519***	0.525***
	(0.031)	(0.001)	(0.148)	(0.74)
Age control	0.003***	0.001***	0.039***	0.009***
	(0.000)	(0.003)	(0.004)	(0.005)
Constant	-0.229***	11.39***	11.84***	11.64***
	(0.060)	(0.465)	(0.606)	(0.929)
Observations	602	123	91	50
R-squared	0.389	0.647	0.582	0.417

*Note: regression coefficients show the probability of subsequent measurements of height (dependent variable) provided that the current measurement reports stunting, controlling for the individual's ages. Robust standard errors in parentheses, statistical significance denoted by *** p<0.01, ** p<0.05, * p<0.1*