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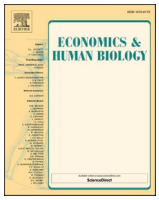

Stunting and wasting in a growing economy: biological living standards in Portugal during the twentieth century☆

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ABSTRACT

Portugal's real income per head grew by a factor of eight during the second half of the twentieth century, a period of fast convergence towards Western European living standards. We use a new sample of about 3,400 infants and children living in Lisbon to document trends in the prevalence of stunting and wasting between 1906 and 1994. We find that stunting and wasting fell quickly from around 1950, for both males and females. We additionally use a sample of more than 26,000 young adult males covering the entire country, which shows a consistent decrease in wasting and stunting with the expected time lag. We discuss these trends in relation to changes in income and public policy, which affected the ontogenetic environment of children. Sustained progress began well before the introduction of democracy.

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.[1] Portugal converged from around one-third of the GDP per capita of the core of Western Europe's high-income 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 3,360 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. Overall, the evidence we find contradicts the dominant paradigm in Portugal's historiography, which considers that the undemocratic regime known as Estado Novo prevented the economic and social modernization of the country. For example, Cardoso (2008, p. 270–2) writes that Portugal "did not experience major social and economic changes after World War II like other European countries", that "the dictatorship represented a long period of economic stagnation", and that "changes were occurring at an unbearable slow rate".[2]

In this study, we focus on two measures of physical growth as indicators of societal changes in the 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

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[1] 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 mid nineteenth century (Palma and Reis, 2019).

[2] See also Rosas (1996, p. 52). This paradigm is not only present in the academic literature but also in school curricula (Mendes et al., 2001, p.52).

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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 WHO Child Growth Standards (De Onis et al., 2006) to identify individuals in our sample as stunted or wasted.[3] We then calculate the prevalence of stunting and wasting by decade, sex and age group: infants (up to 24 months of age) and children (ages 2–5, and 5–18 years of age).[4]

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, 2013; Pato, 2011; Schmidt et al., 2012; 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 around 20% 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 large 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. The improvements that happened in Portugal during the second half of the twentieth century led to a fast convergence of health and welfare outcomes relative to the Western European standards, which did not improve as quickly then.[5] 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, were created in 1943.[6] 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.[7] We cleaned the data and restricted the sample to the period 1905–1994.[8] Finally, since both prior sources cover infants and children only, we additionally study young adults through the *Livros de Recenseamento Militar*, a military source belonging to the Army. Unfortunately, the latter source only allows the study of males.

2.1. 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 1928 infants and children who attended the hospital between 1945 and 1994.[9] The individuals in the sample lived within the proximity of the hospital or were transferred there from hospitals and institutions located elsewhere. Until 1979, when the Portuguese public universal health care system was created, the country relied mainly on a private and charity-run network of hospitals and other similar facilities.[10]

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

[3] Given that the World Health Organization Growth Standards describe the growth of healthy children under optimal conditions, we also take into account the growth reference from the Center for Disease Control and Prevention (CDC, Cole et al., 2000) as a robustness check. The CDC growth reference simply presents the growth patterns of children in a specific location and time, which may not align with optimal conditions as it is likely to some of the children in our sample. Therefore, using this reference provides an additional level of robustness to our analysis.

[4] In order to conform to the conventional categories established by the World Health Organization (WHO) in their Growth Standards (De Onis et al., 2006), we divided our age groups into 0–24 months, 2–5 years of age, 5–18 years of age (note that the last category of the WHO is up to 19 but there are no individuals beyond 18 in our sample). Although the WHO considers all individuals under 18 years of age as children, we adopted the distinction of classifying individuals younger than 24 months as infants and those older as children, which aligns with the guidelines of the Center for Disease Control and Prevention (CDC) (Cole et al., 2000).

[5] In contrast with Portugal, most Western European countries experienced the bulk of their increase in mean stature prior to the Second World War (Hatton and Bray, 2010; see also Floud et al., 2011). In rural Spain, too, a difference in life expectancy of shorter conscripts tended to disappear for twentieth century birth cohorts (Marco-Gracia and Puche, 2021); for the case of Spain see also Cámara et al. (2021).

[6] Arquivo Histórico da Santa Casa da Misericórdia de Lisboa, SCML, Assistência Médica, Hospital Infantil de São Roque, Processos Clínicos de Internamento.

[7] Arquivo Histórico da Casa Pia de Lisboa, IP, Mensurações Antropométricas (1906-1913); Arquivo Histórico da Casa Pia de Lisboa, IP, Processos individuais de alunas e alunos (1914-1970). 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 different from ours and not publicly available.

[8] Our hand-collected dataset consists 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 1905-1994 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 1928 children for the *Misericórdia* dataset, 1,461 children for the *Casa Pia* dataset, and 26,412 for the military recruitment dataset.

[9] 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.

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

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

	Infants (0–24 months)	Children (2–5 Years)	Children (5–10 years)	Total
Males	774	179	89	1,042
Females	609	155	94	858
Total	1,383	334	183	1,900

Notes: We split our sample into three different age groups for consistency with the WHO (2006) guidelines. An alternative split following the CDC reference group guidelines that we use for robustness can be found in the Appendix.

representative of the population.[11] We show in the Appendix that the children in our sample for Casa da Misericórdia are no different from children that visit the hospital for simple consultations. The representativeness of our Misericórdia sample is also confirmed with the comparison with the later 20-year old outcomes.[12]

Data were collected from the clinical file of each child initiated by the doctor or nurse when the child was first admitted. For each child, we collected the year of observation, age of the individual (in months), sex, weight in kilograms, and height in centimetres. We also collected handwritten notes from the attending physician or nurse, namely the clinical diagnoses. To follow the WHO Growth Standards and for simplicity, we divided our Misericórdia sample into three age groups: infants (0–24 months), children (2–5 years) and children (5–18 years). The number of observations in each group is listed in Table 1. Note that the Misericórdia sample only covers children up to 10 years old.

The z-score for height and weight is calculated for each child based on the WHO growth reference. The z-score is a relative measure of growth calculated in terms of standard deviations from the sex- and age-specific mean.[13] Finally, a dummy variable identifies those below the −2 z-score threshold (following De Onis et al., 2006) and 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.[14] Namely, we compare 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.[15]

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.[16] 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.[17]

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

	Males	Females	Total
Born in Lisbon	607	260	867
Born in other regions	431	162	593
Total	1,038	422	1,460

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.

2.2. Casa Pia

The *Casa Pia de Lisboa* is a school located in Lisbon. It is still in operation. During the period we cover in this paper, it received children from all parts of the country, including a few born in the colonies. We collected data from this source for all periods.[18] This school was dedicated to receiving children who had lost at least one of their parents.[19] 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.[20]

We collected the *Casa Pia* data from two documents: the *Livros de Mensurações* – actual books containing 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 became 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).[21] As in the *Santa Casa da Misericórdia* sample, we calculate z-scores for height and weight for each child based on the WHO growth reference.

[11] The low-to-middle socioeconomic segment which were the bulk of Lisbon's population across the period considered is sure to be observed. Nonetheless, it is still possible that as incomes were growing and more hospitals were built, an emerging middle class looked for other options, selecting out over time. If so, our results can be seen as a lower bound for the progress that occurred, as negative selection happened over a period for which we still show considerable anthropometric progress.

[12] Additionally, a number of number of children were sent to the hospital from areas outside of Lisbon. After the mid- to late 1990 s, 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.

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

[14] 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.

[15] See Tables A1, A2 and A3 of the Appendix.

[16] 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.

[17] See Tables A4, A5, A6, A7, A8, A9 and A10 of the Appendix.

[18] Figure A2 of the Appendix shows the distribution of our *Casa Pia* sample over time.

[19] There was a separate school for children with cognitive limitations, which we do not consider here.

[20] Below, we consider repeated visits taking advantage of the longitudinal dimension for those who are observed more than once.

[21] Before 1942 the children were not measured when institutionalized, but they were always measured on their birthdays, meaning that they were measured within a year, at most. After 1942–43, they were measured when they were institutionalized, but this might not have been done immediately; there could have easily been a lag of a few weeks. Hence, the average lag was likely not too different across time.

Table 3
Total children in the 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
1935–1944	59	0	0	59	0
1945–1954	1,043	328	304	247	164
1955–1964	933	309	210	217	197
1965–1974	164	9	11	83	61
1975–1984	95	50	45	0	0
1985–1994	643	346	288	0	0
Total N	3,360	1,042	858	1,038	422

2.3. 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.[22] Table 3 shows details about the contribution of each subsample to the totals.[23] Fig. 1 shows correlations of height and weight, separated by sex and age by place of birth. As expected, we observe infants (0–24 months old) have a lower weight, height, and variability than children and teenagers (2–5 and 5–18 years old), for both sexes.[24]

2.4. Livros de Recenceamento Militar

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 to 1968.[25] This data originates from military records concerned with mandatory inspection for potential recruiting of young males for the Portuguese armed forces. The procedure covered the whole country and was organized to ensure that all young men complied with the military and medical inspection.[26] We collected a random sample which includes observations for municipalities (*concelhos*) covering all major regions of continental Portugal (Table 4). 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).[27] 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.[28]

3. Wasting and stunting among infants and children

3.1. 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 (WHO) below two standard deviations and/or mid-upper arm circumference < 125 mm; the presence of bilateral pitting edema. We focus on the first criterion alone since it is the only one we can measure in our dataset. Wasting references are available at different ages and by sex from the growth references at WHO (De Onis et al., 2006), but only until 120 cm. The World Health Organization (WHO) has two different references for weight-for-height measurements and wasting: one for children who cannot stand in a recumbent position (length from 45 to 110 cm) and another for children who are measured in a standing position (height from 65 to 120 cm).[29] The WHO Multicountry Reference Group (De Onis et al., 2006) measured children between 18 and 30 months old in both positions, resulting in two different standards. Therefore, we focus on wasting among these two specific groups (all our infants and children up to 120 cm).[30] Fig. 2 shows that wasting among infants fell steadily from the mid-1950s, and in the case of males between 65 and 120 cm, improvements come from even earlier (though the timing of the improvement remains uncertain).[31]

3.2. Stunting among infants and children

Child stunting is 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 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 the Growth Reference Standard. Severe stunting is defined as height-for-age below three standard deviations. There are three height-for-age reference values for children of different ages: one for 0–24 months of age, another for those 2–5 years old, and one for children between 5 and 19 years of age.[32] This paper considers children in these three categories consistently with WHO categories.

The stunting prevalence by decade and age category is shown in Fig. 3.[33] Our calculations suggest that the prevalence of stunting was close to 60% for all age groups in 1945, for both males and females, and that it consistently decreased to 20% for younger children. The available

[22] In the Appendix, we show that for the main periods when the two samples overlap (1945–64), the results for each subsample are not statistically different. See Table A11 and the surrounding discussion.

[23] We align with the recommendations of Jenkins and Quintana-Ascensio (2020) that sample sizes of 25 or higher provide reliable indicators for health statistics.

[24] 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).

[25] This data is part of the collection entitled Exército Português, *Relatórios de Inspecção*.

[26] For details concerning the this source, see Palma and Reis (2021, p. 416).

[27] See Palma and Reis (2021) for more details about this source.

[28] 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.

[29] For the WHO standards, see: https://www.who.int/tools/child-growth-standards/standards.

[30] See Table A15 and Table A16 of the Appendix for the prevalence of wasting among infants over time.

[31] Wasting criteria can also be found at CDC and our robustness calculations are available in the Appendix (Figure A3). Our results are consistent looking at both references. Data available at different ages, and by sex, from the CDC (https://www.cdc.gov/growthcharts/clinical_charts.htm).

[32] Since the individuals in our infants and children sample are only 0–18 years of age, our calculation only refer to children up to 18 years of age when we refer to the main sample. We focus on the 19 year old references when we consider young adults.

[33] Note that the CDC equivalent table for the Casa Pia sample is the same as for the WHO criteria, hence we do not repeat it. Table A20 of the Appendix shows the number of observations by group according to CDC criteria for the Misericórdia sample. For specifics about sample sizes, see Table A21 and A22.

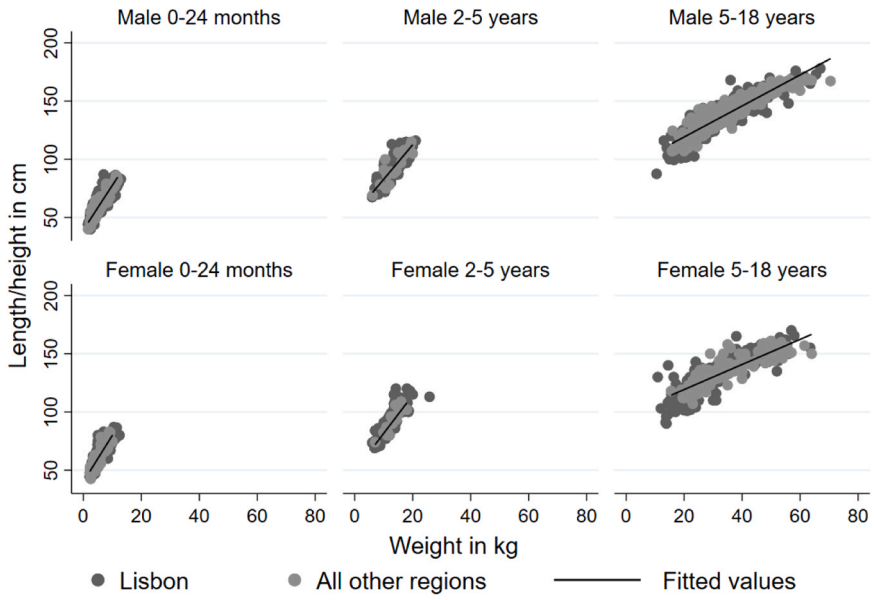

Fig. 1. Height on weight for infants and children of both sexes. Note: the total sample size corresponds to 1,928 individuals from the Misericordia hospital and 1,459 observations for Casa Pia.

evidence for the 5–18-year-old group is more limited but also shows improvement over time. We can observe previous decades for this group, which indicates that prevalences at the beginning of the century were even larger, at least for males, which suggests that the improvement started even before. Please notice that the slight increase in the prevalence of the 5–18 years of age in 1965 is accompanied by a reduction in sample size corresponding to larger confidence intervals.

The prevalences shown in this graph are larger than the ones reported by the CDC standards. This is because the WHO and the CDC make different assumptions.[34] Given the different thresholds, the stunting prevalences vary for each reference although not substantially. The trends described, however, are remarkably similar. Hence we also report the CDC statistics in the Appendix, Figure A4, which show a consistent decreasing trend.

4. Stunting among young adult males

We now move to the discussion of young adults.[35] As explained in Section 2, we can only observe males due to the military nature of the source. However, our sample is representative of those who survived to the age of 20 and lived in Portugal, since the military inspection was universal. We collected a random sample of 26,412 observations from all around the country, focusing on mainland Portugal only, i.e., we do not consider the islands or the former colonies.[36] This sample allows us to check that for each generation, the improvements seen in the children are seen in an different sample concerning 20-year olds observed later.[37] This is hence an independent check for the plausibility of our results. Given that the young adults sample covers the entire country, it also allows us to also track the trends of the spread of improvements to the rest of the country. A downside of this young adults sample is that given its military origin, women are not observed.

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

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

Fig. 4 shows that the prevalence of stunting was consistently lower in Lisbon than in Portugal.[38] As with infants and children, there was a decreasing trend over time: for the country, stunting decreased from around 40% of individuals in 1924 to close to 20% by 1968.[39] Progress happened earlier for those living in Lisbon: stunting decreased from more than 35% in 1924 to less than 20% by 1968. As with infants and children, health improvements began before a tax-financed national health service was created.

The age of measurement of these young adults is 20 years of age, but

[34] The WHO mean stature at 19 for males is 176.54 cm, and the − 2 S.D. equals 161.95 cm. Instead, for the CDC, the mean stature for males at 20: 176.86 cm, and the − 2 S.D. height value is 162.48 cm.

[35] Figure A5 in the Appendix shows the number of observations over time for this database.

[36] We did not collect data beyond 1968 because from 1969 the military inspection began to happen at the age of 18 instead of 20.

[37] There is a literature on catch-up growth after the critical early years and prior to completed height. Some of it suggests that when circumstances change, a rapid catch-up breaking the link between growth in the early years and completed heights might be possible (Schneider and Ogasawara, 2018; Depauw and Oxley, 2019). The evidence suggests that this did not happen in our particular case.

[38] 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 A6).

[39] 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.

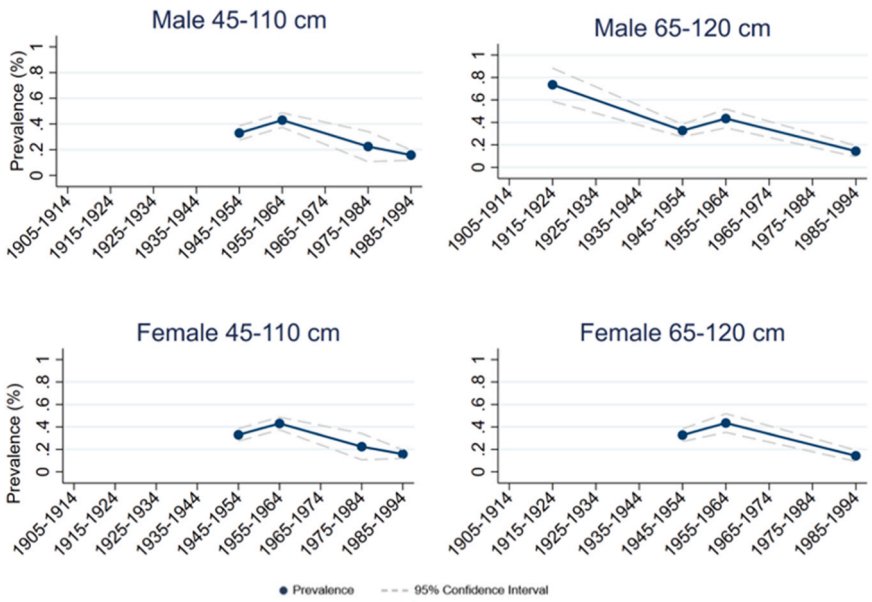

Fig. 2. Wasting for infants (WHO Growth Standard). Note: Wasting prevalences calculated by the authors based on WHO growth standards at recumbent length (45–110 cm) and standing height (65–120 cm). Periods without a dot are interpolated due to low sample size. Please, refer to appendix Table A15 and A16 for sample size information for each group.

the WHO growth standards only reach until the age of 19; therefore, we took particular interest in the CDC version of this graph that is provided in the Appendix (Figure A7), as the CDC growth reference reaches the age of 20. Since the CDC growth reference does not assume optimal growth conditions, it suggests a shorter z-score at 20 than the WHO at 19; hence generally, stunting prevalences are larger using the CDC. However, we can confirm the decreasing trends.

5. Interpretation

Portugal's income and health improvements 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, 2004; Deaton, 2013).[40] Infant mortality due to digestive diseases up to 3 years of age fell, and literacy levels among children rose steadily from the late 1920 s onward (Palma and Reis, 2021). From around 1950, infrastructure improved considerably regarding water access, sewage, and the quality of dwellings (Pato, 2011; Saraiva et al., 2014).[41] This decreased the incidence of diarrhea and digestive diseases that commonly affect children.[42] The infrastructure improvements happened earlier in urban areas, particularly in Lisbon, than elsewhere in the country (Pato, 2011, pp. 97–98). The country began to industrialize systematically and experienced high economic growth and convergence rates to the European core from the early 1950s, hence a decade before entering the European Free Trade Association (EFTA): see Fig. 5 and Lains (2003).

Nutrition in Portugal improved considerably over the twentieth century. At least from the 1950s, and for the country overall, per capita protein consumption from foodstuffs, including meat, eggs, and milk, increased significantly (Table 5).[43] Progress was only 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.

In addition to improved nutrition, 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 child stunting. While the most significant decrease in stunting occurred before the 1960s, most mean height increases occurred 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 concerning 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 indicates a steep decrease between 1940 and 1950, which continued to decrease and then became steep again around 1970

[40] 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., 2023).

[41] For other regions of the world, research has shown that access to water and sanitation infrastructure has a stronger negative relationship with stunting than other public services (Bridgman and von Fintel, 2022).

[42] This had great implications for health outcomes. The proportion of deaths due to digestive diseases reduced from more than 14% in 1940 to less than 3% in 1990. Improvements began in the 1940s, in line with what we find for stunting improvements. For details, see Table A23 in the Appendix, based on Morais (2019), and the accompanying discussion we provide there.

[43] Cardoso (2008, p. 272) presents an alternative but less detailed breakdown of per capita food consumption starting in 1948-49. This also shows that much progress in per capita food consumption had taken place in the 1950s, even though the author ignores this fact in the written text. In particular, consumption of all animal productions except fats increased considerably, and milk consumption quadrupled. Animal protein in meat and milk provide micronutrients which matters greatly for human health and growth (Baten and Blum, 2014, p. 145).

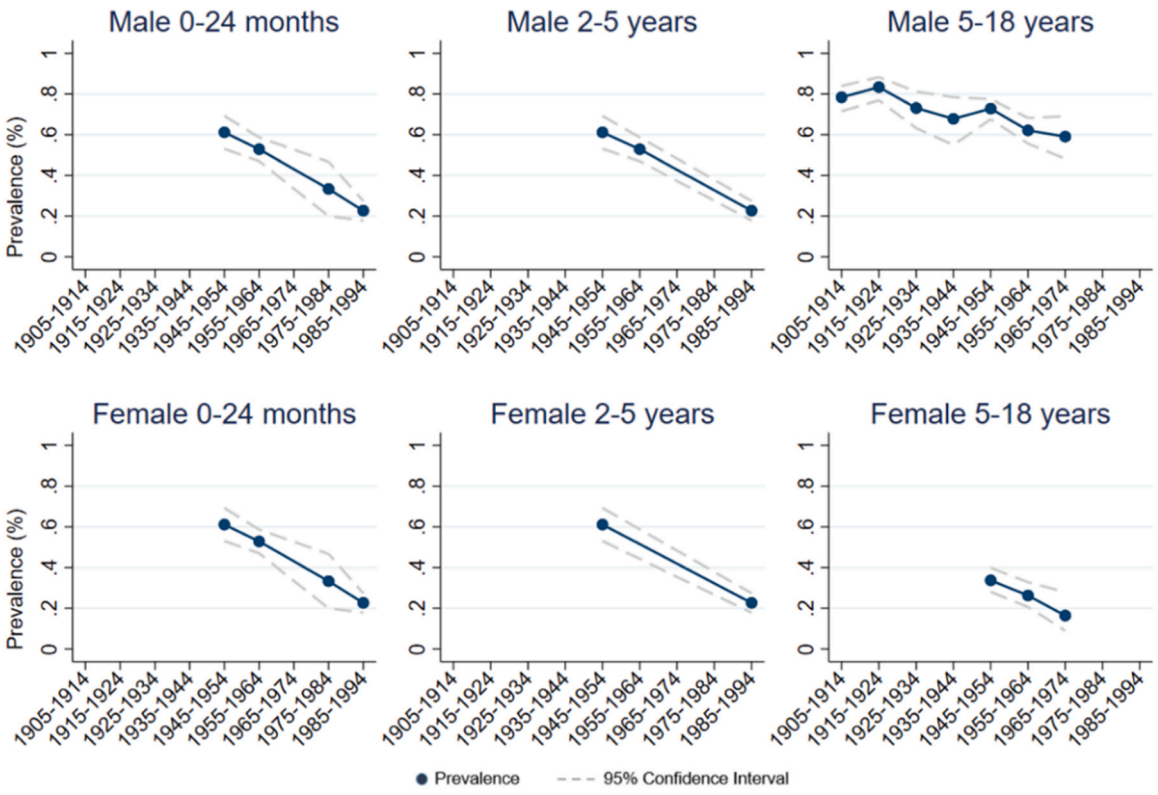

Fig. 3. Stunting by sex and age group (WHO growth standard). Note: Stunting prevalences calculated by the authors are based on WHO growth standards. Periods without a dot are interpolated due to low sample size. Please refer to appendix Tables A17, A18 and A19 for sample size information for each group.

(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 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 great improvements in the period we cover in this paper (Table 6). As the table shows, infant mortality declined sharply after an initial temporary rise during the 1910s.[44] Relatedly, Portugal began a fertility transition in the second half of the 1920s, with the birth rate – measured as the number of surviving births per 1000 people in the population – falling persistently and at times quickly in the following decades, despite a temporary pause during 1940–1960 (Instituto Nacional de Estatística, 2013, p. 38). Data for the fertility rate – average number of children per woman – is unavailable in detail before 1960, but by then, it was down to three.[45] This indicates that a demographic transition was already occurring. The fertility rate fell further to 2.7 by 1974, 1.7 in 1985, and only 1.4 by 1994 (Instituto Nacional de Estatística, 2013, p. 41). High income growth and low fertility levels from the 1950s meant that feeding better each surviving child became possible.

The supply of tax-financed health services increased substantially in quantity and quality during the period under study. These public policies had an impact on health and well-being as happened elsewhere in Western Europe over the twentieth century (Jong, 2015). 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 a public national vaccination plan from 1965, which reduced child mortality due to communicable diseases for children 1-4 years old to less than half within a decade (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 1954–16% by 1960, 30% in 1965, 60% in 1970, and finally, 78% in 1975 (Carreira, 1999, p. 412).[46] In addition, from 1963, a healthcare system known as 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.

5.1. *Individual persistence*

Our prior results point to a long-run improvement in the prevalence of stunting and wasting, backed by an improvement in the provision of nutrition and health. However, we have not discussed the effect of

[44] For comparative evidence showing that Portugal's child mortality was considerably higher than in other Western European countries in the early twentieth century but converged during the period we cover in this paper, see Global Burden of Disease Collaborative Network (2018).

[45] Historically in Portugal, women had 4 or more children, with about a third dying before the age of 7 (Palma et al., 2020).

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

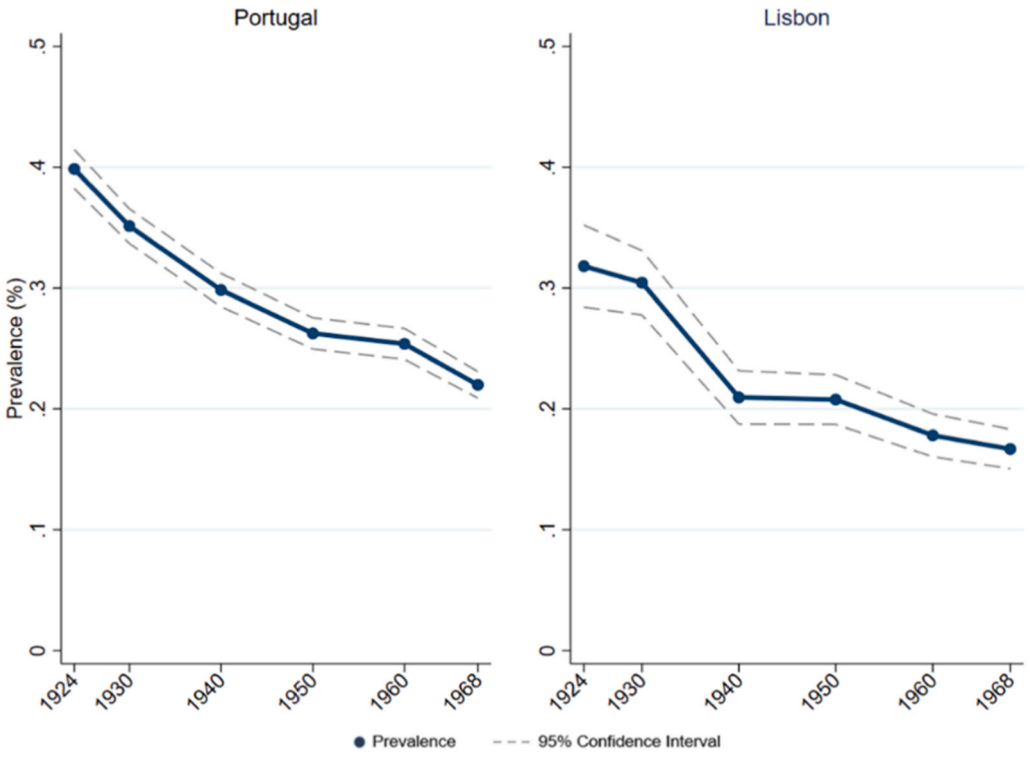

Fig. 4. Comparison of stunting in Portugal vs. Lisbon for 20 year-old males. Note: Stunting prevalences calculated by the authors are based on WHO growth standards at 19 years of age (the latest possible). For details, please see the Appendix, Fig. A6.
Source: Arquivo Geral do Exército, *Livros de Recenseamento Militar* (1924–1968).

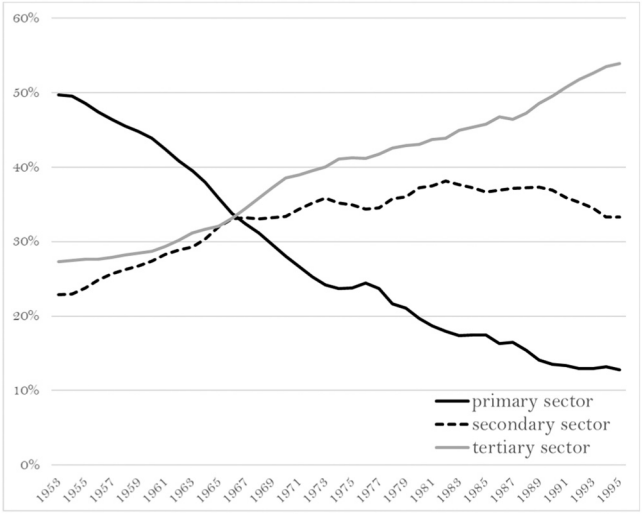

Fig. 5. The sectorial distribution of employment in Portugal's economy, 1953–1995.
Source: our calculations based on the data by Pinheiro (1997).

attending a given institution on individual well-being over time. In the Casa Pia database, extant records indicate that some individuals attended several medical inspections over time during their stay, generally on their birthdays. In this section, we take advantage of the possibility of considering the persistence of stunting over time (scarring effects). For individuals appearing in our sample more than once, we consider the probability of stunting in each subsequent health inspection conditional on the outcome of the previous one. This simple test aims to assess the probability of individuals being able to improve their health indicators in the medium run (over their childhood), once being institutionalized.

Table 7 describes our observations of individuals with multiple records and the stunting prevalence per number of inspection. Firstly, we observe a high level of attrition in the sample (there are fewer observations with a higher number of inspections). Secondly, the stunting prevalence for individuals considered in different inspection numbers increases over time. Note, however, that this table does not track the time of the inspection, so this increase in prevalence does not correspond to an increase of stunting over time: visits took place within a maximum difference of a year (entry day and/or birthdays), so we consider individuals who stayed a maximum of six years in the Casa Pia.[47]

Given the constraints of our dataset, we cannot look at other factors affecting the probability of stunting other than the fact that these individuals appear in a previous inspection.[48] We estimate the following model by OLS, resulting in a Linear Probability Model:

$$Stunted_{t,i} = a_0 + b_1 stunted_{t-1,i} + b_2 controls_i \quad + \quad \varepsilon_i$$

The controls of our regression include the age and sex of the individual as well the corresponding cohort. This way, we control for

[47] Hence, it is unlikely that any of these individuals belong to the stunting statistics of the next decade.

[48] We consider individuals inspected and measured up to 5 times. Most individuals were measured upon entry on the institution and again, systematically, on their birthday. The cohorts they belong to go from 1895 to 1904–1965–1974.

Table 5
Average per capita annual food consumption for selected staples, in kg or liters.

	1948/9	1963	1970	1974	1977	1980	1990
WHEAT	55.0	67.9	75.2	75.2	72.0	75.0	76.7
RICE	8.6	14.5	14.8	17.8	16.1	13.9	17.4
POTATO	80.6	102.3	121.7	110.9	91.9	130.1	128.3
SUGAR	12.0	19.1	25.6	30.0	27.9	31.3	29.3
PORK	3.8	6.0	7.5	9.4	9.4	9.5	15.6
POULTRY	1.3	1.4	7.1	11.9	15.0	11.6	13.0
BEEF	3.8	6.8	11.2	14.3	13.4	10.3	13.0
COD	6.1	6.8	10.1	6.8	5.2	3.0	5.0
EGGS	1.6	3.7	4.4	4.5	4.4	5.1	6.6
MILK	11.9	30.8	51.8	57.3	59.6	60.6	83.5
OLIVE OIL	7.5	6.7	6.9	5.3	4.2	4.2	3.3
WINE	90.6	91.3	79.4	131.0	85.9	95.0	63.3
BEER	2.0	4.4	14.8	32.6	29.5	40.1	67.8

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 liters, all else in kg. We focus on the edible part of foodstuffs, e.g. rice without chaff. In the case of 1977, the source is not clear whether quantities correspond to totals or edible parts. Source: For 1948-49, Instituto Nacional de Estatística (1951). For 1963 to 1974, we rely on Campos (1980); see also Barreto et al. (1996, p. 84). For 1977, we rely on Instituto Nacional de Estatística (1984). For 1980 and 1990, we rely on Instituto Nacional de Estatística (1994, pp. 24-25, 44-45) and Instituto Nacional de Estatística (1999).

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.

different probabilities of stunting for earlier periods and for younger individuals.[49] The results (Fig. 6) show that the probability that individuals' weight was 2 S.D. below the average for their reference group was heavily dependent on the person's prior status during the previous measurement. Individuals stunted in their first inspection likely remained stunted in subsequent visits. This shows that initial deprivation had long-term – likely permanent – adverse health effects for most individuals. Our results also suggest there was no catch-up growth. Hence, the institutional conditions of Casa Pia were at least not so much better than outside that they would have generated it, alleviating concerns about the effect of the time of measurement at Casa Pia.

6. Conclusion

Portugal witnessed its fastest economic development 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

[49] See Table A24 in Appendix for details.

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

Inspection Number	Observations	Stunted and prevalence
First	1,460	503 (0.35)
Second	615	237 (0.39)
Third	122	54 (0.44)
Fourth	90	44 (0.48)
Fifth	59	24 (0.40)

Note: This table shows the number of individuals who had 1–5 health inspections in our records and their stunting prevalence.

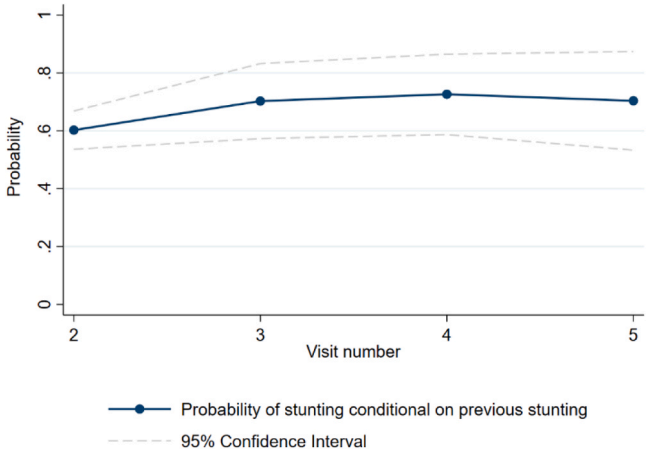

Fig. 6. Probability of stunting by inspection number conditional on stunting in previous visit. Note: This graph shows the probability of appearing as stunting conditional on stunting in the previous inspection, as described in equation (1), using robust standard errors. The regression includes controls on age at measurement, sex and cohort. Data from Casa Pia, described in the text. Refer to Table A24 in the Appendix to check for the regression coefficient results.

affected individuals of both sexes and covered the entire country. The most noticeable changes happened during 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. The progress in health and physiological capital that took place under the Estado Novo regime from around the mid-century is plausibly connected to these public policies, in interaction with the economic growth of the period. Healthcare improvements mattered, but so did better nutrition, with much-increased consumption of high-protein foodstuffs such as poultry, beef, and milk.

Previous work has documented the reformist and developmental nature of the Estado Novo regime (1926/33–1974), along dimensions such as education (Palma and Reis, 2021), banking (Amaral, 2013, 2015), and law (Álvares and Garoupa, 2020). In fact, during the postwar European golden age, despite being a dictatorship, this regime invested in public policies and generated material gains from which most of the population benefited, as was similarly the case in Spain (Prados de la Escosura et al., 2011). Political institutions in any given context are a

bundle, and while the Estado Novo was a dictatorship, it provided certain investments and reforms which led to economic development, convergence to European living standards, and, in time, cultural change as well (Acemoglu and Robinson, 2022).

The macroeconomic progress that occurred was associated with considerable improvements in ordinary citizens' living standards, including infants and children, as we show here. That progress then continued further 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.

Author statement

All co-authors contributed equally to the manuscript.

Appendix: Supporting information

Supplementary information associated with this article can be found in the online version at doi:10.1016/j.ehb.2023.101267.

The data and replication package for this paper is available at: https://zenodo.org/record/8055221

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