Living Standards, Nutrition and Inequality in the Spanish Industrialisation. An Anthropometric View*

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This special issue of *Revista de Historia Industrial* is devoted to the height and standards of living in Spain during the process of industrialisation. The aim is to examine changes in nutrition during the industrial age through anthropometric indicators. The five studies included in this issue provide new evidence on the changes in height among different socioeconomic groups and its relation with health and human well-being in different periods and geographical regions, while exploring inequality even prior to industrialisation and long before the calculation of income distribution became possible in Spain in the late-twentieth century. In addition to tracking the effects of environmental changes on well-being and inequality between the proto-industrial period in the eighteenth century and the industrial leap in the beginning of the second half of the twentieth century, these studies explore the costs of industrialisation in biological standards of living in the short- and the long-term. This introductory article will provide an overview of the study of living standards in Spain from the perspective of anthropometric history, presenting new data and conclusions and an overview of the relevant literature, and finally suggesting future directions of research.

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Nutrition and Human Well-being from the Industrial Revolution Onwards: The Contribution of Anthropometric History

Escaping malnutrition and improving public health standards are among the main human welfare achievements to have occurred since the Industrial Revolution.[1] Industrialisation and urbanisation were decisive processes in the lives of those families who gained access to new opportunities and services, as these resulted ultimately in the improvement of their nutritional state, health and living standards. The economic growth and technological progress achieved by industrialised nations led to an increase in per capita income and life expectancy, and to a decrease in infant mortality. Along with the advances in medical sciences (the dissemination of the germ theory of disease is a significant example), these developments set the stage for the improvement of overall well-being in industrialised nations during the following century. In the long-term, industrialisation had positive effects on public health standards, but at a high social cost, as demonstrated by the debate surrounding the standards of living of the working classes and the negative externalities in urban and industrial environments.[2]

One of the most reliable indicators of past nutrition levels and standards of living is the stature of the different population cohorts. A large body of literature has demonstrated that, over the past 150 years, European populations have undergone an unprecedented increase in stature, of nearly 12 cm, as a direct result of economic progress. These studies have also demonstrated the close link between adult stature and health and development indicators, including productivity.[3] In addition to genetics, stature largely depends on environmental conditions during childhood and adolescence, including diet, physical exertion and infection. Variations in adult stature reflect changes in net nutrition during growth — access to foodstuffs, the quantity and quality of nutrients, and diversification (intake of the necessary calories and proteins) — as well as energy expenditure during physical work and environmental diseases during the first 20 years of life.[4] Studies suggest that improved work organisation, more efficient production and distribution of food, the improvement of sanitary conditions, and the proliferation of institutions that fought against the spread of infection were all determinant factors in the staggering increase in adult height during recent centuries.[5]

1. Fogel (2004); Deaton (2013).
2. For different perspectives on the debate, see Steckel & Floud (1997); Feinstein (1998); Komlos (1998); Szreter & Mooney (1998); Floud, Fogel, Harris & Hong (2011).
3. Steckel (1995); Fogel (2004); Hatton (2014); Komlos & Kelly (2016); Perkins *et al.* (2016). For a global perspective, see NCD Risk Factor Collaboration (2016).
4. Bogin (2001); Silventoinen (2003).
5. Hatton (2014).

Historians and economists have demonstrated that adult stature is not only an excellent proxy for health and living standards. Given the paucity of data concerning inequality and income, stature is one of the better alternative tools for the analysis of income distribution.[6] One of the discipline's key contributions has been to show that stature and income have not always had a parallel evolution, for the former express biological well-being and the later economic well-being. This is one of the most relevant contributions of anthropometrics to social and economic history and the social sciences in general.[7] The so-called 'early-industrial-growth-puzzle' — 'antebellum puzzle' in the USA — indicates that height decreased despite the increase in per capita incomes in the early stages of 'modern economic growth' and the dissemination of industrialisation.[8] The deterioration of the nutritional status observed in Great Britain and other countries as early as the late-eighteenth century, and in the mid-nineteenth century elsewhere, suggests that the take-off of industrialisation was accompanied by an increase of inequality and a reduction in the intake of net nutrients among ample social groups.[9]

The joint analysis of biological and economic variables has decisively improved our understanding of the well-being of both historical and contemporary populations.[10] The use of anthropometric variables has had a transformative effect on economic history, as it has contributed to the development of new approaches which can be used to study the socioeconomic transformation linked to the Industrial Revolution. Nutrition has thus assumed a prominent role in studies of living standards during the spread of industrialisation, especially concerning calorie intake, health and physical-cognitive aspects.[11] Regional patterns and city-countryside variations indicate that height reflects regional differences in diet and, in turn, the availability of nutrients and proximity to animal protein sources.[12]

The European continent escaped malnutrition in the late-nineteenth century. Although privations did not entirely disappear, improvements in public health standards and nutrition began to become noticeable in the 1870s. These improvements were owed especially to urban sanitary reforms and the generalisation of state-sponsored social assistance services. Investment in public sanitary infrastructures (largely sewage systems and the supply of drinking water) was significant in the opening decades of the twentieth cen-

6. Baten & Blum (2012); Blum (2016); Steckel (2013).
7. Komlos (1987); Fogel (1996).
8. Komlos (2012); Craig (2012).
9. Martínez-Carrión (2012); A'Hearn (2016).
10. Komlos & A'Hearn (2016).
11. Floud, Harris & Hong (2015); Kelly, Mokyr & O'Grada (2014); Meredith & Oxley (2014a, 2014b).
12. Baten (2009).

tury.[13] Thenceforth, the overall improvement in diet ran parallel with that of living standards: per capita income, life expectancy and per capita calorie consumption increased, whereas infant mortality and working hours decreased. Average stature increased by 11 cm between the 1870s and the 1980s. Between the cohorts of 1871-75 and 1911-15, the average height increased by 0.76 cm per decade (over 1 cm in Great Britain and the Netherlands). In the twentieth century, the increase was even sharper, with averages of 1.27 cm/decade between 1911-15 and 1951-55 and 1.26 cm/decade between 1951-55 and 1976-80.[14]

Living Standards During the Industrialisation of Spain

Industrialisation in Spain has been viewed in scholarship as a relatively belated and peripheral process of the European Industrial Revolution.[15] Although it had an early start and was accompanied by essential innovations in some regions, especially Catalonia, the spread of industrialisation in Spain was slow, weak and uneven until the early-twentieth century. According to the experts, the main weaknesses in Spanish economic development were shortcomings in the energy supply and the insufficient scope of the market, as well as an economically fragile public sector and the dominance of the primary sector, which presented low levels of investment and productivity and determined low propensity to consumption and demand.[16] The distribution of family expenditure hardly changed until the late-nineteenth century: approximately two-thirds of the expenses corresponded to food, and clothing and shoes corresponded to another fifth,[17] reflecting a typically preindustrial pattern. In general, household consumption, living standards and human development indices in Spain were relatively low compared with those of industrialised Western European countries.[18]

GDP-based per capita estimates reflect a less dynamic trajectory of the Spanish economy compared with the most developed European countries, not only throughout the nineteenth century but up to the 1950s. The picture of the second half of the twentieth century is very different. The Spanish economy made rapid progress in the period that followed World War I (1919-29) and, especially, in the period spanning 1960-1973, the 'economic miracle' period, that followed the liberalisation of the domestic market and the opening

13. Szreter (1988, 2005); Harris (2004); Kunitz (2007); Hatton (2014); Millward & Baten (2010); Millward (2014); Luckin (2015).
14. Hatton & Bray (2010); Hatton (2014); Table I. For the period 1955-80, see Garcia and Quintana-Domeque (2007).
15. Pollard (1981).
16. Nadal (1975); Martín-Aceña & Simpson (1995).
17. Maluquer de Motes (2013).
18. Prados de la Escosura (1988); Crafts (2002); Escudero & Simón (2010).

up to the exterior.[19] Entry into the EU in 1986 inaugurated a new period of economic growth that did not come to an end until the opening decade of the twenty-first century. During this later period of prosperity, Spain grew faster than the European average and reached its highest levels of relative wealth.[20]

In parallel to the process of economic growth, the demographic and epidemiologic transitions and, to a lesser extent, nutritional transition, that had already progressed somewhat in the early-twentieth century, gained momentum in the 1940s and 1950s. Health-related indicators are eloquent: infant mortality, which had been among the highest in Europe, fell by 81% between 1900 and the late 1950s, from 203‰ in 1900 to 43.7‰ in 1960 and 3.9‰ in 2001. Likewise, male life expectancy increased from 34.4 years in 1900-01 to 76.1 years in 2001, while female life expectancy soared from 35.6 to 82.8 years during the same period.[21] The improvement in health conditions towards the end of the period under consideration was directly related to the application of Welfare State policies, the provision of social assistance services, and public investment in healthcare infrastructures. The results of these policies started to become widely visible in cities as early as the first third of the twentieth century, and in rural contexts in the 1960s.[22]

The nutritional transition, for its part, did not kick off until 1960.[23] Calorie intake remained insufficient among several social groups until 1900. It increased in the early decades of the twentieth century as result of the increasing availability of animal protein,[24] but it fell again between the 1930s and 1960s. This drop may be attributed to the effects of the Civil War and the economic policies of early Francoism. The autarchic doctrines adopted in the 1940s and 1950s led to a decrease in the consumption of basic nutrients, especially meat and milk. Calorie intake and the consumption of high-quality protein and micronutrients improved from 1960 onwards, and the process of nutritional transition, and convergence with European consumption patterns, were resumed.[25]

In this context, how did the biological standards of living of the Spanish population evolve? What were the trends in height during the process of industrialisation? In the last two decades, anthropometry has undergone significant advances. The following sections will examine the main contributions to this field, present new data, and propose a new interpretation concerning the nutritional changes undergone during the process of modern economic growth, as well as study the cost of industrialisation.

19. Prados de la Escosura (2003); Maluquer de Motes (2014).
20. Maluquer de Motes (2016).
21. Pérez-Moreda, Reher & Sanz-Gimeno (2015). For 2001, estimates by INE.
22. Vilar & Pons (2015).
23. Cussó (2005, 2010); Cussó & Garrabou (2007).
24. González de Molina, Soto, Infante & Aguilera (2013).
25. Collantes (2014, 2015); González de Molina, Soto, Aguilera & Infante (2014); Pujol & Cussó (2014).

Biological Living Standards and the Relationship to Well-being

Figure 1 illustrates the male height over the last three centuries, calculated on the basis of military draft data.[26] In general, the average height of Spanish males (standardised at the age of 21) was among the lowest in Europe since the Industrial Revolution. By cohorts, male stature underwent the following evolution. 1) In the eighteenth century, the average height was around 163-64 cm; this average fell slightly towards the end of the century. 2) During most of the nineteenth century, the height remained almost stationary at around 162-63 cm; until the 1870s there were slight fluctuations, and the period between 1846 and 1859 witnessed a prolonged depression. 3) Height started to increase around the second half of the 1870s, and this lasted until the eve of WWI, when it reached 165.3 cm. 4) A further deterioration is evident among those born in 1915-1930, which affected conscripts who experienced their adolescent growth spurt in the years of the Civil War (1936-39) and the postwar period (the 'years of hunger'):[27] the average height decreased by just over one centimetre. 5) Finally, the height of those born in 1930 and later increased substantially. The 1981 cohorts (the 2000 draft concluded compulsory military service in Spain) reached an average height of 175.3 cm. Despite the difficulties associated with the data for the late-eighteenth and the early-nineteenth centuries, the increase in average male height between 1840 and 1981 was of nearly 13 centimetres. The most significant increase corresponds to the generations born from 1930 onwards, and especially those of the 1950s. The average increase for conscripts born between 1934 and 1980 is of 1.5 cm/decade.[28] This increase in height parallels the spectacular increase in life expectancy (Figure 1).

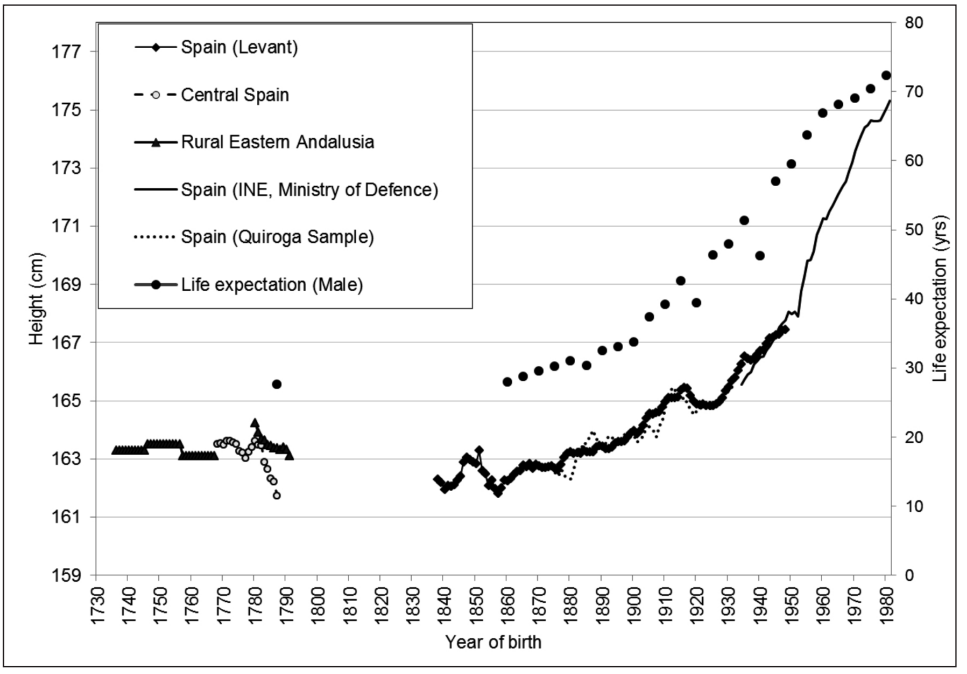
Stature data collected by the *Encuesta Nacional de Salud de España* (ENSE — Spanish National Health Survey) on generations born between 1910 and

26. For the peculiarities of army-based anthropometric data in Spain, see Cámara (2006). The Ministry of Defence and INE have published the data for 1955-2000. For later periods, we have two series constructed on the basis of samples: 1) the longest and more consistent series includes over 350,000 data points concerning individuals born between 1837 and 1949 (drafts of 1857-1969) in five provinces in eastern Spain (Martínez-Carrión & Puche-Gil, 2010, 2011); 2) on a national scale, we have a random sample including the height of 46,385 draftees born between 1874 and 1933 (drafts of 1893-1954), developed by Quiroga (2001). For the closing decades of the *ancien régime*, two regional/local studies provide interesting evidence, although the sample is relatively small and the quality of the data present some problems, which authors have tried to solve with the application of different methodologies. In eastern rural Andalusia, the sample includes 1,500 data points from the towns of Montefrío and Santa Fe (Cámara, 2007). For Central Spain, the sample includes 11,839 data points for 1768-87, see García-Montero (2013).

27. Barciela (2012), pp. 165-166; Comín & Hernández (2013), pp. 271-277.

28. Martínez-Carrión (2005), p. 220; María-Dolores & Martínez-Carrión (2011).

FIGURE 1 ▪ *Evolution of male life expectancy and height (cm) in Spain. Cohorts of 1735-1980 (Height standardised at the age of 21)*



Sources: Male height. Diverse estimates calculated by simple moving averages centred on three years, except for the period 1730-1760 (ten years), because of little data available: Rural Eastern Andalusia (Cámara, 2009); Central Spain (García-Montero, 2013). The most robust data series are: Eastern Spain-Levant (Martínez-Carrión & Puche, 2011); Spain – National Sample of Quiroga (2002); finally, Spain, cohorts of 1934-1980 (Recruitment Statistics, INE-Ministry of Defence). See details in note 60.

Data on male life expectancy: 1787, Dopico & Rowland (1990), p. 597; 1860-1980, Cabré, Domingo & Menacho (2002), p. 127.

1979 reveal that height grew more among males than females.[29] In the early twentieth century, men were on average 10 cm taller than women whereas, of the generations born in the 1970s (which reached physical maturity in the 1990s), sexual dimorphism had increased to approximately 12.5 cm.[30] Using the same methodology and data concerning individuals born between the 1930s and 1980s, average male stature grew by 8 cm (1.6 cm/decade) while female stature increased 4 cm (0.8 cm/decade).[31] Between 1940 and 1960, female height stagnated while male height grew by 3-4 cm. Data from the European Community Household Panel (ECHP) for Spain (up to 2000) indicate that

29. Spijker, Pérez-Díaz & Cámara (2008); Spijker, Cámara & Blanes (2012); Cámara (2015).
30. Spijker, Pérez-Diaz & Cámara (2008); Cámara (2015).
31. Quintana-Domeque, Bozzoli & Bosch (2012), p. 265.

male and female height increased by approximately the same (1.7 cm/decade and 1.6 cm/decade, respectively) in the cohorts for 1950-1980.[32]

Over the last 250 years, the most critical periods for the height of the Spanish population are 1780-90, 1840-70 and 1915-30. The first of these stages, in the late-eighteenth century, corresponds to the decrease in height attested in Europe in 1760-70. This was a more widespread phenomenon than was previously believed: it has been detected in England, Lombardy, France, Saxony, Bavaria, Sweden, Austro-Hungary, Portugal and Spain. The context was one of rapid demographic growth and increasing demand on economic resources, especially in terms of basic nutrients. As aforementioned, climate fluctuations, the increase in food prices and the decrease in real wages all had a negative effect on the nutrition of most Europeans.[33]

Apart from the first 15 years, the hardest times for the biological well-being of the Spanish population in the nineteenth century were the central decades of the century. The drop in height attested in the opening years of the century may be attributed to the great epidemiologic and economic disasters of 1800-1814, the great subsistence crisis of 1803-05, and the effects of the Napoleonic occupation (Peninsular War 1808-12), which contributed to the rise in food prices.[34] The 1820s and the 1830s witnessed a growing trend, which reversed again in the period between the 1840s and 1871-75 because of the rise in basic food prices and the decrease of real wages, and this had a considerable effect on the well-being of the Spanish population in 1850-75.[35] The deterioration in net nutrition can also be explained by the increase in morbidity and, it follows, infant and overall mortality,[36] as well as the problems generated by the dismantling of the charitable institutions of the *ancient régime* and the implementation of liberal reforms.[37] Similarly, the spread of industrialism led to the generalisation of child labour and the strengthening of migration flows towards the cities, which in turn resulted in anarchic processes of urban growth and the habitation of insalubrious dwellings.

During the twentieth century, the generations that suffered the most were those that went through their childhood and adolescence in the 1930s and 1940s. In addition to the deteriorating economic welfare (measured in terms

32. Quintana-Domeque, Bozzoli & Bosch (2012).

33. Komlos & Küchenhoff (2012); Martínez-Carrión (2012). For Portugal, see Stolz, Baten & Reis (2013).

34. For the effects of the two great subsistence crises, see Llopis & Sánchez (2016). For the evolution of living standards indicators in the early-nineteenth century, see García-Montero (2013) and Catalán & Lanza (2015).

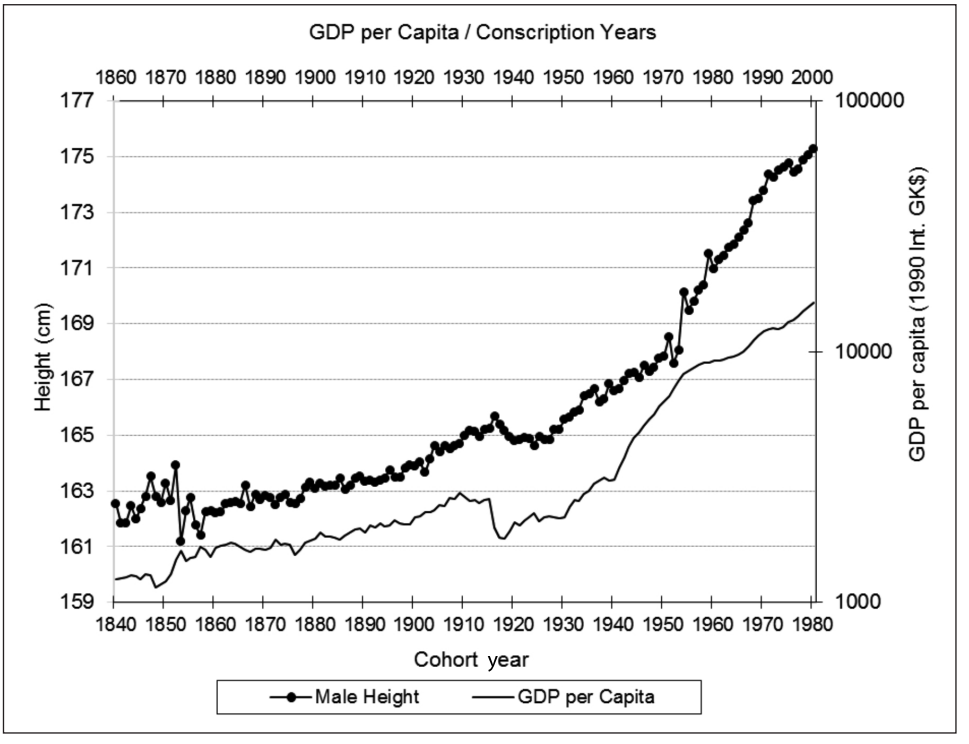
35. Maluquer de Motes (2013, 2016).

36. Pérez-Moreda, Reher & Sanz (2015).

37. The privatisation process of the commons negatively affected the economic situation of a large proportion of rural households and local councils, as well as deteriorating the stock of social capital, Beltrán-Tapia (2016).

of per capita income, real wages and consumption), Spaniards' biological well-being indicators drop, as illustrated in Figure 2, which reflects the average height of military conscripts. This period was characterised by the effects of the Great Depression in the 1930s, the Civil War (1936-1939) and, especially, Francoist autarchic policies. Draftees during the Civil War and the 'years of hunger' (1936-1951) were the shortest of the century.[38] That demonstrates that privations in early puberty and adolescence had a substantial effect on the height of these generations. Although the decrease in height — estimated at slightly over 1 cm in the two most representative national samples (Figure 1) — was not especially dramatic, it is enough to reflect the impact of infant and juvenile malnutrition during the most difficult period in Spain's recent history.

FIGURE 2 ▪ *GDP per capita and male height by cohort & conscription year in Spain, 1840-2000*

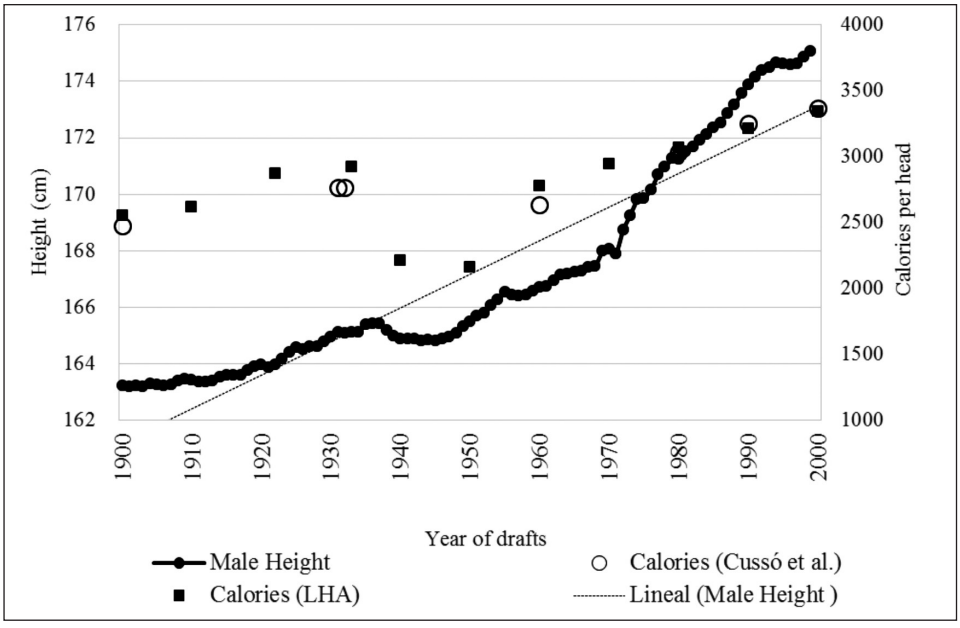


Source: GDP per capita (log scale, per capita GDP levels in 1990 Geary-Khamis dollars from The Maddison-Project, http://www.ggdc.net/maddison/maddison-project/home.htm, 2013 version. Male height: 1840-1969, East-Levant Sample (Martínez-Carrión & Puche, 2011); 1969-2000, Spain (Recruitment Statistics, INE-Ministry of Defence).

38. The sharpest drops correspond to the mid-1940s drafts; see Martínez-Carrión, Martínez-Carrión, Puche, & Ramon (2012); Puche-Gil (2010).

Hunger and infant malnutrition affected large sectors of society during early Francoism, as has recently been confirmed by historical epidemiological studies, supported by infant anthropometric data.[39] The fall in stature among draftees in the 1930-1950 period is related to a loss of economic well-being, especially the fall in private consumption, which dropped sharply between 1935 and 1950; per capita consumption did not recover to previous levels until 1956.[40] Calorie consumption data reveal the severity of the alimentary depression undergone between 1935 and 1960, according to different estimates (Figure 3). After the advances achieved in the first third of the twentieth century, owing to the increased availability of animal protein, between 1933 and 1960, caloric intake decreased by 5.2% according to Pujol and Cussó (2014) and 9.9% according to González de Molina *et al.* (2013). The most dra-

FIGURE 3 ▪ *Calories available for consumption per capita per day and male height by draft date in Spain, 1900-2000*



Source: Estimates for calories per head per day are based on a) Cussó (2010); Pujol and Cussó (2014); b) LHA* (2013). Male height: 1900-1968, East-Levant Sample (Martínez-Carrión & Puche, 2011); 1969-2000, Spain (Recruitment Statistics, INE-Ministry of Defence). Data were estimated by moving averages centred three years.

(*) LHA: Laboratorio de Historia de los Agrosistemas - Agroecosystems History Laboratory (AHL) at the University Pablo de Olavide (Seville); see González de Molina, Soto, Infante and Aguilera (2013).

39. For infant malnutrition during Francoism, see Trescastro, Galiana, Pereyra, Vasallo, Nolasco & Bernabeu (2014).

40. Prados de la Escosura (2003); Maluquer de Motes (2014), Appendix A.3, pp. 626-627.

matic drop in caloric consumption, however, took place in the 1940s, when daily calorie intake fell to 2,209 kcal/day in 1940 and 2160 kcal/day in 1950, more than 25% below the 1930-35 levels.[41]

The lowest estimated data for energy, protein and micronutrient consumption correspond to the mid-1940s.[42] Meat, milk and dairy products, as well as fish, were the hardest to come by during this period of economic autarchy. Economic policies led to rationing, a scarcity of basic products and the rise of the black market (*estraperlo*). Alimentary shortages were aggravated by the restricted supply of water and energy, the sharp fall in wages and the deterioration of labour conditions.[43] Food consumption levels dropped to nineteenth-century levels,[44] and 1930 calorie intake levels were not reached again until 1960. Only after that year did the consumption levels of the most characteristic foodstuffs of the nutritional transition — meat, milk and dairy products — increase significantly in Spain. Convergence with European standards took place in the 1980s.[45]

The corporal mass index is a predictive indicator of health conditions on the basis of height and weight. No significant changes in this index can be attested until the 1980s. Obesity had been hardly relevant until then, but initiated an ascending trend thereafter, increasing from 7.4% in 1987 to 17% in 2012, according to the National Health Survey. It is more common among men than among women, and is especially frequent among the poorer social classes.

Differences in Adult Height in Different Spanish Regions

In Spain, industrialisation was a geographically uneven process, with profound consequences for living standards and height.[46] As well as affecting the speed of economic growth, for better or worse, environmental conditions affected adult height to such an extent that regional differences persisted for a long period afterwards. Catalonia was the first region to follow in the wake of Great Britain in the nineteenth century; Catalonian modern production of

41. González de Molina, Soto, Infante & Aguilera (2013). These estimates are similar to those calculated by García-Barbancho (1960). According to García-Barbancho the greatest fall took place between 1940 and 1947, when the daily intake fell from 2,249 kcal/day to 2,090 kcal/day. The lowest average stature also corresponds to 1947.

42. Villalbí & Maldonado (1996).

43. There are abundant accounts of the harsh living conditions that characterised the period; see Barciela (2013); Comín & Hernández (2013).

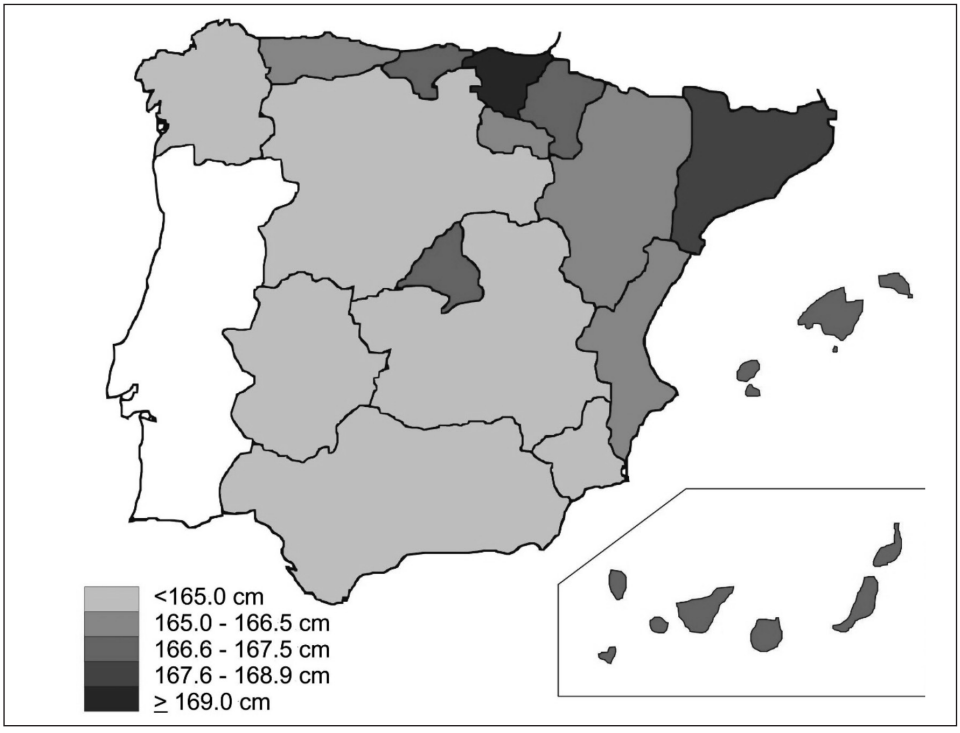
44. Simpson (1995).

45. Pujol & Cussó (2014); Collantes (2014, 2015); Marrodan, Montero & Cherkaoui (2012).

46. Domínguez & Guijarro (2000); Escudero & Simón (2012); Martínez-Galarraga, Rosés & Tirado (2015).

consumer goods soared especially between 1835 and 1861.[47] In the rest of the country, industrialisation was a slow and belated process, despite the fact that some regions and industrial sectors tackled the challenges posed by the second industrial revolution with relative success.[48] By the late-nineteenth century, there was a healthy industrial sector in the Basque Country and the region of Valencia, but industrial expansion did not reach the rest of the country until the 1920s, and was not fully consolidated until around 1960. Economic development and industrial dynamism, and their effect on consumption and diet,[49] resulted in considerable variation in average height, which is well documented from the early-twentieth century onwards.[50]

FIGURE 4 ▪ *Regional male height at 20 years of age in the 1955 draft*

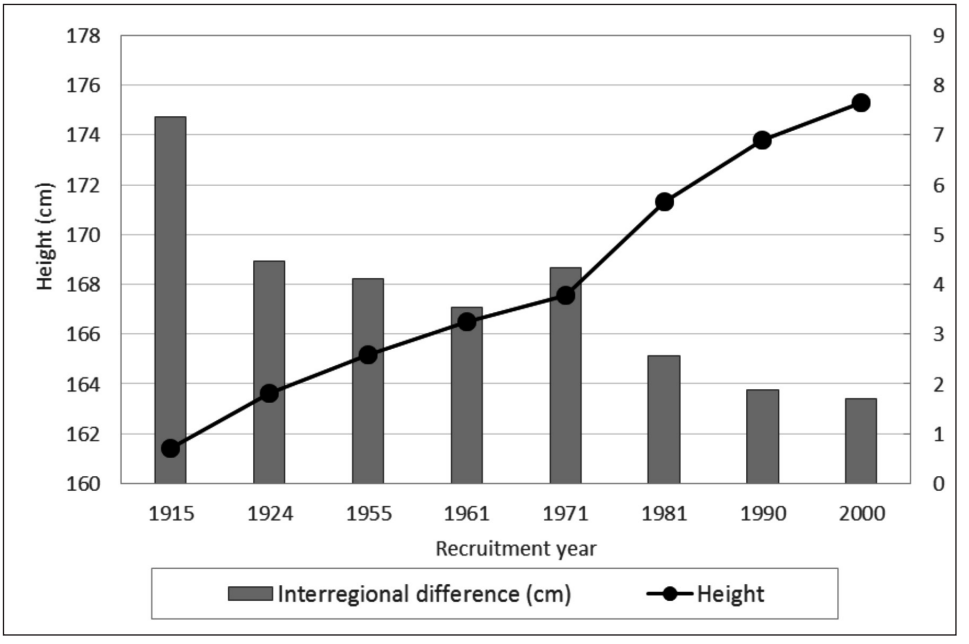


Source: Martínez-Carrión (2005a).

47. Nadal, Benaul & Sudrià (2012); Martínez-Galarraga & Prat (2016).
48. Maluquer de Motes (2014).
49. For the regional distribution of the industrial sector, see Nadal (2003); Parejo-Barranco (2004). For regional variability in the diet, see Nicolau & Pujol (2006, 2015); Pujol & Cusso (2014); and in milk consumption see Muñoz-Pradas (2011).
50. Martínez-Carrión (1994a, 2005a); Gómez-Mendoza & Pérez-Moreda (1985, 1995); González-Portilla (2001); Quiroga (2001, 2010); Quintana-Domeque, Bozzoli & Bosch (2012); Cámara & García (2015).

During the twentieth century, the highest heights were in the Basque Country and Catalonia, along with the island regions of the Canary Islands[51] and the Balearic Islands. Galicia and the interior and southern regions presented the lowest heights.[52] There is a clear pattern between higher statures and industrialised regions with a higher per capita income, and lower statures and predominantly rural, poorer and non-industrialised regions. The net nutrition map based on the 1955 draft (Figure 4) reveals that inequalities still persisted in the late 1960s. In 1955, the Basques were still of the greatest height: 3 cm above the national average. In 2000, the average stature in the Basque Country was 175.7 cm, behind only Navarra and Aragon. In this issue, the study which was undertaken on height in the Basque Country, based on a sample taken in six municipalities of Biscay between 1876 and 2000, demonstrated that a formidable increase of nearly 12 cm occurred.[53]

FIGURE 5 ▪ *Interregional differences in male height in Spain by recruitment year, 1915-2000*



Source: Author's own work, after *Estadísticas del Reclutamiento y Reemplazo del Ejército* and *Anuarios Estadísticos de España*, and Martínez-Carrión (2005a).

51. One study carried out in the municipalities of Santa Cruz (urban) and the Orotava Valley (rural), in Tenerife, reveals that average stature reached 168 cm and 166 cm respectively in the mid-nineteenth century, according to Román-Cervantes (2013).

52. Extremadura, one of the regions studied recently, see Linares & Parejo-Moruno (2015, 2016).

53. Pérez-Castroviejo (2016).

It is interesting to explore the evolution of regional inequality over time. For dates prior to 1900, we only have a regional height cartography for the 1858-59 drafts.[54] The data reflect poorly defined anthropometric patterns, although the average stature in southern and Mediterranean regions seems to be slightly higher. In the mid-nineteenth century, wealthier and more industrialised regions present higher figures for stature: Catalonia, Alicante, the region of Valencia, and, in Andalusia, Seville, Cádiz and even Malaga and Almeria. During the twentieth century, the nutritional polarisation became more acute, and the relationship between industrialisation, per capita income and stature became more obvious, as illustrated in Figure 4.[55] The sharpest differences coincide with WWI. The regional gap narrowed from 7.3 cm in 1915 to 3.5 cm in 1951, only to increase again by 1 cm in the 1960s (Figure 5). This widening of the regional gap appears be related to the industrial push and increasing income differences, as well as to the intense migratory movements that greatly depopulated large tracts of interior rural Spain.[56] The heights started to converge in the 1970s and this was largely achieved by 1990, in contrast with other Mediterranean countries in which regional differences in height data persisted until the late-twentieth century.[57] Regional differences in 2000 were barely 1.71 cm.

The Urban-Rural Gap

Literature on the 'urban penalty', which refers to the penury inflicted on the urban population by early industrialisation, has led to important results in the field of historical demographics,[58] and this is another topic that can be approached using anthropometrics.[59] The target in this case has been to verify the urban-rural gap and to ascertain whether the countryside offered better environmental conditions for infant growth. While historical research carried out in Great Britain, the USA and Australia has suggested a considerable

54. Except for the data corresponding to the Basque Country and the Canary Islands, *Anuario Estadístico de España* de 1860. The data have been analysed by Gómez-Mendoza & Pérez-Moreda (1985), González-Portilla (2001), and recently by Martínez-Carrión (2016) and Martínez-Carrión, Cámara & Pérez-Castroviejo (2016).

55. Martínez-Carrión (2005); Quiroga (2010); Quintana-Domeque, Bozzoli & Bosch (2012); Cámara & García (2015).

56. Domínguez (2002); Collantes & Pinilla (2011).

57. Compared with Italy, regional convergence gained momentum from the 1970s onwards, see Arcaleni (2006), and Martínez-Carrión (2005a).

58. Kearns (1991); Szreter & Mooney (1998); Reher (2001).

59. Komlos & Baten (2004); Zehetmayer (2013); Meinzer & Baten (2016), pp. 282-284; Ver Heyberger (2012).

urban height penalty, results for continental Europe are less clear.[60] Although some studies stress that rural environments were relatively more benign for physical growth, others emphasise the 'urban premium', largely based on the persistence of rural poverty in large tracts of continental Europe, where, in addition, cities were less heavily industrialised and polluted. Furthermore, in these towns the proportion of the population that lived on a high income was higher, and some degree of social assistance was more common.[61] The most significant differences in height, at any rate, were caused by the living conditions and the socioeconomic status of each individual.

In Spain, anthropometric data indicate that young people living in urban areas were better off than their rural counterparts. There was, therefore, a rural height penalty which persisted until well into the twentieth century (Figure 6).[62] This situation, which we can refer to as the 'urban height premium', should not obscure the fact that most Spanish cities were comparatively poor: in the mid-nineteenth century, Spanish cities presented the lowest height values in Europe.[63] In addition, life expectancy in cities was lower than in the countryside until 1930, and urban mortality higher until 1920.[64] At any rate, the evidence for low levels of biological well-being are much more conspicuous in the countryside. When the data available allows for a refined analysis of height data in discrete municipalities and, if possible, for example in the southeast, within these municipalities, we may soon be able to conclude that poverty and malnutrition were a good deal more common in the countryside than in the cities until the mid-twentieth century.

At any rate, the analysis of the urban-rural gap needs a more refined study, at least as far as the characterisation of the environmental and socioeconomic contexts of local and territorial units is concerned. The urban-rural gap was significant even at the intraregional level. In Catalonia, some cities presented lower heights than the countryside in the mid-nineteenth century, owing to the effects of industrialisation, new demographic trends and

60. Steckel & Floud (1997); Humphries & Leunig (2009). For a review of the disadvantages of urban environments in France, see Heyberger (2014), who demonstrates that the larger the city, the lower the stature, especially in the case of Paris. This is explained not so much in terms of protein intake but of epidemiological factors.

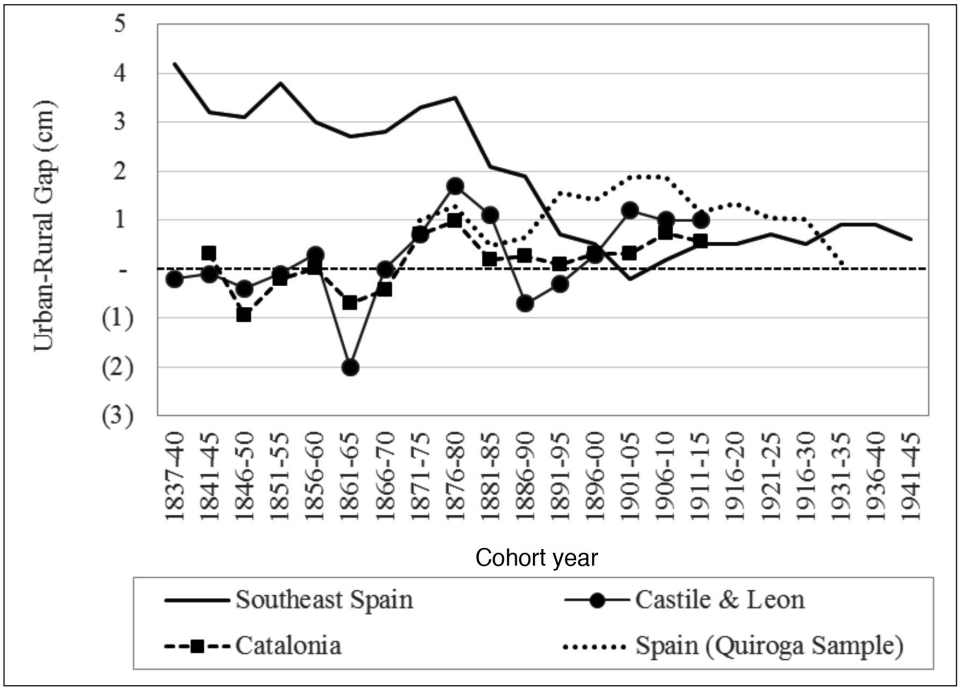
61. For the Netherlands and Germany, see Haines (2004), and Steckel & Floud (1997); for Belgium, see Alter, Neven & Oris (2004); for France see Heyberger (2005); for Portugal, see Reis (2009), and for other European countries, see Floud, Fogel, Harris & Hong (2011).

62. For a national overview, see Quiroga (2002a); for a complete study of different cities and towns in the southeast, see Martínez-Carrión & Pérez Castejón (2002). For a comparative analysis of the southeast and Castile and León, see Martínez-Carrión & Moreno (2007).

63. In the mid-nineteenth century, Castilian cities present the lowest stature values, even below 160 cm: see Moreno-Lázaro & Martínez-Carrión (2009); Hernández-García & Moreno-Lázaro (2009). For the city of Zamora, see Hernández-García, Moreno-Lázaro & Vicente-Ventoso (2009). For Castilian cities in general, see Hernández-García & Moreno-Lázaro (2011).

64. Pérez-Moreda, Reher & Sanz-Gimeno (2015).

FIGURE 6 ▪ *Urban-rural differences in male height in Spain by cohort year, 1837-1948*



Source: Data samples of Spain (Quiroga, 2002a); Southeast and Castile & Leon (Martínez-Carrión & Pérez-Castejón, 2002; Martínez-Carrión & Moreno-Lázaro, 2007); Catalonia (Ramon-Muñoz, 2009, 2011).

changes undergone by the labour market (immigration, female and child labour).[65] Despite the sometimes severe rural penalty, certain specialised agricultural areas were better off compared to nearby urban-industrial areas, owing to the agricultural dynamism of the final decades of the nineteenth century. Locally, from around 1870, certain communities which relied on the practice of irrigation agriculture in the Mediterranean achieved relative levels of prosperity and better biological living standards than nearby provincial capitals.[66] In some rural communities in the Basque Country, the average height was higher than in the cities.[67] All of this suggests that, in addition to the environment, other factors may have had a significant impact on these variables, such as the ownership of land, the size of the typical agricultural unit, the possibility of keeping livestock and the composition of households. These and oth-

65. See in this issue the example of Igualada, Ramon-Muñoz & Ramón-Muñoz (2016).
66. Martínez-Carrión & Pérez-Castejón (2002); Cámara (2009); Puche Gil (2009), Martínez-Carrión, Pérez-Castroviejo, Puche-Gil & Ramón-Muñoz (2014).
67. Martínez-Carrión, Pérez-Castroviejo, Puche-Gil & Ramón-Muñoz (2014).

er institutional factors could have facilitated access to basic nutrients (chiefly animal protein), ensured more equitable income distribution, increased nutritional well-being and reduced inequality.

The evidence also suggests that the countryside underwent a severe nutritional crisis between the 1840s and the 1870s, which also had an effect on urban areas.[68] The causes of this phenomenon include the shortage of basic foodstuffs, the epidemics of typhus, typhoid fever and malaria (which were endemic in irrigation areas, especially in the Mediterranean *huerta*),[69] and the impact of the market system and the subsequent rise in food prices. The rise in the price of animal protein is also connected with the effects of the liberal reforms and the privatisation of the commons. Specifically, the disappearance of the commons led to a decrease in livestock units between 1865 and 1890 and to reduced access to communal resources, which diminished people's ability to gather, hunt, fish and burn charcoal.[70] Commons were a significant source of energy and calories, especially in conditions of rural poverty and low rural income levels. In addition, the tax pressure increased more in agriculture than in other sectors from 1845 onwards, exacerbating the problems suffered by the countryside.[71]

During the first third of the twentieth century, the urban-rural gap narrowed, only to widen again in the opening years of Francoism. From 1960 onwards, peoples' height in the countryside started increasing significantly and converging with the levels of urban height,[72] in a process which was evidence of the overall improvement of living standards everywhere, but especially among rural populations. This improvement was further promoted by nutritional education programmes and the supply of milk supplements for schoolchildren, which significantly enhanced the child diet, mainly in rural areas.[73]

Local Environmental Settings

Military draft-based anthropometric data offer an unprecedented perspective on the long-term effects of local environmental conditions on health and nutrition. The results achieved to date have allowed for multiple compar-

68. This has been attested in the studies on the southeast and Castile & Leon, as well as in Catalonia (Ramon-Muñoz, 2009), the region of Valencia (Puche-Gil 2009, 2011), eastern Andalusia (Cámara, 2009), and Madrid (García-Montero 2009).
69. Martínez-Carrión (1994b).
70. Martínez-Carrión & Pérez Castejón (2002); for an econometric analysis, including Quiroga's 1930 stature data and the impact of the privatisation, see Beltrán (2015).
71. Vallejo-Pousada (2015).
72. Cañabate-Cabezuelos & Martínez-Carrión (2017).
73. Trescastro-López, Bernabeu-Mestre & Galiana-Sánchez (2013).

ative analysis: between industrial and non-industrial cities; between mining towns and rural areas; and also, most significantly, an intra-urban micro-comparative analysis at the district and parish levels has been undertaken.

Malarial environment in rural areas

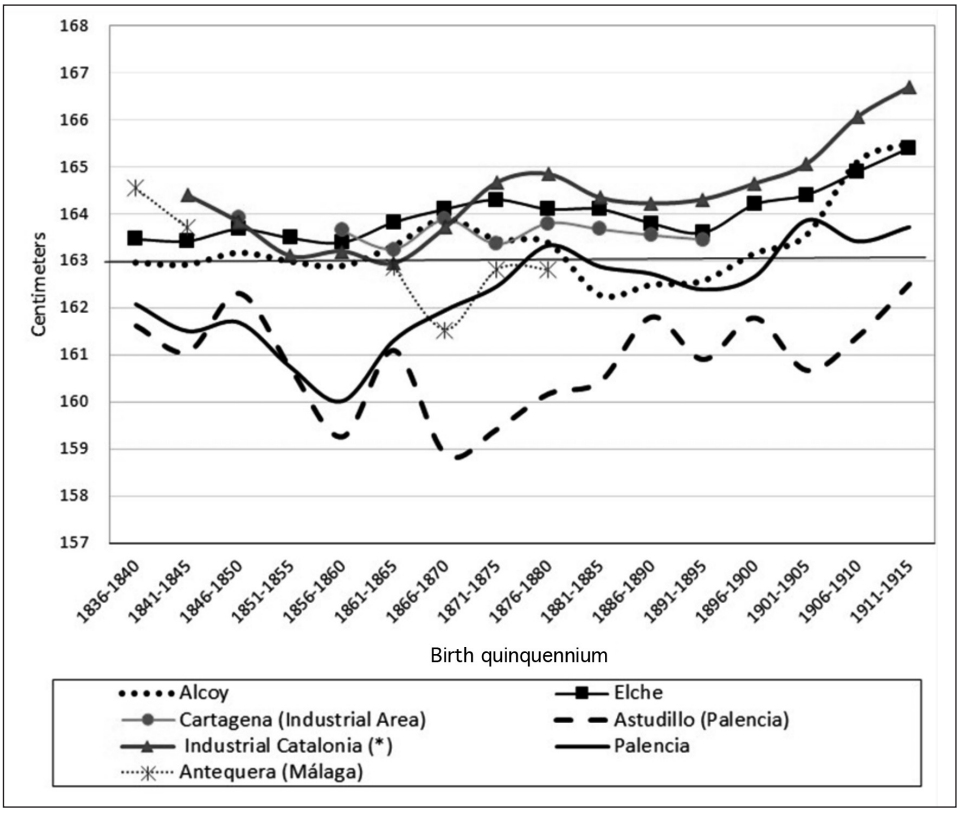
Environmental illnesses have had a huge impact on the nutritional state of the population. One of the most widely disseminated illnesses in Mediterranean countries is malaria. When contracted at an early age, malaria increases the chances of chronic illness in later life and of crippling weakness, with terrible consequences for both the overall state of well-being throughout life and economic productivity. A pioneering work has revealed the impact of malaria on stature in the *huerta* of Murcia, an area rich in marshland and permanently water-logged terrain, during the late-nineteenth century.[74] The differences in stature in villages located near each other (barely 5-10 km apart) but with different levels of exposure to malaria could be significant. Between 1840 and 1880, the inhabitants of wetlands presented the lowest average height, with 158-159 cm at the age of 18-20. The inhabitants of higher areas were somewhat taller (160-161 cm). As is clear from the evidence, average stature was considerably low everywhere, which indicates that poverty and malnutrition were in general endemic to the eastern *huertas*, especially in malaria-ridden areas. Draining projects undertaken from the late-nineteenth century onwards, along with other sanitary measures and 'anti-malaria' policies, led to a significant increase in the height of army draftees, who by 1920 were nearly 3 cm taller on average.

The industrial urban environment

Figure 7 illustrates the evolution of the height of some Spanish cities that became industrialised at the beginning of the European Industrial Revolution. Despite the slight advantage enjoyed by the most dynamic industrial areas, the nutritional deterioration observed in the period 1840-1860 may have been a general phenomenon. Spanish cities suffered a further period of nutritional decline between 1875 and 1895. In certain periods (1845-1860, 1866-1870), the trends observed in urban height are almost identical to those attested for the rural environment, which suggests that most of the problems suffered by the countryside also affected the cities. In any case, the fall in height in urban areas responded to specific causes: in some cases it took place after industrial expansion, for example in Catalonian cities (Igualada and

74. Martínez-Carrión (1986, 1994b[2014]).

FIGURE 7 ▪ *Adult male height in industrial towns during the first industrialisation in Spain. Cohorts of 1836-1915 (Smoothed lines)*



Source: Own work from data of Alcoy (Puche-Gil, 2009); Elche (Martínez-Carrión & Pérez-Castejón, 1998); Cartagena (Martínez-Carrión, 2005); Astudillo and Palencia (Ventoso, Hernández & Moreno, 2009); Antequera (Martínez-Carrión & Cámara, 2015); industrial towns of Catalonia (Ramon-Muñoz, 2011): (*) Igualada and Manresa (Barcelona), and Reus (Tarragona). Standardising criteria heights at the age of 20 years: I have added 1.5 cm to the heights of 18-year-old males and/or 0.5 cm to the heights of 19-year-old males.

Reus) and also in the region of Valencia (Alcoy and Elche);[75] in other places, the main reason for the decrease in height was the decline of traditional manufacturing.[76] In both cases, the dissemination of industrialisation implied considerable demographic growth, boosted by immigration, and the increase

75. For the nutritional state in Catalonian cities, see Ramon-Muñoz (2011). In this issue, see Ramón-Muñoz & Ramón-Muñoz (2016); for Elche and Alcoy (Valencia), see Martínez-Carrión & Pérez-Castejón (1998); Puche-Gil (2009). In this issue, for Alcoy, see Puche & Cañabate (2016).

76. For Castilian cities, see references in note 61. For Antequera (Andalusia), see Martínez-Carrión & Cámara (2015).

of female and child labour in the central decades of the nineteenth century. In some areas, children occupied over one-third of industrial jobs.[77]

Most anthropometric studies have noted the deterioration in child nutritional health in urban environments that occurred until the late nineteenth century. The most intense decline in urban stature occurred during the period spanning the 1840s to the 1870s. The decline was not as severe as in other industrial areas in Europe and America, but it was nevertheless significant considering the low stature of Spanish conscripts in general. In some areas, draftees labelled as short (below 155 cm) reached 20% of the total in the 1870s, in the aftermath of the 1868 subsistence crisis which aggravated the endemic alimentary insecurity.[78] This deterioration, in any case, may be explained by different factors. On the one hand, the arrival of immigrants pushed down wages while increasing food demand and, in consequence, food prices. The increase in the number of members per family unit, the absence of adequate sanitary facilities, and poor hygienic conditions in the crammed living quarters contributed to widespread insalubrious living conditions, and opened the door to infection.[79] Therefore, epidemiological factors aggravated the effects of this economic and hygienic conjuncture. The increase in the incidence of lung diseases (bronchitis and pneumonia, among others) and especially tuberculosis, an illness characteristic of late adolescence and of overcrowding, malnutrition and poverty,[80] as well as those that affected the digestive system (diarrhoea, dysentery, enteritis, gastroenteritis), childhood infections (smallpox, diphtheria, measles and chicken pox) and typhus and typhoid fever, also contributed to the frequency of stunted growth.[81] Finally, we must consider institutional factors. The low levels of public investment in urban sanitary infrastructures (sewerage and the supply of drinking water) until the late nineteenth century,[82] the harsh working conditions and the widespread nature of child labour in pestilential and dark factories and workshops also contributed to keeping stature low.[83]

77. Martínez-Carrión, Puche-Gil & Cañabate-Cabezuelos (2013).

78. For the decline of the nutritional state in Catalonian cities, for example Igualada, see Ramon-Muñoz & Ramon-Muñoz (2016). In Alcoy this decline is clearly related to the deterioration in the conditions which employees had to tolerate in the textile and paper industries: see Puche & Cañabate (2016).

79. For the increase in the number of family members per household and its relationship to low stature, see Ramon-Muñoz & Ramon-Muñoz (2016) in this issue. A preliminary version may be found in Ramon-Muñoz & Ramon-Muñoz (2015).

80. The age group which tuberculosis hits with particular virulence is 15-30 years (Pérez Moreda, Reher & Sanz Gimeno, 2015, p. 265-267).

81. In this issue, see Puche & Cañabate (2016). On the role of environmental illness on stature see Martínez-Carrión, Pérez-Castroviejo, Puche-Gil & Ramón-Muñoz (2014).

82. For the city of Alcoy, see García-Gómez (2015, 2016), and García-Gómez & Puche-Gil (2016).

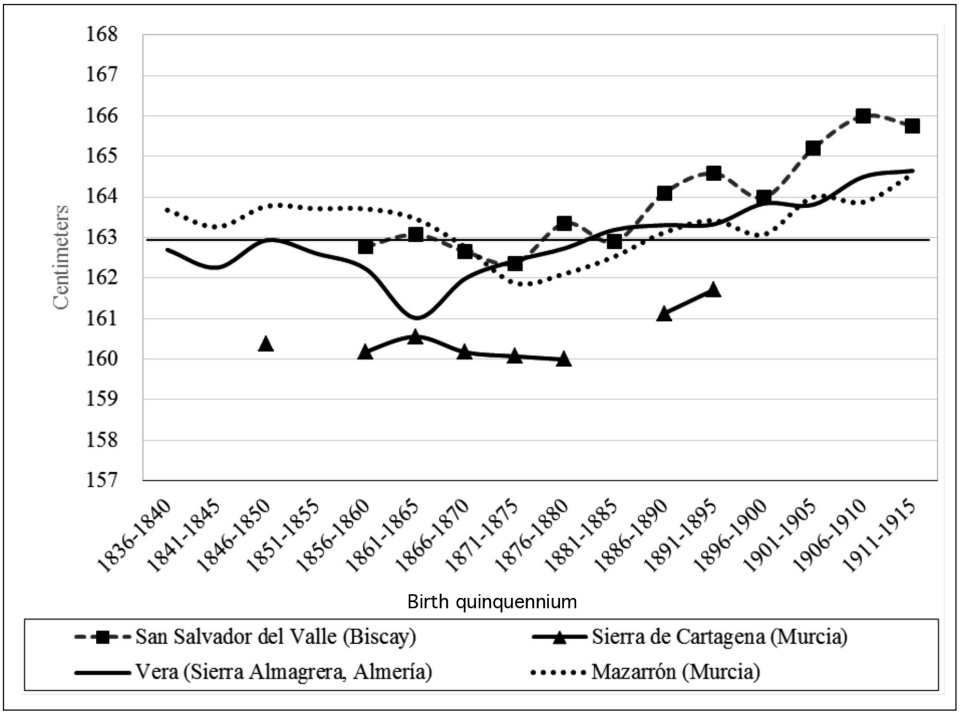
83. Martínez-Carrión, Puche & Cañabate (2013); Martínez-Carrión, Pérez-Castroviejo, Puche & Ramón-Muñoz (2014).

The environment in mining basins

Mines are among the most hostile environments for the physical well-being of humans. In Spain, mining took off in the 1820s, and continued to be very active until the early-twentieth century. The apogee of the mining industry in Spain took place in the last third of the nineteenth century with the arrival of large amounts of foreign capital, which promoted the development of great mining emporia, some of which were also at the technological cutting edge. These mining hubs were mostly located at the coastal periphery of southern and northern Spain.[84]

Figure 8 illustrates the evolution of height in several mining areas during the mining boom. The figure includes data from lead, iron and, to a lesser extent, zinc mining areas, in Vera (range of Almagrera, in eastern Almeria),

FIGURE 8 ▪ *Adult male height in the mining areas in Spain. Cohorts of 1836-1915*



Source: Own work from recruitment data of mining villages in the Sierra de Almagrera (Vera, Almería), Cartagena and Mazarrón (Murcia). Data of San Salvador del Valle (Biscay) in Pérez-Castroviejo (2006). Standardising criteria for heights at the age of 20 years: I have added 1.5 cm to the heights of 18-year-old males and 0.5 cm to the heights of 19-year-old males.

84. Nadal (dir.) (2003).

three mining villages in the range of Cartagena (Alumbres, El Beal and San Ginés de la Jara) and Mazarrón; and also from San Salvador del Valle, one of the most important iron mining areas in Biscay.[85] Mining activity was intense in southeast Spain from 1840-1850 and through to 1890, while the most active period in Biscay was between 1876 and 1913.

A comparison of the data reveals that the height of the conscripts from Cartagena was the lowest among the people of various mining areas analysed. On average, the height of conscripts from Cartagena was 2-3 cm lower than that of the draftees from Mazarrón (Murcia) and Biscay, and more or less the same difference was seen with the conscripts from Vera (Almeria), except for the period 1856-1870. This period was marked by epidemics and agricultural crises, and a large number of miners also found work in agriculture as day labourers. The mining population of Rio Tinto (Huelva) presented a similar trend. After the decrease in the height of those born in 1866-1880, this region presents the highest stature for the period 1881-1900; towards the end of the period under consideration, their height was second only to that of the Basque miners.[86] The importance of child and juvenile labour in mining activities could be the cause of these differences: in Biscay, child labour barely amounted to 5% of the workforce prior to 1902, and never went over 10% between 1905 and 1920; in the lead mines in Almeria and Murcia, on the other hand, it never went below 20% before 1930 and was over 30% between 1868 and 1900.[87]

In Cartagena, the widespread use of children (*gavias*) for carrying and extracting minerals, and long working days, sometimes in underground galleries, is abundantly attested. The low wages paid to children encouraged employers to hire them, but children's pay nevertheless amounted to around 25% of the household income. The use of child labour, however, does not fully explain the difference in height. Mazarrón is barely 40 km from Cartagena, and a similar proportion of child labour has been noted there, but the nutritional health values are notably better. The key may be the local epidemiological and environmental contexts, which means that environmental illnesses and the diet must be studied in more detail. In conjunction with the exhausting working days, these factors could well be the reason behind stunted growth and physiological poverty.[88] In any case, the working conditions suffered by children and adolescents must have had negative consequences on growth and stunted adult stature, as confirmed by the medical reports that were recorded on the initiative of the mining companies.[89]

85. For Vera, Cartagena and Mazarrón, see Martínez-Carrión (2005b). For San Salvador del Valle, see Pérez-Castroviejo (2006).
86. See Pérez de Perceval, Martínez-Carrión & Martínez Soto (2016), in this issue.
87. Pérez de Perceval, Martínez Soto & Sánchez-Picón (2013).
88. Martínez-Carrión (2005b).
89. Cohen & Fleta (2013).

Secondly, the increase in height in the mining areas in Almeria, Murcia and Biscay from the 1880 cohort, after the nutritional slump of 1861-1875, needs to be highlighted. The increase in San Salvador del Valle for those born between 1870 and 1915 was 3 cm, but short-term cycles have been detected which could be related to variations in standards of living affected by peaks of labour-related conflicts.[90] Although urban statures were below rural ones in Biscay, the drop detected in San Salvador del Valle in the cohorts of 1861-65 may be attributed to the massive arrival of immigrants from the nearby Castilian provinces after mining activity began in 1876. Also, we should not disregard the effects of the Third Carlist War, which severely disrupted food supply between 1872 and 1876. In addition, during this period there were several episodes of nutritional crisis which affected rural and urban settings alike. However, a somewhat longer and deeper process of nutritional deterioration is detected in Mazarrón, affecting the 1861-85 conscripts — that is, draftees who went through adolescence in the 1870s, 1880s and 1890s, a period which witnessed rapid demographic growth and the deterioration of environmental conditions, owing to massive immigration. The links between infection, nutrition and migration in the growing — in demographic and economic terms — mining areas in the last third of the nineteenth century need to be explored in more detail.

Height and Socio-Economic Inequality

Inequality has been on the research agenda of anthropometric history from the start, but current levels of inequality in income and wealth have sparked a renewed interest in the topic.[91] In Spain, the focus has been on inter-regional inequality, the urban-rural chasm and the variations between different environmental contexts, but the most successful approaches to date have been those that involve analysis on a micro-scale, on a district level, and include variables such as socioeconomic status and access to education.

It is interesting to note that significant levels of socioeconomic and environmental inequality can be detected even within a single city. Different studies on the district or parish level have been able to distinguish between neighbourhoods 'inside the city walls' (for the wealthy classes and craftsmen) and neighbourhoods 'outside the city walls' (for the industrial workers and poor classes), at least until the disappearance of city walls in the late-nineteenth century.[92] The differences in height were significant, even dramatic, during the nineteenth century, indicating segregation, marginality and poverty, chiefly

90. Pérez-Castroviejo (2006); Hoult & Rojo (2014).
91. Baten & Blum (2012); Blum (2016); Dobado (2015).
92. Hernández, Moreno & Ventoso (2009); Martínez-Carrión & Cámara (2015).

in the neighbourhoods 'outside the city walls'. From the early twentieth century onwards, investment in hospitals and other sanitary facilities, especially the construction of sewerage and drinking water-supply networks, as well as the construction of new, more salubrious urban districts, contributed to the converging of values from different urban sectors over time.

Although less acute than in Great Britain, differences in height according to occupation and social class in Spain are indicative of the social cost of industrialisation. University students are among the tallest population groups, whereas the shortest group is composed of an indeterminate set of unqualified labourers. In the early-twentieth century, a sample of students from the Universidad Complutense de Madrid scored an average height of 167.3 cm; the national average at the age of 21 was approximately 164.4 cm.[93] In the city of Murcia (southest Spain), in the late-nineteenth century, the differences in height between students and agricultural day-labourers was 7 cm, and between students and domestic servants 8 cm; the latter population group was at the lower end of the nutritional scale, with an average height of 158-59 cm.[94] The height of university students in the nineteenth century reflects the quality of the diet of elite and wealthy social groups — something that did not change until the 1950s.

Studies on height and the level of education, based on literacy, which include different levels of wealth, clearly indicate the disadvantages suffered by illiterate social groups. This state of affairs persisted until the 1980s. Education-based inequality underwent the following evolution:[95] inequality was intense between 1850 and 1880, as illustrated by the higher stature of literate groups; it decreased between the late-nineteenth century and the early decades of the twentieth century, during which time the stature gap between literate and illiterate groups narrowed; finally, inequality grew again from the cohorts of 1916-20 and especially from 1930 onwards, and this had a severe impact on draftees born during early Francoism. In the 1930s, the height of illiterate groups clearly reflects the nutritional deficit of poor and marginal social groups. The problem with military data is that it only considers the biological standards of living of men, making it harder to evaluate the gender gap, which must have been significant.

Privation poses the greatest risk to infantile and juvenile growth. In pre-industrial Spain in the eighteenth century, certain groups suffered in endemic

93. For the survey carried out with students in the period 1899-1912, see ver Fuster (2016).

94. Martínez-Carrión (1986), p. 85. See height differences according to profession in Quiroga (2001); Cámara 8200); Hernández, Moreno & Ventoso (2009).

95. Studies on height and education in Quiroga (2003); Martínez-Carrión & Puche-Gil (2009); Hernández, Moreno & Ventoso (2009); Cañabate (2015); Linares & Parejo-Moruno (2013).

conditions of high risk owing to poverty and malnutrition. Chronic malnutrition was the norm, and access to proteins was a defining factor for the nutritional status of certain professions, such as butchers. In general, landowners, qualified personnel, stockbreeders and farmers who possessed animals were the tallest professions, followed by artisans and day-labourers; shepherds and servants were at the bottom of the scale.[96] This situation hardly changed between the eighteenth century and the late-nineteenth century; the most significant change was the slight deterioration in the nutritional status of agricultural day-labourers, which came about due to the collapse of the *ancien régime* and the impact of subsequent liberal reforms.[97]

The social class scheme (HISCLASS) based on HISCO of a wide selection of towns and villages in the region of Valencia in the mid-nineteenth century suggests that farmers and agricultural labourers had the shortest stature, while white-collar and qualified workers had the highest. A century later, the former group had grown by 6 cm, but were still behind white-collar workers, who had grown in average stature by 5 cm. Semi-qualified workers, however, were the tallest group in this second reading, after growing nearly 8 cm.[98] In the late nineteenth century, the worse-off professional groups were certain categories of industrial worker (spinners, tanners and shoe-makers, among others), which is related to the hostile factory environment, especially for children, and also miners (especially in lead and sulphur mines).[99] In any case, the environmental changes and the formidable economic progress of Spain in the twentieth century worked especially in favour of the middle classes (white-collar workers and non-manual semi-qualified workers).[100] These groups benefitted from the greatest nutritional and health-related advances, although all social groups, including the working classes, improved their lot in some measure.

Finally, inequality is also being studied through the analysis of dispersion measures, such as coefficients of height variation (henceforth CV).[101] The results available for the late-eighteenth century indicate a decrease in height which is consistent with the deterioration of economic well-being (real wages and per capita consumption) and the increase of economic inequality.[102] During the industrialisation process, a nationwide study which takes into consid-

96. See in this issue García-Montero (2016), as well as his thesis, García-Montero (2013), for a wide sample taken from Central Spain.

97. For a work that introduced the fall in stature of Spaniards in the closing stages of the *ancien régime*, see García-Montero (2010).

98. Ayuda & Puche (2014), p. 112.

99. See Martínez-Carrión, Puche & Cañabate (2013), pp.252-256; Puche-Gil & Cañabate (2016).

100. Cámara (2015).

101. Baten & Blum (2012); Blum (2013, 2016).

102. In this issue see García-Montero (2016). For the deterioration in economic conditions, see Álvarez Nogal & Prados de la Escosura (2013).

eration the height of draftees from 1893-1954 (the professions of these conscripts were divided into nine professional categories), suggests an increase in inequality before WWI, and a decrease in inequality between 1915 and 1935, and then another increase afterwards.[103] However, the CVs in a wide sample of individual heights in the region of Valencia reveal that inequality decreased between 1870 and 1920, increased from 1930 to 1950, and fell in the 1960s.[104] Different local studies, however, agree that inequality increased in the third quarter of the nineteenth century, decreased after that, and remained low until the Great War, when it started increasing again — a process reinforced by autarchic economic policies. These results apply to both the rural[105] and urban environments.[106] Biological inequality does not follow the same trends as economic inequality, but rather follows in the wake left by conditions of absolute poverty.[107] Although further research is necessary, anthropometric data suggests that the worst periods for the popular classes were the central decades of the nineteenth century and from 1930 onwards; the latter slump is particularly acute due to Francoist autarchic policies. Conversely, the data suggest that the best periods, in anthropometric terms, were the late-nineteenth century and the opening decades of the twentieth century. We know little for the stage of democratic transition, although recent studies show that economic inequality was persistent.[108]

Final Remarks and Future Research

One of anthropometry's most important contributions to economic history has been to offer a new approach to measuring human well-being. The inclusion of anthropometric data has valorised the biological consequences of economic growth and its impact on well-being. Studies on nutrition and health have complemented the existing chrematistic view on standards of living and have sparked debate on the quality and vigour of the workforce from the Industrial Revolution onwards. Physical well-being is directly affected by economic conditions, but nutrition and health conditions also have an effect on the economy. Height standards among Spaniards (until a century ago) are

103. Quiroga & Coll (2000), p. 121.
104. Ayuda & Puche (2014), p. 109.
105. For analyses carried out using height percentiles and quartiles, see Cámara (2009); Hernández & Moreno (2009); Cámara & García-Román (2010); Cañabate-Cabezuelos & Martínez-Carrión (2017).
106. The few analyses that have been carried out to date indicate that inequality increased during the early stages of the industrialisation of Catalonia: see Ramon-Muñoz & Ramón-Muñoz (2016).
107. Prados de la Escosura (2008), p. 310.
108. Torregrosa-Hetland (2016).

a clear reflection of the conditions of privation and poverty, and also of the impact of environmental conditions, which undermined growth or stunted it. Conversely, low biological and nutritional values (small stature and low weight, wasting, sallow complexions, low levels of robustness and low BMI) determined productivity, salaries and cognitive development. These matters have been outlined in this paper, but need to be considered more fully by economic historians, and further micro- and macro-scale research is needed.

Anthropometric evidence places the nutritional status of Spaniards among the lowest in Europe until the late-nineteenth century. After a long period of lagging behind European living standards, Spanish values tended to converge with their European counterparts in the twentieth century. The formidable increase in average adult height in this century was largely the result of the improvement of per capita material standards of living, income and calorie consumption, as well as of the indisputable improvement in healthcare, which can be measured in terms of increased life expectancy and the decline in mortality, after infant mortality fell sharply. Despite the fact that most height analyses are based on local and regional studies, we have gained a clear image of the evolution of biological standards of living in the long term, especially for the generations born after the 1830s.

Anthropometric data suggest that nutritional standards fell and inequality increased in the late-eighteenth century, and again in the central decades of the nineteenth century, after the short-term oscillations that took place in the first half of the century. However, these conclusions need to be supported with more data and broadened to cover other territorial and social settings. Those born in the third quarter of the nineteenth century went through hard times, as reflected in the decrease in height, both in rural and urban contexts, and increasing inequality concerning height. This inequality was caused mainly by the fall in the height of farmers and agricultural workers and, to a large extent, also industrial workers. The nutritional status improved from the cohorts of 1880 until the beginning of the Great War, most significantly in rural areas and among the middle classes. The nutritional deterioration for those born between 1915 and 1930 can be attributed to the 'years of hunger' — a period of widespread poverty which stunted adolescent growth. After that time, the increase in height was dramatic, and this increase occurred in parallel with the improvement of other human-development values. Although average height has increased more in men than women in the twentieth century, indicating sexual dimorphism (differences in stature according to gender), the stature of women has increased in Spain more than in any other European country since 1950. This reveals the impact of the deep socioeconomic transformations on the biological well-being of the Spanish population in the second half of the twentieth century, especially among women. Known biological welfare disparity between men

and women and secular growth requires gender analysis and studies to determine the impact of family size on height.

The impact of industrialisation on nutrition was uneven in the short-and the long-term. In the short term, the picture is rather pessimistic. The waves of mechanisation undergone by industrial cities between the mid- and the late-nineteenth century, which in many cases were accompanied by the widespread dissemination of female and child labour, had a negative impact on nutrition. The terrible working and hygienic conditions in factories, workshops and housing (inhabited by larger households) prolonged the deterioration of urban nutrition and health conditions, which continued until the opening decade of the twentieth century. Despite the impact of the rural height penalty, the biological costs of the early urbanisation process cannot be ignored. This impact was palliated by the sanitary reforms implemented in the late-nineteenth and early-twentieth centuries. However, further research is necessary to clarify the relationship between height and mortality, as well as the link between nutrition and infection, which must have been largely responsible for stunted growth. In the long term, however, industrialisation and economic growth had positive effects, and strongly contributed to the increase in the height of Spaniards. The acceleration of techno-physiological evolution caused by the Industrial Revolution was a veritable physiological revolution, during which bodies adapted to profound economic and environmental changes. Between 1850 and 2000, Spaniards had grown nearly 13 cm and gained 48 years in life expectancy.

After several decades of study using anthropometric indicators, economic history and the economic sciences in general have become more interdisciplinary. Economic history, in addition, has acquired new tools with which to analyse matters such as inequality, which were insufficiently explored or simply lay beyond our reach because of the lack of statistical data for certain periods. The severe problems suffered by developing countries, and even the first world, such as hunger, infant malnutrition and inequality, can only be understood if we have a firm knowledge of past trends. More research on the impact of nutritional shocks, the evolution of the rural-urban gap, and social, territorial and regional differences, will be illuminating and inform nutritional and healthcare policies — the basic pillars of social welfare. Spanish anthropometrics could be an excellent laboratory for the study of economic history.

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Living Standards, Nutrition and Inequality in the Spanish Industrialisation. An Anthropometric View

Abstract

This article presents an overview of the study of living standards in Spain from the perspective of anthropometric history and new data from recent research. The aim is to examine changes in nutrition during the industrial age through anthropometric indicators. The paper provides new evidence on the changes in height among different socioeconomic groups and its relation with health and human well-being in different periods and geographical regions. It also explores inequality before and during the process of industrialisation. In addition to tracking the effects of environmental changes on well-being and inequality between the proto-industrial period in the eighteenth century and the industrial leap in the beginning of the second half of the twentieth century, it explores the costs of industrialisation in biological standards of living in the short- and the long-term. Finally, it suggests future directions of research.

Keywords: biological standards of living, nutrition, inequality, Spain, industrialisation

JEL Codes: I14, I31, N33, N34, R11

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Nivel de vida, nutrición y desigualdad en la industrialización española. Una visión antropométrica

Resumen

Este artículo presenta una visión general del estudio de los niveles de vida en España desde la perspectiva de la historia antropométrica y nuevos datos de las recientes investigaciones. El objetivo es examinar los cambios en la alimentación a través de indicadores antropométricos durante la era industrial. El documento proporciona nueva evidencia sobre los cambios en la altura entre los diferentes grupos socioeconómicos y su relación con la salud y el bienestar humano en diferentes períodos y regiones geográficas. También explora la desigualdad antes y durante el proceso de industrialización. Además del seguimiento de los efectos de los cambios ambientales en el bienestar y la desigualdad entre el período proto-industrial en el siglo XVIII y el salto industrial en el comienzo de la segunda mitad del siglo XX, se exploran los costes de la industrialización en los niveles de vida biológicos tanto en el corto como en el largo plazo. Por último, se sugieren direcciones futuras de investigación.

Palabras clave: niveles de vida biológicos, nutrición, desigualdad, España, industrialización

Códigos JEL: I14, I31, N33, N34, R11