Did Physical Stature Diminish During Spain's Early Industrialisation? The Case of Alcoy, 1840-1915*

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Introduction

Biological living standards among the working classes during the first industrial revolution is an issue that has attracted enormous attention in the literature published in the field of anthropometric history.[1] The majority of studies performed show that urban stature was lower than rural stature in many towns and cities as a consequence of the *urban penalty*[2] in industrialisation processes, despite the contrary findings of some others.[3] Overall, results show that the decline in urban stature during the first industrialisation was linked to environmental conditions in the cities concerned, and depended on the intensity of industrial and manufacturing activity.[4] In the Spanish

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1. Komlos & Baten (2004), Martínez-Carrión & Cámara (2015), Martínez-Carrión, Puche & Cañabate-Cabezuelos (2013), Steckel & Floud (1997), and Voth (2004).

2. Cinnirella (2008), Cuff (2005), Ewert (2006), Haines (2004), and Komlos (1998), among others. The concept of *urban penalty* refers to the health and nutritional impacts of life in the densely populated and insalubrious early industrial cities.

3. Alter, Neven & Oris (2004), Baten (2001), Heyberger (2007), Reis (2009), and Twarog (1997).

4. Cinnirella (2008), and Martínez-Carrión *et al*. (2014).

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case, research has shown that people were generally taller in large towns and cities than in the countryside,[5] despite occasional cases of the urban penalty found towards the end of the nineteenth century.[6]

The main aim of this paper is to examine the impact of early industrialisation on biological living standards in the Valencia region by looking at the case of Alcoy. Though Spain was not one of the countries which led European industrial development, some regions and provinces anticipated the general industrialisation of the country in the nineteenth century.[7] This was the case of Alcoy, a city that was one of the leading industrial centres in Valencia in the 1880s. The "Manchester"[8] of the region, Alcoy was already its most genuinely industrial town in the eighteenth century, when it developed an important wool industry.[9]

The city of Alcoy embarked on a period of vertiginous industrial growth in the late 1830s and early 1840s as local entrepreneurs invested heavily in the wool industry, undertaking a decisive mechanisation of primary production processes (carding and spinning).[10] Industrialisation was not confined to woollen textiles, however, and both paper manufacturing and a metallurgical industry also played their part in the city's rapid economic development.[11] This paper asks whether the speed of Alcoy's initial industrialisation in the second half of the nineteenth century penalized the biological living standards of the population, and especially of the working classes. We address this question using stature data for young men conscripted into the army between 1860 and 1936 (generations born between 1840 and 1915). In this way, we seek to contribute new anthropometric evidence to the debate on the social repercussions of Spanish industrialisation in the nineteenth century.

The paper has four parts aside from this introduction. The first describes the sources used in the study, the sample data and the methodology employed. The second section explains the nature of Alcoy's industrialisation in the nineteenth century, as well as the living and health conditions resulting from the process and the rapid urban development that went with it. The third sec-

5. Martínez-Carrión & Pérez-Castejón (2002), Martínez-Carrión *et al*. (2014), Quiroga (2001, 2002a, 2002b), and Ramón-Muñoz (2011).

6. Martínez-Carrión (2004), Martínez-Carrión & Moreno-Lázaro (2007), and Martínez-Carrión & Pérez-Castejón (1998).

7. Carreras (2005), Carreras & Tafunell (2010), Germán *et al*. (2001), and Nadal (2003, 2009).

8. This expression is used in the foreword to Joan Fuster, Aracil & García-Bonafé (1974), p. 9.

9. Calatayud (2001), Cuevas (2006), Martínez-Galarraga (2009), Nadal (2003), Piqueras (1999), Soto-Carmona (1989), Torró (1994), and Torró & Cuevas (2002).

10. Alcoy's wool industry employed some 8,000 people in 1852. Egea-Bruno (1984), p. 136.

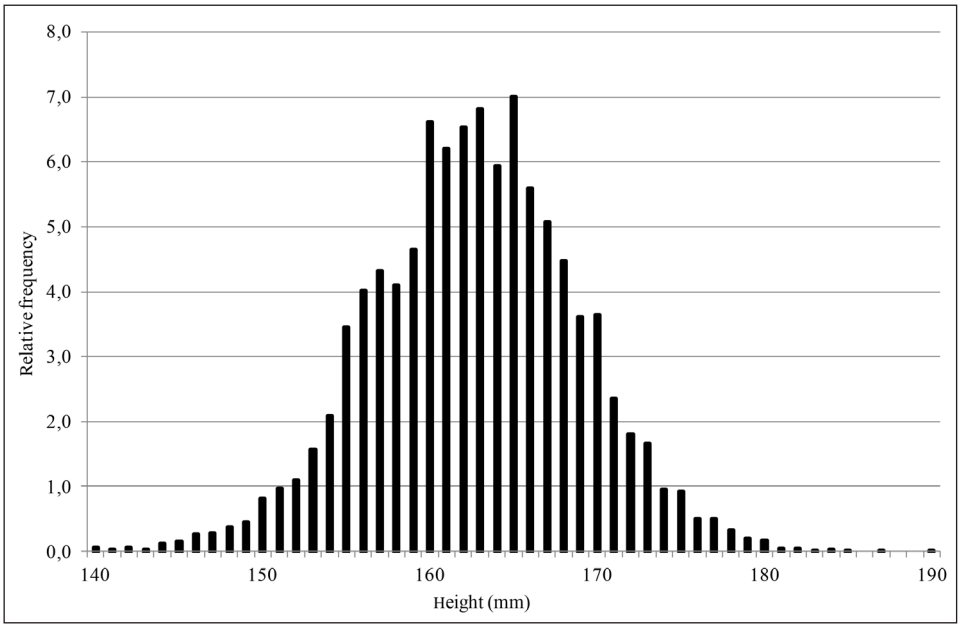
11. Aracil & García-Bonafé (1974), Calatayud (2001), Cuevas (1999, 2006), Egea-Bruno (1984), Martínez-Galarraga (2009), Nadal (2003), Piqueras (1999), Torró (1994), and Vallés (1986).

tion analyses the biological impact of this industrialisation process, based on trends in the mean statures of recruits born between 1840 and 1915, including assessments of the effects of immigration from the rural hinterland, the biological living conditions of the working classes and social inequality. The fourth section presents our final conclusions.

Study Sources, Data and Methodology

The principal data source used in this study consisted of the *Expendientes de Reemplazo* or "Conscription Records" for the period from 1860 to 1936, which contain details of the stature of recruits aged between 19 and 21 drafted in Alcoy. The stature data present no problems of social representativeness or truncation.[12] As shown in Figure 1, the data follow what is almost a normal distribution, except for the typical rounding of statures in the bands ending in 0 and 5. The distributions of frequencies were also calculated with very similar results for each of the periods in which recruits were conscripted at a constant age.

FIGURE 1 ▪ *Distribution of stature frequencies among recruits in Alcoy, conscripts drafted between 1860 and 1936*



Source: Conscription records from the Alcoy Municipal Archives (AMA). Own work.

12. Puche (2009, 2011).

The sample comprises 18,698 height measurements distributed among 22,591 recruits aged between 19 and 21 years drafted in Alcoy in the period 1860-1936, representing 82.7% of the young men conscripted (Figure 1). The remaining 17.3% did not report for conscription for a variety of reasons including death, sickness, emigration and flight. The records detail the birthplace of each conscript, allowing analysis of the impact of immigration on stature. Hence, we looked for differences between the recruits born in Alcoy (who accounted for 47.1% of the sample) and the immigrant cohorts, especially those born in the villages of the Alcoy district who made up 60.5% of total immigration arriving in the city from the province of Alicante (Table 1).

The sources also frequently indicate the conscripts' occupations. Hence, we were able to analyse their distribution in terms of employment in the main sectors of the local economy and to examine the impact of Alcoy's industrialisation on the health and nutritional conditions of the working classes. Meanwhile, it is possible to draw comparisons between groups of differing socio-economic status by grouping occupations into overarching socio-occupational categories. For these purposes, we applied the international historical classification of social class HISCLASS, which is based on HISCO.[13] Both occupational classifications were created by associate researchers at the International Institute for Social History in Amsterdam. HISCO is a classification system listing 1,600 occupations, which HISCLASS converts into twelve major socio-occupational categories based on three main criteria: (i) the manual/non-manual status of the occupation, (ii) the level of skills required to enter a given trade or profession, and (iii) the economic sector concerned. With minor modifications, the HISCLASS occupational classification is useful in a large number of applications.[14] In order to prevent problems resulting from the scarcity of observations in any class relating to the question of immigration, we grouped the conscripts' occupations into five basic socio-occupational categories including only those actually born in Alcoy (Table 1). These were 1) highly skilled non-manual professions (HISCLASS 1 — 0.3% of the anthropometric socio-occupational sample), like students, schoolteachers, doctors and lawyers; 2) medium skilled non-manual occupations (HISCLASS 2 — 18.7%), like shopkeepers, shop assistants and typesetters; 3) medium and low skilled manual occupations (HISCLASS 3 — 68.4%), being the category which embraces the working classes employed in Alcoy's industries in jobs such as spinner, weaver, papermaker, metal worker, carpenter, and so on; 4) smallholders, farmhands and tenant farmers (HISCLASS 4 — 6.7%), with smallholders and tenant farmers classified in a specific category because these

13. HISCO is a historical version of the International Labour Organisation's *International Standard Classification of Occupations* (ISCO, 1968).

14. Van Leeuwen & Maas (2005, 2011), and Tammes (2012).

TABLE 1 ▪ *Anthropometric sample for Alcoy, conscripts 1860-1936*

	Total Conscripts	Conscripts Measured	
		N	%
Alcoy	22,591	18,698[1]	82.7
Place of birth			
1. Alcoy	10,907	9,055	47.1
2. Immigrants	2,435	2,242	11.7
3. No data	9,249	7,916	41.2
2.1. Immigrants born in the province of Alicante	1,621	1,501	66.9[2]
2.2. Immigrants born in the Alcoy judicial district	968	908	60.5[3]
Socio-occupational categories per HISCLASS (only recruits born in Alcoy)[4]			
1. Highly skilled non-manual professions	457	367	80.3
2. Medium skilled non-manual occupations	1,149	1,055	91.8
3. Medium and low skilled manual occupations	4,155	4,027	96.9
4. Smallholders, farm labourers and tenant farmers	391	383	98.0
5. Landless farm labourers	365	333	91.2

1 This total sample does not include the statures of 515 recruits conscripted on an extraordinary basis at the ages of between 19 and 21 years in 1875. In this case, only the stature of 20-year-old recruits was considered, as established in the general legislation governing the draft in that year.

2 Percentage of the total immigrant recruits in the sample of those measured.

3 Percentage of the total immigrant recruits in the sample of those measured and who were born in the province of Alicante.

4 We excluded volunteer recruits enlisting as private soldiers from the socio-occupational sample (124, eleven of whom were measured) and those professing religious orders (3, only one of whom was measured), as these occupations cannot easily be fitted into the HISCLASS classification.

Source: Conscription Records and Filiation Sheets (AMA). Own work.

rural groups were able to benefit from direct access to the land and the production of food;[15] and 5) other low skilled occupations, including landless agricultural labourers (HISCLASS 5 — 6%).

Finally, let us note two methodological considerations. In the first place, the anthropometric analysis is presented by year of birth, as final adult height reflects the nutritional and environmental conditions experienced by an individual from the beginning of his life (even as a foetus) until adolescence.[16] In

15. Blum (2013).

16. Batty *et al*. (2009), Hatton (2013), Martínez-Carrión (2012), Silventoinen (2003), and Steckel (1995, 2009).

the second, the series of drafts in Spain embraces successive legislative changes in the age of conscription (19 to 21 years) between 1856 and 1907. The authors of some studies have opted to standardize stature at the age of 21 using different methodologies.[17] As the present work is a case study and therefore includes fewer observations of stature than other studies based on large regional samples, we present the data without standardisation on the grounds that the changes in the recruitment age would have affected the different social classes and all of the young men called up equally. Hence, the presentation of stature respects the periods in which conscription occurred at different ages (19, 20 and 21 years).

Industrialisation, Urbanisation and Health Conditions in Alcoy

Industrialisation began very late in nineteenth-century Valencia, as it did in other Spanish regions.[18] Nevertheless, some towns embarked on the development of modern industries in the mid-nineteenth century, even if the Valencian economy remained fundamentally agrarian at the beginning of the

MAP 1 ▪ *Geographical location of Alcoy*

Source: Own work.

17. See García-Montero (2009), Martínez-Carrión & Moreno-Lázaro (2007), Martínez-Carrión & Puche (2009, 2010), Puche (2011), and Ramón-Muñoz (2009, 2011).
18. Palafox (2001).

twentieth century.[19] The city of Alcoy is an outstanding example of this process in the province of Alicante (Map 1), as it became one of the leading wool producers in Spain in the second half of the nineteenth century.[20]

Alcoy's economic and industrial growth was as peculiar as it was exceptional — a city stuck in a district with scant resources of its own, isolated from the interior by a barrier of rugged mountains, which nevertheless became a pioneer in the process of industrialisation. This burgeoning of industry can be explained by a combination of three factors. In the first place, there were plentiful streams to turn mills and supply the water needed to wash the wool. Second, abundant fleeces were available locally, provided by the flocks of sheep shorn in early summer before being driven up to pasture in the mountains. Third, transport was furnished by the district's mule drivers, who would cross the passes of the Sierra de Mariola taking the fabrics produced in Alcoy for sale to the consumer markets of Andalusia and other parts of Spain.[21]

Alcoy and its rural hinterland had gradually developed an incipient textiles industry based on wool in the eighteenth century, and output expanded considerably towards the end of this period. In the early nineteenth century, the different stages involved in wool production were still scattered, a serious organisational weakness for the city's emerging textiles industry. Carding and spinning were village industries, while weaving and dying work was concentrated in Alcoy itself.[22] The city's entrepreneurs overcame this handicap, which is fairly typical of proto-industrial structures, by centralizing manufacturing in factories and bringing in the first spinning machine.

Mechanisation of the textiles industry in Alcoy began around 1820, when the first carding and spinning machines were set up. The process was faster in spinning than in weaving. In the early 1860s, mechanical spindles had completely replaced the old manual spindles, but there were still hardly any mechanical looms because of the high cost of the machinery (Figure 2). The mechanisation of spinning intensified in the following decades, reaching a peak in 1885 when there were almost 30,000 mechanical spindles in the city. Although incomplete, this mechanisation drove down costs and cut the retail prices of the cheaper stuffs, which were precisely the products manufactured in Alcoy. Lower prices stimulated demand, above all in Andalusia where the market consisted of numerous poor peasants. Rising demand, which was also driven by protectionist tariff barriers designed to prevent foreign competition, in turn favoured output growths.

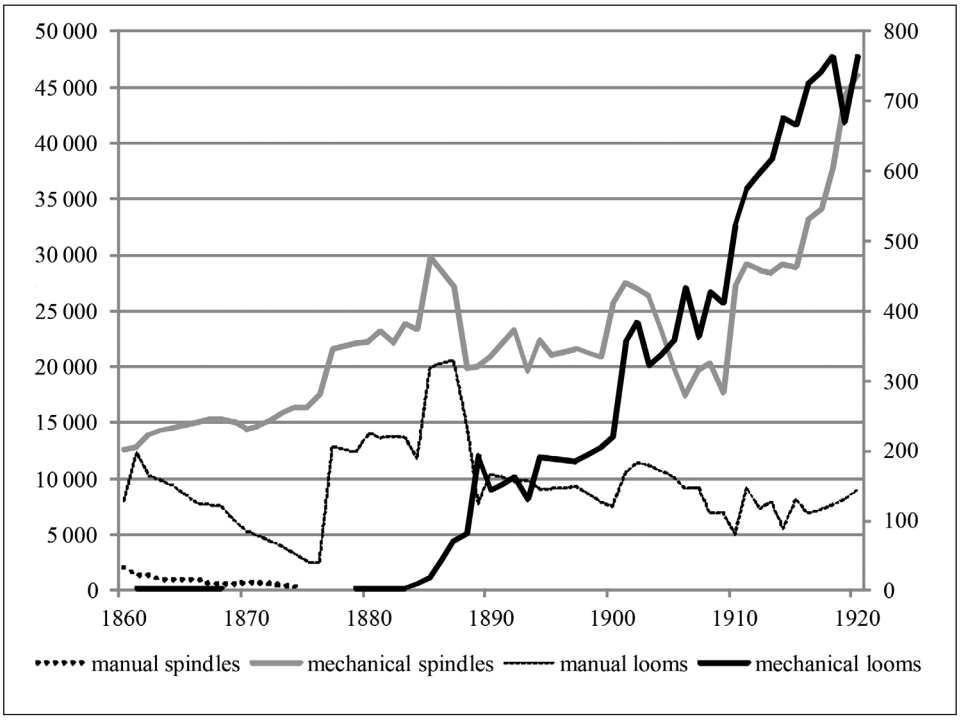
19. Calatayud (2001), Martínez-Galarraga (2009), Miranda (1994), Nadal (1987, 1990, 2003), and Piqueras (1999).

20. Aracil & García-Bonafé (1974), Calatayud (2001), Cuevas (2006), Egea-Bruno (1984), Martínez-Galarraga (2009), Nadal (1990, 2003), and Vallés (1986).

21. Piqueras (1999), pp. 313-314.

22. Aracil & García-Bonafé (1974), Beneito (2003), Egea-Bruno (1984), and Piqueras (1999).

FIGURE 2 ▪ *Spinning machines and looms recorded in the Alcoy industrial register, 1860-1920*



Source: Martínez-Galarraga (2009), pp. 108-111.

Despite the unquestionable technical progress made, the wool industry of Alcoy never succeeded in catching up with its dynamic Catalan rival,[23] and it only succeeded in maintaining a relatively strong position in the Spanish domestic market at the cost of specialisation in low quality textiles and low wages.[24] The development process was completed at the end of the nineteenth century and the beginning of the twentieth in reaction to the severe crisis that affected the wool industry in the 1880s,[25] resulting in the mechanisation of

23. In the first place, the Catalan textiles industry had conquered the national market by displacing traditional manufacturing (cotton and wool) in other regions. Second, the Catalans had been quick to try out new forms of industrial organisation, and by 1860 vertical integration was a fact in Catalonia, which facilitated the adoption of more advanced production technologies and effective adaptation to the volatile Spanish market. Maluquer de Motes (2001), and Nadal (2003, 2009).

24. Aracil & García-Bonafé (1974), and Piqueras (1999).

25. In the early 1880s a series of poor harvests in Andalusia depressed demand in Alcoy's main market, a situation that was compounded by the free trade policy implemented in 1869, which the tariff review of 1877 only worsened by lowering the level of protection afforded to woollen textiles and opening up the Spanish market to foreign competition. Furthermore, this competition was sharply focused, as the customs duties charged on lightweight cloth were

weaving, the implementation of the protectionist tariff of 1891, and the widespread use of coal to fire steam engines,[26] which was made possible by the new railway line from Alcoy to the port of Gandía. The line entered service in 1893 and supplied the city with fuel for several decades.[27] As a result of these technical innovations, Alcoy entered the twentieth century with a fully established, even "mature", manufacturing industry.[28]

As in other industrial cities of western Europe, the process of industrialisation in Alcoy was accompanied by rapid urban development beginning in the 1830s. This intense process of development in turn affected the population of villages in rural areas of the district. The fastest urban growth took place between the mid-1840s and the end of the 1870s, by which time much of the population of the rural hinterland had drifted to the city that had grown up alongside the development of the factory system and the mechanisation of the initial stages of the wool production process (Table 2).

According to Beneito (2003) and García-Gómez (2013, 2015), urban development and the absence of public health policies resulted in a general

TABLE 2 ▪ *Population growth in Alcoy, 1793-1930*

Year	Population	Growth (%)
1793	14,626	
1845	19,697	34.7
1857	25,315	28.5
1877	32,497	28.4
1887	30,132	-7.3
1900	32,053	6.4
1910	33,896	5.7
1920	36,463	7.6
1930	38,739	6.2

Source: Population censuses, Spanish National Institute of Statistics. Own work.

much lower than the tariffs on heavier cloth, encouraging overseas competitors to concentrate on summer fabrics, which were precisely the stuffs in greatest demand in Spain, so that local producers were driven out of the market. Until 1869, the textiles industry, and in particular woollens, had enjoyed the protection of extremely high tariff barriers. Both of these factors (poor harvests in Andalusia and the competitive weakness of Alcoy's textiles industry in both the domestic and international markets) brought about a collapse in output and caused great instability in the industry, sparking a migratory process that would affect exclusively textiles workers. Egea-Bruno (1984), and Martínez-Galarraga (2009).

26. Calatayud (2001), Cuevas (1999), and Martínez-Galarraga (2009).

27. Abad *et. al* (1991).

28. Calatayud (2001), and Martínez-Galarraga (2009). Alcoy's textiles industry enjoyed a considerable export boom during World War I.

worsening of living conditions for the population of Alcoy in the second half of the nineteenth century, as they worked in a multitude of miniscule, poorly equipped workshops and lived in cramped, insalubrious houses in densely populated neighbourhoods, where urban infrastructure was deficient and diet generally inadequate. Again, like other populous industrial cities, Alcoy suffered waves of epidemics and a high rate of infectious disease in the nineteenth century (Tables 3 and 4).[29]

After the crisis of manufacturing in the countryside, many of the rural district's peasants migrated to the city in search of higher earnings. This resulted in an intense rural exodus to Alcoy in the central decades of the nineteenth century, and the city grew to the point of saturation, receiving immigrants without the infrastructure needed to accommodate them.[30] Overcrowding and the proliferation of shanty towns and slums were the characteristic features

TABLE 3 ▪ *Evolution of infectious diseases in Alcoy, 1875-1879 / 1928-1932 (%)*

Cause	1875-79	1898-1902	1928-32
Airborne pathogens	35.6	39.1	27.0
Waterborne and foodborne pathogens	14.9	12.6	9.1
Microorganisms	3.6	8.3	4.5
	54.1	**60.0**	**40.6**

Source: Beneito (2003), p. 266.

TABLE 4 ▪ *Airborne infectious diseases in Alcoy and district villages, 1875-1879 / 1928-1932 (%)*

	1875-1879		1898-1902		1928-1932	
	Alcoy	District	Alcoy	District	Alcoy	District
Smallpox-Measles	8.9	2.8	7.6	3.7	0.3	1.7
Laryngitis	2.2	3.9	0.6	0.9	-	0.3
Bronchitis-pneumonia	18.6	13.4	20.0	17.4	16.9	14.3
Tuberculosis	4.2	3.6	6.7	4.0	7.7	5.6

Source: Beneito (2003), p. 269.

29. Beneito (2003). According to this study, Alcoy and its district were affected by successive outbreaks of cholera between 1830 and 1920 (1833-34, 1853-55, 1859-60, 1865 and 1884-85), not to mention the flu epidemic of 1918. The worst of all was the cholera epidemic of 1884-85, which resulted in the erection of a *cordon sanitaire*, hindering trade, preventing the import of cloth and other raw materials, and driving a contraction in the city's economy. Beneito (2003), pp. 165-218.

30. Beneito (2003).

TABLE 5 ▪ *Infant mortality in Alcoy and other municipalities of the district*, 1875-1879 / 1928-1932 (‰)*

	Infant Mortality (Per 1,000 live births)		Neonatal Mortality (First month of life)		Post-Neonatal Mortality (Next 11 months)	
	Alcoy	District	Alcoy	District	Alcoy	District
1875-1879	169	149	45	53	125	95
1898-1902	131	149	34	60	97	88
1928-1932	79	96	22	41	57	54

* Agres, Acoleja, Alcosser de Planes, Alfafara, Almudaina, Alqueria d'Aznar, Balones, Bañeres, Benasau, Beniarrés, Benifallim, Benilloba, Benillup, Benimarfull, Benimassot, Castalla, Concentaina, Fageca, Famorca, Gaianes, Gorga, Ibi, l'Orxa, Millena, Muro, Onil, Penàguila, Planes, Quatretondeta, Tibi, and Tollos.

Source: Beneito (2003), p. 36.

of urban development at this time. These conditions led to an increase in airborne diseases which were rife in Alcoy at the end of the nineteenth and beginning of the twentieth centuries. The mortality rates from bronchitis and pneumonia were significantly higher than in rural districts (18.6% of deaths compared to 13.4% between 1875 and 1879, and 20.0% compared to 17.4% between 1898 and 1902). This may be ascribed to overcrowding, dreadful environmental and working conditions, and poor health provision in the city in these decades.[31]

The rise in urban morbidity was reflected in infant mortality rates. Except for neonatal mortality, which was higher in rural areas, post-neonatal and infant mortality was at all times higher in Alcoy than in the surrounding villages in the second half of the nineteenth century (Table 5). Like other European and American industrial cities,[32] Alcoy suffered an initial urban penalty in the early years of its industrialisation. The height of Alcoy's inhabitants will reveal the impact of the urban-industrial penalty in anthropometric terms.

Height During the Industrial Boom: Evolution and Effects of Immigration

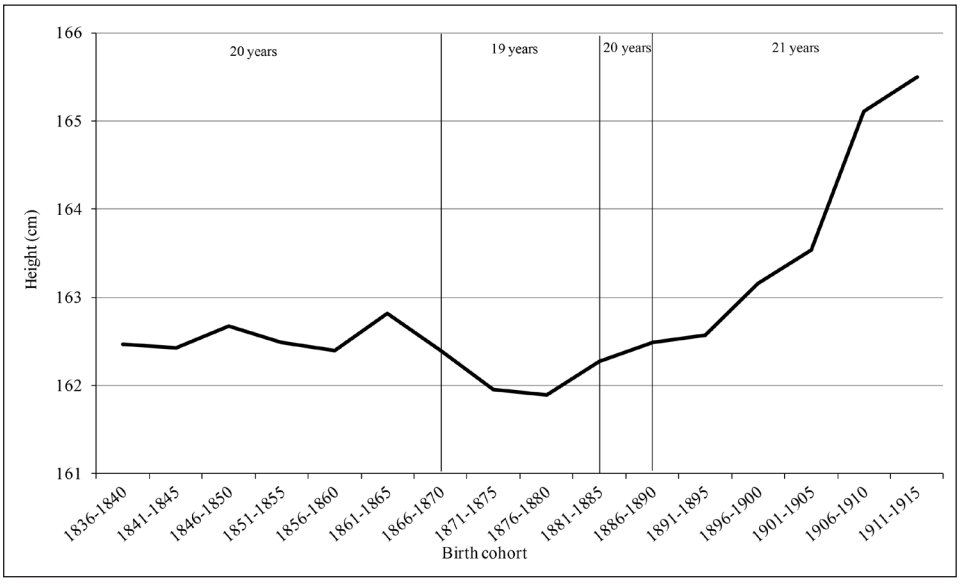
Figure 3 shows the trends in the average height of conscripts drafted in Alcoy from among the five-year birth cohorts of 1836-40 to 1911-15. To begin with, we may observe that industrialisation had positive long-run effects on the biological living standards of Alcoy's population. Average height in Alcoy increased by around 3 cm between the generations born in the 1840s and 1915. The greatest gains were made by the cohorts born in the early twen-

31. Beneito (2003), pp. 266-269.
32. Martínez-Carrión *et al*. (2014), pp. 36-41.

tieth century, however. Average height did not in fact increase at all in the second half of the nineteenth century, and there were moments when it actually decreased. Stature at the age of 20 stagnated at around 162.5 cm among those born between 1836-40 and 1861-65. However, the height of 19-year-old recruits born between 1865-66 and 1876-80 fell by one centimetre from 162.8 cm to 161.8 cm (Figure 3). This deterioration and the subsequent slow recovery meant that the average height of young men conscripted in Alcoy at the end of the nineteenth century, which was 162.5 cm, was still practically the same as it had been half a century before (162.4 cm, cohort of 1841-1845). Given the risks inherent in any comparison of average stature at different ages, and assuming that the conscripts drafted at the age of 19 had not yet completed their growth, it would seem prudent to argue that the anthropometric decline may have been less. However, stature diminished among the generations born in the 1860s and 1870s during a crucial stage in the process of industrialisation and urban growth.

The anthropometric evidence would support a pessimistic view of the early industrialisation of Alcoy, in which the transition from proto-industrial activities to the factory system in the mid nineteenth century caused a worsening of the population's living standards. The main factors contributing to the

FIGURE 3 ▪ *Average height of conscripts in Alcoy.[1] Cohorts of 1836-40 / 1911-15* (Five-year mean)*



1 Mean height series for Alcoy shown in Table A.1. of the Appendix.

Source: Alcoy Conscription Records (AMA). Own work.

decline in biological living standards and public health in Alcoy during the boom which took place between 1850 and 1880 were strong demographic growth, rapid urbanisation and the spread of infectious diseases, especially among infants and children, caused by intense mobility and an increase in contagion. Child labour was also a factor, as we shall see below.[33]

What influence did migration have on height? Did it play a part in the diminishing stature of young men between 1860 and 1870? Were those born in Alcoy taller than immigrants from nearby villages or vice versa? The sources do not tell us how old immigrants were when they arrived at their destinations (in the present case Alcoy). Also, we lack information on the environments in which they grew up (countryside or industrial city), or how different environmental conditions may have influenced their development in the two principal growth phases of infancy and adolescence. Nevertheless, we may suppose that some of the immigrant recruits arrived in the city as children brought by

TABLE 6 ▪ *Average height of conscripts born in Alcoy and rural immigrants from the surrounding district.[1] Cohorts of 1861-65 / 1911-15 (Five-year mean)*

Age	Birth Cohort	Born in Alcoy		Rural Immigrants	
		No.	Height	No.	Height
20	1861-65	763	163.0	90	162.1
19	1866-70	634	162.4	36	161.8
19	1871-75	1,278	162.0	118	162.0
19	1876-80	713	161.9	58	160.9
20	1881-85				
21	1885-90				
21	1891-95	776	162.7	82	163.5
21	1896-1900	1,256	163.1	106	163.0
21	1901-05	1,381	163.3	169	164.6
21	1906-10	1,112	165.1	131	165.3
21	1911-15	927	165.3	118	166.2

1 The anthropometric sample of immigrant recruits born in the villages of Alcoy's judicial district comprises 908 height measurements distributed by municipality as follows: Agres (56), Alcoleja (24), Alcosser de Planes (17), Alfafara (13), Almudaina (10), Alqueria d'Aznar (10), Balones (4), Banyeres (95), Benasau (17), Beniarrés (18), Benifallim (28), Benilloba (46), Benillup (1), Benimarfull (7), Benimassot (2), Concentaina (213), Fageca (7), Famorca (4), Gaianes (17), Gorga (17), Lorcha (20), Margarida (8), Millena (9), Muro (67), Penàguila (79), Planes (16), Tollos (6), and Torremanzanas (96).

Source: Alcoy Conscription Records (AMA). Own work.

33. According to a recent study by Garcia-Gomez (2015), although between 1840 and 1897 wages and nutrition for Alcoyano workers improved, the increased purchasing power and consumption of food did not compensate for the worse conditions of life and work under industrialisation.

their migrant parents, while others must have arrived in puberty and the early stages of adolescence.

As Table 6 shows, biological living standards rose both in Alcoy itself and in the rural villages of the district towards the end of the nineteenth century. The greatest progress was made by immigrants, who were shorter on average in the mid-nineteenth century. The stature of immigrant cohorts born between 1860 and 1870 was almost always below the average for those born in the city (1 cm shorter in the 1861-65 and 1876-1880 cohorts). Despite the small size of the sample (908 measurements of immigrants), this evidence is important for various reasons: *a*) it reflects the influence of rural immigration on the decline in stature in the mid-nineteenth century, as posited; and *b*) assuming that a majority of these immigrants arrived in the city during puberty, the data would dispute the existence of a possible urban penalty in the early years of Alcoy's industrialisation. However, if it is supposed that a majority of the rural immigrants arrived in childhood and, therefore, that they grew up and developed physically in the newly industrializing city, the data would reflect a negative biological impact on migrants from the countryside to the city. This case would be in line with the findings of other studies of early European industrialisation.[34] Leaving possible interpretations to one side, we may wonder whether we can actually know if stature declined during the early period of industrialisation in Alcoy in the middle decades of the nineteenth century. Based on the height data for men born in Alcoy, it appears that we can. With all due caution, given that the comparison of average heights refers to people of different ages and the majority of the 19-year-old conscripts would not have finished growing, Table 6 shows that the mean stature of the cohorts born between 1861-65 and 1876-70 fell from 162.9 cm to 161.8 cm. As observed in the general series, this decline occurred during a key phase of the industrialisation process. The evidence suggests, then, that the natives of Alcoy born in the 1860s and 1870s suffered the consequences of an industrial-urban penalty generated by the rapid transition from proto-industrial manufacturing to the factory system and the environmental impacts of rapid urban development.

Given our ignorance of the exact ages at which rural immigrants arrived, we can only say that the environmental context was at least equally harsh and insalubrious, though it may have been different, in Alcoy and in the agricultural municipalities of its district. City life was unhealthier, because of overcrowding in the slums, the conditions in the workshops, and industrial pollution. Moreover, the nutritional conditions endured by children were worse in

34. Cinnirella (2008), p. 247.

the city than in the villages.[35] The presence of women and child workers in the factories also involved enormous risks. Many mothers with babies worked punishingly long hours, which forced them to wean their offspring early despite the inherent health hazards. In the countryside, meanwhile, the pace of work was slower and mothers could take infants with them to their work in the fields and continue breastfeeding. Even so, poor diet was widespread in both town and country.

The situation gradually improved for the cohorts born towards the end of the nineteenth century and above all in the early decades of the twentieth century. From the standpoint of urban facilities, welfare policies and new sewage and sanitary infrastructure reached the more industrial cities first.[36] The launch of sanitary reform was no exception in Alcoy.[37] The agricultural villages of the Alcoy district continued to use cesspits in the absence of sewerage, and drinking water was drawn either from streams or from *aljibes* or cisterns, and it was often contaminated. In the countryside, children lived in direct contact with domestic animals and dung, and there is evidence that waterborne infections and diseases transmitted via food or by animals were more prevalent among rural infants than in the city of Alcoy.[38]

Biological living standards rose in the early decades of the twentieth century in step with environmental and socio-economic progress, leading to a decrease in morbidity and mortality, better housing and sanitation (at least in the medium term after the effects of the urban penalty had been overcome), and improvements in diet and working conditions. Between 1897 and 1920, the mortality rate fell from 30.2‰ to 22‰ in Alcoy as a result of improved hygiene and sanitation (development of basic urban information as a result

35. Although food prices in Alcoy in the mid-nineteenth century were no higher than in surrounding villages (because of their isolation from commerce and the precariousness of communications), Alcoy's industrial workers were obliged to spend more of their income on food than farm workers, because they could not supply themselves with food, as many peasant families were able to do on the land. This situation was certainly affected by the taxes charged in the city on numerous staples, and the low wages earned by industrial workers were therefore were expended almost entirely on basic foodstuffs (87.1% in 1837 and 78.3% in 1913). As the process of industrialisation progressed and stabilized towards the end of the nineteenth century, the prices of basic goods rose and many workers in Alcoy found themselves worse off financially. In 1884, certain basic foodstuffs like wheat, barley, chickpeas, oil and rice were more expensive in Alcoy than in the surrounding villages, according to the Official Gazette of the Province of Alicante, and prices in the city were above the provincial average. Beneito (2003), pp. 63-64, and García-Gómez (2015), p. 166.

36. Bell & Millward (1998), and Cutler & Miller (2005). The town of Elche provides a key case study for Spain. Martínez-Carrión & Pérez-Castejón (1998), and Martínez-Carrión & Moreno-Lázaro (2007).

37. García-Gómez (2013, 2015), and García-Gómez & Salort (2014).

38. Based on the data presented in Table 5, the neonatal mortality rate (first month of life) was higher in the rural areas of the district of La Hoya de Alcoy than in the industrial city itself until well into the twentieth century. Beneito (2003), p. 36.

of sanitation reform)[39] and the reduced incidence of infectious diseases (Table 3). Infant mortality fell sharply from a rate of 131‰ in 1900 to 79‰ by 1930 (Table 5). Child labour also decreased and the legislation became stricter in 1900, although controls had scant effect until after World War I.[40] In general, the working classes of Alcoy saw their working conditions improve, which would be inexplicable without the first stirrings of collective bargaining,[41] and to a lesser extent the emergence, pressure and demands of the nascent trade union movement.[42]

Biological Status of the Working Classes: An Anthropometric Approach

By the mid-nineteenth century, Alcoy was an eminently industrial city. In addition to the textiles industry (which accounted for 39% of the occupations declared by the conscripts), it also had thriving metal working and paper manufacturing industries (16.4% and 8% of occupations, respectively). Considering the importance of these and other industries, this section will look at the biological status of the working classes in Alcoy during the process of industrialisation based on the reports prepared by the *Comisión de Reformas Sociales* (CRS, or Social Reform Commission), which contain valuable information on the financial and working conditions of workers, including wages and female and child labour.[43] Alcoy alone of the towns in the province of Alicante submitted a lengthy report.

Leaving aside certain medium-sized factories, the ratio of employers to workers employed in the industries of Alcoy reveals a scenario in which small workshops predominated over large factories.[44] Given the individualism of the local entrepreneurs and their preference for the easy profits afforded by tariff barriers and the exploitation of labour (reflected in low wages and long working hours), it is not hard to understand that the conditions in which the proletariat of Alicante lived and worked were very hard during the early years of industrialisation. The extent of child labour is a touchstone for the harshness of working conditions, and it affected especially the families of industri-

39. Beneito (2003), and García-Gómez (2013, 2015).
40. Borras (2013).
41. Vallès (1986).
42. Soto-Carmona (1989), pp. 247-286.
43. The Commission was created in 1883 as a government body charged with reporting on the condition of the working class and promoting social reform. *Reformas Sociales, Tomo IV*, "Oral and written depositions taken by the Social Reform Commission in the province of Alicante", pp. 21-20.
44. CRS, oral deposition, section *Asociación*, p. 29.

al workers as the local Reform Commission of Alicante noted in 1884,[45] pointing out that the Child Labour Act of 24 July 1873 was routinely flouted. Boys were employed in the local industries from the age of six and girls from the age of eight, and their working hours were the same as those of the adults they were assigned to assist. The combination of gruelling work and low defences against disease were mirrored in their physical condition. This matter was raised by the working man Francisco Moltó in his oral statement to the CRS made in November 1884: "*Nótese la disminución de la talla que se observa en las quintas en los mozos de esta localidad, y se verá cuán cierto es todo lo que se ha dicho acerca del desmerecimiento que sufre el organismo con el trabajo prematuro a que se obliga la juventud*".[46]

Our anthropometric estimates confirm this observation. Table 7 shows that the height of industrial workers belonging to the cohorts of 1861-65 through 1876-80 declined during the period of the greatest demographic pressure. The boys who worked in the textiles and paper industries were the worst affected. The average stature of spinners and weavers dropped by 2 cm in this period, as did the height of factory hands (in this case until 1866-70), while the workers of the paper mills grew an average of 1.4 cm shorter and locksmiths 1.3 cm until the cohort of 1871-75. In contrast, the average height of bricklayers and carpenters remained the same at some 163 cm.

Environmental and working conditions inside the workshops and factories of Alcoy were hardly the best for the health of the workers. Most did not meet even minimum levels of hygiene and salubriousness.[47] The paper industry was the worst of all. Lack of space meant that no safety distance was kept between machines, leading to constant accidents. The case of child operators of the trip hammers[48] used in textile and paper factories is eloquent: mishaps were common and many lost their hands, disabling them for life and preventing them from returning to work to earn a living.[49]

The deterioration in the biological status of young men occupied in the textile factories and paper mills up to the 1880s suggests that their diet was also poor, so that their daily calorie intake was insufficient to provide the en-

45. CRS, written deposition, *Memoria de la Comisión local de Alcoy,* section *Trabajo de los niños*, pp. 64-65.

46. CRS, oral deposition, section *Trabajo de los niños*, p. 46. Translation: "Consider the small size of recruits conscripted from this town, and you will see how true is everything that has been said about the ill effects suffered by the body as a result of the premature labour into which the young are pressed".

47. Conditions in many occupations were permanently damp (the textile and paper mills especially used large amounts of water, which was boiled in open vats), and countless workers spent their lives breathing in noxious steams and fine particles of lint. Beneito (2003), pp. 56-62.

48. A usually heavy machine hammer used for fulling cloth and beating sheets of paper.

49. Egea-Bruno (1984), and Beneito (2003).

TABLE 7 ▪ *Average stature in industrial occupations in Alcoy.[1] Cohorts of 1856-60 / 1911-15 (Five-year mean)*

		Bricklayer		Carpenter		Locksmith		Factory Hand		Paper Mill Worker		Spinner		Weaver	
Age	Birth Cohort	No.	Height	No.	Height	No.	Height	No.	Height	No.	Height	No.	Height	No.	Height
20	1856-60	1	166.8	8	161.6	2	164.2	21	160.8	19	162.9	2	162.8	75	161.9
20	1861-65	15	160.6	37	162.8	21	163.5	53	161.6	88	163.3	26	163.2	242	163.1
19	1866-70	50	163.3	39	163.4	29	164.6	23	159.5	37	162.4	20	163.7	143	161.3
19	1871-75	63	161.9	64	163.1	53	162.2	31	161.8	75	162.8	49	160.0	286	161.5
19	1876-80	22	163.6	46	162.8	29	163.1	85	162.5	21	161.9	10	161.0	177	161.1
21	1891-95	11	164.3	14	159.9	18	163.9	13	161.3	2	165.7	25	160.5	42	160.7
21	1901-05	14	163.6	14	163.0	10	163.6	18	164.8	6	159.3	30	161.7	88	163.4
21	1906-10	35	163.8	42	164.7	14	165.2	67	164.7	19	165.1	30	164.4	142	164.0
21	1911-15	19	169.1	34	164.3	12	163.6	37	165.4	12	167.1	16	162.9	53	165.2

1 Recruits born in Alcoy.

2 Data is unavailable for the cohorts of 1856-59, 1862, 1865, 1878, 1880-90 and 1892-1903.

Source: Conscription Records and Filiation Sheets for Alcoy (AMA). Own work.

ergy needed for the long working day.[50] Low wages and high prices for basic commodities must have made malnutrition common. The diet of Alcoy's workers around 1870 was far from balanced or healthy. It was made up basically of bread, wine, oil, pulses and vegetables, occasionally supplemented by a little meat, usually pork, and fresh or salt fish (the meagre 480 grams of fish and one kilo of fresh or preserved meat consumed on average per head in Alcoy each year is striking); butter, milk and eggs were practically never available to the poor. Fruit and vegetables were to be had depending on the season.[51]

This diet began to improve at the end of the nineteenth century as a result of the relative fall in prices, and the effects were felt in the cohorts born in the early twentieth century. This occurred in a context of increasing calorie intake,[52] and improving hygiene and working conditions in the wake of sanitation reform and the spread of action by workers.[53] The stature of workers in the most representative industrial occupations increased on average by 4 cm. The paper workers and *selfactineros* (spinning machine operators) stand out, the latter growing to an average height of more than 167.0 cm by the end of the period and the latter topping 169.2 cm. Despite this improvement, the body mass index of the young men of Alcoy just before the outbreak of World War I was still relatively low at 20.2, 20.8 and 20.6 in 1912, 1913 and 1914, respectively. Though falling within the interval of healthy weight established by the WHO, these values all fall within the lower range denoting thin bodies in general.

Were the industrial recruits taller than conscripts drafted from the countryside? Table 8 shows that recruits occupied in the textiles industry and paper manufacturing were shorter than agricultural labourers and farmhands until the late nineteenth century, by which time the somewhat better conditions won as a result of workers' demands had begun to improve the anthropometrics displayed by factory workers. Until the cohort of 1876-80, the mean height of agricultural labourers and farmhands was 163.2 cm, compared to 162.7 cm for paper workers, 162.1 cm for weavers and 161.8 cm for

50. On the characteristics of the diet of working families in Alcoy between 1850 and 1912 see the study by García-Gómez (2015), pp. 167-169.

51. Beneito (2003), p. 64.

52. By the mid-1880s, the daily *per capita* calorie intake of Alcoy's workers had risen to more than 2,000 calories, and at the beginning of the twentieth century gross nutrition was at last sufficient to cover the energy demands presented by their working conditions. The *per capita* intake of 2,091 calories in Alcoy in 1884 rose to 2,156 in 1897, and by 1912 it was 2,244 calories, very close to the estimated nutritional requirement for the Spanish population in 1990 (2,260) and 1910 (2,250). García-Gómez (2013, 2015). Despite this increase in calorie intake, since the early twentieth century the working families of Alcoy reduced the purchasing of food products with higher relative prices, such as fish, meat, eggs and milk. In the case of milk, and although its consumption in Spain grew slowly from the late nineteenth century, the productive rigidities and, above all, high levels of social inequality prevented the spread of greater milk consumption among the lower classes, those with less economic resources. Collantes (2014).

53. García-Gómez (2013).

TABLE 8 ▪ *Average stature by occupation in Alcoy.[1] Cohorts of 1856-60 / 1911-15 (Five-year mean)*

Age	Birth Cohort	Agricultural Labourer		Farmhand		Paper Mill Worker		Weaver		Spinner	
		No.	Height	No.	Height	No.	Height	No.	Height	No.	Height
20	1856-60	6	162.6	19	168.1	19	162.9	2	162.8	75	161.9
20	1861-65	54	161.8	45	163.3	88	163.3	26	163.2	242	163.1
19	1866-70	24	164.0	38	162.5	37	162.4	20	163.7	143	161.3
19	1871-75	46	163.2	92	162.0	75	162.8	49	160.0	286	161.5
19	1876-80	28	164.3	58	160.7	21	161.9	10	161.0	177	161.1
21	1891-95	5	154.8	14	162.2	2	165.7	25	160.5	42	160.7
21	1901-05	34	163.2	21	164.8	6	159.3	30	161.7	88	163.4
21	1906-10	58	163.3	48	165.4	19	165.1	30	164.4	142	164.0
21	1911-15	30	164.7	44	165.0	12	167.1	16	162.9	53	165.2

1 Recruits born in Alcoy.

2 Data is unavailable for the cohorts of 1856-59, 1862, 1865, 1878, 1880-90 and 1892-1903.

Source: Conscription Records and Filiation Sheets for Alcoy (AMA). Own work.

spinners. This suggests, then, that young men working in the textile and paper industries suffered a penalty until the end of the nineteenth century.

Table 8 shows that the height of farmhands also diminished by 2.5 cm between 1861-65 and 1876-80. However, the average height of agricultural labourers did not decline, indeed it actually increased by some 2.5 cm during the industrial boom (cohorts of the 1860s and 1870s). It is probable that these agricultural workers alternated, or even combined, their labour in the fields with jobs in the city's workshops, which may have earned them extra wages and allowed them to eat better.

Exploring Inequalities in Nutritional Health

Finally, let us consider the matter of nutritional inequality in view of the average statures found in the socio-occupational categories provided by the HISCLASS international classification (Table 9). The data show a) that height increased in almost all social groups over the long run, and b) that large variations in height existed depending on the socio-occupational category and earnings of individuals.[54] The differences between the young men of the up-

54. These nutritional inequalities by socio-professional categories have also been documented in other Spanish industrial cities in the second half of nineteenth century, as in the case of Antequera (province of Andalusia). Martínez-Carrión & Cámara (2015).

TABLE 9 ▪ *Average stature of socio-occupational categories in Alcoy[1] per HISCLASS. Cohorts of 1856 / 1911-15 (Five-year mean)*

Age	Birth Cohort[2]	Socio-Occupational Categories									
		HISCLASS 1		HISCLASS 2		HISCLASS 3		HISCLASS 4		HISCLASS 5	
		No.	Height	No.	Height	No.	Height	No.	Height	No.	Height
20	1856-60	2	164.0	18	165.8	146	162.4	19	168.1	8	160.6
20	1861-65	30	166.1	69	164.8	537	162.8	45	163.3	62	161.7
19	1866-70	32	166.3	67	163.7	420	162.3	38	162.5	34	162.1
19	1871-75	84	164.4	143	164.0	816	161.9	92	162.1	55	162.7
19	1876-80	36	162.2	85	162.1	480	162.0	58	160.7	33	163.6
21	1891-95	11	163.7	26	164.9	164	161.5	15	161.7	12	160.5
21	1901-05	19	165.9	112	165.1	345	163.3	21	164.8	36	163.1
21	1906-10	60	166.7	278	165.9	637	164.7	50	165.3	63	163.5
21	1911-15	93	167.7	257	165.9	482	164.8	45	164.9	30	164.5
		367		1,055		4,027		383		333	

1 Recruits born in Alcoy.

2 Data is unavailable for the cohorts of 1856-59, 1862, 1865, 1878, 1880-90 and 1892-1903.

Source: Conscription Records and Filiation Sheets for Alcoy (AMA) and HISCLASS classification. Own work.

per and middle classes (HISCLASS 1 and 2) and those of the working classes (HISCLASS 3, 4 and 5) were already significant in the mid-nineteenth century and remained so until its end, only to diminish gradually beginning in the early twentieth century. Those occupied in the professions and white collar workers were generally taller than industrial workers, farmhands and agricultural labourers until the turn of the twentieth century. The shortest statures are found among industrial (HISCLASS 3) and agricultural (HISCLASS 5) workers. From the early twentieth century onwards, improved diet and working conditions, not to mention the development of public hygiene and sewerage infrastructure favoured progress among the working classes.

The data show that all of the socio-occupational categories were affected by diminishing biological living standards in the early stages of industrialisation except for agricultural workers. The case of the highly skilled and medium skilled professions (HISCLASS 1 and 2) is paradigmatic. Mean stature fell in both categories between 1861-65 and 1876-80, by 3.9 cm in the case of HISCLASS 1 and 2.7 cm in HISCLASS 2. The average height of smallholders and farmhands (HISCLASS 4) declined in the same proportion by some 2.6 cm. However, the biological diminution in the height of industrial workers and artisans (HISCLASS 3) was much smaller (0.8 cm). Despite the unequal intensity of the diminution in average stature across industrial occupations (Table 7), the data suggest that industrial wage earners

born in the 1860s and 1870s suffered the worst values in terms of their nutritional condition.

Conclusions

This paper contributes to the debate on the social repercussions of early industrialisation in Spain. Our study shows that stature diminished in the mid-nineteenth century when industrialisation was just taking off, and that it did not recover until the generations born in the late nineteenth century and only began to rise in the early twentieth century. Average height in Alcoy increased by three centimetres between the cohorts of 1891-95 and 1911-15. The stature data suggest that the transition from the kind of proto-industrial activities characteristic of manufacturing at end of the eighteenth and beginning of the nineteenth centuries to the factory system caused a sudden collapse in living standards and nutritional health among the inhabitants of Alcoy. The result was a decline in average stature beginning in the middle decades of the nineteenth century, when the spinning industry in Alcoy underwent a process of mechanisation. The appearance of these new, more labour-intensive methods of production penalized the physical development and health of the countless children who worked in the city's principle industries, many of whom suffered from malnutrition.

The losers in the early stages of Alcoy's industrialisation were mainly the workers of the textiles and paper industries, whose average height diminished by approximately two centimetres. There were, however, no winners among the working classes, because the deterioration of their already poor living standards affected them all, whatever the industry in which they were employed. The first signs of improvement appear towards the end of the nineteenth century, and especially in the early years of the twentieth, when biological living standards began to rise, partly due to relatively higher wages but also as a result of the role of government in regulating first the conditions of child labour and then public sanitation in the decade to 1910. The effects of these reforms may be observed in the decline in mortality in general, but especially in infant mortality, which began around 1900. Thereafter, social gains became increasingly significant.

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APPENDIX

TABLE A.1 ▪ *Average height of conscripts in Alcoy. Cohorts of 1836-40 through to 1911-15 (Five-year mean)*

Age	Birth cohort	Total conscripts	Conscripts measured	Height (cm)
20	1836-40	223	219	162.46
20	1841-45	1,009	978	162.42
20	1846-50	1,009	943	162.67
20	1851-55	951	456	162.49
20	1856-60	1,158	1,005	162.39
20	1861-65	1,707	1,586	162.82
19	1866-70	756	722	162.39
19	1871-75	1,526	1,502	161.95
19	1876-80	1,061	1,035	161.89
20	1881-85	1,482	1,256	162.27
21	1886-90	1,518	1,360	162.49
21	1891-95	1,873	1,546	162.57
21	1896-1900	1,886	1,545	163.15
21	1901-05	2,192	1,819	163.54
21	1906-10	1,893	1,489	165.11
21	1911-15	1,580	1,237	165.50
		21,824	18,698	
19	1856	314	277	162.39
21	1854	453	238	161.68
		22,591	19,213	

■

Did Physical Stature Diminish During Spain's Early Industrialisation? The Case of Alcoy, 1840-1915

Abstract

This paper looks at the effects of early industrialisation in Spain on biological living standards. The case study focuses on Alcoy, one of the towns that pioneered Spanish industrialisation in the nineteenth century. Based on anthropometric data for the height of military conscripts between 1860 and 1936 (cohorts born between 1840 and 1915), the study shows that average stature diminished among the generations born in the 1860s and 1870s, coinciding with the early stages of mechanisation in the textiles industry and accelerating urbanisation. However, poor diet among the inhabitants of Alcoy's rural hinterland was a further contributing factor to this decline in stature. The anthropomorphic evidence suggests that early industrialisation in Alcoy worsened health conditions and the net nutritional status of the town's working class.

Keywords: early industrialisation, biological living standards, Spain, height

JEL Codes: I31, N33, N63, N93, R11

■

¿Se redujo la altura durante los inicios de la industrialización? El caso de Alcoy, 1840-1915

Resumen

Este artículo analiza los efectos de la primera industrialización española en el nivel de vida biológico. Examina el caso de Alcoy, una de las ciudades pioneras de la industrialización española del siglo xix. A partir de datos antropométricos, especialmente la estatura de los reclutamientos militares entre 1860 y 1936 (cohortes nacidas entre 1840 y 1915), el artículo revela un deterioro de la altura promedio para las generaciones nacidas en las décadas de 1860 y 1870, coincidiendo con la primera etapa de la mecanización de la industria textil y la aceleración de la urbanización. A la caída de la estatura contribuyó también la pobreza nutricional de los inmigrantes del *hinterland* rural de Alcoy. La evidencia antropométrica sugiere que los comienzos de la industrialización alcoyana deterioraron las condiciones de salud y el estado nutricional neto de las clases trabajadoras.

Palabras clave: primera industrialización, nivel de vida biológico, España, estatura

Códigos Jel: I31, N33, N63, N93, R11