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Inhalt

I. Abhandlungen und Studien

Holger Schutkowski

Subsistence, social status and stature – Approaches from Historical Anthrology
to the reconstruction and significance of dietary patterns..... 13

Editha Marquardt

Das kleine Geschlecht? – Zur Geschichte der Frauen aus anthropometrischer
Sicht. Ein Überblick 29

Michael R. Haines and Richard H. Steckel

Childhood Mortality & Nutritional Status as Indicators of Standard of Living:
Evidence from World War I Recruits in the United States..... 43

Jörg Baten

Heights and Real Wages in the 18th and 19th Centuries:
An International Overview..... 61

J.W. Drukker and Vincent Tassenaar

Shrinking Dutchmen in a Growing Economy:
The Early Industrial Growth Paradox in the Netherlands..... 77

José Miguel Martínez-Carrión and Juan José Pérez-Castejón

On the Height of Spanish Recruits During the Early Phases of Modern
Economic Growth..... 95

Carl Mosk

Secular Improvement in Well-Being: Britain and Japan Compared..... 113

Lance Brennan, John McDonald and Ralph Shlomowitz

Change in the stature of North Indians from British Rule to early independence..... 129

II. Diskussion

Ingeborg Cleve

Dem Fortschritt entgegen. Ausstellungen und Museen im
Modernisierungsprozess des Königreichs Württemberg (1806-1918)..... 149

Heidrun Homburg

The First Large Firms in German Retailing – The Chains of
Department Stores from the 1920's to the 1970/80's:
Structures, Strategies, Management.....171

Walter Kamphoefner

Südamerika als Alternative? Bestimmungsfaktoren der deutschen
Überseewanderung im 19. Jahrhundert199

III. Forschungs- und Literaturberichte

Jesper Jespersen

Some Aspects of J. M. Keynes's Theoretical Contributions
to the Economic Debate of the 1920's.....219

Klaus F. Zimmermann

Aussiedler seit 1989 - Bilanz und Perspektiven.....225

Autorenverzeichnis

On the Height of Spanish Recruits During the Early Phases of Modern Economic Growth*

By José Miguel Martínez-Carrión (Murcia) and Juan José Pérez-Castejón (Murcia)

I. Introduction

This paper is part of a larger project that investigates long-run changes in the biological standard of living of Spaniards during the 19th-20th centuries. Data collected focus on physical stature at the onset of modern economic growth. We will analyze whether there is any evidence of the historical divergence between the trends in heights and income, as observed for many now-developed countries in the nineteenth century. The existence and nature of the phenomenon referred to as the mystery of the "early industrial growth puzzle" or the "antebellum puzzle" in the American context, has been the subject of discussion and debate in North America and Europe¹.

We construct a height series on the basis of records of 127,310 conscripts born between 1837 and 1913 in nine towns of Southeastern Spain and examine the relationship between height and GDP per capita. Data show that physical stature declined between the 1850s and 1870s. From these results, we derive implications about the biological standard of living at the beginning of Spain's modern economic growth. Finally, the height trends are placed in an international context.

II. Anthropometric history in Spain

The beginning of anthropometry in Spain is associated with the so called "health debate" initiated by military and hygienist physicians, including Monlau whose, *Remedios del pauperismo* (1845), marked the beginning of this debate². In view of "the moral and physical decline of the population", as some put it, reports on physical stature were published and the causes of the "physiological degeneration of civilised countries"³ explored. The Spanish response to the pioneering work of Villermé and Quetelet in epidemiological auxology appeared from the 1860s onwards⁴. The issue was first left in the hands of military physicians, but by the turn of the twentieth century it was also being discussed by anthropologists, who warned about the disparity of "races" and the existence of inequalities across social groups. The military physi-

* This paper received grants from the DGICYT, Project PB94-1149 and de Departament for Universities of Murcia's Autonomous Government, Projects PSH 95/35 and HUM 96/43. We are indebted to Bernard Harris and John Komlos for their helpful comments on an earlier version of this paper, and to Ginés Diaz Carmona for his help in the data collection and computation between 1995-1997, and to Pilar Martínez Pelegrin for her review of the English version.

- 1 J. Komlos, Shrinking in a growing economy? The mystery of physical stature during the Industrial Revolution, in: *Journal of Economic History* 58, 1998, pp. 779-802.
- 2 The first study was by the physician G. Andrés-Espala, *Consideraciones sobre las variedades de estatura e influencia que ejercen en la salud. Discurso leído en el acto de investidura de Doctor, Facultad de Medicina y Cirugía, Universidad Central Madrid, 1854.*
- 3 M. Tschouriloff, Estudio sobre la degeneración fisiológica de los pueblos civilizados (causas de la degeneración), in: *La Gaceta de Sanidad Militar* III, 1877, pp. 45-52, 109-115, 192-199, 276-283, 301-05, 363-66, 384-92.
- 4 F. Bona, Estadística física de las tallas y de los defectos físicos, in: *Revista General de Estadística* II, 1863, pp. 305-321. A. Chinchilla, Estadística de Sanidad Militar, in: *Revista General de Estadística* III, 1864, pp. 1-31.

cian Gregorio Andrés-Espala pointed out that "a direct relationship exists between height and the welfare, strength and energy of a nation", and that "in poor and decaying countries, short stature prevails, whereas the opposite is the case in prosperous, flourishing ones"⁵. Some decades later, the works of the anthropologists Telesforo Aranzadi and Luis de Hoyos-Sainz revealed regional differences in height and explained them by variations in the "environment in its broadest sense"⁶. The works of other authors⁷, were also supported by the Reales Academias de Ciencias Políticas y Morales y de Medicina, by the Comisión de Reformas Sociales, and the Congreso Internacional de Higiene y Demografía held in Madrid in 1898. The social issue from an anthropometric point of view, thus did not escape the notice of Spanish scholars in the nineteenth century.

Now, a century later, studies in anthropometric history have unveiled considerable evidence on the trends and cycles of heights from the beginning of the industrial revolution. Hand in hand with economic history, anthropometry has reinvigorated the debate on the standard of living during industrialisation. The incorporation of hundreds of thousands of data to the study of height and weight in different countries has allowed the debate to extend to broad areas of the world and to cover virtually all social groups. Thus, the most general issue may now be approached: that of welfare during the various stages of economic growth⁸.

This new "anthropometric history", as John Komlos and more recently Richard H. Steckel⁹ have come to call it, has also found an echo in Spain. Height data have for some years been explored using various sources and methods¹⁰. Given the limitations posed by some conventional indicators of welfare, the possibilities opened up by anthropometric studies are wide-ranging, and relevant to the economic and social history of contemporary Spain. The anthropometric

5 G. Andrés-Espala, Reflexiones sobre la talla, peso y perímetro torácico, in: Gaceta de Sanidad Militar III, 1877, pp. 2-3.

6 T. Aranzadi/L. Hoyos-Sainz, Lecciones de antropología, Madrid 1893.

7 L. Figuerola, La talla de los mozos para el servicio militar sorteados y medidos en las quintas de 1858 a 1867, in: Memorias de la Real Academia de Ciencias Políticas y Morales, tomo VII, 1893, pp. 305-311; F. Olóriz-Aguilera, Discursos leídos en la Real Academia de Medicina, Madrid 1896; L. Sánchez-Fernández, El hombre español útil para el servicio de las armas y para el trabajo. Sus características antropológicas a los 20 años de edad, Asociación Española para el Progreso de las Ciencias, Madrid 1913; P. Suárez-Inclán, El problema del reclutamiento en España, Madrid 1905.

8 C. Floud/K.W. Wachter/A.S. Gregory, Height, health and history: nutritional status in Britain 1750-1980, Cambridge 1990; J. Komlos, Nutrition and economic development in the eighteenth-century Habsburg monarchy. An anthropometric history, Princeton 1989; J. Komlos (ed.), Stature, living standard, and economic development. Essays in anthropometric history, Chicago 1994; J. Komlos (ed.), The biological standard of living on three continents. Further explorations in anthropometric history, Boulder 1995; J. Komlos/J. Baten (eds.), Studies on the biological standard of living in comparative perspective, Stuttgart 1998; J. Komlos/T. Cuff, Classics in Anthropometric History, 1998 R.H. Steckel/R.C. Floud (eds.), Health and welfare during industrialization, Chicago 1997.

9 R. Steckel, Strategic ideas in the rise of the new anthropometric history and their implications for interdisciplinary research, in: Journal of Economic History 58/3, 1998, pp. 803-820.

10 A. Gómez-Mendoza/V. Pérez-Moreda, Heights and welfare in Spain 1900-1930, in: Komlos, The biological standard of living, pp. 81-91; J.M. Martínez-Carrión, Niveles de vida y desarrollo económico en la España contemporánea. Una visión antropométrica, in: Revista de Historia Económica XII, 1994, pp. 685-716; J.M. Martínez-Carrión, Stature, welfare and economic growth in nineteenth century Spain: the case of Murcia, in: Komlos, Stature, p. 76-89; J.M. Martínez-Carrión/J.J. Pérez-Castejón, Height and standard of living during the industrialisation of Spain: the case of Elche, in: European Review of Economic History II/2, 1998, pp. 201-230; J.M. Martínez-Carrión/J.J. Pérez-Castejón, Height and standard of living in Spain 1860-1969: evidence from the southeastern region, in: Komlos/Baten, pp. 31-46; G. Quiroga, Height evolution in Spain, 1893-1954. An analysis by regions and professions, in: Komlos/Baten, pp. 359-383.

data used so far in Spain have come from military records. These data are easier to process than many other historical economic data¹¹.

III. Data and reconstruction of a height series

Table 1: The heights of conscripts by birth quinquennium, nine municipalities in South-eastern Spain

Quinquennium of birth	Total number of conscripts	Number of conscripts measured	% of conscripts measured	Mean Height (cm.)	Age
1837-1840	3,361	3,076	91.5	161.4	20
1841-1845	6,365	6,162	96.8	161.2	
1846-1850	5,190	4,580	88.2	162.1	
1851-1855	2,797	2,052	73.4	161.7	
1856-1860	10,811	8,937	82.7	161.0	
1861-1865	10,748	9,365	87.1	161.4	19
1866-1870	12,482	12,160	97.4	161.0	
1871-1875	13,052	12,823	98.2	160.7	
1876-1880	11,986	11,648	97.2	161.0	
1881-1885	12,622	12,037	95.4	162.5	20
1886-1890	14,378	13,862	96.4	163.3	21
1891-1895	11,715	10,153	86.7	163.3	
1896-1900	8,483	6,357	74.9	163.6	
1901-1905	7,568	6,037	79.8	164.0	
1906-1910	7,205	5,505	76.4	164.6	
1911-1913	3,148	2,556	81.2	165.0	
TOTAL	141,911	127,310	89.7		

Source: *Archivos municipales*, Actas and expedientes de reemplazo; see Appendix.

Aggregate annual height series can be constructed for Spain from the 1850s onwards. Earlier data are both scarce and fragmentary, and almost non-existent for the end of the eighteenth century. This study begins with the 1857 draft and presents data on cohorts born between 1837 and 1913, a period when GDP per capita was increasing¹². The series pertains to nine municipalities of Southeastern Spain: Elche, Orihuela, (the south of Valencia), Murcia, Cartagena, Torre Pacheco, Totana, Cieza, Yecla (in Murcia), and Vera (in east Andalusia). Because of its economic and environmental characteristics, the geographic area considered is representative of the Spanish economy of the nineteenth century¹³. We have a sample of the height of 127,310 conscripts out of a total of 141,911 men (89.7 per cent) called up for service (Table 1). The rest – 10.3 percent – were either deserters, emigrants or missing men.

We used the following criteria in the selection of municipalities: (1) availability of long enough anthropometric series, (2) reliability of data, (3) socio-economic characteristics of the

11 *J.M. Martínez-Carrión*, Los niveles de vida del campesinado en la España contemporánea. Algunas reflexiones, in: *Noticiario de Historia Agraria* 14, 1994, pp. 25-57.

12 *L. Prados de la Escosura*, Spain's Gross Domestic Product, 1850-1990. A New Series. Documento de Trabajo, Madrid 1993. *A. Carreras*, Industrialización española: estudios de historia cuantitativa, Madrid 1990.

13 A series based on six of the nine municipalities between 1837 and 1948, in: *Martínez Carrión/Pérez Castejón*, Height.

populations considered – either agricultural or industrial –, (4) areas defined both geographically and environmentally, and (5) availability of demographic and socio-economic information supporting an anthropometric interpretation. The towns of Cartagena and Vera were characterised by a large percentage of mining population; Cartagena, Murcia, Orihuela, and Elche were important urban centres; Cartagena and, notably, Elche experienced industrial development particularly in metallurgy and shoe-making. In general, the surroundings of all the towns had a large share of their rural population engaged in farming activities. They experienced processes of agricultural specialisation: Totana (orange), Cieza (fruit, *esparto*), Yecla (wine), Torre Pacheco (cereals) beginning in the second half of the nineteenth century. The height series in some towns do have some gaps, particularly at the end of the 'six-year revolutionary period' (1868-1874) in 1873, as a result of the riots and popular revolts against the "Quintas" (compulsory conscription)¹⁴.

The main problems in height series may be posed by the introduction of changes affecting conscription age and by the rounding of height data. The biases associated with a truncated height distribution are not present in this study, because of universal conscription established in the "Ordenanza para el Remplazo del Ejército" (Ordinance on Military Drafts)¹⁵. The reliability of the data has been ascertained using the Kolmogorov-Smirnow and χ^2 tests (See Figures 1 and 2 for a comparison between sample and theoretical distribution for some years in Elche). Only after 1970 are we able to find marked irregularities and a more widespread use of rounding due to the implementation of the new National Service Law of 1968.

IV. The results

Figure 3 shows the trend of the Spanish heights at the onset of modern economic growth. The results obtained, using three-year moving averages, point to the existence of two marked trends: a decline in the reign of Isabel II and the Revolutionary Period, and an increase during the Restoration. Annual data are presented in Table 2. It is immediately apparent, that heights of 20-years-olds born between 1838 and 1865 declined by 0,8 cm. Between 1848 and 1860 the decline was still bigger: some 1,6 cm. This pattern suggests an initial worsening of welfare measured in net nutritional terms as in a number of other countries including the United States¹⁶. Secondly, a recovery is evident among those born after 1876. The increase in physical stature became decisive by the 1890s. Between 1865 and 1885 the average heights increased by some 1,2 cm; thus, the losses of the 1840s and 1850s were made up entirely: those born after the late 1880s tended to be taller than their mid-century counterparts. The height of 21-years-olds increased between 1886 and 1905 by 1,3 cm. Hence, biological living standards improved considerably for young men born at the end of the 19th and the beginning of the 20th century. By WWI Spanish military recruits were on average 165 cm tall.

To assess the degree of consistency between height and other welfare indicators, we compare *per capita* income with the height series even though the former refers to the nation-wide average, whereas the latter is regionally restricted. *Per capita* income refers to the year when the recruit was measured (Figure 4). The results reveal no relationship between both series un-

14 A. Feijóo-Gómez, *Quintas y protesta social en el siglo XIX*, Madrid 1996.

15 Martínez-Carrión/Pérez Castejón, *Height*.

16 Komlos, *Shrinking*, p. 779.

Figure 1: Gaussian distribution vs. sample distribution. Elche: 1970

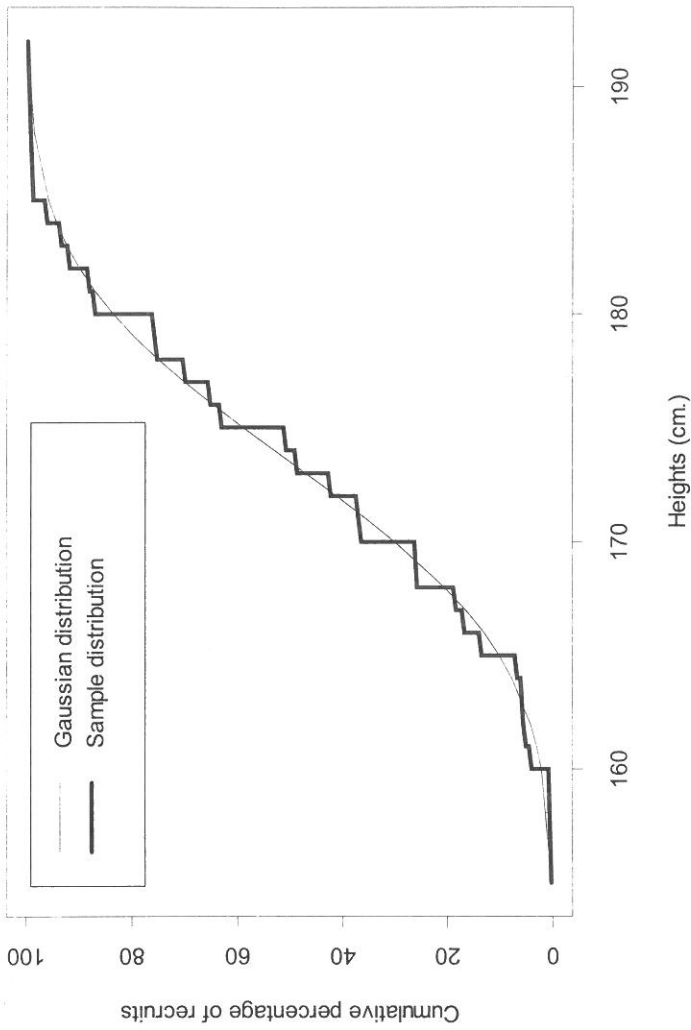


Figure 2: Gaussian distribution vs. sample distribution. Elche: 1870

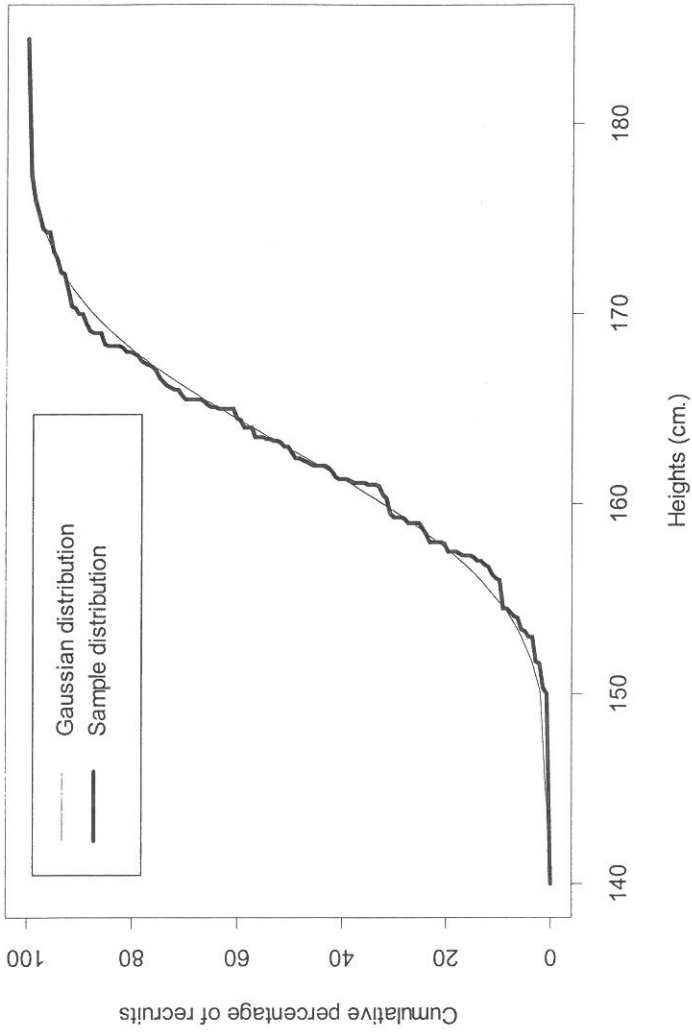


Figure 3: Trend of height in Spain

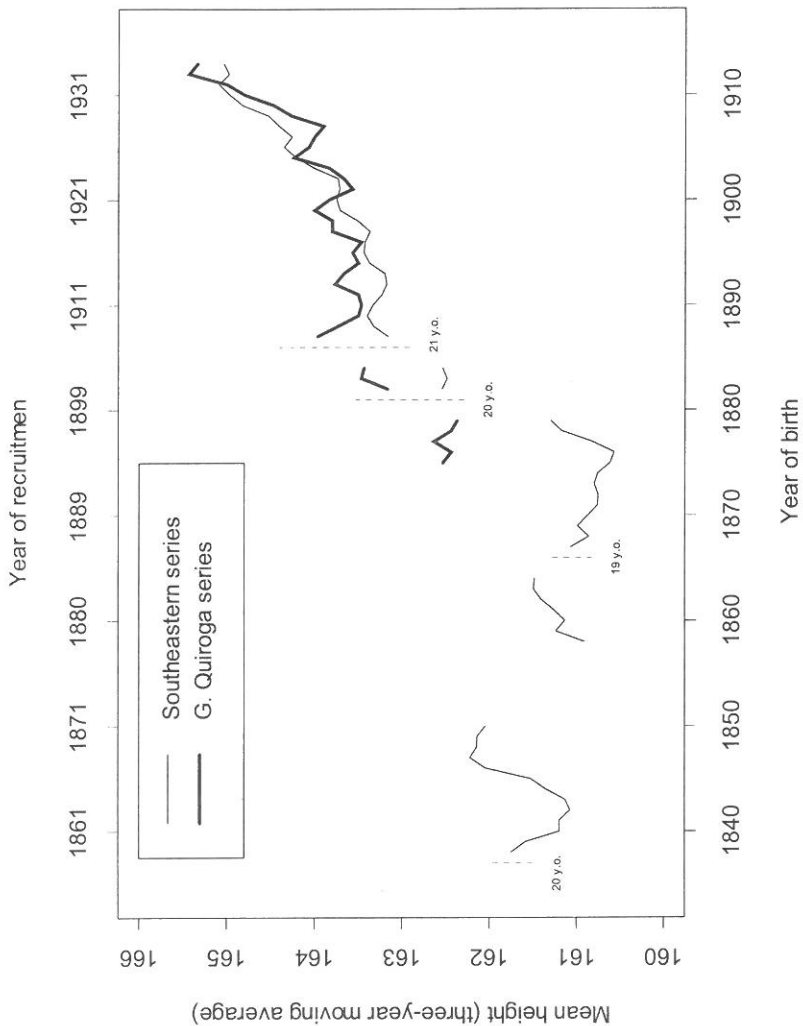


Table 2: Mean height by birth cohorts and recruitment years

Age	Year of recruitment	Mean height	Age	Year of recruitment	Mean height
20	1858	162,3	19	1895	160,5
20	1859	162,1	19	1896	160,8
20	1860	160,8	19	1897	161,2
20	1861	161,8	19	1898	161,5
20	1862	161,0	19	1899	161,2
20	1863	160,8	20	1901	162,6
20	1864	161,4	20	1902	162,5
20	1865	161,2	20	1903	162,5
20	1866	161,4	20	1904	162,4
20	1867	162,0	20	1905	162,7
20	1868	162,7	21	1907	163,0
20	1869	162,0	21	1908	163,1
20	1870	161,7	21	1909	163,4
20	1871	162,7	21	1910	163,5
20	1872	161,7	21	1911	163,4
20	1873	n.d.	21	1912	163,2
22	1875 (*)	160,7	21	1913	163,2
21	1875 (*)	161,5	21	1914	163,2
20	1875	162,5	21	1915	163,2
19	1875 (*)	161,1	21	1916	163,7
20	1877	160,2	21	1917	163,4
20	1878	161,4	21	1918	163,2
20	1879	161,1	21	1919	163,5
20	1880	161,1	21	1920	163,8
20	1881	161,1	21	1921	163,8
20	1882	161,5	21	1922	163,6
20	1883	161,6	21	1923	163,7
20	1884	161,4	21	1924	163,9
20	1885	161,5	21	1925	164,4
19	1885 (*)	161,6	21	1926	164,3
19	1886	160,5	21	1927	164,3
19	1887	161,1	21	1928	164,2
19	1888	160,9	21	1929	164,8
19	1889	160,9	21	1930	164,7
19	1890	160,8	21	1931	165,0
19	1891	160,6	21	1932	165,2
19	1892	160,9	21	1933	165,0
19	1893	160,9	21	1934	164,7
19	1894	160,5			

(*) Extraordinary Draft /Conscription.

Source: Archivos Municipales, Expedientes de reclutamiento y reemplazo.

Figure 4: Mean height of recruits and GDP per capita at recruitment year

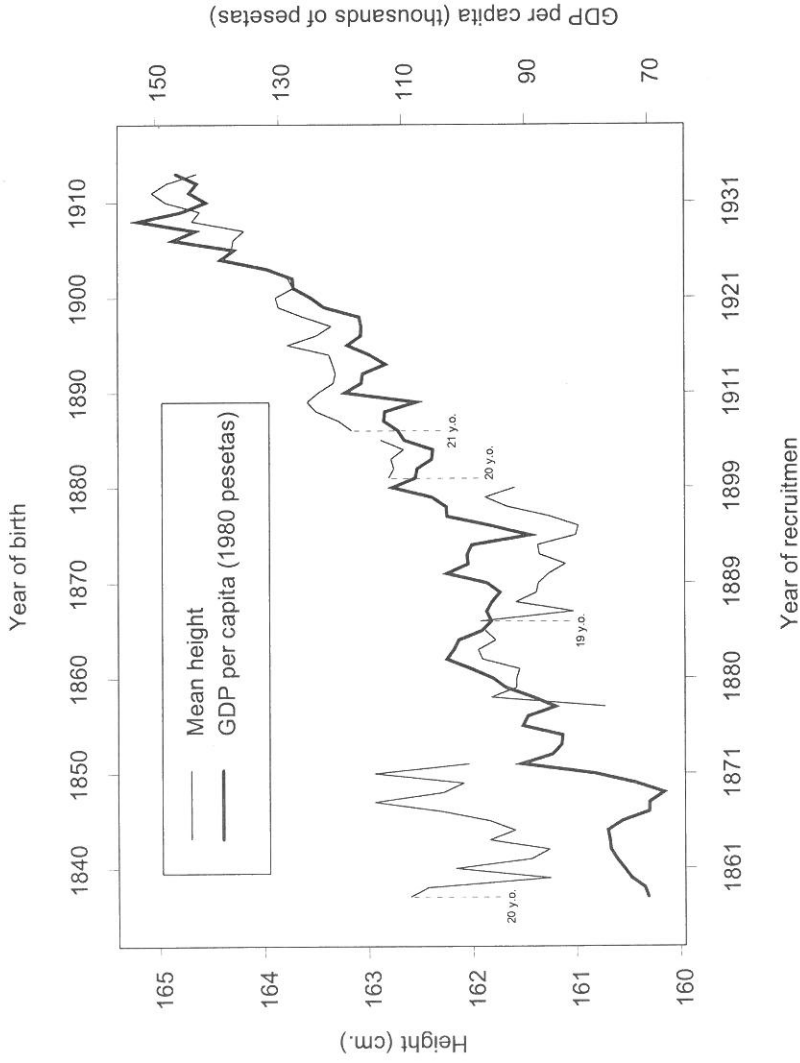
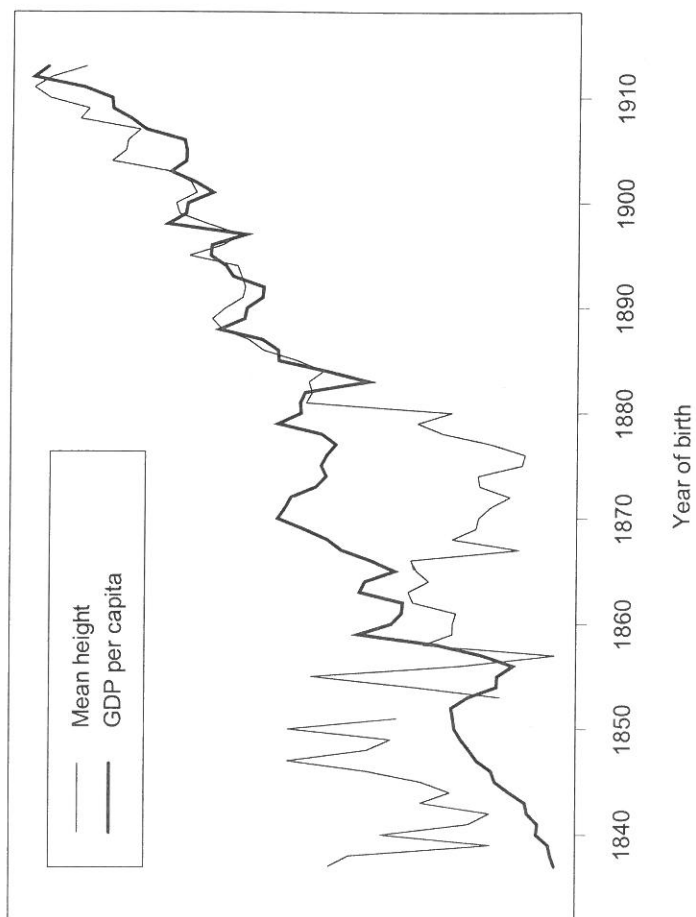


Figure 5: Mean height and GDP per capita at age 13



til about the birth cohort of 1875 when the correlation between the two series increases. Certainly, relationship seems also to be high between 1860 and 1875, though the levels differ¹⁷.

We believe that the lack of correlation between income and height during the initial stages of modern economic growth in Spain may well be related to Kuznets' inverted U hypothesis, namely that income inequality rises and then falls with the level of economic development. The Spanish case supports the Kuznetsian hypothesis already verified in other countries during early industrialisation and the first stages of economic growth¹⁸. In any event, the decline in the height of those born between the 1840s and 1870s shows that the period of economic growth did not bring about improvements in biological welfare standards. The greater physical stature of those born between the 1880s and 1910s, however, are in agreement with an increase in average earnings.

The Spanish evidence confirms that the environmental and nutritional conditions during adolescence were very important for physical growth (Figure 5) in keeping with the biological and anthropometric literature¹⁹. The rate of growth is faster at adolescence, and therefore it is precisely during these years that environmental and economic factors play the most decisive role.

A comparison with other living standard indicators would be useful, but are scarce at the regional level. Among the other welfare indexes conventionally used, such as consumption expenditures, real wages, child mortality, life expectancy, and literacy, the most abundant for Southeastern Spain is child mortality. The infant and child mortality series available at the local and regional level for rural and urban areas of Biscay²⁰, Madrid, Castilla la Nueva, and País Valenciano²¹, and for some towns in the province of Murcia such as Yecla and the rural and mining areas of Cartagena show increased infant mortality from about 1850 to the 1880s. Data from various sources reveal that, in general, morbidity and infant and child mortality rates up to 9 years old, were not favourable in most parts of the country. "The decline in mortality typical of the period 1780-1840 (with the exception of the great mortality crises of early nineteenth century) was reversed during the central decades of the century"²². Hence, life expectancy and height moved in unison. The final years of the nineteenth century marked the

17 We then explore the possible relationship between average height and the *per capita* income at certain ages of childhood and adolescence. This approach is based on the assumption that a generation's final average height reflects the net nutrition, that is the food intake less energy output resulting from environmental factors during childhood and adolescence. Biometric studies have shown that growth may be retarded, even halted as a consequence of malnutrition suffered in childhood and adolescence: hence the importance of food intake prior to reaching maturity we therefore, compare average height of recruits with income at various ages: at birth, and at the ages of eight and thirteen. The comparison between height and income at age 13 showed the most similarity, but only for the generations born after the mid 1880s.

18 *Steckel/Floud*, Height and welfare. *Komlos*, Shrinking, pp. 793-95.

19 *Eveleth/Tanner*, Worldwide variation in human growth, Cambridge 1990. *J.M. Tanner*, A History of the Study of Human Growth, Cambridge 1981. *J.M. Tanner*, Fetus into Man: Physical growth from conception to maturity, Cambridge 1978. *R.H. Steckel*, Stature and the standard of living, in: *Journal of Economic Literature* XXXIII, 1995, pp. 1903-1940.

20 *M.E. González-Ugarte*, Mortalidad e industrialización en el País Vasco, Vizcaya 1860-1930, in: *Boletín de la ADEH*, XII/1, 1994, pp. 33-53. *M. Arbaiza/A. Guerrero/A. Pareja*, Mundo rural y mundo urbano en la transición de la mortalidad vizcaína 1770-1930, in: *Boletín de la ADEH* XIV/2, 1996, pp. 19-55.

21 *D.S. Reher/V. Pérez-Moreda/J. Bernabeu-Mestre*, Assessing change in historical contexts: childhood mortality patterns in Spain during the demographic transition, in: *C.A. Corsini/P.P. Viazzo (eds.)*, Long-term study of infant and child mortality, The Hague 1997, pp. 35-56.

22 *D.S. Reher*, La familia en España. Pasado y presente, Madrid 1996, p. 171.

dividing line of Spain's epidemiological transition and – as with physical stature – child and general mortality rates started to improve.

V. Accounting for Spanish height cycles in the first phases of modern economic growth

1. The evidence

Table 3: Heights of Spanish recruits by birth year and age

Birth year	Conscription year	Age (years)	Southeastern Spain	SPAIN				
				SP ₁ ^{a)}	SP ₂ ^{b)}	SP ₃ ^{c)}	SP ₄ ^{d)}	SP ₅ ^{e)}
1838	1858	20	162.3		160.9			
1840	1860	20	160.8			163.5	162.1	
1845	1865	20	161.2					
1850	1870	20	161.7					
1855	1875	20	161.1					
1860	1880	20	161.1					
1865	1885	20	161.5					
1870	1889	19	160.9					
1875	1894	19	160.5	162.2				
1880	1899	19	161.2	162.1				
1885	1905	20	162.7	163.2				163.5
1890	1911	21	163.4	163.1	162.4*			
1895	1916	21	163.7	163.1	163.0**			
1900	1921	21	163.8	163.8				
1905	1926	21	164.3	164.5	163.4***			
1910	1931	21	165.0	164.5				
1913	1934	21	164.7	165.8				

a) Sources and methods, see *Quiroga*, Height Evolution.

b) Estimated heights of the Statistical Annuals, see *Gómez-Mendoza / Pérez-Moreda*, Heights and Welfare. *1892, **1894-95, ***1905-06.

c) Id, see *Oloriz-aguilera*, Talla humana, cohorts of 1839-41.

d) Id, see *Aranzadi / Hoyos*, Lecciones de antropología. Cohorts of 1839-41.

e) *Sánchez-Fernández*, El hombre español, cohorts of 1883-86.

Based on the above findings we now turn to the explanation of the cycles of height and of the biological standards of living. We find that our explanation of the decline in height is quite similar to the one outlined by Komlos²³. The beginnings of Spain's modern economic growth between 1850 and about 1890²⁴ coincided with a deterioration of height of the cohorts born between 1840s and 1860s. Increases in *per capita* income were not translated into better nutritional status and biological living standard for male adolescents until the cohorts born in the 1880s and 1890s. The decline in physical stature by 0,8-1 cm between 1840s and 1870s indi-

23 Komlos, Shrinking.

24 A. Carreras, Industrialización. P. Martín-Aceña/J. Simpson (eds.), The economic development of Spain since 1870, Aldershot 1995. L. Prados de la Escosura, Spain's gross. L. Prados de la Escosura, De imperio a nación. Crecimiento y atraso económico en España 1780-1930, Madrid 1988. G. Tortella, El desarrollo de la España contemporánea. Historia económica de los siglos XIX y XX, Madrid 1994.

cates that Spaniards experienced a nutritional deterioration. The gains were too significant. Conscripts born between the late 1880s and 1910 increased in stature by 2 cm. This fact leads us to reconsider the slightly pessimistic view depicted in some studies on the standard of living of Spaniards in the early twentieth century. Similar conclusions to our own can be derived from the height series constructed by Quiroga with a representative sample of Spanish recruits (see Table 3 and Figure 3). Different estimates of Spanish heights are compared in Table 3.

2. The causal factors

The deterioration of health measured in terms of infant and child mortality had a decisive influence on physical stature. In addition, the greater variability of income, greater income inequality, and trends in real wages also had an impact on biological living standards until the 1880s. The epidemic outbreaks of 1833-35, 1853-56, 1859-60, 1865, 1868, and 1885 must have weakened the organism of children and adolescents. In contrast, improved health, measured by the downward trend of the various mortality rates after 1890, led to taller stature. Once the high morbidity demographic regime disappeared by the late nineteenth century, the positive relationship between stature and income at age 13 became evident, also at time of recruitment.

Population growth also contributed to the deterioration in nutritional status in rural areas. Demographic pressure resulted in subdivision of land, fragmentation of land tenancy, and the expansion agriculture into of low productivity areas. In addition, urbanization also led to an increase in food prices, relative to the prices of other goods between 1850 and the 1870's²⁵. As a consequence, caloric intake declined and nutritional status of a large segment of the population deteriorated. Emigration was the only solution to this problem for many rural families. Moreover, increasing population density, in combination with growing urbanization and increasing trade, created the environmental conditions conducive to rapid transmission of diseases.

The effect of market integration on the evolution of welfare is another factor accounting for the deterioration of height between 1850 and 1890. The redefinition of property rights after the liberal reforms between 1830 and 1850 favoured the mobility of factors of production, promoted investment, and increased employment²⁶. However, agricultural specialisation and the intensification of agricultural output were achieved by increasing working hours and the participation of youth in agricultural production²⁷. This was in response to the loans incurred in order to market agricultural produce, and to repay debts accumulated due to both more expensive rents²⁸ and higher taxes²⁹. The probable outcome was the impairment of health as a result

25 E. Ballesteros, Una estimación del coste de la vida en España 1861-1936, in: *Revista de Historia Económica* 15, 1997, pp. 363-95. Real wages in: D.S. Reher/E. Ballesteros, Precios y salarios en Castilla la Nueva: la construcción de un índice de salarios reales 1501-1991, in: *Revista de Historia Económica* XI/1, 1993, pp. 101-151. J. Simpson, Real wages and labour mobility in Spain 1860-1936, in: P. Scholliers/V. Zamagni (eds.), *Labour's reward. real wages and economic change in the 19th- and 20th-century Europe*, Hants 1995, pp. 182-200.

26 A. García-Sanz, Crisis de la agricultura tradicional y revolución liberal, in: A. García-Sanz/Garrabou (eds.), *Historia agraria de la España contemporánea*, vol. I: Cambio social y nuevas formas de propiedad 1800-1850, Barcelona 1985, pp. 7-99. R. Garrabou/J. Sanz-Fernández, La agricultura española durante el siglo XIX: inmovilismo o cambio?, in: R. Garrabou/J. Sanz-Fernández (eds.), *Historia agraria de la España contemporánea*, Vol. II: expansión y crisis 1850-1900, Barcelona 1985, pp. 7-191. Prados, *De imperio a nación*.

27 J.M. Borrás-Llop (ed.), *Historia de la infancia en la España contemporánea 1834-1936*, Madrid 1996.

28 R. Robledo, *La renta de la tierra en Castilla la Vieja y León 1836-1913*, Madrid 1984.

29 F. Comin, Public finance in Spain during the nineteenth and twentieth centuries, in *Martin-Aceña/Simpson, Economic developmen in Spain*, pp. 521-60.

of greater intensity of human effort and energy output. Under these conditions, family food intake in *per capita* terms was probably reduced and part of the output normally intended for subsistence was diverted to the market, in order to counterbalance the impact of increased need for cash. Conditions were then ripe for morbidity and mortality to rise. Exhausted bodies from long hours of straining physical work and malnutrition must have been easily seized with diseases and epidemics, thus giving rise to higher mortality and shorter statures.

3. Some implications and consequences

From the 1850s until well into the 1880s there was a large and increasing percentage of undernourished men as shown by in the increase of conscripts with heights under 155 cm (Figure 6). Table 4 compares various percentiles of the stature of men born in Southeastern Spain, with conscripts enjoying one of the highest standards of living namely those of the US born in the 1960s³⁰. This physiological and nutritional pattern of the 1860s and 1870s (table 4) with adverse impact on morbidity lasted until about 1890. The vicious circle between morbidity and mortality was alleviated with the vaccination and health programmes launched by national and local authorities from the 1890s which led to the disappearance of epidemic outbreaks.

Table 4: Sample percentiles of Spanish recruits compared to modern height standards

Year of birth	10 th percent.	25 th percent.	50 th percent.	75 th percent.	90 th percent.	Number of recruits	Recruitmen Age
1850	154,9	159,0	163,2	167,1	171,0	610	20
1875	149,5	156,1	161,2	165,5	169,5	2312	19
1890	156,0	159,5	163,2	167,5	171,0	2789	21
1910	157,5	161,3	165,2	168,9	172,2	1031	21
USA ^e	168,5	172,4	176,8	181,2	185,1		18

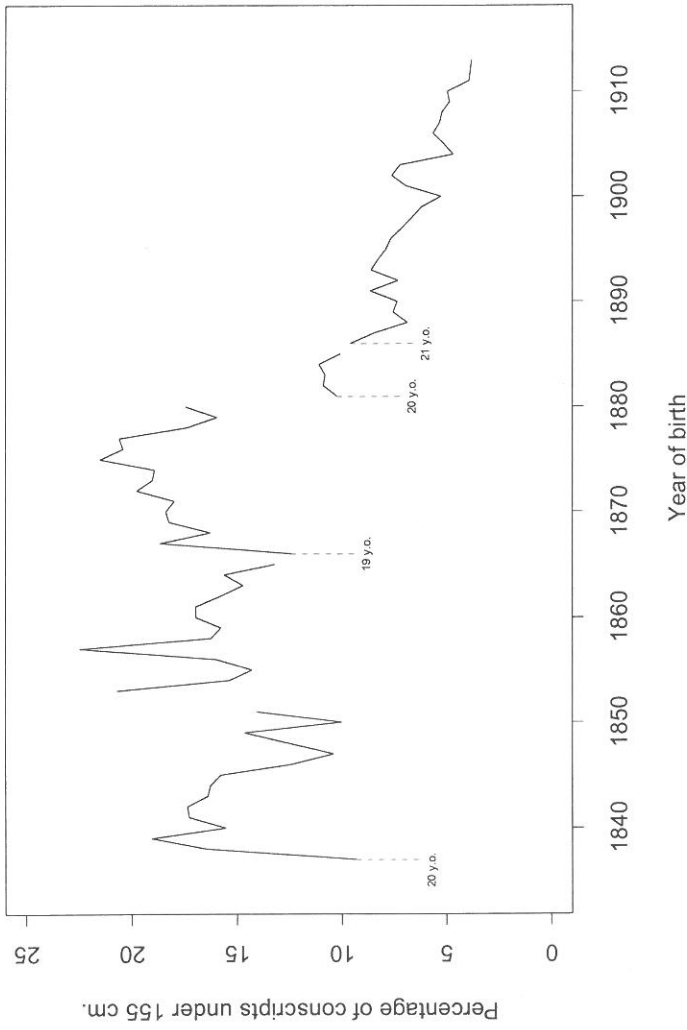
^aNote: USA data (for 1960) from National Center for Health Statistics 1977, reported in Steckel (1996).

Was the deterioration in mean height at the beginning of modern economic development brought about by greater economic inequality? Data on family income, and wealth reveals that land concentration in a few hands was widespread. As the Gini coefficient reveals, land was unequally distributed until 1900 when the agrarian crisis brought about changes in farm management³¹. The hypothesis, that the deterioration in height which meant that the human organism was weakened, and more prone to disease prevented the increase in labour productivity during the second half of the 19th century should be considered in future studies. The diminution in the height of adolescents was evident from about 1860 to 1890, and the existence of taller, healthier, stronger men after 1890 may have had positive feedback effects on labour productivity.

30 R.H. Steckel, Percentiles of modern height standards for use in historical research, in: *Historical Methods* 29, 1996, pp. 157-166.

31 R. Garrabou (ed), *La crisis agraria de fines del siglo XIX*, Barcelona 1988. R. Garrabou (ed.), *Propiedad y explotación campesina en la España contemporánea*, Madrid 1992.

Figure 6: Percentage of conscripts under 155 cm



The increase in food production after 1890³² should be considered in relation to the energy requirements of slightly larger men and not only relative to population size. Increased population and urbanisation had an influence on the amount and quality of food consumed. Dietary diversification and more protein consumption (more meat and milk) increased height, which in turn increased the consumption, production, and trade in foodstuffs, as a result of increased *per capita* energy requirements. From the final decades of the nineteenth century and, even more notably, from the beginning of the twentieth century, Spain experienced the initial phase of expansion of personal consumption. The stature of cohorts born between 1870 and 1910 increased by 3,5 cm, well above the average European growth rate. The study of stature by occupation and social category and the social distribution of income could shed further light on this issue.

VI. The height and living standards of Spaniards in international perspective.

Finally, it is revealing to place the evolution of height in international perspective. The question now is to check if the decrease in height is consistent with the trend observed in other populations. It should be remembered that the height series presented here is regional, but that is often the case in anthropometric history³³.

Table 5: Socio-economic indicators by country in the first phase of industrialisation.

	<i>Approximate Period</i>	<i>GDP/Capita Growth Rate</i>	<i>Mean Male Height</i>	<i>Life Expectancy</i>	<i>Literate</i>	<i>Urban Population</i>
United Kingdom	1760-1800	0.2	168.2	36	50	29
USA	1820-1850	0.9	172.4	42	77	10
France	1820-1850	1.3	164.4	40	49	22
The Netherlands	1850-1870	0.5	165.9	40	80	44
Sweden	1850-1870	1.2	169.1	44	92	11
Germany	1850-1870	1.5	166.2	38	95	34
Australia	1860-1890	1.8	172.0	48	55	42
Spain	1860-1890	1.3	161.5	33	30	29
Japan	1880-1900	1.0	157.0	38	70	50

Source: *Steckel/Floud*, Welfare, pp. 425, 438-46. For Spain, per capita income data is from *Prados*, Spain's gross, p. 58; life expectancy from *Reher*, Familia, pp. 169-171; literacy from *Núñez*, Fuente de la riqueza, p. xxx; and urbanisation (1887 rate, urban population in towns with over 5000 inhabitants) from *Gómez-Mendoza/Luna-Rodrigo*, desarrollo urbano, p. 20.

Table 5 shows some standard of living indicators by country and phase of industrialisation. Although the data are approximate, they allow us to compare the welfare level attained in the first stages of economic development. We consider that Spain experienced that stage between 1860 and 1890, although it might have occurred earlier according to Carreras³⁴, and we use the estimates of growth of *per capita* income Prados, and compare them to estimates of life expectancy³⁵, literacy³⁶, and urban population³⁷ for the period considered (Table 5).

32 J. Simpson, Spanish Agriculture: The Long Siesta, 1765-1965, Cambridge 1995.

33 See *Steckel/Floud*, Welfare. J. Baten, Ernährung und wirtschaftliche Entwicklung in Bayern, 1730-1880, Stuttgart 1999.

34 Carreras, Industrialización.

35 Reher, La familia en España.

The data confirm that Spain had very low living standards in international comparison at the early stages of industrialisation. Spaniards were among the shortest in Europe, but probably as tall as eastern Europeans and people living around the Mediterranean³⁸. However Spaniards were taller than Japanese, one of the countries that began their industrialisation at about the same time³⁹. Spain also had the lowest life expectancy and literacy levels, but urbanisation was at an intermediate level.

Table 6: Decline in height at the onset of modern economic growth

Country	Approximate Period By Birth Cohorts	Decline in Height Cm
Habsburg Empire	1750-1790	3.5
United Kingdom (male) ^a	1760-1790	0.7
	1820-1850	5.4
United Kingdom (female) ^b	1790-1815	2.5
	1835-1855	2.5
The Netherlands	1810-1837	3.5
USA	1830-1890	4.0
Russia	1830-1865	3.0
Germany ^c	1750-1770	3.0
Germany ^d	1860-1872	2.5
	1879-1885	2.0
Sweden ^e	1840-1859	4.0
Australia	1867-1893	3.0
Spain ^f	1838-1865	0.8

a) The years 1760 to 1850 embraced two downturns and an upturn from 1790 to 1820 such that the net decline was 2.0 cm over the period. The upturn between 1790 and 1820 was 4.1 cm.

b) Height improved by about 0.75 cm between 1815 and 1835.

c) Data of Bayern,

d) Data of Wurttemberg, Height improved by 3.3 cm between 1872 and 1879.

e) Data of West regions.

f) Data of Southeastern regions.

Source: *Steckel/Floud*, Welfare, p. 430; *Komlos*, Nutrition; *Drukker/Tassenaar*, pp. 356-356; *Mironov*, Diet, p. 73; *Baten*, Ernährung, p. 70; *Sandberg/Steckel*, Height and Economic History: The Swedish Case, in: *Annals of Human Biology* 14, p. 104 *Spain*, see Table 2.

That Spain had low living standards compared to those of industrialised countries is well-known⁴⁰. However, the question remains to what extent the diminution in the biological standard of living in Spain between 1850 and 1870 (at a time when the industrialisation and

36 C.E. Núñez, *La fuente de la riqueza: educación y desarrollo económico en la España contemporánea*, Madrid 1992.

37 A. Gómez-Mendoza/G. Luna-Rodrigo, *El desarrollo urbano en España 1860-1930*, in: *Boletín de la ADEH* IV/2, 1986, pp. 3-22.

38 B.N. Mironov, Diet, health, and stature of the Russian population from the mid-nineteenth to the beginning of the twentieth century, in: *Komlos*, The biological standard, pp. 59-79.

39 T. Shay, The level of living in Japan 1885-1938: New evidence, in: *Komlos*, Stature, pp. 173-201.

40 N.F.R. Crafts, Some dimensions of the quality of life during the British industrial revolution, in: *Economic History Review* 50, 1997, pp. 617-39.

economic growth process accelerated, at least in some regions), found parallels in other countries at similar stages of economic development. The findings confirm that the United Kingdom, USA, Germany, Sweden, Australia, and the Habsburg Empire all experienced reductions in height at the onset of modern economic growth (Table 6). The alarm raised by scientists and hygienist physicians in the 1860s and 1870s on the “physiological degeneration of civilised nations” was empirically founded: there were more shorter people and an increase in epidemics. To be sure, the debate on the causes of this phenomenon is still far from over.