Biological Welfare and Inequality During the Mining Boom: Rio Tinto, 1832-1935*

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Introduction

The standard of living in the Spanish mining sector has attracted the attention of historiographers for at least thirty years. The indicators for measuring them have improved in recent years. Whereas before they comprised a series of conventional indicators of economic well-being, such as real male wages, they now consist of a less economic group of indicators that are broader and more complex, in accordance with renewed interest in a subject that has shifted towards concepts such as human well-being and quality of life. Child labour; the Human Development Index; diet and consumption; nutritional status measured with anthropometric indicators such as stature, weight and body mass index; workplace accidents, and even environmental costs, among others, are all aspects that have recently been analysed in some panoramic studies.[1]

One of the most highly debated issues has been the quality of life of the working classes during the mining boom. Between the mid-nineteenth century and the First World War, a rare demographic growth took place, generated by immigration and an unprecedented urban explosion in the mining ba-

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1. Martínez-Carrión (2006); Escudero & Barciela (2012).

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sins, which has attracted the attention of specialists seeking to determine the social and economic costs, and, more recently, the environmental impact. In this context, the study of the size of human growth or nutritional status constitutes one of the main focuses of study recently carried out on the lead and iron basins in the south-east of Spain and Biscay.[2]

As is well known, anthropometric history has acknowledged the value of nutritional status based on the height of individuals, considering the concept of net nutrition.[3] (This determines adult height, which is the difference between the energy and nutrient intake and the energy expenditure generated by morbidity and physical exercise during childhood and adolescence, and is a good proxy of the environment, health and inequality).[4] Based on anthropometric data corresponding to the Rio Tinto basin in the province of Huelva, the study analyses the impact that the mining boom had on the biological standard of living and focuses on inequality. The heights of the military recruits of Zalamea la Real (AMZR) and Nerva (AMN) from 1852 to 1935 constitute the main data source. Therefore, the study focuses on a period of notable demographic and socioeconomic changes which affected the wellbeing of those born between 1832 and 1914.

The main aim of the article is to study the nutritional health and inequality of the male population affected by the mining boom of the Restoration period. We particularly wish to examine what occurred during the golden age of the mining industry, which was witnessing technological changes that affected Rio Tinto between 1873 and 1896, and these had a strong impact on employment and demographic growth due to intense immigration. During this period, a new business model emerged, brought about by the Rothschild family, who actively participated in managing the company, so obtaining control and huge profits.[5] Inequality is studied in terms of differences in height according to literacy, according to whether the subjects were natives or not and according to the coefficients of variation (CV). Based on the importance of nutritional poverty, we have used the height percentiles to explore the extent of malnutrition. The study has five sections. The second and third sections following this introduction analyse the environmental context of the mining fever and the demographic boom, which was largely due to intense immigration. The fourth section constitutes the essence of the article and presents anthropometric evidence which discusses aspects of inequality and the nutritional status trends of the workers in different subsections. Conclusions are drawn in the fifth section.

2. For early studies on the south-east of Spain, see Martínez-Carrión (2004, 2005); in Biscay see Pérez-Castroviejo (2006).
3. Komlos (1994).
4. Blum (2013); Floud, Fogel, Harris & Hong (2011, 2014).
5. Avery (1974); Harvey (1981); López-Morell (2013); Broder *et al.* (2014).

Environmental Context of the Mining Industry in Rio Tinto

In general terms, mining activity during the early industrialisation processes had a huge impact on the working and living conditions of the mining population. The researchers of the day were aware of this, as we can see from the texts of that time.[6] Rio Tinto (Huelva) is a unique basin due to the type of mineral and the work organisation: large mining activities in the hands of a large company which dominated the production scenario of copper mining. It was an unusual case within Spain at that time, similar to that of Almadén (Ciudad Real), where a large mineral deposit was exploited by a single state-owned company.

The copper deposits of Rio Tinto were significant in the global copper mining scene. Exploited since ancient times, they constituted resources that were rich in copper pyrites corresponding to the so-called *Iberian Pyrite Belt*. Rio Tinto was directly controlled by the state until 1873. In 1870 the government had approved its sale at an exceptional price for the time: 92.8 million pesetas. Business operations were thereafter carried out by an English consortium organised and directed by the British financier, Hugh Matheson (c. 1820-1898), who founded Rio Tinto Company Ltd (hereafter referred to as, RTCL) to mine the deposits.[7] It was an unusual operation in Spanish mining, which until then had mined through "concessions". However, in 1873 the surface property and the underground property were sold in perpetuity. The mines were controlled by foreign capital until 1954, when they were sold to the Compañia Española de Minas de Rio Tinto SA. However, the brand prevailed in a large international corporation: Rio Tinto Group, one of the most important mining multinationals today and which has no connection with the area from which it takes its name.

After 1873, with the new British owners, the production and demographic panorama of the area changed radically. The new company renewed the mining technology (open cast mining), transport infrastructure (railway lines, loading dock) and foundry technology.[8] The most decisive period of technological change for the company was between 1873 and 1896 (Harvey, 1981). The enormous production potential of the basin enabled the company to

6. Many texts were written by hygienists on the physical conditions of the workers and their height. Martínez-Carrión; Puche & Cañabate (2013). On child labour in the mines, see Pérez de Perceval, Martínez-Soto & Sánchez-Picón (2013a).

7. The British firm Clark, Punchard & Co, the Deutsche National Bank de Bremen, the London-based insurance group Smith, Payne & Smith, the Industrial Bank Arthur Heywood, Sons & Co, of Liverpool, and the German engineers based in Huelva, Sundhein and Doesth, also participated (Flores-Caballero, 1981; Arenas-Posada, 1999; López-Morell, 2013).

8. Avilés (2008).

MAP 1 ▪ *Current situation of the districts of the mining basin of Rio Tinto (Huelva)*

Source: Author's own work.

quickly recover the capital invested and obtain significant profits.[9] RTCL became the world's leading company in terms of the volume of mineral extracted between 1877 and 1891 and in the subsequent years it remained among the four top companies.[10] Spain was ranked second in terms of world copper production after the United States: it produced almost 20% at the end of the 1880s and between 11% and 12% at the beginning of the twentieth century.[11]

RTCL was colossal within the Spanish mining sector, constituting its largest private company at that time. The territory used for the mining activities, the characteristics of its acquisition, the high number of employees and the scale reached by its economic activity were key factors in the configuration of the demographic development. Its influence could be clearly seen in Minas de Riotinto and Nerva, where the company owned a large part of the municipal land. The mining district as a whole experienced an exceptional economic boom, which completely transformed the life of the province and Huelva became the fourth most industrialised province in Spain in 1887.[12]

9. Particularly after the 1890s, with the entry of shareholders from the Rothschild family. Flores-Caballero (1981); Chastagnaret (2000); López-Morell (2013).
10. Nadal (1981), p. 459.
11. Metallgesellschaft (1904).
12. Domenech (2008).

The environmental impact generated by the mining boom in Huelva has been one of the most studied aspects in recent years, due mostly to the after-effects on the population's health and on the rural environment. The treatment of copper ore introduced in the nineteenth century — open-air calcination kilns, artificial cementation or "teleras" — generated sulphuric smoke with a high level of chemical pollution of the atmosphere. The phenomenon, known as "acid rain", was harmful to health and the environment and affected woodland and the growth of vegetation and crops, and consequently affected cattle and the food chain.[13]

The open-air calcination method had been used before by the Marquis of Remisa, who leased Rio Tinto to the state between 1829 and 1849. It consisted of burning tonnes of mineral arranged in large heaps or pyramids — "teleras" — covered with dry branches in the open air. The use of this method peaked with the implantation of RTCL. The cones burned continuously throughout the year to eliminate part of the sulphur contained in the mineral extracted; this was copper leaching. This system gave rise to huge "blankets" of toxic smoke clouds that covered the area for a good part of the year. Until the 1850s and 1860s, the emissions were relatively small, and although the procedure harmed the forests — uncontrolled forest clearing for wood combustion — the toxicity of the gases for human health was hardly observed.[14] The majority of the debates at the time focused on deforestation.[15]

The 'invisible damage' reached intolerable levels during the period of the British company's presence.[16] Gases with high sulphur and arsenic contents emitted by the teleras — a method that was banned in Great Britain in the mid-nineteenth century — gave rise to citizen demonstrations, particularly by farmers and RTCL workers. At the height of the mining boom, more than two million tonnes per year were calcined and up to 600 tonnes of toxic gases were emitted each day.[17] Following the pattern of other European demonstrations against factory smoke and foundries (mainly English), the movement against the emissions led to the creation of the Anti-Smoke League in the 1880s, which came to its peak in 1888, the "year of the shootings". The protest on the 4 February led by the inhabitants of Zalamea de Real — who shouted "Down with the smoke, long live agriculture!" — and in which thousands of farmers from the area and miners who were unhappy with the wage conditions in the "blanket days" participated, was resolved tragically with al-

13. On environmental effects, see Borrero (1887), Quirós & Iglesias (1989), and Pérez-Cebada (1999, 2001, 2006, 2014). Also Pérez-López (1994), Ferrero-Blanco (1994).
14. Borrero (1887); Cortázar (1888).
15. Ferrero-Blanco (2001); Pérez-Cebada, (2001).
16. Pérez-Cebada (2014a and 2014b).
17. Borrero (1887); Ferrero-Blanco (1998), p. 44.

most two hundred people being shot dead by the army.[18] The tragedy of Minas de Riotinto was followed by an interesting scientific debate concluded in 1890 with a report issued by the *Royal Academy of Medicine.* It confirmed the safety of the Huelva smoke, an essential argument which enabled the government to lift the ban on open-air calcinations that had been enforced after the massacre. The emissions prevailed until the twentieth century, when the company found a way to obtain profit from exploiting the waste sulphur generated in the calcinations.[19]

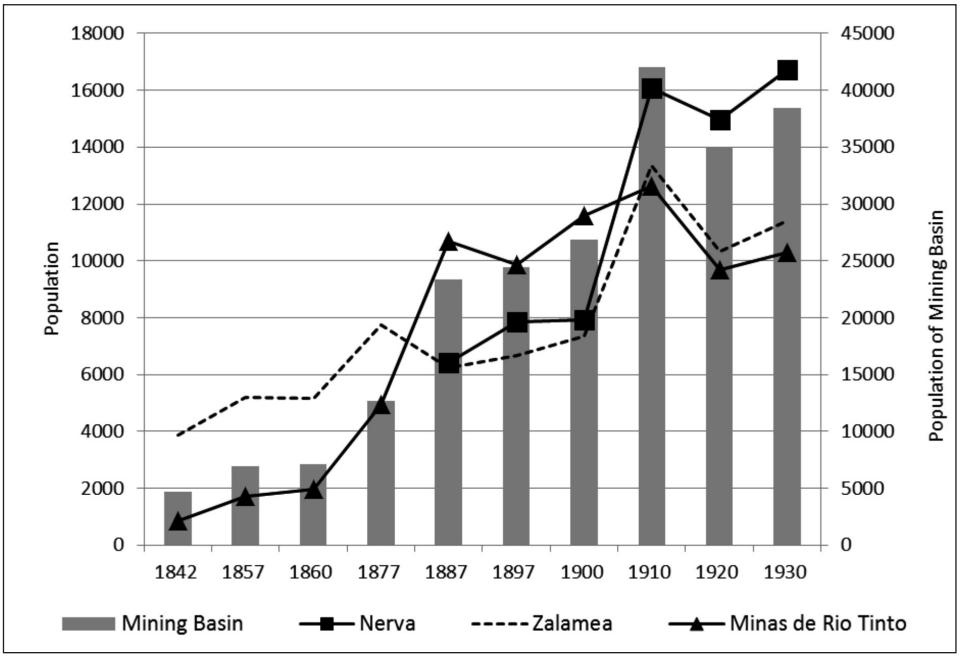
The Economic and Demographic Situation: Nerva, An Avalanche of Immigrants

Around 1870, at the beginning of the mining fever in Huelva, the most prevalent population nuclei were Zalamea la Real and Minas de Riotinto, particularly the former, due to its physical size and demographic weight. In the decades leading up to the establishment of the English company, the basin recorded significant migratory flows, which are reflected in the population censuses. The pace of demographic growth between 1840 and 1880 reveals how the mining sector attracted the inhabitants of the neighbouring areas and provinces. The area of Zalamea included many villages which grew demographically in the middle decades of the nineteenth century, particularly Minas de Riotinto, El Campillo, El Villar, Buitrón, Las Delgadas and Pozuelo. Some villages grew quickly due to the development of mining activities from the 1830s and 1840s. This was the case of Minas de Riotinto where, after becoming independent in 1841, the population grew five-fold between 1842 and 1877. During this period, the population of the Mining Basin increased by 170%. Zalamea — which still included Nerva (it was known as Aldea de Riotinto) — duplicated its population (Figure 1).[20]

The need for abundant labour for open air extraction increased the pull factor of the English company.[21] The rapid activity which the RCTL had been engaged in since 1873 multiplied the number of mining jobs. In only four years, the British firm had employed around 4,000 workers and in 1888 it had

18. Avery (1974); Ferrero-Blanco (1998, 2001).
19. Pérez-Cebada (2014a).
20. The mining activity grew from the 1840s. In the area of Zalamea, in 1857, the mines of Cabezo del Tinto, Nuestra Señora de la Salud (Chaparrita), Lusencia, Poderosa, Peña de Hierro, Luisa and Inglesa took off and from 1870, the manganese mines began to prosper. Consequently, the first railway line was built during this year in El Buitrón by the Compañía de Minas de El Castillo. We are grateful to Manuel Domínguez Cornejo and Antonio Domínguez Pérez de León for providing this information.
21. Arenas (2011).

FIGURE 1 ▪ *Population of the mining basin of Rio Tinto, 1842-1981*



Source: INE, Population censuses (right-hand axis — mining population of the basin).

hired 8,643 miners.[22] In addition to the people from the Huelva mountain areas, the influx of immigrants from Andalusia and Extremadura and even from the Portuguese Algarve and other provinces even further away was decisive. The presence of workers from Orense and Zamora is particularly remarkable, as at that time there was no railway connection along the Ruta de la Plata (Silver Way).

The demographic growth at the beginning of the 1880s was decisive for Nerva in becoming a municipality in its own right. Separated from Zalamea la Real in 1885,[23] the new municipality included the villages of Aldea de Riotinto, Ventoso, Minas de Chaparrita and Peña del Hierro (Figure 1). After the first avalanche of immigrants, Nerva had a population of 6,431, according to the 1887 census. The non-residents who were not registered accounted for 49.3% of the population and men almost 60% of the total population of the municipality. The population of the mining basin grew by 83.6% be-

22. Gil-Varón (1984), p. 17. Around 1879, the two large mining companies of the area (Rio Tinto and Tharsis) employed some 8,000 workers, Cortázar (1888), p. 15. For the English presence of technical staff and specialized professionals, see Galán (2013).

23. Gaceta de Madrid, year CCXXIV, number. 191, Law of 10 June 1885.

tween 1877 and 1887, mainly concentrated in the new town of Nerva, and Minas de Riotinto, whose population grew by 115.3%, reaching some ten thousand inhabitants when there had been barely one thousand in the middle of the century.

The 1890s was marked by a demographic slowdown in the province and in the district. This was particularly dramatic in Minas de Riotinto, probably because of the readjustment in mining operations which gave rise to a significant reduction in the workforce of RTCL.[24] At the end of the nineteenth century, the population began to grow again and Nerva became the largest mining municipality in terms of inhabitants in 1910, and remained so until the 1930s. The first decade of the twentieth century constituted an exceptional juncture for the mining sector of Huelva. The dismantling of the Corta Atalaya mine, which began in 1907, made Rio Tinto the largest Spanish open cast mine.[25] The workforce grew from 13,108 to 16,465 workers between 1906 and 1908.[26] Eighty-four per cent of the workers residing in Nerva were immigrants (Table 1). Displacement of the population between the mining settlements was significant and increased at a tearing pace in the villages of Nerva, for example Peña del Hierro experienced a five-fold increase of its population. Also, Los Ermitaños, a place which was uninhabited in 1900, became repopulated as a result of the mining operations carried out there by the English company Peña Copper Mines Co. Ltd.[27] In addition to the demographic growth of Zalamea, settlements were also created around the principal mines, including Palanco, Guadiana, Tinto y Santa Rosa and Castillo de Buitrón. This constituted the second great demographic explosion of the mining district of Rio Tinto.

TABLE 1 ▪ *Immigrants in the mining basin in the decade 1900-1910*

Municipality	Workers Employed by RTCL	Workers Native to the Town Employed by RTCL	Total Immigrants	% of Immigrants of RTCL Workers
Rio Tinto	2,133	713	1,420	66.6
Nerva	3,188	508	2,680	84.1
Zalamea	583	430	153	26.2
Campillo	829	28	801	96.6
Total	6,733	1,679	5,054	75.1

Source: Census of 1910, Gil-Varón (1984:29), and Salkied (1970).

24. Gil-Varón (1984), p. 25
25. Avery (1985) p. 170.
26. Gil-Varón (1984).
27. Pinedo (1963), p. 316.

The new wave of immigration in the first decade of the twentieth century could have exacerbated the problems of hygiene and public health. From 1876 the RTCL constructed villages designed to accommodate the workers and their families close to the mines, which had even better sanitation conditions than other villages. Some settlements had temporary access to public fountains, a washing place, a school, a medical dispensary, a warehouse of essential goods, electricity, and even sanitation by way of hygiene contraptions which were commonly known as "carts". This was the case at Minas de Riotinto and La Atalaya, but not in Nerva, where the majority of the immigrant population was concentrated.

The installation of public toilets became widespread in the mining villages from the first decade of the twentieth century, but demographic pressure increased the overcrowding problems of homes. In 1920 the mining settlements still had no running water, according to an English report which appealed for more public fountains.[28] The most spacious residences with better

FIGURE 2 ▪ *Production (mineral in thousands of tons) and workforce of RTCL and the population of Nerva, 1875-1935*

Source: Mineral: Gil-Varón (1985), pp. 226-229. Population: Spanish population census. Workforce: Archive Foundation Minas de Riotinto (AFMRT), personnel registers. The workforce refers to the miners and does not include those workers in the facilities in the city of Huelva or transport personnel (port and rail).

28. Report by Sir Rys Williams, sent by the Rothschilds due to the conflict of 1920, see Ferrero-Blanco (2003), p. 291.

sanitary conditions, such as those in the improved and tarmacked neighbourhoods, were intended to house the directors, preferably English staff, and the highest qualified workers.

The mining crisis broke out just before the First World War. Fierce competition between the companies operating in the province and international competition from the new American basins led to a fall in production to the levels of the beginning of the 1880s and an increase in unemployment (Figure 2). The demographic decline was sharp in Minas de Riotinto, but not so severe in the municipality of Nerva (Figures 1 and 2). With the reduction in the demand for labour and of real wages there was an increase in unemployment and social conflict. In fact, the workers' discontent had begun in 1911 with the growing mechanisation, but accelerated with the spectacular increase in prices and the low wages which reduced the standard of living until after the post-war period. The strike of 1920 had hardly made any impact on the situation of deprivation and misery and led to the dismissal of 3,500 workers, almost 20% of the workforce of RTCL. From that moment, emigration began to rise and having family relationships or being a native to the area facilitated access to the labour market, a procedure which was thereafter managed openly by the labour organisations and the RTCL.[29] In 1935, the company expelled unemployed workers without papers or those who were not registered in the municipality.[30] This labour policy would also determine the demographic trend, which was less dynamic than in previous periods. The economic crisis at the beginning of the 1930s ended the growth cycle experienced by the copper mining sector in the last twenty-five years of the nineteenth century.

Anthropometric Evidence

Sources, data and their representativeness

The principal source of data corresponds to the records of classification and declaration of soldiers (ACDS), which were adjoined to the personal files of the enlistment process and the complaints and revision records. We have drawn data from the ACDS and personal files of the recruits corresponding to the municipalities of Zalamea la Real between 1852 and 1889, and of Nerva from its constitution in 1885 until 1935. As the former municipality was segregated from the latter in 1885, we have reconstructed the height series of Zalamea in order to analyse the evolution of biological welfare before the mining boom and connect the two series in the mid 1880s. We present the series correspond-

29. Galán (1997), p. 133; Arenas (2011).
30. Archive of the RTCL, IB6-19 Resident workers.

ing to Zalamea in two sections: Zalamea1, which includes the young men of the whole of the municipality between 1852 and 1884 and therefore includes those of Nerva (mainly Aldea de Riotinto), and Zalamea2, which excludes the latter after being segregated from Zalamea. The timeframe of the second section is short (the five-year period 1885-89), but it enables us to differentiate the biological welfare in both towns at the beginning of the mining explosion.

The resulting linked series of height is that of recruits from between 1852 and 1935, or we could also say the generations born between 1832 and 1914. As is frequently the case, the study considers height from the year of birth. The details corresponding to the characteristics of the sample can be seen in Table 2.

TABLE 2 ▪ *Characteristics of the sample*

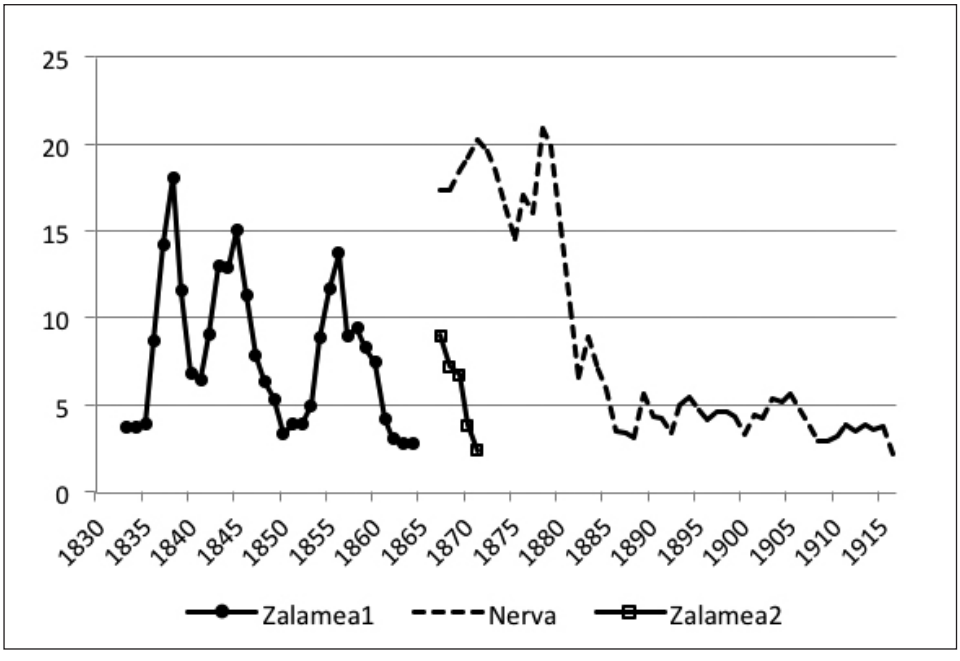
Decade of Birth			N	%	Average	Standard Deviation
	1832-39		182	2.5	163.96	7.9
	1840-49		422	5.9	163.38	6.3
	1850-59		333	4.6	163.49	7.0
	1860-69		479	6.7	162.54	6.0
	1870-79		772	10.7	160.68	9.2
	1880-89		1,096	15.2	164.14	6.1
	1890-99		1,695	23.5	164.99	6.3
	1900-09		1,259	17.5	165.05	6.3
	1910-15		960	13.3	164.85	5.9
	Total		7,198	100.0		
Education	Nerva	Literate	2,601	43.6	164.16	6.4
		Illiterate	1,195	20.0	162.05	8.6
		ND	2,174	36.4		
		Total	5,970	100.0		
Place of Birth	Nerva	Natives	1,455	24.4	164.53	6.24
		Immigrants	2,593	43.4	163.15	7.62
		ND	1,922	32.2		
			5,970	100.0		
		Andalusia	738	12.4	162.65	7.57
		Castile	176	2.9	159.05	10.79
		Extremadura	490	8.2	162.49	7.96
		Huelva	1,154	19.3	164.40	6.57
		Rest	35	0.6	162.30	7.55

Source: AMN and AMZR, ACDS; own work.

The heights are registered in millimetres from 1861 although the recruits previous to this were measured according to the old Castilian system of feet, inches and lines. The heights between 1856 and 1861 (born 1836-41) have been converted to the decimal metric system following the scales of the bar standards "Marco de Burgos" or "vara de Castilla". For previous recruits we have used the French measurement (the King's foot or the Paris foot), otherwise the average heights would range between 130 cm and 150 cm, highly incredible for male adults (Cámara-Hueso, 2006). We have not taken into account the recruits between 1849 and 1851, as there was a cut due to a failure to record the data relating to those who were too short to enter the army.

The problems of Spanish military enlistment sources are well-known and it is not necessary to go into details. One of the problems is related to the minimum age established for the draws and recruitments of the youths called up, which varied between 1852 and 1907 from 18 to 21 years old. To homogenise the height series, we have standardised the heights at 21 years of age (strictly speaking, those young men who had turned twenty), the age which was stipulated for accessing military service in a good part of the twentieth century (from 1907 to 1970). Composed of young men of the same age, the Zalamea

FIGURE 3 ▪ *Ratio of young men with heights of under 155 cm. Cohorts of 1832-1915 (Third-order moving averages)*



Source: AMN and AMZR, ACDS; own work.

series is homogeneous between 1852 and 1885 (Zalamea1). However, Nerva was subject to the changes that occurred from then until 1907.[31]

The need to homogenise the heights at a specific age for the period can be seen in Figure 3, which shows the percentage of young men measuring less than 155 cm and considered as short and who were excluded from military service. Although the ratio of short subjects can be interpreted as a symptom of the prevalence of malnutrition, the high proportion of this group until the first recruitment of youths of 21 years of age (1907 or the cohort of 1886) shows that they were still growing. This reinforces the need to standardise at 21 years of age.

In order to standardise the series at a specific age, we considered the standard mean in generations measured at different ages in accordance with the fiftieth percentile (P_{50}), once the reglamentary age had been changed.[32] Therefore, we have used P_{50} of those born in the five-year periods 1876-80, 1881-85 and 1886-90, whose variation rates in centimetres with respect to different age intervals are shown in Table 3. For the shortest section of Zalamea2, we have used the estimated increases based on the heights of the men between 19 and 21 years of age recruited in this municipality between 1884 and 1889.[33] The procedure provides greater consistency when analysing trends in the biological standard of living.[34]

We also observed that the incidence of absence among recruits was low until 1911. However, the gap between the total number of young men called up and those who were finally measured grew after this year. The ratio of those who attended the measurement was significant: around 85% in the recruits between 1907 and 1915 and 68% in those between 1915 and 1935. The lower ratio at the end of the period is due to the emigration after the crisis of the Great War.

31. According to the data for Nerva, the average age of the recruits rose from 18.7 in 1885-99 to 19.5 in 1901-05, and to 20.5 in 1907-35.

32. We have followed the approach of Ramon-Muñoz (2009). For other methods of estimation, see Martínez-Carrión & Moreno-Lázaro (2007), and Cámara-Hueso (2009).

33. The result of the increases in enlistments of 1884-80 in Zalamea la Real is as follows:

Age	Average Height	No. Recruits	Age Range	Increase in cm
19	163.64	304	From 19 to 20	1.36
20	165.00	57	From 20 to 21	0.35
21	165.35	20	From 19 to 21	1.71

34. We have observed greater increases in height among earlier recruits, those corresponding to 1849-51 at age 18 to 20 (born in 1830-32). The results are as follows: from 18 to 19 years the height increased 2.37 cm and from 19 to 20 increased 1.74 cm. In short, from 18 to 20 there was an increase of 4.11 cm which we have not considered in this study. The reason is that these recruitments exclude the heights of those who were short for their age, those who were not tall enough, and the sample is relatively small (39 cases).

TABLE 3 ▪ *Increase in height corresponding to the 50th percentile (P_{50}) in the young men of Nerva aged 19-21 years, 1876-1890*

					Increase in Height	
Age	**Born**	**Recruited**	**Men measured**	**P_{50} (cm)**	**Age interval**	**Cm**
19	1876-80	1895-99	330	162.5	From 19 to 20	1.22
20	1881-85	1901-05	429	164.5	From 20 to 21	0.95
21	1886-90	1907-11	736	165.0	From 19 to 21	2.17

Source: AMN, ACDS; own work.

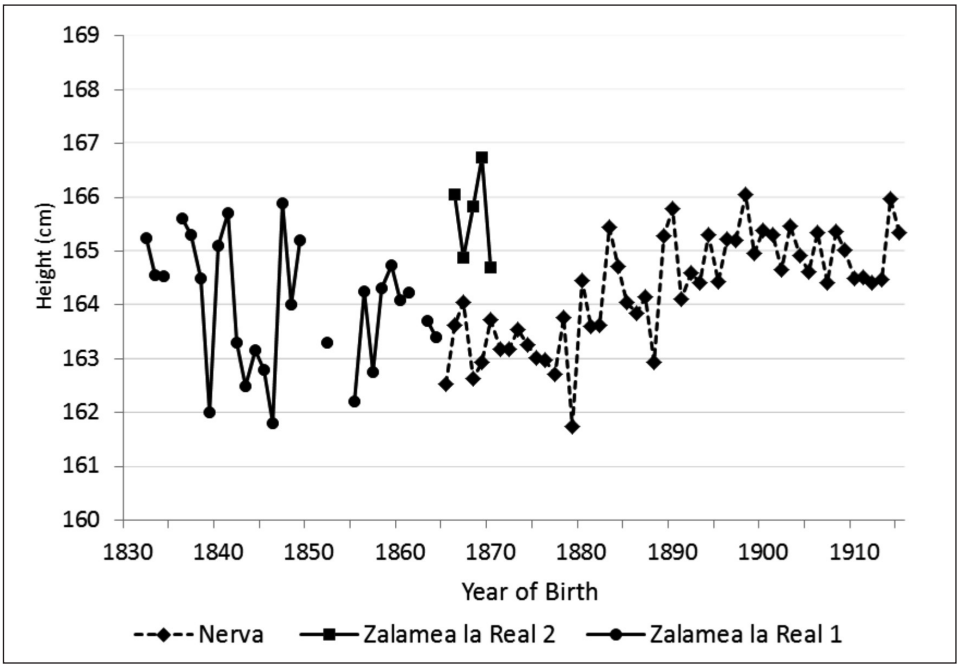
Finally, we verified the normality of the height data. The histograms reveal that there are no problems in the distribution of heights in centimetres in the distribution tails.[35] We observed a degree of concentration in the heights with centimetres ending in 0 and 5, which is fairly normal with this type of data. The concentration hardly affects the estimate of average heights. The only period which displays any abnormality is 1901-1905, due to the lower number of cases. The histograms show a bell-shaped distribution with no truncation, which we could define as a typical Gaussian distribution.

Trends in biological welfare: before and after the mining boom

The evolution of the mean statures of Zalamea la Real and Nerva are shown in Figure 4. At first sight, the series from both municipalities suggest that the biological welfare was not very different between those born in the middle decades of the nineteenth century and those born in the early decades of the twentieth century and that between these two periods there was a decline in the wellbeing of those born in the 1860s and 1870s. We can observe a lack of progress in the standards of living measured in net nutrition, which could be associated to the mining sector, which took over from agricultural activities from the 1870s and 1880s and produced a demographic shock which changed the population composition in terms of natives and immigrants. In this respect, we should indicate some of the limitations found by the study of the behaviour of height in the growth cycle: 1) there is no data available regarding the height of the miners, they appear as labourers and data corresponding to professions were rare until the recruits of the 1880s; 2) we do not know the demographic size of the mining settlements which were formally included within the municipality of Zalamea and in 1885 became part of the municipality of Nerva.

35. Martínez-Carrión, Pérez de Perceval & Martínez-Soto (2014), p. 15.

FIGURE 4 ▪ *Mean height standardised at 21 years of age in Zalamea la Real and Nerva. Cohorts of 1836-1915*



Source: AMN and AMZR, ACDS; own work.

An analysis of the data produces the following results. For the recruits born in Zalamea la Real at the beginning of the period, between 1832 and 1840 (recruited in 1852-60), the average height was 164.6 cm. This local average is slightly higher than the Spanish average for the same period,[36] higher by almost two centimetres than that of the rural settlements of Andalusia[37] but almost one centimetre lower than that of the population of Antequera (Malaga), one of the most industrial cities.[38] At the end of the period, for the recruits of Nerva born in 1906-1915 (recruited in 1925-1935) the estimated average is 164.9 cm. Therefore, no significant changes can be observed between the beginning and the end of the century analysed. However, we can see that the cohorts whose childhood and teenage years coincided with the mining boom were relatively shorter than those who were born in previous decades (Figure 4). Comparing the heights during the years when the two se-

36. Martínez-Carrión (2012).
37. Cámara (2009), Cámara & García-Román (2010), p. 105.
38. Estimate only for the cohorts of 1836-37. Martínez-Carrión & Cámara-Hueso (2015).

ries coincided (cohorts of 1865-70 whose adolescence ended in 1889), we can see that those in Zalamea la Real (Zalamea2 series) were taller than in Nerva. During these years, Nerva received an avalanche of immigrants and its population was made up mostly of outsiders, as revealed by the recruits of 1880, as we shall see further on. Therefore, we believe that the height of the young men in Nerva, shorter than that of their counterparts in the same period (Zalamea2), was determined largely by immigration and, consequently, by the nutritional poverty of their places of origin, as we shall see later.

We can observe that the series of Zalamea la Real had greater annual oscillations than that of Nerva. This is due to the lower volume of data and probably because it was affected more by the epidemic morbidity crisis of the middle decades of the nineteenth century. The ups and downs reflected by the heights could be related to the impact of nutritional crises (food crises and epidemics evident in the short recruits in 1838, 1845 1855, 1869 and 1879). Even so, it cannot be denied that relatively tall heights were registered in the initial stage: an average of 164.6 cm for the cohorts of 1836-40 which increased to 164.7 cm in 1846-50. The data suggest that the decline began from the cohorts of 1850 (Figure 4). There was a decrease of seven millimetres between those born in the five-year period 1846-50 and those born between 1861 and 1865.

The physical deterioration is observed principally when immigration intensified. In the Zalamea1 series, only the data corresponding to the 1884 recruits (cohort of 1864) include details of the origin of the recruits: 41% were not native to the area, coming mainly from the province of Badajoz. The data reveal height differences between different origins. While those born in Zalamea measured, on average, 163.9 cm, the average height of immigrants was 162.6 cm. The data, although sparse, reinforce the effect of immigration on the decrease in height at the end of the Zalamea1 series, whose averages fit well with those of Nerva (Figure 4). In line with the pessimistic view for those born in Nerva between 1866 and 1880, who were children until the beginning of the 1890s, the impact of environmental conflicts could explain this decline. During these years, the problems of the teleras and the calcinations with sulphuric acid emissions in the atmosphere reached an extraordinary scale. Not only did they cause problems of deforestation but they also affected the development of cattle and crop farming, and consequently the food chain, and in turn human well-being.[39] The toxicity of the smoke could have affected the health of women and children. "Fever, frequent coughing, vomiting, diarrhoea and gastrointestinal complaints, conjunctivitis, dyspnoea", among other illnesses, increased with the inhalation of sulphur dioxide.[40] The reports indicate that sul-

39. See studies by Pérez-Cebada (2014).
40. Quirós & Iglesias (1989), p. 291.

phurous products formed a dense foam on the dam waters, they covered the utensils in rooms and filled homes with dust, impregnated the clothes of the labourers and affected the entrails of cattle.

Another influential factor may have been the diffusion of child labour. In the province of Huelva, child labour did not fall below 10% among the workers until the second decade of the twentieth century.[41] Low wages for the miners gave rise to a higher incidence of the employment of minors from the age of at least nine, together with female labour in the manufacture of espadrilles and in domestic service in order to increase complementary income and cover the most basic needs.[42] Morbidity could have been another determinant, as revealed by the evolution of gross mortality. During the six-year period between 1873 and 1879 mortality rates were higher than the general rate at 40 per 1,000 and for three years it was higher than 50 per 1,000. During this period the mortality rate did not fall below 30 per 1,000.[43] We cannot ignore the overcrowding of people and families in homes[44] and the pressure on resources — particularly the prices of food, energy and rents, variables which have not been studied — as a consequence of the avalanche of immigrants in 1870-80.[45] Growing children and adolescents may have been affected both by disease and nutritional deprivation. With these assumptions, it is highly probable that the energy cost derived from environmental conflicts, the morbidity rate and child labour would impoverish the nutritional state and delay growth, affecting the recruits of the 1880s and 1890s most of all, who had been children in the 1860s.

The cohorts born between 1881 and 1900, who were children and adolescents in the first decades of the twentieth century, experienced an improvement in their biological standard of living. The increase in height measured in five-year averages between those born in 1876-80 and those born in 1896-1900 was two centimetres, reaching 165.4 cm. This increase in height coincided with an improvement in the economic situation and the huge increase in employment between 1895 and 1915 (Figure 2). The body mass index (BMI) (kg/m^2)) could be evidence of the acceptable nutritional status of the recruits

41. Pérez de Perceval & Sánchez-Picón (2005); Pérez de Perceval, Martínez-Soto & Sánchez-Picón (2013).

42. Galán (1997), p. 132.

43. Ferrero (1994), pp. 139-182.

44. In 1889, the average number of residents per dwelling was seven and it was frequent to find several families under the same roof, even with more than twelve people from different places and provinces. Galán (1997).

45. A report published in the *Anales de la Real Academia de Medicina* on 1 February 1890, in response to claims made by CRTL against the R. D. of 29 February 1888, which banned the calcinations, referred to the sordid living conditions of the mining families: "narrow, torturous and dirty streets which are poorly paved or unpaved; small and badly constructed houses; poorly ventilated and dark rooms; individuals crowded together in them; filthy toilets" (Tomo X, cuaderno 3, p. 229).

at the beginning of the twentieth century, although this is only estimated for 1912 (those born in 1891, Table 3). Even those in the third percentile were not underweight.

There followed a period of stagnation and crisis which prevailed until the recruits of the Second Republic. The nutritional crisis affected those born between 1910 and 1913 (recruits of 1931-34) who were children during the most critical phase: from the beginning of the Great War until 1924. These years were particularly hard, which is reflected in the decrease in the workforce of RTCL in the decade following 1914 (Figure 2). Wage conditions worsened and the labour conflicts increased after 1911 (strikes of 1913 and 1920-21). Many families were living in poverty and suffered from hunger. The scarcity of food for children and of nursing mothers in 1920, a year of conflict, reached such a scale in the mining basin that support from the unions was required. This situation was unprecedented, working-class families throughout the whole of Spain temporarily fostered more than 3,000 vulnerable children.[46] Years before, in 1918, an inspection carried out by the company regarding the physical conditions of the workers revealed that: "only 32.6% were really physically fit. The physical conditions of the children in the district are extremely poor and only a small percentage will be accepted to work for the company".[47] This clearly proves that the increase in the prevalence of malnutrition affected the increase in the proportion of short subjects (Figure 3) among the recruits of 1917-24. During these years, the deterioration in biological welfare was notorious and evident in the decrease in the height of recruits from 1919 who were born after 1899 (Figure 4).

The impact of migrations on the evolution of height

The mining populations constitute an ideal laboratory for analysing the inequalities in biological welfare of both natives and immigrants whose nutritional status was influenced principally by the environment of their origin. The nutritional status of immigrants could differ considerably depending on their geographic origin and was influenced by different social, economic and environmental conditions. In previous sections we have indicated the importance of the avalanche of immigrants in the last decades of the nineteenth century and early decades of the twentieth century.

The data regarding the origin of immigrants are scarce and the information about the length of residence is omitted in the measurement record. In order to determine these details for Nerva we have carried out an individual reconstruction using the nominal list of the recruits, and comparing it with

46. Ferrero-Blanco (2003), pp. 249-250.
47. Ibidem, pp. 281-282.

TABLE 4 ▪ *Length of residence in Nerva of the young men measured in 1885/86 and 1891/93, and height at age 19 years*

1885-86			
Years of Residence	**No. of Men**	**%**	**Average Height**
5 and less	46	43.8	160.7
5.1 to 10	36	34.3	161.8
10.1 to 15	7	6.7	161.0
More than 15	16	15.2	162.8
1891-93			
5 and less	78	36.1	160.5
5.1 to 10	52	24.1	161.2
10.1 to 15	48	22.2	161.6
More than 15	38	17.6	160.6

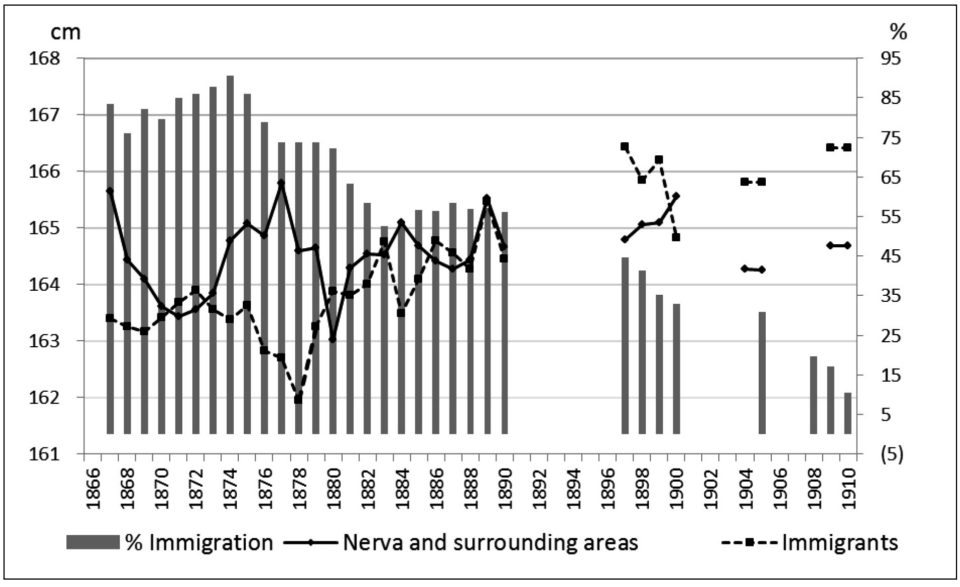
Source: AMN, ACDS; own work.

the information drawn from the parishes and civil registries. In 1885-86, 43% of the young male population had been residents for less than five years, while 15.3% had been living there for more than 15 years. In 1891-93 the percentages were 36% and 17.4% respectively (Table 4). At the beginning of the mining boom, the residents who had been registered in the municipality for less time had average heights that were slightly lower: 2.1 cm shorter than those who had been living there for longer or who had been born there. Years later, the new residents were still shorter than those who had resided there for longer. In short, the data suggest a nutritional deterioration of those who had recently arrived with respect to those who were more settled. This is consistent with the business strategies of the RTCL, which opted to favour the local workforce who occupied the better paid positions.[48] Consequently, the natives had a better diet, they were given less severe activities and jobs and they avoided a greater incidence of accidents.[49] This distinction between workers discriminated the poorest immigrants and may have influenced the difference in heights observed depending on geographical origin.

Figure 5 shows the comparison of the evolution of heights of migrants and natives. We can observe that immigrants had a biological standard of living that was relatively lower than that of the natives during the mining boom, particularly in the early years of RTCL, but the differences are not significant. In the previous section we indicated that the young men of Zalamea

48. Arenas (1999).
49. Galán (1997); Arenas (2011).

FIGURE 5 ▪ *Immigration (%) and differences in height between natives (Nerva and surrounding areas) and immigrants. Cohorts of 1866-1910 (Third-order moving averages)*



Source: AMN, ACDS; own work with heights standardised at 21 years of age.

were relatively taller than those of Nerva at the beginning of the expansion phase of the mining sector. The data suggest that the weight of immigration may have been a determining factor. A breakdown of the men in accordance with their place of origin confirms this for the recruits at the end of the nineteenth century. The immigrant population was grouped according to well-defined geographical areas, which enabled us to identify environmental or socioeconomic characteristics. The data referring to the geographical origin of the recruits coincide with those of the origin of the workforce hired by the British company.[50]

The periods are not homogeneous as there are gaps in the information regarding the origin of the recruits in some years.

The analysis of recruits according to their regional origin reveals, first, that a good proportion of the young men came from bordering areas and the different provinces of Andalusia, Extremadura and north-west Spain, such as Zamora, and the provinces of Galicia. In the majority we observe low biological standards of living with respect to the natives of Rio Tinto (Table 5). From the north-west of Spain we can highlight the immigrants from Zamora who, together with those from Galicia, had the worst nutritional status throughout the period, particularly between 1885 and 1905 (cohorts of 1866-

50. Gil-Varón (1984).

TABLE 5 ▪ *Differences in height between recruits from different geographic origins and those from Rio Tinto*

		Rio Tinto (*)	Province of Huelva	Western Andalusia	Eastern Andalusia	Extrema-dura	North-West Spain
1885-99	1866-80	164.5	- 0.1	- 1.4	- 2.2	- 2.5	- 5.3
1901-05	1881-85	164.9	- 0.7	- 2.9	- 2.2	- 0.4	- 3.0
1907-15	1886-94	164.8	0.2	- 0.4	0.4	- 0.4	- 1.9
1916-31	1895-1910	164.9	1.7	- 0.7	2.2	0.6	- 1.4

(*) Rio Tinto: Recruits in Nerva who were born there or in the surrounding area.

Source: AMN, ACDS; own work with heights standardised at 21 years of age.

1885). Their average heights were extremely low, three centimetres shorter, followed by immigrants from Extremadura and eastern Andalusia. This influenced the estimation of the average height of Nerva.

At the beginning of the period, the tallest subjects were those from Huelva and those native to the area (Nerva and Zalamea). The differences between the natives and immigrants were significant. During the installation and first growth phase of the company RTCL, the heights of the recruits in Nerva and the surrounding areas (born 1866-1880, who were adolescents until 1899) reached 164.5 cm, similar to that of the Zalamea2 series for 1866-70. The data suggest that the mining explosion was not as significant for the natives and that the fall in average height in Nerva and Rio Tinto was due, mainly, to the volume of immigrants. In this period, immigrants accounted for 80% of the population and were, on average, 1.2 cm shorter than the natives of Rio Tinto (Table 5). Over time, the differences between the natives and the immigrants were diluted and we observe some stagnation between the former and the growth of the immigrants from Andalusia and Extremadura and the province of Huelva. The case of immigrants from eastern Andalusia is striking, as at the end of the period they had grown after having recorded relatively much lower heights at the beginning. But the data regarding the origin of immigrants were fragmentary since the First World War and scarce, and therefore not significant.

Height and inequality in the access to education

The importance of human capital for well-being according to educational levels has attracted the attention of specialists. Biomedical research shows the association between height and educational achievements within a wide battery of indicators of socio-economic status. Social scientists indicate that height is associated with physical and mental health and the cognitive ability of adults. Good health in infancy is positively correlated with educational

achievements and employment. The relationship between social status and educational levels and height has been studied by economic historians in recent times.[51]

Unlike the male populations of Andalusia and Extremadura, which had low percentages of literate adults, the proportion of literate young men from Nerva was much higher, by 20 and 40 points, and more pronounced between 1900 and 1920. With respect to the Spanish average, the differences were not pronounced, although there was more of a gap in the early decades of the twentieth century. In short, the educational gap in favour of Nerva was wide between 1900 and 1925 and was at its largest in the second decade of the twentieth century. The data confirm the interest of the company in selecting literate workers.[52] The RTLC invested in training the youngest workers. It educated those who began working in the mine and constructed primary schools.[53] In 1920, the eight schools that the company had built in Rio Tinto were attended by 2,203 children. In Nerva, 366 children went to the company's school.[54] In the lead up to the Second Republic, 90% of the young men in Nerva were literate (Figure 6).

The correlation between height and education measured in literacy rates in Nerva is high (R=0.74) and shows, as in other studies, that the advancement in literacy was associated to the increase in height. Figure 6 reflects the inequality in height of the cohorts from 1887 to 1910, depending on whether they knew how to read and write. At the beginning of the period, the relationship between height and education is clearer. From the first decade of the century the correspondence becomes more blurred, although the data are fragmentary

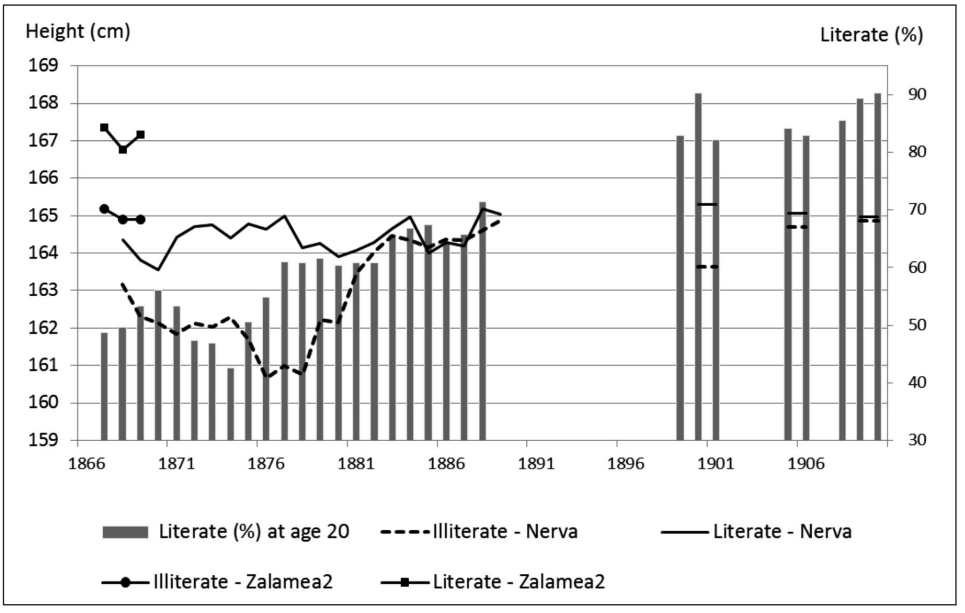
TABLE 6 ▪ *Average height of young men according to education*

	Recruits	Cohorts	Mean Heights		No. of Cases		Diff A/B
			Illiterate (A)	Literate (B)	A	B	
Zalamea	1885-89	1866-70	164.98	166.96	92	145	- 1.98
Nerva	1885-99	1866-80	161.74	164.30	520	584	- 2.56
Nerva	1901-05	1881-85	164.12	164.44	191	334	- 0.32
Nerva	1907-15	1886-94	164.73	164.85	227	498	- 0.12
Nerva	1916-31	1895-10	164.55	165.09	148	922	- 0.54

Source: AMN, ACDS; own work with heights standardised at 21 years of age.

51. Quiroga (2003); Martínez-Carrión & Puche-Gil (2009).
52. Rodriguez-Burguillos (2011).
53. González-Vilches (1981); Gil-Varón (1984).
54. Ferrero-Blanco (2003).

FIGURE 6 ▪ *Average height of young men according to education and ratio of literacy in Nerva (Cohorts 1867-1910). (Third-order moving average)*



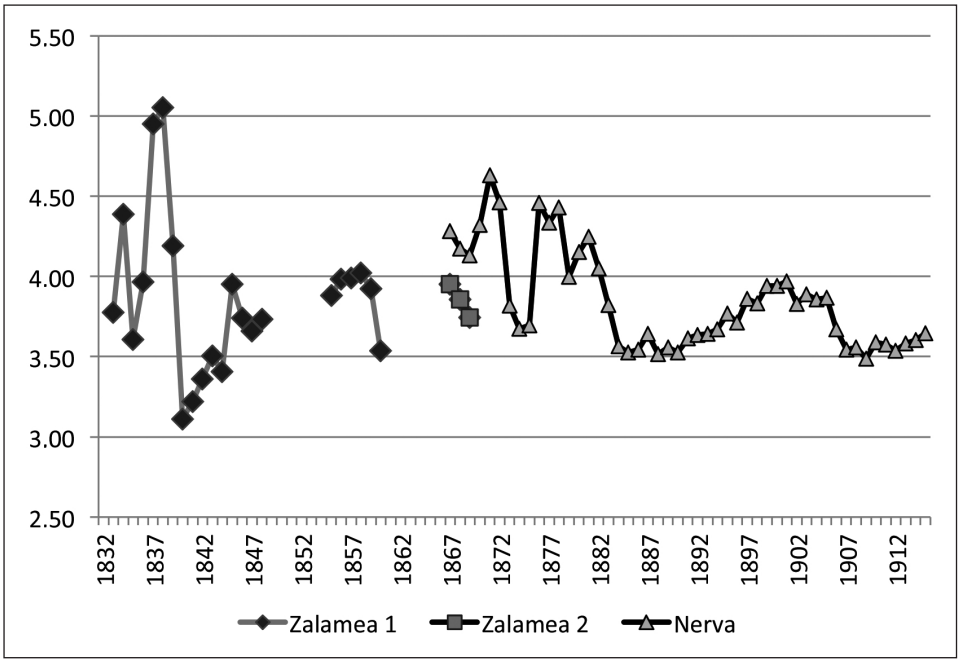
Source: AMN, ACDS; own work with heights standardised at 21 years of age.
Ratio of literacy in Nerva at age 20: third order averages only for cohorts of 1866-89

for the final period. The results show that the boys from poor families with less economic resources, the illiterate, are the shortest of those born between 1867 and 1881 (recruits of 1885-1900). The difference in height between the literate and illiterate reached an average of two centimetres among the recruits of Zalamea (1885-89) and somewhat more in Nerva between 1885 and 1899 (Table 6). In some years, the differences reached four centimetres (Figure 6). The two series converged as from the birth cohorts of 1880. In general, the pronounced differences at the beginning of the mining boom suggest an increase in inequality which fell in the following decades and the poorest people began to enjoy higher levels of biological welfare.

Exploring inequality

Dispersion measures can reveal the evolution of inequality when anthropometric data provide very little information about professions of the different groups and social classes. Bearing in mind the limitations of these measures, they constitute an approximate indicator. Recently, some studies in the field of anthropometric history have used coefficients of variation (CV) in order to determine the behaviour of inequality in heights, similar to the Gini co-

FIGURE 7 ▪ *Coefficients of variation. Cohorts of 1832 and 1915 (Third-order moving averages)*



Source: AMZR and AMN, ACDS; own work. Method: Heights shorter than 131 cm have not been taken into account, (considered as cases of "dwarfism") in order to avoid contemplating extreme values considered as abnormal. The CV is derived from the ratio between the standard deviation of the heights and the average of all the heights multiplied by 100. The third order moving averages results are presented.

efficients that measure inequality in income and wealth.[55] In this study we have used CVs to determine whether inequality increased in the golden era, which was characterised by a significant technological change in the mining sector.

Figure 7 shows the evolution of inequality expressed by the CVs — the ratio between the standard deviation of the heights and the average of all the heights multiplied by 100. The results indicate an upward and downward oscillating movement of inequality with a decreasing trend at the end of the long period: in general, it was higher at the beginning in the 1930s, and then fell in the following decade before increasing again among the cohorts of the late 1850s. However, the most solid results are observed in the Nerva series after the cohorts of 1866, when inequality increased. Until 1880, except for the years between 1873 and 1875, higher values were recorded. These decreased in the following years and increased again among those born between 1895 and 1905. In short, the CV increased among those young men whose ad-

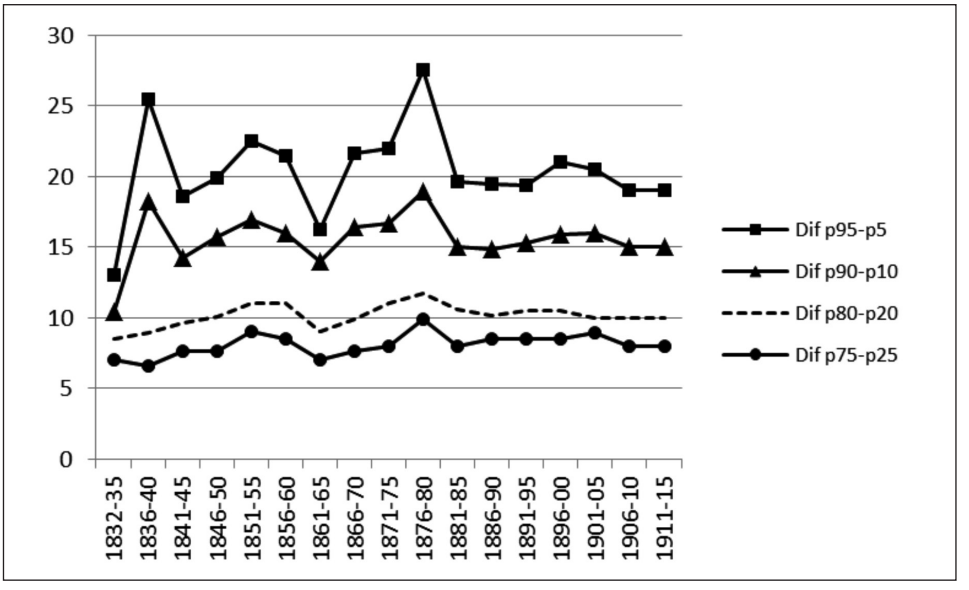
55. Baten (2000); Blum (2013).

olescent growth spurt occurred at the beginning of the mining boom and later, during it. The data suggest that the nutritional poverty of immigrants was the cause of the increase in inequality during the English company's earliest phase, which affected the childhood and adolescence of the cohorts of 1870. The upturn at the beginning of the twentieth century affected the generations that lived through the economic crisis and the Great War and the subsequent years. Specifically, it affected the recruits of 1912 and 1924, who experienced unemployment and poverty, and it explains the increase in labour disputes.[56]

Another distribution or concentration measure are the height percentiles which also provide information about inequality. Using information about the population groups with lower and higher averages on the scale and seeing how they evolve over time can be useful to determine the delayed or slow growth of the most vulnerable sectors. The percentiles provide an insight into the variability of the nutritional status.

We have estimated the evolution of the percentiles and the difference between them to determine the inequality between the tallest and shortest populations (Figure 8). Nutritional health specialists focus on the lowest outliers in order to detect situations of malnutrition and indicate that the third percentile (P_3) is the most sensitive to nutritional deficit. The five-year results reveal

FIGURE 8 ▪ *Differences in cm between the tallest and shortest. Zalamea la Real (cohorts 1832-1885) and Nerva (cohorts 1862-1915)*



Source: AMZR and AMN, ACDS; own work.

56. Ferrero-Blanco (2003).

that among those born in the periods 1836-40 and 1861-65 the outliers tended to come closer together, where the highest values (P_{95}) decreased slightly and the lowest (P_5) increased. The most pronounced differences between the two groups were in 1836-40, reaching more than 25 cm and the difference between the P5 and P_{95} was close to 16 cm. A small group of the population could have suffered from malnutrition as the results reveal that 10% of the young men were shorter than 155 cm between 1836 and 1840, 1851 and 1855 and, most of all, among the cohorts between 1866 and 1880, when they were in their adolescence during the mining boom. Equally interesting are the differences between the tallest 20% and the shortest 20%. In both groups the average height shows a downward trend between 1836 and 1840. While the tallest group recovered between 1861 and 1865 and grew until the period 1896-1900, the shortest 20% continued its downward trend until 1880. The inequality measured by these percentiles increased between the cohorts of 1861-1880, who were the recruits who had their adolescent growth spurt between 1875 and 1905. The results in Figure 8 support those previously found in Figure 7. This finding must be related to immigration and the demographic pressure which affected food supplies at a time of overcrowding and atmospheric pollution. The nutritional poverty measured was higher among immigrants. The case of Nerva anthropometrically confirms the deteriorating nutritional situation and the increase in inequality in such an important sector of the mining population.

Conclusions

This article analyses the evolution of the biological standards of living in Rio Tinto, one of the largest mining basins (copper pyrites) in Spain. The face of this basin was radically changed when the state sold the mines to a large English consortium in 1873. The new owners began a modernisation process and created communication infrastructures which gave rise to a significant increase in production and a high demand for labour. RTCL became the largest mining company in Spain. The need for workers led to a migratory avalanche which, in turn, prompted the constitution of new local councils, which broke away from the initial municipality of Zalamea la Real. The majority of the mining population was concentrated in the town of Nerva (which became independent from Zalamea in 1885). There were different phases in the demographic pace: growth until the 1890s, a slowdown at the end of the century and an upturn at the beginning of the twentieth century. The growth cycle ended with the outbreak of the First World War and the production model and the population of the area fell into crisis.

The main objective of the study was to analyse the evolution of height as an indicator of nutritional status. We used the heights of the young men from

Zalamea la Real as the parent municipality in the mining basin and those of the recruits of Nerva between 1852 and 1935 (cohorts born between 1832 and 1914). In order to resolve the problems caused by the young men being measured at different ages, the heights have been homogenised at a certain age (21).

The results show a slight reduction among the cohorts of the 1860s and 1870s, which was more pronounced in Nerva. This could be related to a series of determining factors, particularly the avalanche of immigrants of people coming from deprived areas (Portugal, Orense, Zamora, Extremadura, and other provinces in Andalusia). The adverse environmental conditions could also have been influential, such as the calcination of minerals (teleras) which were highly pollutant, but this hypothesis requires further research supported by an analysis of morbidity and death. The problem of overcrowding could also have been influential. The settlements of the basin were not prepared for such a high rate of population growth in such a short time and, consequently, hygiene-sanitation levels declined. The intense immigration affected the average height, given that the young men who arrived had suffered a more pronounced deterioration in their nutrition than the natives. Over time, the initial differences became diluted, not only between the natives and migrants but also depending on their access to education.

We have explored the inequality in depth by analysing the dispersion measurements (coefficients of variation) and the height percentiles. The results of the CVs show an oscillating movement of the inequality with a downward trend at the end of the period. The nutritional poverty of the first immigrants may have increased inequality among the young men who were adolescents during the mining boom. The recovery at the beginning of the twentieth century coincided with a higher incidence of labour disputes. At the end of the period we can observe a slight increase related to the economic crisis during the First World War and the problems of the subsequent decades. The model of the large-scale mining industry with a well-organised, modern company, different from those operating in the rest of the peninsula, did not bring about significant advancements with respect to the biological well-being of the populations. The heights of the miners at the end of the period studied, in the lead-up to the First World War, were no different to those recorded for the rural population of Zalamea la Real in the mid-nineteenth century.

REFERENCES

Aldana, Lucas de (1875), *Las minas de Rio-Tinto en el trascurso de siglo y medio, desde su restauracion por Wolters en 1725 hasta su venta por el estado en 1783: con un apéndice en el cual se reproducen el manifesto de Wolters y los cinco folletos á cuya publicacion dió motivo.* Madrid: P. Nuñez.

Arbaiza-Vilallonga, Mercedes (1997), "Causas sociales de la mortalidad durante la industrialización vizcaína (1877-1930)", *Asclepio*, 49, 1, pp. 245-283.

Arenas-Posadas, Carlos (1999), *Empresa, mercados, mina y mineros. Río Tinto (1873-1936)*. Huelva: Universidad de Hueva & Fundación Río Tinto.

Arenas-Posadas, Carlos (2011), "Padres y patrones. Poder y mercado en la cuenca minera de Riotinto. 1873-1936", in Pérez Macías *et al* (eds.), *Río Tinto. Historia, patrimonio minero y turismo cultural*. Huelva: Servicio de Publicaciones de la Universidad de Huelva & Fundación Rio Tinto, pp. 231-242

Avery, David (1974), *Not on Queen Victoria's birthday. Story of the Río Tinto Mines*. London: Collins.

Avilés-Palacios, C. (2008), "Innovaciones y mejoras tecnológicas en la explotación de las minas de Río Tinto (1873-1897)", *Boletín Geológico y Minero*, 119 (3), pp. 331-342.

Baten, J. (2000), "Economic development and the distribution of nutritional resources in Bavaria, 1797-1839", *Journal of Income Distribution*, 9, pp. 89-106.

Blum, M. (2013), "The influence of inequality on the standard of living: Worldwide anthropometric evidence from the 19th and 20th centuries", *Economics and Human Biology*, http://dx.doi.org/10.1016/j.ehb.2012.12.002.

Borrero, Pedro (1887), *Las calcinaciones al aire libre en la provincia de Huelva*. Madrid.

Botella y de Hornos, F. de (1868), *Descripción geológica-minera de las provincias de Murcia y Albacete*. Madrid: Colegio Nacional de Sordo-Mudos.

Broder, Albert; Pérez de Perceval, Miguel Á.; Sánchez-Rodríguez, Alejandro, and Marchán Sanz, Carmen (eds.) (2014), *La inversión extranjera en la minería española*. Madrid: IGME.

Cámara-Hueso, A. D. (2006), "Fuentes documentales antropométricas en España: problemas metodológicos para los siglos xviii y xix", *Historia Agraria*, 38, pp. 575-582.

Cámara-Hueso, A. D. (2009), "Long Term Trends in Height in Rural Eastern Andalusia (1750-1950)", *Historia Agraria,* 47, pp. 47-63.

Cámara-Hueso, A. D. and García-Román, J. (2010), "Ciclos largos de nivel de vida biológico en España (1750-1950): propuesta metodológica y evidencias locales", *Investigaciones de Historia Económica,* 17, pp. 95-118.

Cortázar, Daniel de (1888), *La mina de Río Tinto y sus calcinaciones. Discurso pronunciado, en la conferencia del 26 de enero de 1888 celebrada en el Ateneo de Madrid.* Madrid: Manuel G. Hernández, Impresor de la Real Casa.

Cohen-Amselem, Arón (1987), *El Marquesado del Zenete, tierra de minas. Transición al capitalismo y dinámica demográfica (1870-1925).* Granada: Universidad de Granada.

Chastagnaret, G. (2000), *L´Espagne, puissance minière dans l´Europe du xxe siècle*. Madrid: Casa de Velázquez.

Delgado, Aquilino; Regalado, María de la Cinta, and Moreno, Alfredo (2010), "Poblados mineros desaparecidos. Cuenca Minera de Riotinto (Huelva)", *De Re Metallica*, 14, pp. 1-11.

Domenech, J. (2008), "Mineral resource abundance and regional growth in Spain, 1860-2000", *Journal of International Development*, 20, pp. 1122-1135.

Escudero, A. and Perez-Castroviejo, P. M. (2010), "The living standard of miners in Biscay (1876-1936), wages, the human development index and height", *Revista de Historia Económica Journal of Iberian and Latin American Economic History*, vol. 28, 3, pp. 503-534.

Escudero, Antonio and Barciela, Carlos (2012), "Niveles de vida en la minería española (1870-1913). Historiografía y nuevos enfoques e hipótesis", in De Lemps, Xavier Huetz and Luis, Jean-Philippe (coords.), *Sortir du Labyrinthe. Études d'Histoire Contemporaine de l'Espagne. Hommage à Gérard Chastagnaret.* Madrid: Casa de Velázquez, pp. 89-126.

Ferrero-Blanco, María Dolores (1994), *Capitalismo minero y resistencia rural en el suroeste andaluz: Riotinto, 1873-1900.* Huelva: Diputación Provincial de Huelva.

Ferrero-Blanco, María Dolores (1998), "Los sucesos de Riotinto de 1888 según 1os directores de la Rio Tinto Company Limited", *Revista de Historia industrial*, 14, pp. 43-81.

Ferrero-Blanco, María Dolores (2001), "Los humos de Huelva: rentabilidad minera frente a salubridad", in Pérez-Cebada, Juan Diego (ed.), *Minería y medio ambiente en perspectiva histórica*. Huelva: Universidad de Huelva, pp. 145-182.

Ferrero-Blanco, María Dolores (2003), "La huelga minera de Río Tinto de 1920. El diagnóstico de sir Rhys Williams, enviado de los Rostschild", *Revista de Estudios Regionales*, 67, pp. 249-303.

Flores-Caballero, Manuel (1981), *La venta de las minas de Riotinto*. Huelva: Diputación Provincial de Huelva.

Flores-Caballero, Manuel (1983), *Riotinto: la fiebre minera del xix*. Huelva: Diputación Provincial de Huelva, 1983.

Floud, R.; Fogel, R.; Harris, B., and Hong, S. C. (2011), *The Changing Body: Health, Nutrition, and Human Development in the Western World since 1700*. Cambridge: Cambridge University Press.

Floud, R.; Fogel, R.; Harris, B., and Hong, S. C. (eds.) (2014), Health, mortality and the standard of living in Europe and North America since 1700. Cheltenham: Edward Elgar Publishing, 2 vols.

Galán, Agustín (1997), "Familia y trabajo en la comarca de Río Tinto, 1873-1936", *Huelva en su Historia,* 6, pp. 125-136.

Galán, Agustín (ed.) (2013), *La presencia "'inglesa" en Huelva: entre la seducción y el abandono*. Sevilla: Universidad Internacional de Andalucía.

García, Cristóbal (2011), "Cuenca minera de Riotinto, 1931-1936: crisis económica e inestabilidad municipal", in Pérez Macías *et al*. (eds.), *Río Tinto. Historia, patrimo-*

nio minero y turismo cultural. Huelva: Servicio de Publicaciones de la Universidad de Huelva & Fundación Rio Tinto, pp. 213-229.

Gil-Varón, Luis (1984), *Minería y migraciones. Río Tinto 1873-1973.* Córdoba: Sociedad Cooperativa Industrial Tipografía Católica.

González-Ugarte, María Eugenia (1994), "Mortalidad e industrialización en el País Vasco. Vizcaya, 1860-1936", *Boletín de la Asociación de Demografía Histórica*, 12, pp. 35-53.

González-Vílchez, M. (1981), *Historia de la arquitectura inglesa en Huelva.* Sevilla: Universidad de Sevilla & Diputación Provincial de Huelva.

Harvey, C.E. (1981), *The Rio Tinto Company: an economic history of a leading international mining concern, 1873-1954*. London / Cornwall: Alison Hodge.

Komlos, John (1994), *Stature, Living Standard and Economic Development: Essays in Anthropometric History.* Chicago: University of Chicago Press.

López-Martínez, Antonio (1999), "Trabajadores Portugueses en las Minas de Río Tinto", in Parejo, A. and Sánchez Picón, A., *Economía Andaluza e Historia Industrial. Estudios en Homenaje a Jordi Nadal*. Motril: Asukaría Mediterránea, pp. 231-244.

López-Morell, Miguel Ángel (2013), *The House of Rothschild in Spain, 1812-1941*. Studies in Banking and Financial History. Ashgate.

Martínez-Carrión, José Miguel (2004), "Salud, ambiente y bienestar biológico: la estatura en el municipio de Cartagena (siglo xix)", *Áreas. Revista Internacional de Ciencias Sociales*, 24, pp. 157-189.

Martínez-Carrión, José Miguel (2005), "Estatura, salud y nivel de vida en la minería del sudeste español, 1830-1936", *Revista de Demografía Histórica*, 23(1), pp. 177-210.

Martínez-Carrión, José Miguel (2006), "Los niveles de vida en la minería española, 1840-1936", in Pérez De Perceval, M. A.; López-Morell, M. A., and Sánchez Rodríguez, A. (eds.), *Minería y desarrollo económico en España.* Madrid: Síntesis, pp. 237-255.

Martínez-Carrión, José Miguel (2012), "La talla de los europeos, 1700-2000. Ciclos, crecimiento y desigualdad", *Investigaciones de Historia Económica*, 8(3), pp. 176-187.

Martínez-Carrión, José Miguel and Cámara-Hueso, Antonio David (2015), "El nivel de vida biológico durante el declive de la industrialización andaluza: el caso de Antequera", *Revista de Historia Industrial*, 58, pp. 129-159.

Martínez-Carrión, José Miguel and Moreno-Lázaro, Javier (2007), "Was there an urban height penalty in Spain, 1840-1913?", *Economics and Human Biology*, 5(1), pp. 144-164.

Martínez-Carrión, José M.; Pérez De Perceval, Miguel A., and Martínez-Soto, Ángel P. (2014), "Desigualdad y bienestar biológico durante el boom minero: Rio Tinto, 1836-1935". DT-AEHE No. 1401 (http://www.aehe.net/2014/01/dt-aehe-1401.pdf).

Martínez-Carrión, José Miguel and Puche-Gil, Javier (2009), "Alfabetización, bienestar biológico y desigualdad: la Comunidad Valenciana, 1850-1970", *Historia Agraria*, 47, pp. 167-186.

Martínez-Carrión, José Miguel; Puche-Gil, Javier, and Cañabate Cabezuelos, José (2013), "El trabajo infantil y la estatura durante la primera industrialización española, 1840-1930", in Borrás Llop, J. M. (ed.), *El trabajo infantil en España (1700-1950)*. Barcelona: Icaria & Publicacions i Edicions de la Universitat de Barcelona, pp. 235-272.

Martínez-Soto, Ángel Pascual and Pérez De Perceval, Miguel Á. (2010), "Asistencia sanitaria en la minería de la Sierra de Cartagena-La Unión (1850-1914)", *Revista de la Historia de la Economía y de la Empresa*, 4, pp. 93-124.

Martínez-Soto, Ángel Pascual; Pérez De Perceval, Miguel Á., and Sánchez Picón, Andrés (2012), "Entre miseria y dolor. Trabajo y salud en la minería del sureste (segunda mitad del siglo xix-primer tercio del xx)", in Cohen, A. (ed.), *El trabajo y sus riesgos en la época contemporánea. Conocimiento, codificación, intervención y gestión*. Barcelona: Icaria & Universitat de Barcelona, pp. 211-251.

Martínez-Soto, Ángel Pascual; Pérez de Perceval, Miguel Ángel, and Sánchez-Picón, Andrés (2008), "Itinerarios migratorios y mercados de trabajo en la minería meridional del XIX". *Boletín Geológico y Minero*, 119, 3, pp. 399-418.

Menéndez-Navarro, Alfredo (1996), *Un mundo sin sol. La salud de los trabajadores de las minas de Almadén (1750-1900)*. Granada: Universidad de Granada.

Metallgesellschaft (1904), *Recueils Statistiques sur les métaux suivants : Plomb, Cuivre, Zinc, Étain, Argent, Nickel, Aluminium et Mercure.* Frankfurt: C. Adelmann.

Nadal, J. (1981), "Andalucía, paraíso de los metales no ferrosos", in Bernal, A. M. (dir.), *Historia de Andalucía. VII. La Andalucía liberal (1778-1868)*. Barcelona: Cupsa & Planeta, pp. 399-460.

Navarro, Domingo; Martínez-Soto, Ángel Pascual, and Pérez de Perceval, Miguel Ángel (2004), *La vida en la sierra minera de Cartagena. Evolución demográfica de la diputación de El Beal (1880-1970)*. Murcia: Laborum.

Pérez-Castroviejo, Pedro M. (1992), *Clase obrera y niveles de vida en las primeras fases de la industrialización vizcaína.* Madrid: Ministerio de Trabajo y Seguridad Social, 1992.

Pérez-Castroviejo, Pedro M. (2005), "Niveles de bienestar de la población minera vizcaína. Factores que contribuyeron al descenso de la mortalidad, 1876-1936", *Revista de Demografía Histórica,* 23(1), pp. 71-105.

Pérez-Castroviejo, Pedro M. (2006), "Poder adquisitivo y calidad de vida de los trabajadores vizcaínos, 1876-1936", *Revista de Historia Industrial*, 30(1), pp. 103-143.

Pérez-Cebada, Juan Diego (1999), "Minería del cobre y contaminación atmosférica: estrategias empresariales en las cuencas de Swansea, Huelva y Montana", *Revista de Historia Industrial*, 16, pp. 45-67.

Pérez-Cebada, Juan Diego (2001), "Deforestación y lluvia ácida en la mina: el primer expediente de compensación por daños provocados por efecto de la contaminación atmosférica (1847)", in Martínez-Alier, J. and González De Molina, M. (ed.), *Naturaleza transformada. Estudios de historia ambiental.* Barcelona: Icaria, pp. 239-262.

Pérez-Cebada, Juan Diego (2006), "Relaciones laborales y contaminación en la minería del cobre", in Pérez De Perceval, Miguel Á.; López-Morell, Miguel Á., and

Sánchez-Rodríguez, Alejandro (eds.), *Minería y desarrollo económico en España.* Madrid: Síntesis & IGME, pp. 271-286.

Pérez-Cebada, Juan Diego (2014), *Tierra devastada. Historia de la contaminación minera (en las grandes cuencas de minerales no ferrosos hasta 1945*). Madrid: Síntesis.

Pérez-Fuentes, Pilar (1993), *Vivir y morir en las minas. Estrategias familiares y relaciones de género en la primera industrialización vizcaína.* Bilbao: Universidad del País Vasco.

Pérez-López, Juan Manuel (1994), *Las calcinaciones al aire libre "Las Teleras": los conflictos sociales de 1.888: causas y consecuencias*. Riotinto: Fundación Rio Tinto.

Pérez De Perceval, Miguel Ángel; Martínez-Soto, Ángel Pascual, and Sánchez-Picón, Andrés (2013a), "El trabajo de menores en la minería española: 1860-1940", in Borrás Llop, J. M. (ed.), *El trabajo infantil en España, (1700-1950).* Barcelona: Icaria & Universitat de Barcelona, pp. 153-191.

Pérez De Perceval, Miguel Ángel and Sánchez-Picón, Andrés (2005), "El trabajo infantil en la minería española, 1850-1940", in *VIII Congreso de la Asociación Española de Historia Económica*, [Internet: http://www.um.es/hisminas/wp-content/uploads/2012/06/a1_perez_perceval_sanchez_picon.pdf].

Pinedo-Vara, I. (1963), *Piritas de Huelva: su historia, minería y aprovechamiento*. Madrid: Summa.

Quiroga, Gloria (2003), "Literacy, Education and Welfare in Spain", *Peadagogica Historica*, 39, 5, pp. 599-619.

Quirós, Francisco and Iglesias, Arcadio (1989), "La lluvia ácida de Riotinto en el centenario de un conflicto medioambiental", *Ería: Revista cuatrimestral de geografía,* 17, pp. 285-292.

Rodríguez-Burguillos, Andrés (2011), "La enseñanza como mecanismo de control social de las empresas mineras en la comarca de Riotinto", in Pérez Macías et al. *Río Tinto. Historia, patrimonio minero y turismo cultural*. Huelva: Servicio de Publicaciones de la Universidad de Huelva & Fundación Rio Tinto, pp. 709-717.

Ramon-Muñoz, Josep Maria (2009), "Bienestar biológico y crecimiento agrario en la Cataluña rural, 1840-1936", *Historia Agraria*, 47, pp. 119-142.

Ramon-Muñoz, Josep Maria (2011), "Industrialización, urbanización y bienestar biológico en Cataluña, 1840-1935: una aproximación antropométrica", *Revista de Historia Industrial*, xx, 2, pp. 41-71.

Rúa-Figueroa, R. (1859), *Ensayo sobre la Historia de Minas de Riotinto.* Madrid: Viuda de D. Antonio Yenes.

Sánchez-Picón, Andrés and Pérez De Perceval, Miguel Ángel (1999), "La mano de obra de la minería española (1868-1900). Una aproximación regional y sectorial", in Carreras, A. *et al*. (eds.), *Doctor Jordi Nadal. La industrialización y el desarrollo económico de España*, Vol. II. Barcelona: Universitat de Barcelona, pp. 856-873.

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Biological Welfare and Inequality During the Mining Boom: Rio Tinto, 1832-1935

Abstract

This study explores the impact of the mining boom on the biological standards of living and inequality in Rio Tinto, the main copper basin in Spain. It uses the heights of military recruits in the towns of Zalamea la Real and Nerva between 1852 and 1935 (birth cohorts of 1832-1914). The majority of the mining population of Nerva, which had become independent from Zalamea la Real in 1885, was concentrated close to Minas de Riotinto, following the extraordinary influx of immigrants, mostly attracted by the British company RTCL after establishing its operations there in 1873. The anthropometric results reveal that: 1) the height of males decreased slightly among the cohorts of the decades 1850-1870, whose childhood and adolescence coincided with the beginning of the mining boom; 2) the inequality (measured by CVs, percentiles and ratios of short-stature subjects) increased among the cohorts of the 1870s, made up of immigrants, principally in Nerva. During this period, the gap between the height of the native population and the immigrants also increased, as did the gap between the literate and illiterate populations. Finally, 3) the improvement in the biological welfare of the cohorts corresponding to 1880-1890 was undermined in the subsequent decades due to the impact of the mining crisis. In the lead-up to the Great War, the height of the miners in Nerva was no different to that of the rural population of Zalamea in the mid-nineteenth century.

Keywords: biological welfare, mining, standard of living, Rio Tinto Company, height

JEL Codes: I12, J24, N13, D63

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Bienestar biológico y desigualdad durante el «boom» minero: Río Tinto, 1832-1935

Resumen

Este trabajo explora el impacto del *boom* minero en los niveles de vida biológicos y la desigualdad en Río Tinto, la principal cuenca cuprífera de España. Emplea las tallas de los reemplazos de Zalamea la Real y Nerva desde 1852 a 1935 (cohortes de 1832-1914). El segundo municipio, desagregado del primero en 1885, concentró la mayor parte de la población minera junto al de Minas de Riotinto, después del impresionante aluvión inmigratorio alentado por la firma inglesa RTCL tras su instalación en 1873. Los resultados antropométricos muestran que 1) la talla masculina se deterioró levemente en las cohortes entre las décadas de 1850 y 1970, cuya infancia y adolescencia coincidió con el comienzo del *boom* minero; 2) la desigualdad (medida por CV, percentiles y ratios de cortos de talla) aumentó en las cohortes de la década de 1870, compuestas por inmigrantes, principalmente en Nerva. En esos años aumentó también la brecha entre la talla de los nativos y de los inmigrantes y entre la de los alfabetizados y analfabetos; 3) los avances del bienestar biológico en las cohortes de 1880 a 1900 se malogran en las siguientes por el impacto de la crisis minera. A las puertas de la Gran Guerra europea, las tallas de los mineros en Nerva no diferían de las del mundo rural de Zalamea a mediados del siglo XIX.

Palabras clave: bienestar biológico, minería, nivel de vida, Rio Tinto Company, estatura

Códigos JEL: I12, J24, N13, D63