BIOLOGICAL WELFARE AND NUTRITIONAL INEQUALITY IN RURAL MEDITERRANEAN SPAIN: THE IRRIGATED AREA OF VALENCIA, 1859-1939*

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ABSTRACT

This article analyses the biological welfare and inequality of the male population of the irrigated area of Valencia between 1859 and 1939. It studies the effects that the agrarian development process had on physical welfare and the relationship between height and access to land ownership. Height data for conscripts in five municipalities constitute the source for the study. The results reveal that there was a growing trend in the evolution of heights in the irrigated area of Valencia at the beginning of agrarian capitalism. Nutritional inequalities can be observed between farmers and farm workers: land owners were taller than landless labourers. However, this biological inequality diminished over the period under study.

Keywords: biological welfare, nutritional inequality, the irrigated area of Valencia, 1859-1939
JEL Classification: I10, I14, I15, N33

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1. INTRODUCTION

Over the last four decades, anthropometric history has studied the changes in human welfare based on height and the construction of health indices, analysing the complex relationships between economic growth and the biological welfare of communities in the last three centuries (Komlos, 2009; Steckel, 2009; Fogel et al., 2011). Spanish historiography has made significant progress in recent years (Martínez-Carrión, 2002a, 2014; Martínez-Carrión and Moreno-Lázaro, 2007; María-Dolores and Martínez-Carrión, 2011; Spijker et al., 2012; Ayuda and Puche, 2014; Martínez-Carrión, 2016; Puche and Cañabate-Cabezuelos, 2016; Pérez-Castroviejo, 2016). Although significant achievements have been made, a more in-depth statistical study of welfare is required, particularly with respect to biological inequality in the Spanish rural community (in 1900 the Spanish agrigultural sector still employed 60.7% of the active population).

The pioneer study in this field referred to the region of Murcia (Martínez-Carrión, 1986), and was followed by others focused on other geographical regions of Spain, such as rural Catalonia, eastern Andalusia, Castile-Leon and Madrid (Ramon Muñoz, 2009; Cámara, 2009; Hernández and Moreno-Lázaro, 2009; Moreno-Lázaro and Martínez-Carrión, 2009; Garcia-Montero, 2009) and on Spain as a whole (Beltrán, 2015). All of them reveal that the liberal reforms and the beginnings of agricultural capitalism in the mid-nineteenth century did not lead to the improvement of the biological living conditions of the Spanish rural population. The privatisation of communal lands in some regions (for example in rural eastern Andalusia) did not have positive effects, increasing inequality within rural communities.

The diversity characterising the Spanish agricultural sector at the end of the nineteenth century, due to the land tenure system, the crop and livestock farming systems, the techniques used, the levels of capitalisation, the unequal presence of irrigation, the yields obtained and the type of land or the climatic conditions, indicate that a more in-depth study of the relationships between biological welfare and agricultural growth in rural Spain is required. This article, which analyses the height of males in irrigation areas in rural Valencia between the mid-nineteenth century and the mid-twentieth century, represents a contribution in this direction.

In this context, this study has a double objective: first it evaluates the impact of agricultural growth on the biological standard of living experienced in the irrigated

areas of Valencia between the mid-nineteenth century and the mid-twentieth century; and second, it calculates how this process affected the inequality in the biological welfare of the population engaged in agriculture, distinguishing between farmers and farm workers.

The new institutional framework that emerged from liberalism and the boost of the international markets gave rise to the growth of intensive crop farming in the irrigated areas of Spain. Therefore, it is necessary to analyse the impact of this growth model based on intensive agriculture and exports on biological welfare and health, and the extent of the socio-nutritional inequalities within the rural communities. Until well into the twentieth century, land ownership was generally considered as the principle expression of social inequality within rural communities (Garrabou et al., 2014), and in the Valencian agricultural sector small and medium-sized farms predominated over large properties[1]. In this study we analyse the average height of the rural conscripts in accordance with their access to land ownership. We have divided the individuals of the sample into two social classes in accordance with the social classification of the primary sector in HISCLASS[2]; farmers and farm workers. Although the HICLASS classification divides primary sector workers into three groups (farmers, lower-skilled farm workers and unskilled farm workers), we have joined the latter two into one group which we have called farm workers, as our sources do not enable us to make this distinction.

The principal sources of data for this study are the height data corresponding to 14,199 conscripts engaged in agricultural activities (of which 10,493 were farmers, and 3,706 were farm workers), who were measured in five municipalities of the eastern part of Valencia where irrigated farming was developed, at least after the mid-nineteenth century. This rural sample has been obtained from the 48,841 conscripts of these municipalities during the period of study. A weakness of this rural sample is the limited number of observations for the 1860s and 1870s as there was less information available

[1]The proportions given by the engineer Pascual Carrión who wrote the first Agricultural Reform Project during the Second Republic, are: small owners 57%, medium owners 27% and large owners 16%, Carrión (1973, p. 107).The data drawn from another recent study confirm the predominance of landowners and tenants in the eastern coastal region of Spain: 55.3% in 1890; 61.9% in 1910; and 73.8% in 1930 (Carmona, Rosés and Simpson, 2015).

[2]HISCLASS is based on HISCO, a historicised version of the International Labour Organization's 1968 International Standard Classification of Occupations (ISCO). HISCO and HISCLASS were created by researchers associated with the International Social History Institute in Amsterdam. HISCO is an occupational classification system providing a list of 1,600 occupations. HISCLASS transforms these occupations into a convenient number of socio-occupational categories by means of a set of theoretical and fixed criteria. The main dimensions of the HISCLASS socio-occupational categories are the manual/non-manual division, the skill level, and the economic sector, Silvestre et al (2015) and Leeuwen and Maas (2011).

regarding the profession of the conscripts compared with the subsequent decades. Therefore, in this article we have used the overall sample of 48,841 conscripts (total population of young men) to analyse the evolution of the average height in the irrigated area of Valencia and the sample of farmers and farm workers to analyse the biological inequality in accordance with their access to land ownership. The results reveal that there was a growing trend in evolution of height in these rural areas over the long term. In contrast to the observations of other rural areas of the Spanish Mediterranean (Martínez-Carrión and Pérez Castejón, 2002; Ramón-Muñoz, 2009), our results suggest that in the irrigated area of Valencia the beginning of the agricultural changes and the intensification of production in the mid-nineteenth century did lead to an improvement in the biological welfare of the populations. Our results also reveal nutritional inequalities between the rural groups; the landowners always had higher levels than landless farm workers. It can be deduced that access to landownership became a determining factor of the socioeconomic and biological differences in the traditional agricultural societies. These biological differences have also been documented in other Spanish rural areas, such as south-east Spain (Martínez-Carrión and Pérez-Castejón, 2002).

Throughout the second half of the nineteenth century and the first third of the twentieth century, as in other rural Mediterranean parts of Spain, the production systems in Valencia's agricultural sector underwent a remarkable modernisation and intensification process. This occurred in parallel with the progressive integration of the region's agricultural sector into the international economy within the context of the first globalisation process, due particularly to the growing export orientation of the economy. The region of Valencia, like other eastern and southern regions of Spain, gained comparative advantages by specialising in certain crops, such as citric fruits, rice, vegetables, olives and grapes. This enabled it to extend its exporting capacity and food supply to the national and international markets. This agro-export model was based, in turn, on: the widespread use of irrigation, the early incorporation of inorganic fertilisers, the adoption of crops that generated high physical and monetary yields[3] and the predominance of skilled manual labour in agricultural tasks that were difficult to mechanise. Furthermore, the agri-food sector experienced a significant diversification

[3] In the Spanish context, the agricultural product of the region of Valencia was superior to the Spanish average: in particular, the province of Valencia had the highest land productivity indices of the country in 1931 and was ranked second in terms of agricultural labour productivity (Simpson, 1994).

and modernisation process and a considerable increase in its production capacity (Garrabou, 1985; Piqueras, 1985; Mateu and Calatayud, 1996; Calatayud, 2001; Calatayud and Millán, 2010).

The study is structured into five parts. After this introduction, the second section describes the principle changes in production experienced by the irrigated area of Valencia between 1850 and 1930, whereby the region's agricultural sector became integrated into the international markets and the irrigated area oriented a good part of its production towards the market. The third part describes the sources and the sample used in the study together with the methodology applied. In the fourth section, the results are presented. Furthermore, the impact that the process of agricultural growth had on the biological welfare of population in the irrigated area of Valencia is analysed. In addition, biological inequality in accordance with access to land ownership is also addressed. Several models have been estimated for both of these aspects. The final conclusions are drawn in the fifth and closing part of the study.

2. THE IRRIGATED AREA OF VALENCIA, 1850-1930

Throughout the nineteenth century, Spanish agriculture underwent a growth process that was driven both by higher demand due to an expanding domestic market in which some products (such as wheat) received considerable protection, and booming external demand for products such as wine, oil and vegetables from countries in western Europe (Garrabou and Sanz, 1985; Gallego and Pinilla, 1996, Pinilla, 1995). This expansion, however, did not give rise to any significant technological changes because the aridity of most of the Peninsula restricted the adoption of the innovations arising from the Atlantic agricultural revolution.

The agricultural crisis at the end of the century and a new technological supply from the United States gave rise to greater changes in the first third of the twentieth century, with a significant increase in labour productivity (Gallego, 2001; Bringas, 2000). However, despite this undeniable improvement, in 1935, it was still lower than that of the majority of western European countries (O'Brien and Prados, 1992, pp. 530-531). Spanish agriculture required a large workforce, not because of the farmers' resistance to change but due to the low level of development of industrial activities which gave the sector significant weight in the economy (Silvestre, 2005). The agricultural sector was characterised by the high price of capital and the low price of labour, which hindered a more profound technological change (Clar and Pinilla, 2009).

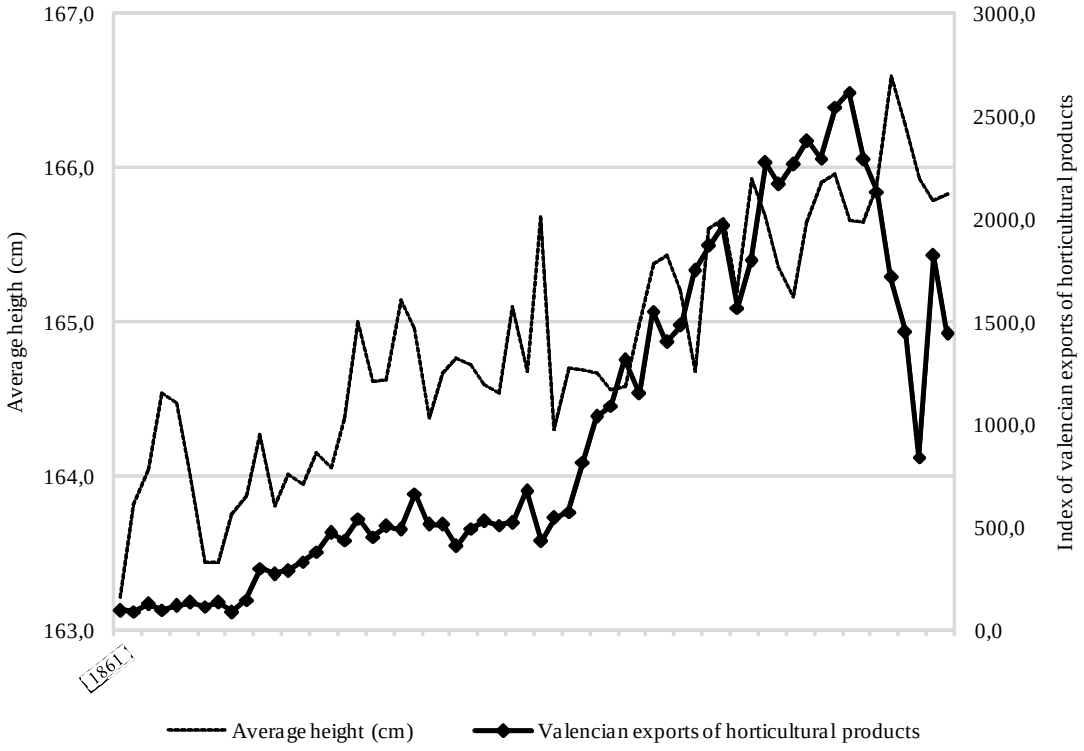
Within this context, the agricultural sector of the Mediterranean coastal area, particularly in the province of Valencia, had specialised in vegetables which incurred relatively low comparative costs. The specialised agriculture of the Spanish Mediterranean area became integrated into international markets and experienced significant development (Garrabou, 1985, Pujol et al., 2001; Pinilla and Ayuda, 2009, 2010; Ramon-Muñoz, 2013). The irrigated area of Valencia developed considerably at the end of the nineteenth century and during the first third of the twentieth century and Spain gained significant weight in international markets in terms of these products (Garrabou, 1985; Piqueras, 1985, 1999; Garrabou and Pujol, 1988; Calatayud, 2001; Calatayud and Millán, 2010; Pinilla and Ayuda, 2009).

From the 1850s and after the culmination of the crisis of trade specialisations which began in the eighteenth century (barrilla plant, silk and later, hemp), the Valencian agricultural sector began to cultivate a new wave of crops for domestic and international markets. Although the expansion of vine-growing activities was mainly concentrated in rainfed areas, in the long term, agricultural growth in the region of Valencia was based on irrigated farming. In 1922, this intensive farming represented a quarter of the cultivated area, but if we examine the value of production, in 1931, fruit and vegetables represented 67% (Calatayud, 2001, p. 166; Calatayud and Millán, 2010, p. 213). The irrigated area of Valencia was very diverse which gave it numerous production options. This means that we must consider the different specialisations, each with their own specific characteristics, as the studies carried out indicate that from the end of the nineteenth century, there was a trend that ran in parallel with the concentration of ownership and the consolidation of family ownership. The significant development of the irrigated area of Valencia was not only based on the new agricultural bourgeois class (Calatayud et al., 1992), but also on small landowners and tenants. The small farms were as profitable or even more so than the medium-sized and large farms (Calatayud 1989a). Far from a cereal monoculture, rice, oranges and a variety of vegetables with a more dynamic demand contributed to the strong boom experienced in the irrigated areas in the second half of the nineteenth century and the first third of the twentieth century (Pinilla and Ayuda, 2008; Garrabou, 1985; Piqueras, 1985, 1999; Calatayud, 1989b, 2001; Garrido, 1999, 2004; Palafox, 2001; Calatayud and Millán, 2010). Consequently, the region of Valencia increased its exports of horticultural products. Graph 1 shows that this growth was spectacular, multiplying by approximately sixteen between 1861 and 1913. During the First World War, however,

exports experienced a significant decline, but recovered again in the 1920s (Piqueras, 1985, 1999).

GRAPH 1

AVERAGE HEIGHT IN THE IRRIGATED AREA OF VALENCIA AND VOLUME INDEX OF VALENCIAN EXPORTS OF HORTICULTURAL PRODUCTS (ORANGES, ONIONS AND RAISINS) AT 1910 PRICES (1861=100), BIRTH COHORTS OF 1861-1920



Source: Conscription and call-up records; historical municipal archives from Valencian municipalities composing the anthropometric sample. The amounts exported have been drawn from Piqueras (1985, pp. 229-230) and the prices of the different products from Gallego and Pinilla (1996).
Note: 48,841 conscripts.

As a result of this commercial dynamism, Valencian exports represented a significant precentage of Spain's total exports of Mediterranean horticultural products. The case of oranges, a crop almost exclusively grown in Valencia's coastal areas, was spectacular, but this was not an isolated case (Calatayud, 1989a, 1989b; Garrido, 1999). In addition to oranges, rice and horticultural products were also significant. The latter, although covering only 10% of the cultivated land, had an important qualitative weight. In around 1930, vegetable crops formed a highly significant part of Valencia's agricultural sector and in many aspects were relevant for the economy: the income generated (including currency for exports), the labour employed and the ties with other

associated activities. In addition, the production of vegetables consolidated one of the most characteristic areas of rural Valencia, *la huerta* (orchard)[4] (Calatayud, 2001; Calatayud and Millán, 2010).

3. DATA AND METHODOLOGY

In order to address the objectives described, this study analyses the height data of 14,199 conscripts engaged in agriculultural activities, corresponding to the cohorts born between 1859 and 1939. These were the generations which carried out their military service between 1879 and 1960. The height data and other variables of interest (level of education, place of birth, appeals in order to be declared exempt from military service, and, most of all, access to land ownership) are drawn from the local military recruitment series of five municipalities in Valencia which, at least from the mid-nineteenth century, were engaged in the intensive crop cultivation characteristic of irrigated farming (Map 1). Several criteria have been considered in the selection of the municipalities: the characterisation of the agricultural growth model based on its product specialisation; the geographical location and restricting environmental conditions and the availability of long-term local military recruitment series. Based on these criteria, the five towns selected were: Villarreal (province of Castellón), Alzira, Sueca, Gandía (province of Valencia) and Pego (province of Alicante).

Villarreal is located in the region of La Plana Baja. It developed a specialisation in oranges cultivated for export very early on (from the 1820s). The main players in the expansion of citric fruit cultivation, which intensified from the 1870s, were the small landowners who planted orange trees in their groves[5] (Garrido, 1999, 2004). In Alzira (Ribera Alta), however, the growth of orange cultivation was due to the landlords, who, in the mid-nineteenth century, focused on marginal carob and olive grove areas, while the orchards were used for crops for self-consumption and to be sold on the market (vegetables, tubers and bulbs). The new crop incorporated into the intensive agriculture of the groves in Júcar stimulated a high demand for paid labour which was covered partly by families who had small plots of land (Garrido, 1999; Calatayud, 1989b; Calatayud and Millán, 2010). The expansion of orange crops across non-irrigated areas which were watered with groundwaters, extended to other municipalities of Valencia,

[4] Irrigated land used for growing legumes, vegetables and fruit trees.
[5] In 1882, the percentage of the irrigated area of Villareal covered with orange groves was 64% and in 1907 it had risen to 89% (Garrido, 1999, p. 206).

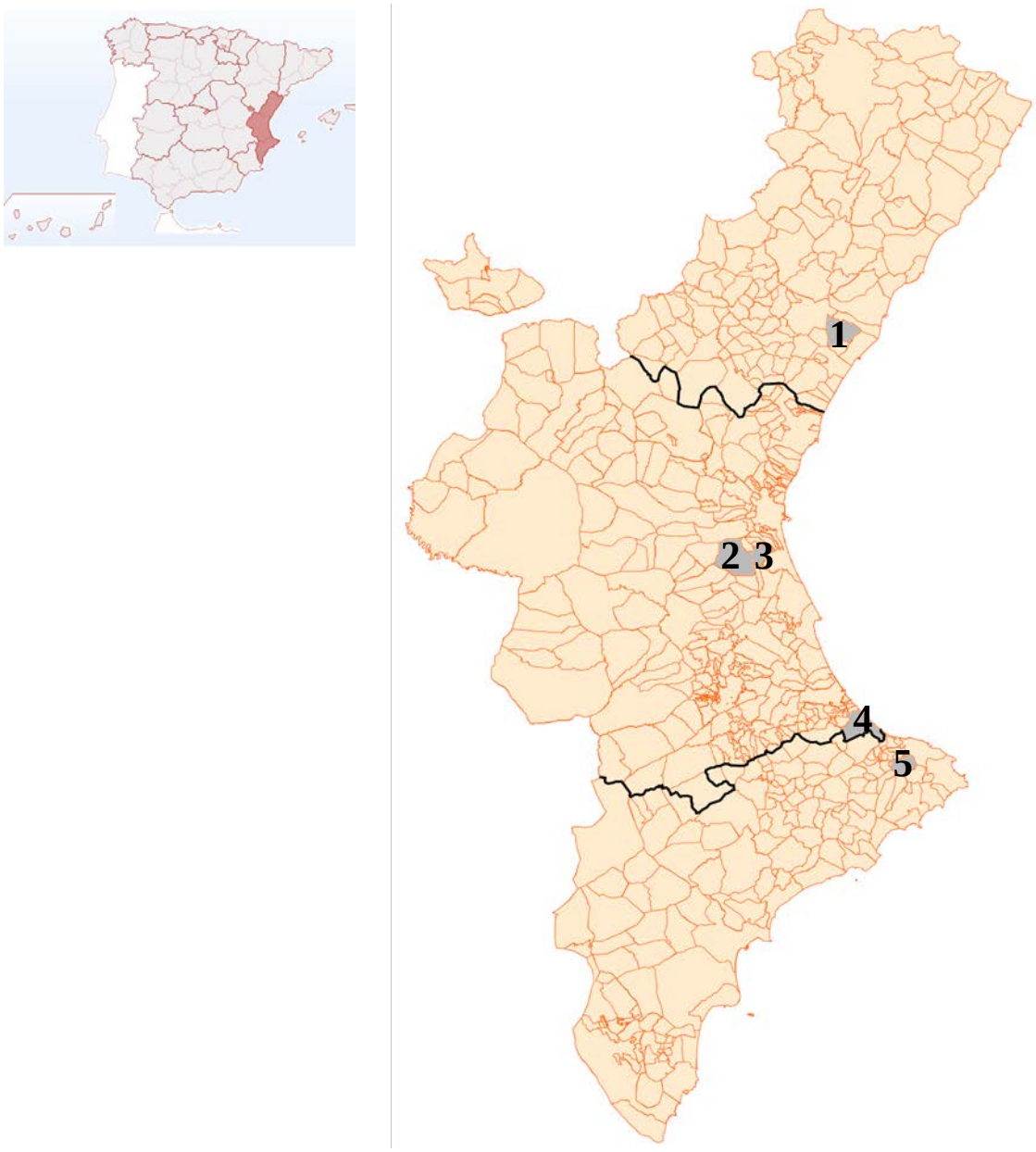
such as Gandía (La Safor) and Pego (Marina Alta). In both towns, the importance of irrigation reinforced the leading role played by small farms with their intense specialisation in vegetable cultivation (Calatayud and Millán, 2010). The stimulus from urban and international markets was decisive for the growth of irrigated crops. The final municipality selected is Sueca, which is intensely specialised in rice and which has highly defined environmental characteristics. Rice was the intensive crop with the most weight in the irrigated area of Valencia for the whole of the nineteenth century. This crop was able to supply the annual peasant self-consumption and also provide a surplus to be sold on the market. It had a high output per unit area and experienced a growth phase until the 1870s[6]. After the difficulties of the 1880s, and despite tariff protection from 1891, rice underwent a technical improvement process which translated into a recovery of profitability, an increase in yields (due to the use of chemical fertilisers and progress made in seed selection) and a growth in exports. (Garrabou, 1985; Piqueras, 1985; Calzado, 1995; Calatayud, 2001). With greater or lesser intensity, in the five municipalities selected, agroindustrial activities were developed from the end of the nineteenth century (Piqueras, 1999; Calatayud, 2001). In summary, in our case the five municipalities selected represent different areas of rural Valencia which adapted their production structure, within a context of agricultural specialisation, to external markets.

Although in 1900 all of the municipalities analysed –except for Pego – had populations of more than 10,000 inhabitants, they were not urbanised until the mid-twentieth century. They were "*agro-towns*" as the majority of their inhabitants were employed in the agricultural sector (Martínez-Carrión and Moreno-Lázaro, 2007; Ayuda and Puche, 2014).

[6] Between 1840 and 1880, the rice-growing area in Sueca increased from 44,390 Hn to 70,290 Hn, and in 1922 it covered an area of 83,954 Hn (Calzado, 1995, p. 220).

MAP 1

MUNICIPALITIES ANALYSED*



Source: Authors' own elaboration.

* Municipalities of the sample (district, province and principal production specialisation): 1. Villarreal (Plana Baja, Castellón; oranges); 2. Alzira (Ribera Alta, Valencia; oranges and vegetables); 3. Sueca (Ribera Baja, Valencia; rice and vegetables); 4. Gandía (La Safor, Valencia; oranges, raisins and vegetables); and 5. Pego (Marina Baja, Alicante; rice, oranges and raisins).

To analyse the biological inequality in accordance with access to property ownership, we have used the anthropometric rural sample of 14,199 conscripts who declared that they were employed in production activities related to agriculture and livestock farming (Table 1). The number of conscripts who declared themselves to be

land-owning farmers[7] is 10,493 (73.9% of the sample), of whom 9,503 (90.6%) were born and measured in the same municipality as those making up the sample[8]. On the other hand, the number of conscripts who declared themselves to be landless farm workers[9] is 3,706 (the remaining 26.1% of the sample), of whom 3,131 (84.5%) were born and measured in the same municipality as those who made up the sample (Table 1). The possiblity that this rural sample is biased in some way cannot be ruled out, as we do not have information about the individuals who may have emigrated before being measured in the municipalities analysed in this study. However, it can be confirmed that for our case this bias would not be highly relevant, because as the intensive agriculture in the region of Valencia offered greater job opportunities and required more labour and capital, there was a low incidence of emigration among the population of the irrigated area of Valencia[10]. This was related to the development of small and medium-sized farms which were more prosperous in terms of employment and wealth in contrast to the poverty of the farm workers of other Spanish agricultural regions (Martínez Carrión, 2002b, p. 30). The breakout of the First World War gave rise to an increase in migrations from the irrigated area of Valencia which was much affected by the international situation and the fall in its main agricultural exports (Nicolau, 2005, p. 92)[11].

Our rural sample has two advantages: first, the data enable us to evaluate the role that access to land ownership had on height and on the biological welfare of the rural populations of the irrigated area of Valencia between the mid-nineteenth century and the first third of the twentieth century; and second, working with data of an almost homogeneous population implies that our results are probably not affected by cultural or genetic factors which have been pointed out in other studies (Blum, 2013).

[7] Landowning farmers are all those who owned or leased lands, who worked or cultivated the land directly or who had control over agricultural production irrespective of the size of the farm.

[8] Immigrants are considered as all conscripts born in a different municipality to where they were measured.

[9] Landless farm workers are all those who were unspecialised and who worked for a daily wage in the different agricultural tasks and who did not own or lease land or have any type of control over the agricultural production.

[10] Comparatively, the people from the rain-fed area of Valencia emigrated more. Part of these net outflows corresponded to the wine growing areas which were highly affected by the phylloxera crisis at the beginning of the twentieth century (Bonmatí, 1989).

[11] A comparison with the data of the immigrants to the city of Barcelona, a major destination of Valencians, in 1930, reveals that the population from these municipalities in this city represented only 2.6% of the Valencians residing there, and their weight of the total population of the region of Valencia in the same year was 4.8% (Silvestre, Ayuda and Pinilla, 2015).

Although the data corresponding to the Spanish conscripts do not have any truncation problems due to the requirement of a minimum height as in the case of other national armies in the nineteenth century (Komlos, 2004), they do suffer from problems shared by other countries. The most important refers to the successive changes in the age of recruitment which occured in Spain between 1856 and 1907. From the implementation of "universal" conscription, between 1856 and 1907, the legal age for military service was modified four times: 1856, twenty years of age; 1885, nineteen years; 1901, twenty years again; and 1907, twenty-one years. In order to resolve this problem we have standardised the heights of the conscripts aged 19 and 20 to the age of 21[12], following the methodology applied by Ramon-Muñoz (2009). According to our calculations, we have increased the height of the conscripts measured at 19 years of age by 1.5 cm and those measured at the age of 20 by 0.7 cm (Ayuda and Puche, 2014)[13]. Subsequently, and to verify the quality of the data, we have constructed two histograms[14] which show the frequency distributions of the heights of the conscripts engaged in agricultural activities and measured between 1879 and 1920 (cohorts of the second half of the nineteenth century) and between 1921 and 1960 (cohorts of the first third of the twentieth century). In general terms, the histograms show a normal distribution (Graphs A-1 and A-2 of the Appendix).

[12] This can be justified because in accordance with studies on physical growth revealing the existence of malnutrition and high child and youth mortality, as was the case in 19th-century Spain (Sanz Gimeno and Ramiro Fariñas, 2002), physical growth could persist until the age of 21-22. In addition to the health and epidemiological conditions in childhood, there are international studies that have revealed that economic factors, such as wages, can also influence this prolongation of adult height growth (Baten, 2000a). The evidence is interesting as it shows that, as well as the childhood years, all anthropometric analyses should also consider the economic circumstances during adolescence. This article has taken this into account.

[13] We have calculated height averages on the basis of the 50th percentile of the three generations of youths who were measured at different ages and close in time (the three first cohorts of our sample) and space (conscripts from the irrigated rural areas in five municipalities in the Valencian region).

[14] We also performed several normality tests (Doornick-Hansen, Shapiro-Wilk, Jarque-Bera), but the null hypothesis is rejected for usual significance levels. However, as we have large samples, this is not a problem (Bodenhorn, Guinnane and Mroz, 2013).

TABLE 1

RURAL SAMPLE CHARACTERISTICS, BIRTH COHORTS OF 1859-1939

	Independent variables	Cases		Average height (standard deviations)	
		Farmers	Farm Workers	Farmers	Farm Workers
Total		10,493	3,706	165.1 (6.4)	163.9 (6.5)
Towns	Alzira	2,434	2,329	164.2 (6.3)	163.2 (6.6)
	Gandía	1,336	136	162.6 (7.8)	164.9 (6.8)
	Pego	331	102	167.8 (5.5)	168.6 (6.4)
	Sueca	2,036	397	165.9 (5.9)	163.7 (6.1)
	Villarreal	4,356	742	165.8 (5.9)	165.4 (5.8)
Birth decade	1860	914	529	161.7 (6.9)	161.7 (6.6)
	1870	1,102	576	161.6 (7.1)	161.8 (6.8)
	1880	1,761	528	164.6 (6.2)	163.7 (6.1)
	1890	1,023	368	165.7 (5.7)	164.6 (5.9)
	1900	539	221	165.1 (5.6)	164.8 (6.2)
	1910	1,000	275	165.8 (5.8)	165.2 (5.8)
	1920	2,253	416	165.9 (5.8)	165.1 (6.2)
	1930	1,901	793	167.0 (5.9)	166.1 (6.1)
Appeals for exemption	Not exempt	9,019	3,074	165.6 (5.7)	164.6 (5.8)
	Physical appeals (exempted)	1,104	360	162.6 (8.5)	163.4 (4.5)
	Social appeals (exempted)	204	118	162.6 (6.4)	161.9 (6.9)
	No appeal (exempted)	183	159	155.5 (9.4)	153.5 (8.3)
Literacy	Illiterate	3,761	1,913	163.5 (6.8)	162.5 (6.8)
	Literate	6,732	1,793	166.0 (5.9)	165.5 (5.9)
Place of birth	Native	9,503	3,131	165.2 (6.3)	163.8 (6.6)
	Immigrants	990	575	164.4 (6.4)	164.2 (6.2)
	Immigrants (Valencian region)	646	312	164.4 (6.6)	164.2 (6.2)
	Immigrants (Andalusia)	45	51	163.9 (6.6)	163.8 (4.9)
	Immigrants (Castilla–La Mancha)	96	121	162.5 (5.8)	163.9 (6.8)
	Remaining immigrants	203	91	165.3 (6.2)	164.9 (5.8)

Source: Conscription and call-up records; historical municipal archives from Valencian municipalities composing the anthropometric sample

Note: The average heights have been calculated for the sample of the conscripts engaged in agricultural activities.

The anthropometric analysis is divided into two parts. First, the evolution of the biological welfare in the irrigated areas of Valencia has been examined based on the trend in the average height of the conscripts recruited in the five municipalities of the sample and after focusing on the conscripts who were land-owning farmers and landless farm labourers among the birth cohorts of 1859 and 1939. Second, several models have been estimated with the aim of establishing whether being a landowner enabled farmers to exercise control over agricultural production and, in general, whether having a higher level of economic resources influenced physical growth and final height. As control variables we have used the towns where they were measured, the decade of birth, the

physical appeals and social type (for example, economic poverty, family situation or being an orphan) presented by the conscripts to appeal for exemption from military service, the level of literacy and the place of birth. Furthermore, and in order to study the relationship between height and access to land in greater depth, as well as estimating a model for the whole of the period under study, we have estimated another two models for two different sub-periods: the birth cohorts of 1859-1899 (6,801 conscripts, 47.9% of the sample) and the birth cohorts between 1900 and 1939 (7,398 conscripts, the remaining 52.1% of the sample). This chronological division is determined by the agricultural crisis at the turn of the century, which constituted a point of inflection in the evolution of the Spanish agricultural sector, and the evolution of Valencian agricultural exports. This crisis, however, did not have a highly significant impact on the agriculture of the Valencian region. The fall in production was much less serious than that of other regions and the structure of crops did not change radically. With respect to agricultural exports, considering that they experienced moderate growth until the beginning of the 1890s, we have decided to integrate the 1890s into the first sub-period. The beginning of the first of these periods was characterised by the consolidation of new property rights, the emergence of a renewed agricultural elite class made up of the new purchasers of rural assets in the nineteenth century and the boom in intensive crops. The second stage was characterised by the definitive advance of specialised irrigated crops and the maximum expansion of commercial agriculture (Calatayud, 2001).

4. RESULTS AND DISCUSSION

4.1. Evolution of height in the irrigated area of Valencia

Graph 2 shows the average heights of all the conscripts in the five municipalities making up the sample of the irrigated area of Valencia corresponding to the birth cohorts of the 1860s and 1930s, and the evolution of the coefficient of variation of height (CV)[15], originally suggested by Baten (2000b) and used in other studies as a indicator of economic inequality (Blum, 2013; Ayuda and Puche, 2014). The height data reveal, on the one hand, a secular growth trend of biological welfare in the long

[15] Here the CVs have been calculated with the standardised heights, although the CV has also been calculated for the raw heights, for homogeneous age groups and the main conclusion is that, for the two cohorts where the individuals are measured at different ages, the CV is higher for those measured at 19 years of age than those measured at 20 years, which are higher than the CV for those measured at 21 years of age. However, most of our recruits were measured at 21 years old, and conscripts were only measured at a different age in the first three decades.

run, and on the other, the existence of some downturns that altered the growth rhythm of this trend, for example during the decade of the 1890s.

GRAPH 2
AVERAGE HEIGHT AND HEIGHT INEQUALITY (CV) IN THE IRRIGATED AREA OF VALENCIA, BIRTH COHORTS BETWEEN 1860 AND 1930

Source: Conscription and call-up records; historical municipal archives from Valencian municipalities composing the anthropometric sample

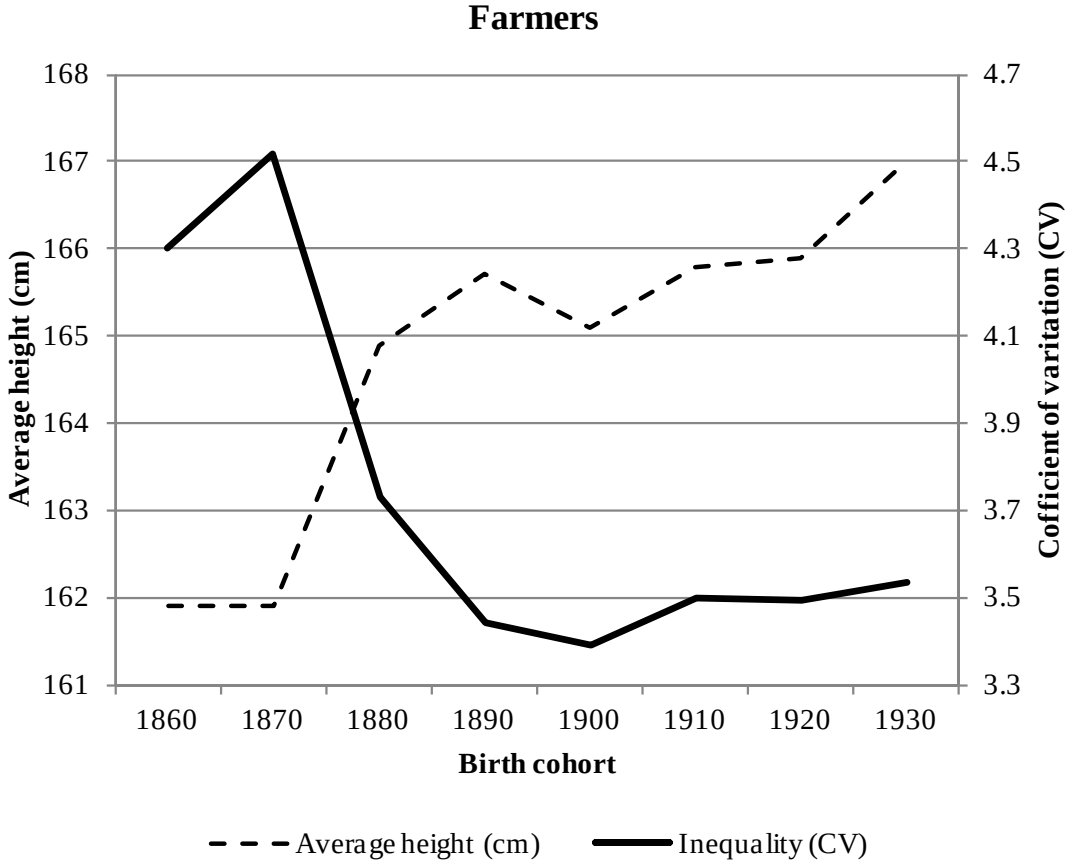
Note: 48,841 conscripts

In the long term, the average height of the conscripts in the irrigated area of Valencia increased by 3 cm, if we take the averages of the birth cohorts of the 1860s and 1930s as a reference, with average height estimates of 163.8 cm and 166.8 cm respectively.

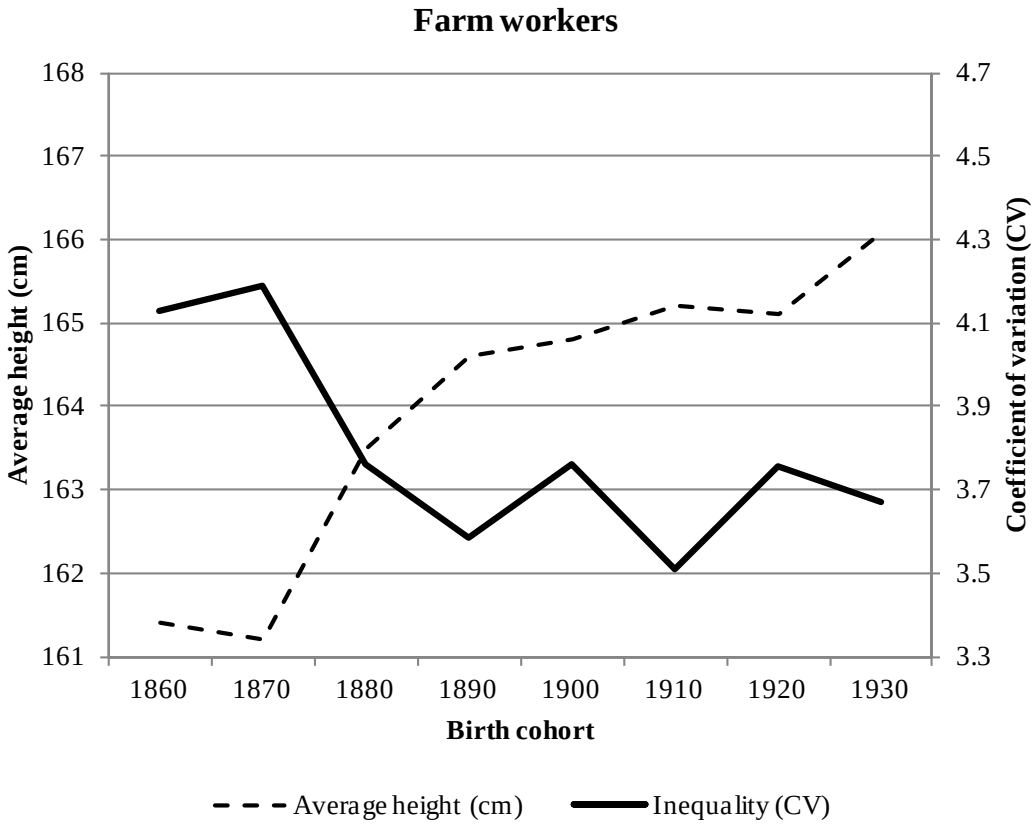
The CV suggests that the height inequalities were acute in the mid-nineteenth century, then they diminished at the end of the century and increased slightly with the birth cohorts of the 1900s and 1930s -the military recruits of the initial years of the Franco regime- (Graph 2). In general, the evolution of the average height and the CV for the irrigated area of Valencia was very similar in the analysis of height in accordance with access to land ownership (Graph 3), except in the first two decades, may be due to the bias mentioned in the introduction.

GRAPH 3

AVERAGE HEIGHT AND HEIGHT INEQUALITY (CV) OF FARMERS AND FARM WORKERS IN THE IRRIGATED AREA OF VALENCIA, BIRTH COHORTS BETWEEN 1860 AND 1930



Note: 10,493 conscripts



Source: Conscription and call-up records; historical municipal archives from Valencian municipalities composing the anthropometric sample.

Note: 3,706 conscripts

Spanish anthropometric historiography has revealed that the beginning of Spain's modern economic growth in the mid-nineteenth century did not give rise to an improvement in the living and health conditions of the urban and rural communities (Martínez-Carrión and Pérez-Castejón, 2002; Martínez-Carrión and Moreno-Lázaro, 2007; Ramon-Muñoz, 2009). The results obtained in this study, on the other hand, reveal an improvement in biological welfare in the irrigated area of Valencia in the middle decades of that century. Of the cohorts of the decades of 1860 and 1880, the average height of the population of the irrigated area of Valencia increased by 1 cm coinciding with the extension of intensive farming and the intensification of production for the market, and all of this in spite of the extension of child labour and the increase in morbidity and mortality rates.

Studies carried out on the agricultural systems that characterised the intensive farming of Valencia have revealed that they offered greater job opportunities and required more labour and capital and that, even though small family-run farms were their driving force, generated higher levels of productivity and wealth than other types

of agriculture in Spain (Calatayud, 1989a; Simpson, 1994; Palafox, 2001; Calatayud and Millán, 2010). The expansion of intensive agriculture was based on high-yield crops that coexisted with subsistence crops and, most of all, on the growing use of the factor markets (Calatayud, 1989a, 2001). As a result, the irrigated area of Valencia generated more prosperity in terms of employment and wealth. In fact, and as previously mentioned, there was a low incidence of emigration among the people from the irrigated area and its economy displayed higher growth rates (Calatayud, 2001). Other economic indicators, such as the evolution of agricultural exports, also suggest that the beginnings of the intensive and commercial agricultural model in the irrigated area of Valencia in the mid-nineteenth century gave rise to an improvement in the biological welfare of its population. In Graph 1 we can observe that while exports of horticultural products began to rise in the 1870s, reflecting agricultural growth, height also increased, which was a symptom of the improvement of the biological standard of living.

Graph 2 also reveals that the rising trend in biological welfare slowed at the end of the nineteenth century. Among the birth cohorts of the end of the 1880s and the 1890s, the average height in the irrigated areas of Valencia stagnated. Considering that during these years the health and epidemiological conditions began to improve, expressed in a fall in the morbidity and mortality rates, particularly among children (Gozálvez, 2003), the aforementioned stagnation in height can be explained, in part, by the moderate impact caused by the agricultural crisis at the end of the century. Apart from cereals, this crisis also extended to other crops characteristic of the irrigated area of Valencia, such as rice, raisins and, later, oranges (Piqueras, 1985), which would have affected the biological welfare of the population of the irrigated area of Valencia. A comparison between the exports of horticultural products and the evolution of average height reveals that, among the cohorts of the middle of the decades of the 1880s and 1890s, the stagnation of exports had a negative effect on the biological welfare of the male population in the irrigated areas of Valencia, which also stagnated.

Graph 2 shows that the conscripts born after the cohorts of the 1900s had higher biological standards of living. The average height of the birth cohorts of the 1900s and 1930s in the irrigated area of Valencia increased by almost 1.5 cm and the CV stood at 3.6%. The increase in height indicates that there was an improvement in nutritional status. This anthropometric growth should have been related to a new economic and demographic cycle characterised by the progress made in commercial agriculture, the

demand of nearby urban markets, the increase in agricultural exports and the fall in child mortality rates. There were dynamic sectors which reinforced employment and increased the income of farmers. The most spectacular case was that of horticultural products, such as onions (Garrabou, 1985; Piqueras, 1985, 1999). In general, the situation of the agricultural sector in the region of Valencia was positive, particularly in the irrigated areas, as in addition to export growth there was also greater internal demand arising from the emerging urban markets (such as Valencia)[16]. Again, a comparison between the exports of horticultural products and the evolution of average height reveals that from the beginning of the twentieth century, the former had a positive effect on the biological welfare of the male population. So, we can observe that the growth experienced in the heights of the cohorts of the 1900s coincided with the increase in exports in the 1900s and beginning of the 1910s (Graph 1). The health and epidemiological conditions also improved, as shown by regional and local studies, particularly after the decades of the 1890s and 1900s, which report a decrease in overall child (<1 years old) and youth (1-9 years old) mortality and an increase in average life expectancy, all in a context of a decreasing morbidity rate (Ferrater and Terol, 1996, pp. 269-271; Gozalvez, 2003).

The cohorts of 1910, 1920 and 1930 were the generations that served in the army during the troubled years of the Second Republic, the Civil War and the early years of the Franco regime. Judging from the data represented in Graph 2, and far from what could be expected with respect to the poor economic and supply conditions at the end of the war and during the post-war period[17], the biological welfare of the conscripts of the irrigated area of Valencia improved. Even when hunger and poverty should have constituted the way of life for a considerable part of Valencia's population at that time, the structure of land ownership in some areas (irrigated areas) and the good rhythm of agricultural exports after the 1950s were factors that may explain why the situation for the conscripts in this region differed from the general situation in the rest of Spain (Clar

[16] Between 1877 and 1900 the population of the city of Valencia grew from 143,861 to 213,550 inhabitants.

[17] In the case of oranges, the mediocre orange season of 1932-33 marked the beginning of a serious crisis for the crop which culminated during the years of the Civil War when the confrontations between the different components of the republican sector with regard to how to organise production, exports and the difficulties generated by the war, led to a slight reduction in foreign sales. In the 1940s, Franco's autarchic policy and its effects on the scarcity of currency with which to supply the inputs necessary to maintain the activity negatively affected the most dynamic sector of Valencia's economy. The modernisation process suffered a clear stagnation and not only in the citrus sector. The maximum levels of production obtained during the pre-war period in 1929 would not be reached again until 1960, Piqueras (1999) and Palafox (2001).

et al., 2016; Palafox, 2001). In general terms, the rural areas, due to the greater possibilities of accessing basic foods, enjoyed relatively higher biological standards of living than the urban centres during the initial years of the Franco dictatorship (Ayuda and Puche, 2014).

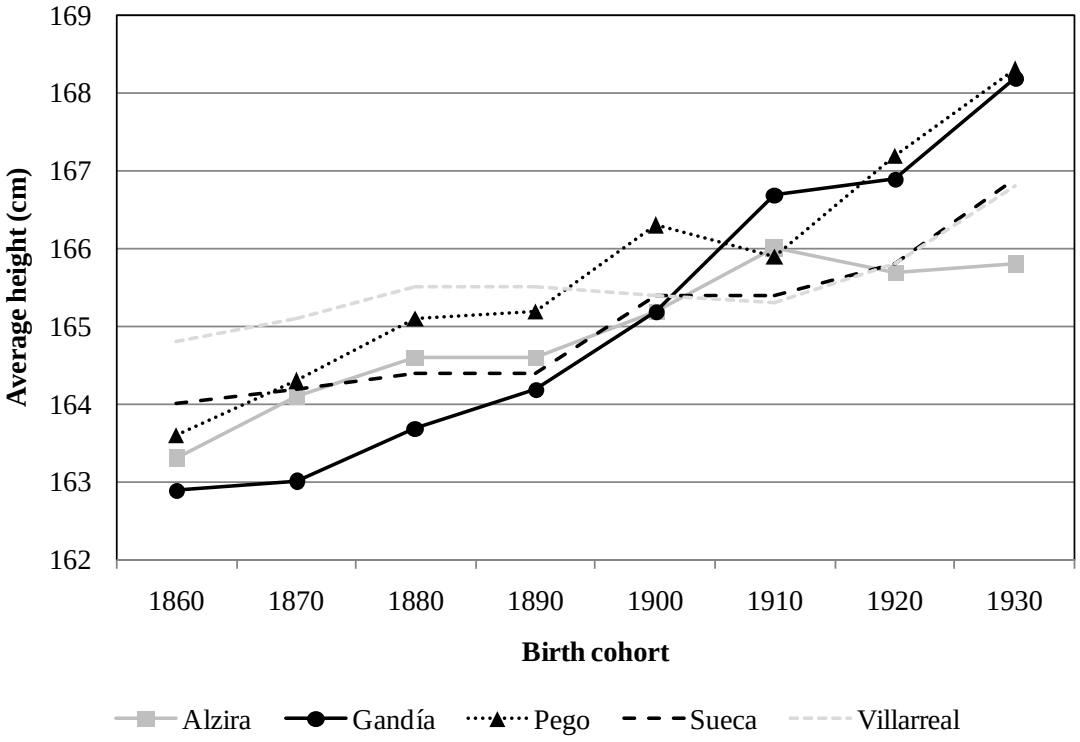
During the period of time analysed, economic inequality (height inequality measured with the coefficient of variation) diminished with average biological well-being (average height): the average height of the population increased by 3 cm throughout the period, while the coefficient of variation decreased by 0.4, indicating that height inequality declined (Graph 2). This was also the case for the two socioeconomic groups, farmers and farm workers (Graph 3).

To finish this section we will analyse the average heights of the conscripts from the five selected municipalities (Graph 4). In general terms, and consistent with the findings of other provincial studies (Heyberger, 2007), differences may be observed between the heights of the different municipalities within an overall long-term upward trend[18]. The local differences in average height, which were acute in the mid-nineteenth century, decreased among the cohorts of the beginning of the twentieth century, probably due to economic progress and improvements in healthcare experienced by the five towns as a result of agricultural growth and the fall in morbidity and mortality rates, and increased again during the early years of the Franco regime.

[18] This upward trend began in the 1870s, although in rural Valencia some municipalities suffered the negative impact of the First World War. In the case of France, Heyberger (2007) records how Brie (a rural town specialised in cereal crops) suffered the negative impact of the agricultural depression of the last quarter of the 19th century. In both cases, a positive correlation is observed with some economic indicators. For example, in Limousin (a rural municipality also specialised in cereal crops), the annual height of the conscripts is positively correlated with the weight of cattle. In our case, we can observe that the annual height of conscripts is positively correlated with the exports of horticultural products from the cohorts born in the mid-nineteenth century.

GRAPH 4

AVERAGE HEIGHT IN FIVE MINICIPALITIES IN THE IRRIGATED AREA OF VALENCIA, BIRTH COHORTS BETWEEN 1860 AND 1930



Source: Conscription and call-up records; historical municipal archives from Valencian municipalities composing the anthropometric sample.

Note: 48,841 conscripts.

4.2. Height and inequality in accordance with access to landownership

Was there biological inequality between landowners and landless farmers? Did the access to land ownership affect final height? Table 1 and Graph 5 show the contrasts in the average height of the rural conscripts of the irrigated area of Valencia in accordance with their access to land ownership among the cohorts born between the 1860s and 1930s. The results reveal that landowning farmers were always taller than landless farm workers, although they did not grow much more over time. Between the two dates, landowners and tenants grew by 4.8 cm and farm workers by 4.4 cm. The differences in height were very small in the mid-nineteenth century, they increased at the end of the century (generations who did their military service during the 1900s and 1910s, in the final phase of the first wave of globalisation) and reduced relatively during the first third of the twentieth century. This reduction in inequality was more evident among the cohorts of the 1900s and 1910s, probably due to the progress made in the redistribution of income as a result of the developments in collective bargaining,

particularly during the early years of the Second Republic (1931-1933). In contrast, the height differences increased again, affecting the cohorts born in the 1920s and 1930s. This could be due to the negative effects of the Civil War, and particularly, Franco's autarchy, which gave rise to an increase in poverty and inequality among the most disadavantaged social groups.

GRAPH 5

AVERAGE HEIGHT OF FARMERS AND FARM WORKERS IN THE IRRIGATED AREA OF VALENCIA, BIRTH COHORTS BETWEEN 1860 AND 1930

Source: Conscription and call-up records; historical municipal archives from Valencian municipalities composing the anthropometric sample

In Table 2 we can see the results of the ordinary least square estimates, robust to heterokedasticity, of three models: the first refers to all the conscripts engaged in agricultural activities (14,199 rural conscripts), the second corresponds to farmers (10,493 conscripts) and the third to farm workers (3,706 conscripts), with the objective of identifying possible causes of biological differences between the two rural groups. The dependent variable is the height standardised at 21 years (in centimetres) and the explanatory variables are shown in the first column. The second and third columns show the estimated coefficients (Coeff.) and standard errors (se), respectively, for the

general model; the fourth and fifth columns show the estimated coefficients and standard errors for the farmers model; and the sixth and seventh columns for the farm workers model.

In the general model (14,199 conscripts) there is a dummy variable "Farmers", taking the value of 1 if the conscript is a farmer and zero if he is a farm worker, in order to distinguish whether there are differences between these two rural groups. As the "Farmers" dummy variable is positive and significant, even at the 1% level of significance, we can conclude that there are some differences between these two rural groups, in favour of the farmers (0.4 cm). We have presented the two other models in order to distinguish between the two rural groups; farmers and farm workers.

The variables used in the estimates can be divided into four groups. The first group is called *towns*, composed of 4 dummy variables taking the value 1 if the individual was conscripted in this town and zero if not, and their coefficients measure the difference between those born in this town and those born in the base town, which is Villarreal. According to our estimates, for the total sample size and for the farmers, Pego is the town with the highest figure for estimated average height and Gandía has the shortest estimated average height, but for the farm workers, the largest estimated differences in height are between those of Pego[19]and those conscripted in Alzira. The second group is called *Decades of birth*, composed of 7 dummy variables taking the value of 1 if the individual was born in this decade and zero if not, and their coefficients measure the difference in the average height between those born in this decade and those born in the base decade, which is that of those born between 1859 and 1869, while the rest of the variables remain fixed. According to our estimates, the farmers with and without land in the irrigated area of Valencia born in the decade 1930-39 were, on average, 3.6 cm and 3.3 cm taller than the birth cohorts of 1859-69, respectively. (Table 2, Decade of birth, column 4 and 6).

[19] The estimates of the coefficients of variable Pego are biased upwards as we only have height information for this town for conscripts born in the last two decades. With the exception of the 1890s, the lack of height data for the previous decades is because there is no information regarding the profession of the conscripts. Nevertheless, comparisons of the local height series (with and without the profession) carried out in previous studies and in Graph 4 reveal that, from the end of the nineteenth century, the average height of the conscripts from Pego was taller than that of the other municipalities in the sample (Puche, 2011, p. 384).

TABLE 2

REGRESSION RESULTS: DETERMINANTS OF HEIGHT AND SOCIAL INEQUALITY IN THE IRRIGATED AREA OF VALENCIA, BIRTH COHORTS OF 1859-1939
(Dependent variable: height at 21 years, in centimetres)

	All		**Farmers**		**Farm Workers**	
	Coeff.	se	Coeff.	se	Coeff.	se
Intercept	162.8***	0.22	163.3***	0.25	163.2***	0.39
Towns						
Villarreal	Ref.		Ref.		Ref.	
Alzira	-0.55***	0.13	-0.33**	0.16	-1.08***	0.29
Gandía	-1.65***	0.20	-1.79***	0.22	-0.15	0.64
Pego	1.00***	0.30	0.64*	0.33	1.94***	0.70
Sueca	-0.46***	0.15	-0.39**	0.17	-1.05**	0.43
Decade of birth						
1859-1869	Ref.		Ref.		Ref.	
1870-1879	0.01	0.22	-0.13	0.28	0.21	0.34
1880-1889	2.06***	0.21	2.10***	0.26	1.76	0.36
1890-1899	3.16***	0.25	3.31***	0.31	2.43***	0.46
1900-1909	2.58***	0.28	2.56***	0.34	2.59***	0.55
1910-1919	2.64***	0.26	2.50***	0.31	3.01***	0.49
1920-1929	2.79***	0.22	2.73***	0.27	2.86***	0.44
1930-1939	3.51***	0.23	3.58***	0.29	3.27***	0.40
Appeals for exemption						
Declared fit to serve	Ref.		Ref.		Ref.	
Physical appeals (exempt.)	-2.81***	0.21	-3.22***	0.25	-1.57***	0.41
Social appeal (exempted)	-1.80***	0.36	-1.59***	0.45	-1.99***	0.62
No appeal (exempted)	-9.50***	0.44	-8.86***	0.62	-10.41****	0.59
Education						
Illiterate	Ref.		Ref.		Ref.	
Literate	0.86***	0.13	0.84***	0.15	0.69***	0.25
Place of birth						
Natives	Ref.		Ref.		Ref.	
Imm. (Valencian region)	-0.65***	0.21	-0.69***	0.25	-0.63*	0.35
Imm. (Cast.-La Mancha)	-3.03***	0.44	-4.14***	0.60	-1.77***	0.64
Imm. (Andalusia)	-2.93***	0.61	-2.26**	0.99	-2.65***	0.75
Remaining immigrants	-0.97***	0.35	-1.04**	0.43	-0.87	0.60
HISSCLAS						
Farm Workers	Ref.					
Farmers	0.42***	0.12				
Sample size	14,199		10,493		3,706	
Adjusted R^2	0.16		0.14		0.20	

Source: Conscription and call-up records; historical municipal archives from Valencian municipalities composing the anthropometric sample

Notes:
OLS estimates; *se* denotes robust standard error.
* Statistical significance at 10% level.
** Statistical significance at 5% level.
*** Statistical significance at 1% level.

The third group of variables measures differences in terms of *Socio Economic Status* (SES), such as the health status, the family situation or the access to educational resources. We can divide this group into two sub-groups of variables. The first sub-

group includes the variables called *Appeals for exemption* where the base group is formed by the conscripts *declared fit to serve* and three dummy variables; *Physical appeals* (*exempted*) which is a variable that takes the value of 1 if the individual is declared exempt for physical appeals and zero if not; *Social appeal (exempted)* which takes the value of 1 if the individual is declared exempt for social appeals and zero if not; and *No appeal* (*exempted*) which takes the value of 1 if the individual is exempt from doing military service but has not appealed. The second sub-group includes the variables that measure the *Educational level* of the conscripts. *Illiterate* constitute the base group and the *Literate* is a dummy variable taking the value of 1 if the conscript is literate and zero if not.

The main results arising from the estimates are that the farmers with and without land who were excluded from military service due to physical problems were, on average, 3.2 cm and 1.6 cm shorter, respectively, than those farmers with and without land declared as fit to serve; those farmers with and without land who were declared exempt from military services due to social causes (family situation of poverty, elderly parents, being an orphan, etc) were, on average, almost 1.8 cm shorter respectively than their counterparts who were declared fit for service; finally, those farmers and farm workers who were declared exempt from military service without having presented an appeal were, on average, 8.9 cm and 10.4 cm shorter, respectively, than those who were declared as being fit (Table 2, Appeals for exemption, column 4 and 6). Our data reveal that there was a phenomenon that conditioned these strong differences: the high number of conscripts who were exempt due to their short height[20]. In general, it can be deduced that these conscripts came from the most disadvantaged groups of Valencia's rural society. The results are conclusive, as they indicate the decisive influence that health and poverty conditions and problems of physical growth had on biological welfare (Ayuda and Puche, 2014).

From the estimates of the coefficients of the variable that measures the level of education we can conclude that the land-owning and landless farmers who were literate were taller on average than those who were illiterate. More specifically, they were almost one centimetre taller (Table 2, Education, column 2). This difference in height between literate and illiterate people is wider among farmers than among farm workers

[20] It has been calculated that of the 183 farmers who were declared exempt from military service without making an appeal, 124 were too short to be recruited (67.8%), and of the 159 farm workers who were exempt without having made an appeal, 119 were too short (74.8%).

(Table 2, Education, column 4 and 6). The results of the models confirm that the positive relationship between literacy and height and access to education is related to a higher final average height and greater biological welfare (Ayuda and Puche, 2014; Martínez-Carrión and Puche, 2009).

The fourth and final group of variables contains those relating to the *Place of birth*, which, as a base group includes the *natives* and also four dummy variables to indicate immigrants from different areas. For example, *Immigrant (Valencian region)* takes the value of 1 if the individual was born in the *Valencian region*, but in a municipality different to the one where he was measured and zero if not. From the estimate of their coefficients we can deduce that the place of birth and the unequal levels of economic development are important factors. The farmers with or without land born in the same municipalities as those where they were measured (natives of the sample) were taller than immigrant farmers with or without land, even with respect to immigrants from the same region. The immigrant farmers born in other municipalites in the region of Valencia were, on average, 0.7 cm shorter than the native farmers (Table 2, Place of birth, column 4 and 6). The difference is remarkable, particularly if we take into account that some of these immigrant farmers could have been born in one of the five municipalities included in the sample, as well as other rural communities in the region of Valencia. With respect to the latter, it can be inferred that they could have emigrated from rural municipalities with environmental conditions that were relatively worse and with a less advanced agricultural sector. There is less doubt with respect to the comparison carried out between farmers with and without land who were immigrants born in other Spanish regions. The model reveals that the immigrant farmers born in Castilla-La Mancha and Andalusia were shorter, on average, than the farmers from the irrigated area of Valencia, specifically 4.1 cm and 2.3 cm shorter respectively. With respect to the landless farm workers who were immigrants from these two regions in the centre and south of Spain, their average heights were 1.8 cm and 2.7 cm shorter respectively than those of the landless farm workers in the *huertas* of Valencia (Table 2, Place of birth, column 4 and 6).

The econometric evidence corresponds to that observed in the Spanish agricultural historiography, which establishes the existence of different *Spanish agricultures* in virtue of variables such as the difference in productivity or the structure of ownership, among others (Gallego, 1993). In the economic modernisation process, which took place between 1850 and 1930, certain territories clearly gained positions and

others lost them to different degrees. The region of Valencia was an unquestionable winner, as it was then one of the most dynamic areas in terms of agriculture and the Spanish economy. Among the undeniable losers were Andalusia and Castilla-La Mancha, which had always remained within the parameters of a typically rainfed agriculture, with a predominance of traditional crops. Our results suggest that these differences were reflected in rural heights.

To end this section, we would like to examine in depth the role that access to land had on the biological welfare of the rural male populations of the irrigated area of Valencia between the 1860s and the end of the 1930s. To do this we have estimated three models in order to compare the influence of the variables analysed on the height of the two rural groups selected, farmers and farm workers, and whether this influence changed in different periods of time. The first estimate refers to the whole period of the study, while the second and third address respectively the cohorts born between 1859 and 1899 and between 1900 and 1939 (Table 3).

TABLE 3

REGRESSION RESULTS: DETERMINANTS OF HEIGHT AND SOCIAL INEQUALITY IN THE IRRIGATED AREA OF VALENCIA, BIRTH COHORTS OF 1859-1939
(Dependent variable: height at 21 years, in centimetres)

	Model 1 1859-1939		**Model 2** 1859-1899 (first sub-period)		**Model 3** 1900-1939 (second sub-period)	
	Coeff.	se	Coeff.	se	Coeff.	se
Intercept	163.2***	0.39	163.4***	0.52	165.7***	0.67
Town						
Villarreal	Ref.		Ref.		Ref.	
Alzira	-1.08***	0.28	-1.17***	0.45	-0.75*	0.39
Gandía	-0.14	0.65	-4.12***	1.25	0.33	0.69
Pego	1.95***	0.70	-2.17	1.82	2.35***	0.74
Sueca	-1.04**	0.43	0.05	0.65	-1.81***	0.59
Villarreal*Farmers	-1.85	1.99	3.53**	1.64	-0.89	2.23
Alzira*Farmers	-1.10	1.97	3.84**	1.66	-0.47	2.21
Gandía*Farmers	-3.50*	2.07	4.10**	2.04	-0.80	2.31
Pego*Farmers	-3.16	2.08	4.82*	2.46	-2.19	2.31
Sueca*Farmers	-1.21	2.01	2.84	1.77	0.77	2.27
Decade of birth						
1859-1869	Ref.		Ref.			
1870-1879	0.21	0.33	0.26	0.33		
1880-1889	1.76***	0.36	2.04***	0.37		
1890-1899	2.44***	0.45	2.68***	0.51		
1900-1909	2.60***	0.55			Ref.	
1910-1919	3.00***	0.49			-0.03	0.60
1920-1929	2.85***	0.44			-0.40	0.67
1930-1939	3.26***	0.39			0.17	0.65
1859-1869*Farmers	-0.31	0.49	-0.38	0.63		
1870-1879*Farmers	-0.66	0.47	-0.91	0.58		

1880-1889*Farmers	0.02	0.45	-0.92	0.55		
1890-1899*Farmers	0.56	0.51				
1900-1909*Farmers	-0.36	0.63			-1.29*	0.72
1910-1919*Farmers	-0.83	0.51			-0.84	0.51
1920-1929*Farmers	-0.44	0.43			-0.38	0.43
1930-1939*Farmers						
Appeals for exemption						
Declared fit to serve	Ref.		Ref.		Ref.	
Physical appeals (exempted)	-1.56***	0.40	-2.17***	0.54	-0.71	0.61
Social appeals (exempted)	-1.99***	0.62	-2.61***	0.67	-0	1.49
No appeal (exempted)	-10.41***	0.59	-12.56***	0.51	-2.79**	1.42
Declared fit to serve*Farmers	2.25	1.93	-2.11	1.60	1.05	2.15
Physical appeals (exempted)*Farmers	0.56	1.96	-5.22***	1.64	0.69	2.21
Social appeals (exempted)*Farmers	2.46	1.98	-1.53	1.65	0.30	2.51
No appeal (exempted)*Farmers	3.80*	2.11	-0.10	1.79	2.42	2.99
Education						
Illiterate	Ref.		Ref.		Ref.	
Literate	0.69***	0.25	0.55*	0.31	0.859**	0.40
Literate*Farmers	0.15	0.29	0.10	0.36	0.39	0.47
Place of birth						
Natives	Ref.		Ref.		Ref.	
Immigrants (Valencian region)	-0.62*	0.34	-1.47***	0.53	-0.18	0.44
Immigrants (Castilla-La Mancha)	-1.76***	0.63	-4.88***	1.53	-1.48**	0.65
Immigrants (Andalusia)	-2.64***	0.74	-1.27	4.20	-2.42***	0.74
Remaining immigrants	-0.69	0.50	-1.91	1.41	-0.40	0.53
Immigrants (Valencian region) *Farmers	-0.07	0.42	0.88	0.69	-0.47	0.53
Immigrants (Castilla-La Mancha) *Farmers	-2.06**	0.96			-2.07**	0.98
Immigrants (Andalusia) *Farmers	0.37	1.24			0.15	1.27
Remaining immigrants*Farmers	-0.49	0.62	0.26	1.97	-0.52	0.64
Sample size	14,199		6,801		7,398	
R^2 Adjusted	0.16		0.25		0.04	

Source: Conscription and call-up records; historical municipal archives from Valencian municipalities composing the anthropometric sample

Notes:
OLS estimates; *se* denotes robust standard error.
* Statistical significance at 10% level.
** Statistical significance at 5% level.
*** Statistical significance at 1% level.

In Table 3, a single model has been estimated for all of the individuals with the objective of distinguishing the effects of the independent variables on the endogenous variable for the two categories, farmers and farm workers. We have also introduced a dummy variable multiplying each independent variable, *Farmers*, which takes the value of one if the individual is a farmer and zero if he is a farm worker. If we analyse the first group of independent variables (*Town*), we can appreciate significative differences between the two periods. In the first period (1859-1899), the differences within the same town between farmers and farm workers were significant in favour of the farmers in four of the five municipalities. However, in the second period (1900-1939) these differences were no longer significant. With respect to the first sub-group of the set of variables that measure the effect of the SES (*Appeals for exemption)*, the general model finds hardly any differences in height between the two rural groups in accordance with

the appeals, although differences were found during the first sub-period. Of the cohorts between 1859 and 1899, the farmers who were excluded from military service because they had claimed to have physical problems were, on average, 5.2 cm shorter than the farm workers declared exempt for the same reason (Table 3, Model 2, Column 4). But they were not only shorter, they also made more appeals (10.5% as opposed to 2.9%). What factors could explain this difference in height? It could be argued that a proportion of the land-owning farmers who lived during the period 1870-1910 experienced the economic improvements associated with the expansion of intensive and commercial agriculture, but their bodies suffered the effects of the agricultural growth period as a consequence of the intensive use of labour, the intensification of production and a possible relative reduction in food consumption. With respect to the second sub-group of variables which measure the effect of the SES on height (*Education*), the three models reveal hardly any significant differences in height between the literate land-owning farmers and landless farmers (Table 3, Models 1, 2 and 3, Columns 2, 4 and 6). The same can be observed in the last group of independent variables (*Place of birth*). However, there is one surprising result: although the coefficient is not highly significant, the immigrant farmers from Castilla-La Mancha were, on average, 2.1 cm shorter than the immigrant farm workers from the same region (Table 3, Model 1, Column 2). In the rest of the immigrant groups there are no significant differences in height between farmers and farm workers.

In summary, from the estimates for the two sub-periods we can observe that in the first sub-period there are some differences between farmers and farm workers but, in the second sub-period the differences between farmers and farm workers were hardly significant which indicates that the inequality observed between these two groups diminished over time.

5. CONCLUSIONS

Based on the selection of five municipalites in the region of Valencia engaged in irrigated farming, this article has examined two issues related with the biological standard of living in Mediterranean rural Spain: first, the impact that the expansion of intensive and commercial agricultural and the agricultural growth process had on the physical welfare of the male population between the mid-nineteenth century and the first third of the twentieth century; and second, the influence that the socioeconomic status, measured in terms of access to landownership, had on the final average height

and on the social inequality of the rural communities. For both of these objectives the height data of the population of 41,841 conscripts, and a rural sample of 14,199 conscripts engaged in agricultural activities (10,493 farmers and 3,706 farm workers) between 1859 and 1939, have been analysed.

The anthropometric evidence shows that in the long term, the average height in the irrigated area of eastern Valencia increased by approximately 3 cm among the cohorts born between 1859 and 1939. The balance, in strictly biological terms, was positive. In this sense, one of the most relevant results that we have obtained is that, in contrast to what has been observed in other rural areas of Spain, the beginning of the production specialisation processes and the integration of the Valencian agricultural sector into the markets in the mid-nineteenth century did lead to an improvement in the biological standard of living of the populations of the irrigated area of Valencia. As described in the article, the intensive agriculture of Valencia offered greater employment opportunities and required more labour and capital, and although small family-run farms were the driving force, they generated higher levels of productivity and wealth. Therefore, there was a low incidence of emigration among the people from the irrigated area of and its economy displayed higher growth rates.

In addition to the evolution of height and the hypotheses regarding its determinants, during the period under study, we have identified two significant facts: first, that economic inequality (height inequality) diminished while the average biological well-being (average height) increased. This has been observed for the whole male population and also for the two rural groups analysed in the irrigated area of Valencia (farmers and farm workers). The second fact is the existence of biological inequalities depending on the socioeconomic status. The study of height in accordance with access to land ownership reveals that, at least from the mid-nineteenth century, land-owning farmers were taller than landless farm workers. The disappearance of aristocratic privileges and the formation of a market society gave rise to social differences which were reflected essentially in the economic domain, depending on wealth. In addition to the landowners and different tenants, there was another social group which had no access to ownership; the landless farm workers. The estimates carried out have revealed that for the cohorts of the second half of the nineteenth century, the biological differences between land-owning farmers and landless farm workers were significant, while during the second period considered, the cohorts of the

first third of the twentieth century, these nutritional inequalities between the two rural groups were not significant.

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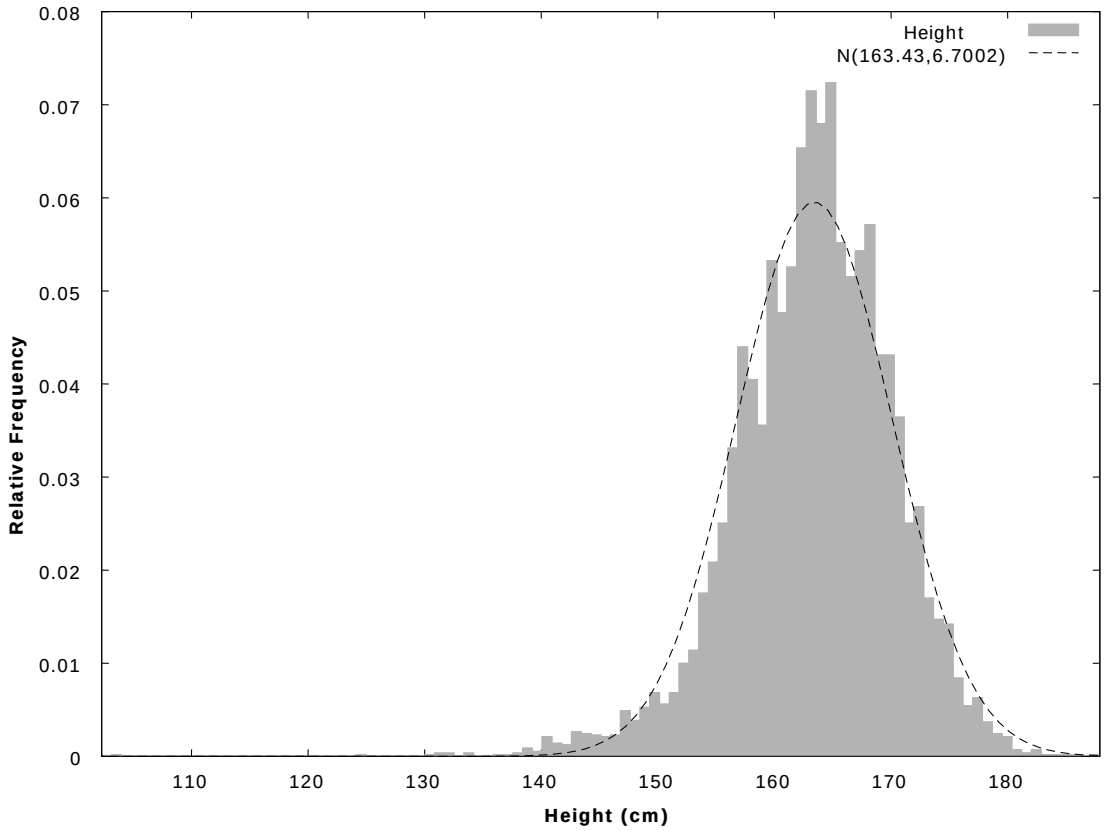
APPENDIX

GRAPH A-1

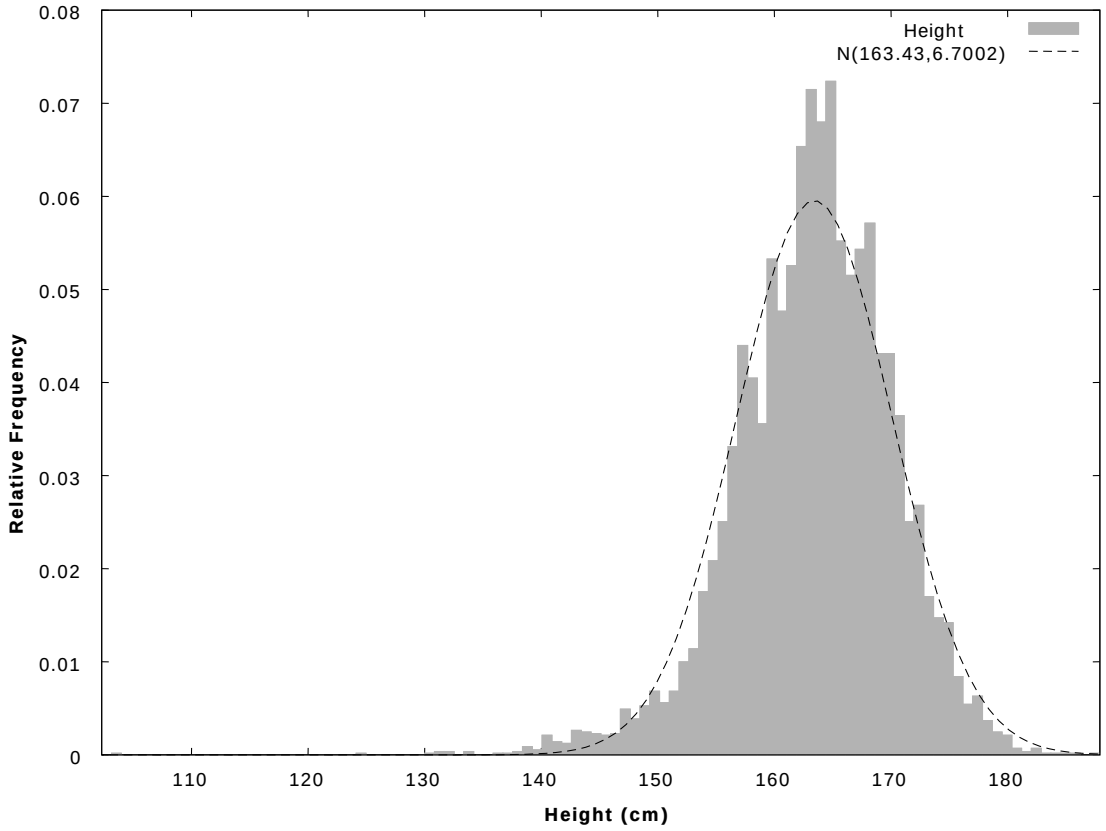
DISTRIBUTION OF THE HEIGHTS OF THE CONSCRIPTS MEASURED IN THE IRRIGATED AREA OF VALENCIA, RECRUITS OF 1879-1920 (BIRTH COHORTS OF 1859-1899)



Source: Conscription and call-up records; historical municipal archives from Valencian municipalities composing the anthropometric sample

GRAPH A-2

DISTRIBUTION OF THE HEIGHTS OF THE CONSCRIPTS MEASURED IN THE IRRIGATED AREA OF VALENCIA, RECRUITS OF 1921-1960 (BIRTH COHORTS OF 1900-1939)



Source: Conscription and call-up records; historical municipal archives from Valencian municipalities composing the anthropometric sample