



Short men in poor lands: The agrarian workers from southwestern Spain in anthropometric perspective

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ABSTRACT

With a sample of heights of almost 60,000 men, born between 1855 and 1979 and recruited between 1876 and 2000, our work analyzes the nutritional gap between the agrarian and non-agrarian population in Extremadura, a Spanish region located among the poorest ones in Europe. The analysis reveals that this difference is not only statistically significant, but also tends to increase as the average stature of the active population grows. Among the causes of the agrarian height penalty, our article focuses mainly on the economic differences. However, the research also insists on the roots of these differences, especially those linked to the adverse physical conditions of the territory, the dynamics of the Christian conquest in the Middle Ages and the strong and persistent concentration of land ownership in the region. In short, this paper concludes that the anthropometric gap between agrarian and non-agrarian workers is due not only to economic causes, but also to geographical, historical and institutional reasons.

1. Introduction

The present study uses anthropometric theory to analyze the historical evolution of inequality. This theory considers that the height reached at the end of the physical growth stage (18–22 years) is the expression of the net nutritional status (Steckel, 1995), what remains of the nutrition after discounting the energy consumed by the basal metabolism, the physical activity and disease (Floud, 1991). In this sense, adult stature has been used in recent decades as a good indicator of biological standard of living (Komlos, 1985) since it synthesizes some of the most important variables of physical well-being: family income, price of agrarian products, food technology, health, hygiene, environmental health, educational level or working conditions (Eveleth and Tanner, 1976; Bogin, 1988; Martínez-Carrión, 2001). Given its ability to integrate the different circumstances in which growth occurs during childhood and youth, anthropometric research has also revealed the capacity of height to study inequality as a specific dimension of living conditions (Cámara et al., 2019). Differences in stature by gender, educational level, place of residence, social status, family wealth, labor

market or between members of different castes, ethnic groups, and even neighborhoods within the same city or siblings from the same family have been used to analyze inequality in different parts of the world from several perspectives (Quiroga, 2001; Guntupalli and Baten, 2006; Cinnirella, 2008; Martínez-Carrión and Puche, 2009; Floud et al., 2011; Baten and Blum, 2012; Schoch et al., 2012; Inwood and Masakure, 2013; Deaton, 2013; Núñez and Pérez, 2014; Blum, 2016; Inwood et al., 2015; Meinzer and Baten, 2016; Varea et al., 2019; Cámara et al., 2019; Salvatore, 2020; Ramon-Muñoz et al., 2021).

Occupation has been the subject of special concern among the multiple determinants of height inequality, but not so much as a differentiating variable itself, but rather as a proxy of socioeconomic status (Baten, 2000; Komlos and Kriwy, 2002; Salvatore, 2004; Case and Paxson, 2008). In this way, following social stratification models, such as the HISCLASS grouping (Van Leeuwen and Maas, 2011), anthropometric historiography has been able to identify in the last decades significant differences in stature between the diverse social layers. The results, in any case, continue to ratify what the pioneers of anthropometric history have been maintaining since the beginning of the

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discipline: that height increases with social status (Steckel, 1983; Komlos, 1994; Baten, 2000).¹

Behind such a sensible conclusion, there are obviously many nuances hidden, but not as many as those that hide the anthropometric differences that have historically existed between the different occupational groups. Within them, the one that seems to contain the greatest doses of internal inequality is precisely the one that has had the greatest economic importance in traditional societies, that is, the agrarian sector. Not always, however, anthropometric studies have echoed these internal differences. In fact, in the works referring to the 18th and 19th centuries, farmers appear among the tallest in the active population in many of the territories studied to date, from the USA (Komlos, 1987; Sunder, 2013) to Chile (Llorca-Jaña et al., 2018), passing through Ireland (Young et al., 2008), Bavaria (Lantzch and Schuster, 2009), South Africa (Inwood and Masakure, 2013), Sweden (Silevntionen et al., 2001), France (Heyberger, 2014) or Flanders (Depauw, 2017). The explanation for such a privileged situation seems to be linked to proximity to food, especially meat and milk, and, in some cases, to more frequent exposure to sunlight and thus increased production of vitamin D (Carson, 2009). The basic idea is that farming families enjoyed better access to nutritional resources in an era when food technology and market integration of highly perishable products was still limited (Komlos, 2003).

On the contrary, in most of the anthropometric studies dedicated to the 20th century, farm workers appear among the shortest in society. This is the case of Belgium (Alter et al., 2004), India (Guntupalli and Baten, 2006), Russia (Mironov, 2007), Czechoslovakia (Cvrcek, 2009), New Zealand (Inwood et al., 2015) or Spain (Quiroga and Coll, 2000). In the latter case, agrarian workers are at the bottom of the anthropometric stratification in all the territories studied to date: Murcia (Martínez-Carrión, 1986), Castilla y León (Moreno-Lázaro and Martínez-Carrión, 2009), Valencia (Ayuda and Puche, 2014), Antequera (Martínez-Carrión and Camara, 2015), Hellín (Cañabate, 2015), Alcoy (Puche and Cañabate, 2016) or Castilla-La Mancha (García-Montero, 2018).² The explanation in these cases is not always explicit, but it seems reasonable to think that it is related to the low salary level of agrarian workers and to what we can call the paradox of proximity, that is, the fact of being closer to food than other professional groups, but not being able to access them because they do not own the land or the cattle that produce them. In this sense, the main differentiating element is not the distance to nutritional resources but the ownership of such resources.

With this starting idea, our study analyzes the differences in height between the agrarian workers and the rest of the active population in Extremadura (Map 1). Located on the southern border of Spain with Portugal and administratively divided into two provinces (Cáceres to the north and Badajoz to the south), Extremadura is, unlike most of the Spanish territories studied so far, a region that has never been industrialized, not even during the so-called “Spanish miracle” of the 1960s. If

¹ In line with Baten and Blum (2011), one of the most important reasons for the anthropometric differences between social strata is that generated by the purchasing power and, by derivation, nutrition. And it is that high-quality foods, particularly ones that contain animal protein, such as meat and milk, are more expensive than carbohydrates because raising livestock requires more inputs in terms of land and time. Therefore, it is usually the wealthier social classes that enjoy a higher quality diet. Food of the lower strata, however, is based more on carbohydrates, since they offer more energy per monetary unit compared to animal proteins. Since meat and milk are engines in the growth process, the social elites end up being mostly significantly taller.

² Even though Spain is one of the countries in which anthropometric historiography has recently advanced the most, we still do not have homogeneous height series for each Spanish region. Some works (Quiroga, 2001; Martínez-Carrión et al., 2016) allow us to approach the regional differences in height, but none of them allow us to know anthropometric differences by occupation at the regional level.

we add to this an agrarian structure with very low productivity, dominated by large-scale exploitation and the strong concentration of land ownership, by the latifundia after all, the region under study becomes a magnificent laboratory to contrast the hypothesis of a possible agrarian penalty in terms of biological well-being. Furthermore, as the analysis is carried out on a truly large dataset (58,485 records) and over a really long period of time (1855–2000), the results of our research are very significant for anthropometric historiography.³

2. Sources, data and methods

Our research is fundamentally based on the individualized records to which the Military Recruitment Law of 1856 gave rise to in Spain. This law established compulsory military service and imposed on all city councils in the country the duty to annually collect the medical and anthropometric information of all young men of legal enlistment age. Since then, until the extinction of compulsory military service in 2001, every year, around the same dates, these boys were summoned to physical recognition in each municipality. From this type of examinations are born the so-called Acts of Classification and Declaration of Soldiers (henceforth, ACDs). In them, the municipal authorities not only collect the height of all the men called up, but also the chest circumference and, from 1955 onwards, the weight. In addition, the ACDs include the affiliation, place of birth and residence, level of literacy and, in many cases, the profession of each recruit. This qualitative information is very useful for carrying out disaggregated analyzes such as the one proposed here.

Previously, however, it is convenient to solve some methodological problems. One of the most limiting is that derived from the very nature of ACDs. Since they are sources prepared by the town halls, they are not usually centralized in a single archive, but scattered throughout the archival holdings of each municipality. The information they provide is also not aggregated, so it is necessary to collect it recruit by recruit. In such circumstances, anthropometric studies of a regional nature can only cover a limited number of localities, trying, yes, to compose representative samples of each region. The sample used here, made up of 58,485 records, comes from young people born between 1855 and 1979, recruited between 1876 and 2000 in thirty municipalities in Extremadura. All the economic and demographic realities of the region are represented in this dataset, which we have called Extremadura’30. Some of the localities of it fit into what demographers call “agro-cities” (Reher, 1986), large towns with an economic structure tilted towards agriculture and livestock, but with a greater weight of industry and services than in rural areas. The remaining municipalities in the sample follow the guidelines observed by Extremadura’s economic historiography for the region (Linares-Luján and Parejo-Moruno, 2013): overwhelming predominance of the agrarian sector until well into the 1950s, little presence of the industry and growing importance of construction and services from the 1920s.

The second problem of ACDs is that generated by changes in the age of enlistment (Cámara, 2006). From the conscription of 1907–1971, this age was legally established at 21 years, just in the last phases of the period in which the anthropometric theory places the end of the stage of physical growth (18–22 years). However, before and after those dates, Spanish military legislation modified the recruitment age several times, making it vary from 18 to 20 years. In principle, according to the range established by anthropometric theory, these modifications should not affect our height series in any way. However, given that, in contexts exposed to nutritional problems, physical development can exceed 20

³ Such as Öberg (2014: 141) points out, despite the large number of studies carried out so far, few explore long term changes in socioeconomic height differences. Most studies investigate only parts of the 19th or the 20th century and long-term changes are generally inferred from different samples or age groups within cross-sections.

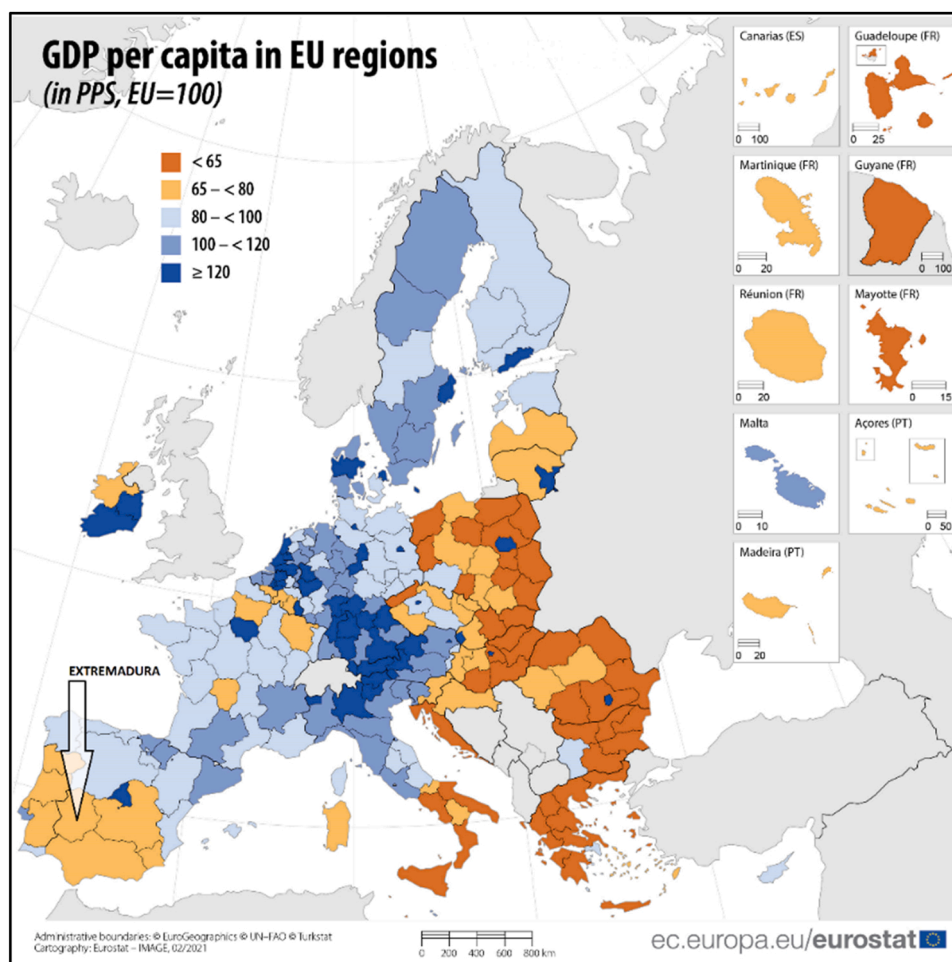


Fig. Map 1. Extremadura in Europe (2020).

Source: European Commission (Eurostat) <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210303-1>.

years, Spanish economic historiography has tended to homogenize the samples extracted from the ACDs, standardizing at 21 years the mean height of men recruited at 18–20. There are different standardization methods. The one used here (Ramon-Muñoz and Ramon-Muñoz, 2016) consists of calculating the median stature of all the age groups contemplated in the military legislation and adding the resulting differences to the average height of the young people who were measured before the age of 21 (Linares-Luján and Parejo-Moruno, 2021).

The third methodological problem is more difficult to solve. It refers to information provided by ACDs about each recruit's specific profession. In the occupations included in the secondary and tertiary sector, as well as in the students, generally university ones, there are usually no identification problems. It is just in the jobs linked to the agrarian sector in which the sources of military recruitment pose the greatest difficulties. Compared to other Spanish regions, the Extremadura's ACDs do not always allow to distinguish between land or livestock owners and permanent or temporary workers. It is true that, as is logical in a region characterized by the strong concentration of land property, most of the recruits who declare working in the agrarian sector are recognized in the sources as day laborers, seasonal workers or agrarian peons. We are talking about landless, low-skilled workers, hired to perform specific tasks (planting, harvesting, pruning, threshing, shearing, milking, grazing, etc.). Together with them, the ACDs sometimes speak of owners and even tenants and sharecroppers, but, above all, of "rural people" (*gente del campo*). The Extremadura's historiography distinguishes different types of occupations within this latter category, from

the permanent or temporary worker to the farmer or rancher, both occupations that are closer to the owner than to the employee. In these circumstances, given that it is impossible to classify the many recruits who declare being rural people, we have chosen not to make any differences within the jobs linked to agriculture and livestock.⁴ This can introduce an upward bias in the average height of the agrarian population that should not be ignored in our anthropometric comparison.

Nor can we ignore the differences in interpretation to which the reference dates used to analyze the series of heights resulting from military recruitment may give rise. In principle, common sense warns us against using the year of conscription as a time witness for each generation. At the age of 21, that is, in the final phase of the period of physical growth, the influence of economic and non-economic variables on adult height is in clear recession (Bogin, 1988). The same does not happen with the year of birth. As anthropometric theory holds, the stature attained at 20–22 years of age records the net nutritional impact

⁴ From the 30,173 recruits that make up the agrarian sector in our sample, 33.2% declare being rural people. Along with them, 46.2% claim to be a landless worker (fundamentally day laborers) and only 0.07% (22 recruits) confess to being an owner. In Appendix 3 we summarize the differences in average height shown by the main categories that the ACDs allow us to identify within the agrarian population. Keep in mind, however, that these differences can be highly biased by the number of records available for each category.

accumulated from the earliest moments of physical growth. Following this criterion, the specialized literature tends to use the year of birth as the reference date for the interpretation of height series. However, given the volatility of stature in the short term, anthropometric historiography also tends to calculate the average height among recruits born over the same five-year period or birth cohort (Martínez-Carrión, 1994). In the representation of our series, we follow this procedure, but adding a secondary horizontal axis with the recruitment cohorts. The objective of this second axis is to try to capture the adjuvant circumstances that may have influenced adult height throughout puberty (Spijker et al., 2008; Depauw and Oxley, 2018).⁵

To interpret the anthropometric series constructed from the ACDSs, in addition to the graphic representation of the average heights, we have chosen to use two very simple statistical techniques: the simple index number and the equality test of means. The index number helps to observe with a single glance how the distance between the different groups that make up a variable fluctuates over time. Calculated as a percentage of any value over the same base value, the index number is perhaps the simplest method to visually detect convergence processes, that is, to observe whether the distance that separates two or more groups within a same variable decreases over time. The test of equality of means or T-test goes a little further by allowing us to know if the difference between these groups is statistically significant or the result of chance. The T-test implies a hypothesis test where the null hypothesis is that the difference between the means compared is not statistically significant. To interpret the results obtained, we must use the criterion “observed level of significance” (*Sig.*). If this value is less than the conventionally used significance limit (0.05), we must reject the null hypothesis and conclude that the observed difference is statistically significant.

3. Results

Once standardized and represented graphically (Fig. 1), the two series of heights that we have constructed for Extremadura are quite consistent. To begin with, they confirm the great anthropometric trends recently observed for the entire male population (Linares-Luján and Parejo-Moruno, 2021). Thus, after the anthropometric downturn generated by the last great subsistence crises of the 19th century, especially the so-called “end-of-the-century agrarian crisis” (Garrabou, 1985), the active population begins a practically uninterrupted climb that raises the average height of non-agrarian recruits by 13.5 cm and that of agrarian ones by about 14.5 cm. We are talking about an average increase of 0.9 cm per decade for non-agrarian workers and 1.0 cm per decade for agrarian ones, something especially significant in a region as backward as Extremadura. This powerful growth only seems to lose strength at specific times, especially during the period between 1910–14 and 1925–29. The deceleration shown by our two series at that time is related not only to the inflation inherited from the First World War (1914–1918) and the Spanish flu of 1918, but also with the critical environment in which children born thereafter experienced the adolescent growth spurt. This context was marked over all by the generalized shortage that the Spanish Civil War caused between 1936 and 1939 (García-Pérez, 2010) and the famine that the ironclad autarkic policies of the post-war period originated between 1939 and 1952 (Linares-Luján and Parejo-Moruno, 2020).

The conjunctural causes that explain the stagnation of our height sample between 1910 and 1929 have been addressed in other works and will be summarized in the following section. Here, therefore, we will

only dwell briefly on the long-term reasons that allow to understand the sustained growth that such series show from 1870–74 onwards. In this sense, we believe that the most appropriate is to invoke to the variables that, in addition to the energy consumed by the basal metabolism’s maintenance, impossible to measure with the available sources, most directly influence adult height: nutrition, disease and physical effort. From this triple perspective, the longitudinal growth of the active population in Extremadura, agrarian and non-agrarian one, seems to be due to three major improvements: the “nutritional transition”, the “health transition” and the technical transformation that accompanies “structural change”.

Regarding nutrition, it must be said that food problems, especially among the day laborer population, persisted in Extremadura until well into the 20th century. In fact, the few available sources on the subject, which we will discuss later, suggest that it was not until the mid-1950s that these problems began to disappear. It was therefore then that the region witnessed the nutritional transition, a process that entailed the intensification of the level of calorie consumption and the degree of diversification of the diet throughout the Western world during the 19th and 20th centuries (Popkin, 1993).

Much earlier it seems to have begun the health transition in Extremadura. This process was characterized by the pass from a demographic regime of high mortality, governed by infectious diseases and concentrated in early ages, to a regime of very low mortality, dominated by chronic and degenerative pathologies especially concentrated in the older population (Pérez-Moreda et al., 2015). Some monographies allow us to date the beginning of such a process in Extremadura in the last decades of the 19th century (Sánchez, 1991). In essence, the epidemiological change in the region reduced the probability of death in the stages prior to adulthood and modified the etiology of the disease, passing from morbidity related to malnutrition and lack of hygiene to a morbidity mainly linked to the improvement of life expectancy (Sánchez and Leonato, 1993).

Together with the health transition, Extremadura also witnessed a transformation in the economic structure and a change in working conditions. Industrialization passed without sorrow or glory by Extremadura (Zapata, 1996), but the proportion of agrarian workers in the region was decreasing throughout of the entire 20th century. The loss of importance of the agrarian workforce was accompanied by a relative increase of the workers employed in the services and, above all, of the students. This transformation stimulated the growth of the average height of the male population through three ways. On the one hand, the relative increase of the better fed recruits (students). On the other, the proportional growth of occupations that require a less physical effort (service sector). Finally, the relative decrease in the population employed in trades of a greater energy expenditure, that is, the agriculture and livestock tasks. In the process of change, however, the agrarian population also continued to grow physically. And it is that, in the mid-1950s a rapid mechanization of the countryside began in Extremadura, as in the rest of the country. This fact, on which we will insist later, contributed to consolidate the increase of the mean height of the agrarian population by reducing the energy needs of agricultural and livestock tasks.⁶

In no case, neither the reduction of the energy required by physical effort or by illness, nor the late but certain improvement in nutrition, managed to substantially reduce the observed height gap between the agrarian and non-agrarian population (Fig. 1). It is more, our series

⁵ It is important to clarify that our height sample does not pose truncation problems (Komlos, 2004). Spanish military legislation did impose a minimum height for compulsory military service, but all young people of enlistment age were included in the ACDSs, regardless of whether they were ultimately classified as unfit by local authorities. See Appendix 1.

⁶ In this matter it is advisable to be extremely cautious. Energy expenditure at work depends on many factors that are difficult to weigh in historical terms: age, sex, height, weight, environmental temperature, duration of the task, etc. However, some reports carried out by the WHO for certain physical activities (World Health Organization, 1985) seem to confirm the idea that, with some exceptions within the manufacturing industry and construction, non-agrarian activities tend to consume less energy than non-mechanized agrarian activities.

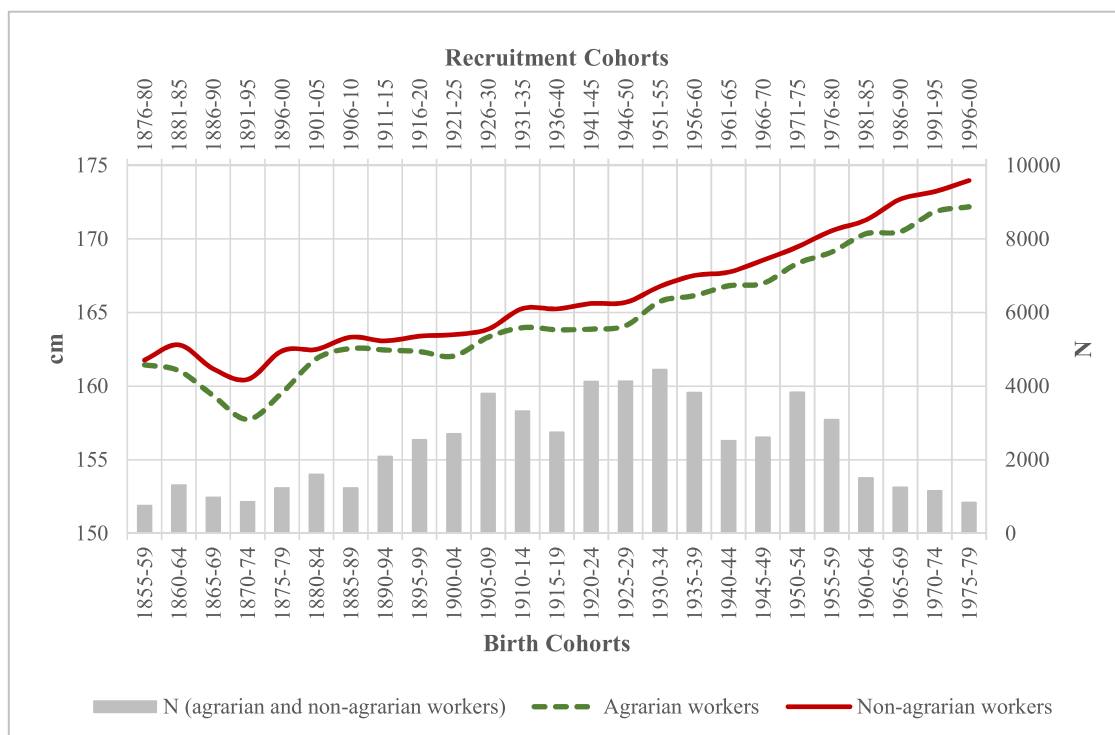


Fig. 1. Mean height of male population included in the sample Extremadura'30 (standardized stature at 21 years in cm and total number of records). Sources: own elaboration based on the ACDSs of Aceuchal, Almendralejo, Azuaga, Arroyo de la Luz, Barcarrota, Cáceres, Caminomorisco, Campo Lugar, Fuentes de León, Hervás, Jerez de los Caballeros, La Albuera, La Coronada, Madroñera, Magacela, Mérida, Montánchez, Plasencia, Oliva de la Frontera, Quintana de la Serena, Salvaleón, San Vicente de Alcántara, Valle de la Serena, Valverde de Leganés, Villafranca de los Barros, Villanueva de la Serena, Zafra, Zahínos, Zarza la Mayor and Zorita.

reveal that, despite the gains accumulated in the long term by recruits from agriculture and livestock (1 cm more than the non-agrarian population), the anthropometric difference between one part and another of Extremadura's society not only did not decrease during the period under study, but it tended to increase progressively after the start of sustained growth of height (Fig. 2). We are talking about a 1.8 cm difference in 1975–79 compared to 0.6 cm in 1880–84. It goes without saying, therefore, that, unlike other territories in which the increase of stature led to a decrease in anthropometric inequality (Brundtland et al., 1980; Peck and Vajgerö, 1987; Kuh et al., 1991; Cernerud, 1993; Sunder, 2003; Li et al., 2004; Li and Power, 2004), the region witnessed of a process of clear height divergence that we will try to explain in the next section.

For now, it should be clarified that the height gap between the agrarian and non-agrarian population is also supported by the tests of equality of means carried out on the whole of our sample (Table 1). With an observed level of significance of 0.00, we must reject the null hypothesis and conclude that the difference between the mean stature of recruits employed in the agrarian activity and that of young people employed in the other sectors is statistically significant. It is clear, therefore, that it is the penalty and not the agrarian premium that works in Extremadura throughout the period under study.

This finding is also confirmed if we apply the T-test to each of the cohorts into which we have divided the recruits included in our height sample (Table 1). Only in the generations born in 1855–59, 1880–1894, 1905–09 and 1960–64, just when the anthropometric difference between agrarian and non-agrarian workers is more reduced, does the equality of means test offer significance levels greater than 0.05. Therefore, it is not chance but the reality that determines the penalization of male stature observed in Extremadura among the population dedicated to agricultural and livestock tasks.

Following this line of interpretation, in the next section we will explore the reasons behind such professional penalty. We will start from

the consideration of adult stature as an expression of energy accounting mainly made up of nutrition, disease and physical effort. For reasons of space, we will only address the incidence of nutrition in stature gap, leaving the study of the incidence of health and physical effort for another occasion. It should be noted that nutrition is probably the most important exogenous or environmental element when interpreting longitudinal trends in height (Eveleth and Tanner, 1976; Bogin, 1988). It is also a synthesis of many other variables among which not only is the economy represented, but also, as we shall now see, geography, history, the institutional framework, technology or politics.

4. Discussion

In Spain, the close relationship between nutrition and anthropometric performance was already perfectly reflected in the answers to the interrogation carried out by the Ministry of Commerce, Instruction and Public Works in 1849. The survey, distributed among provincial authorities, economic societies and agrarian boards of the country to know the situation for the establishment of entities specialized in mortgage credit, dealt with various issues, among them, the living conditions of agrarian workers (García-Sanz, 1980). The testimony offered in this regard by the Agriculture Board of Tarragona, a province located in the rich region of Catalonia, is not wasted:

“(…) currently the unhappy day laborer and even the small owner are condemned not to a frugal subsistence, but an insufficient one (…); the result of this sad existence is that the worker grows rachitic, that his strength soon abandons him, that his offspring are also weak and rachitic, for he bears in his body the seal of scarcity and misery of the one who gave him his being, and, finally, that perishes before its time” (own translation from García-Sanz, 1980: 67).

If this is the physiological picture of the working class in one of the provinces of Spain with the greatest anthropometric development

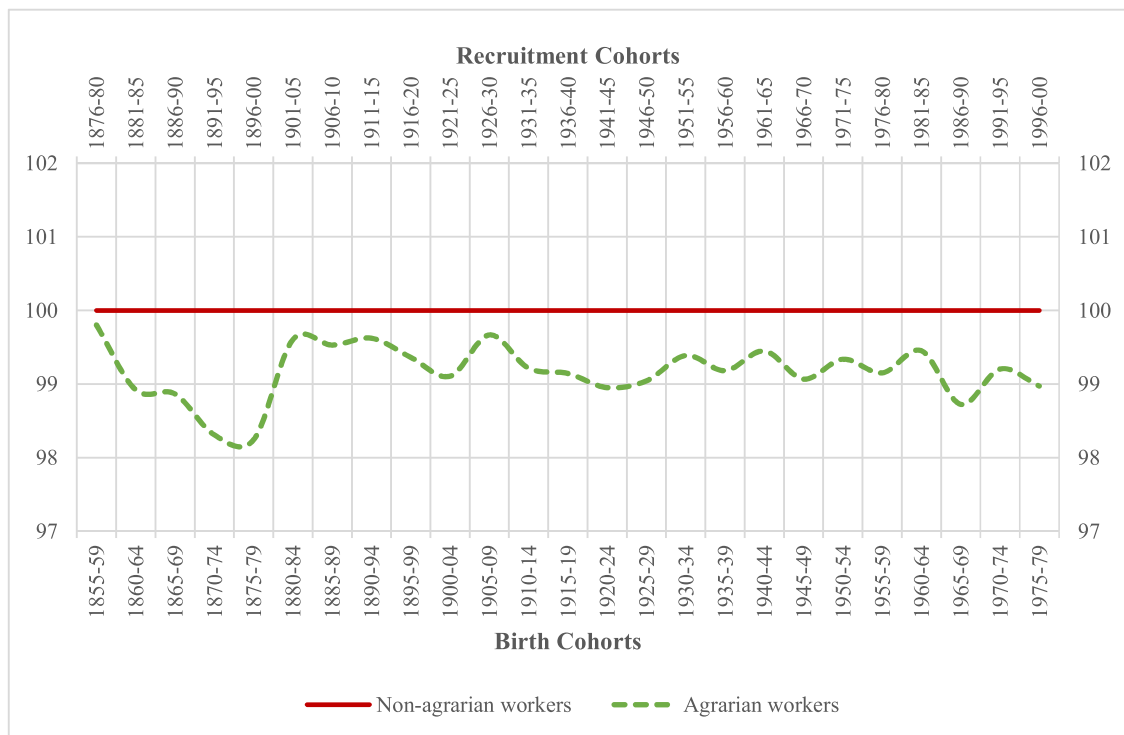


Fig. 2. Mean height of male population included in the sample Extremadura’30 (index numbers with base 100 in average height of non-agrarian workers). Source: the same one as Fig. 1.

Table 1
Independent samples T-test for dataset Extremadura’30 (agrarian and non-agrarian workers).

Birth Cohorts	Recruitment Cohorts	t	df	Sig.	Means Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
1855–1979	1876–2000	-38.09	58,483	0.00	-2.42	0.06	-25.48	-22.99
1855–59	1876–80	-0.46	744	0.65	-0.33	0.72	-17.46	10.89
1860–64	1881–85	-4.35	1311	0.00	-1.91	0.44	-27.76	-10.50
1865–69	1886–90	-2.51	972	0.01	-1.65	0.66	-29.34	-3.60
1870–74	1891–95	-3.73	852	0.00	-2.54	0.68	-38.83	-12.02
1875–79	1896–00	-5.42	1231	0.00	-2.69	0.50	-36.65	-17.17
1880–84	1901–05	-1.73	1602	0.08	-0.67	0.39	-14.27	0.88
1885–89	1906–10	-1.63	1231	0.10	-0.75	0.46	-16.51	1.54
1890–94	1911–15	-0.79	2080	0.43	-0.26	0.34	-9.22	3.94
1895–99	1916–20	-2.62	2539	0.01	-0.75	0.29	-13.09	-1.88
1900–04	1921–25	-5.23	2704	0.00	-1.45	0.28	-19.98	-9.09
1905–09	1926–30	-1.95	3798	0.05	-0.43	0.22	-8.67	0.02
1910–14	1931–35	-4.32	3323	0.00	-1.01	0.23	-14.63	-5.50
1915–19	1936–40	-4.21	2745	0.00	-1.17	0.28	-17.14	-6.24
1920–24	1941–45	-8.24	4127	0.00	-1.75	0.21	-21.63	-13.31
1925–29	1946–50	-7.12	4132	0.00	-1.52	0.21	-19.34	-10.99
1930–34	1951–55	-5.10	4449	0.00	-1.03	0.20	-14.29	-6.35
1935–39	1956–60	-5.98	3817	0.00	-1.33	0.22	-17.66	-8.94
1940–44	1961–65	-3.47	2519	0.00	-0.99	0.29	-15.53	-4.32
1945–49	1966–70	-5.54	2605	0.00	-1.52	0.27	-20.60	-9.82
1950–54	1971–75	-4.65	3828	0.00	-1.13	0.24	-16.11	-6.55
1955–59	1976–80	-5.29	3086	0.00	-1.66	0.31	-22.75	-10.45
1960–64	1981–85	-1.43	1502	0.15	-0.62	0.43	-14.69	2.32
1965–69	1986–90	-4.50	1247	0.00	-2.05	0.46	-29.41	-11.55
1970–74	1991–95	-3.15	1151	0.00	-1.70	0.54	-27.53	-6.38
1975–79	1996–00	-2.65	840	0.01	-1.91	0.72	-33.23	-4.95

Source: the same one as Fig. 1.

(Martínez-Carrión et al., 2016), it is not difficult to imagine how dramatic the situation of the agrarian worker could be in the middle of the 19th century in Extremadura. In fact, the responses sent from the region in 1849 give the keys to such a tragic situation. In the province of Cáceres, for example, the provincial authorities estimated an average annual wage for day laborers of 945 *reales*. They also calculated a mean annual expenditure of 1460 *reales* for a family of 4–5 members. According to these figures, the salary of a day laborer in the mid-19th century only covered 65% of the family expenses, expenses that, in terms of food, only included bread, oil, chickpeas and potatoes. Worse still was the situation in the province of Badajoz, where the provincial authorities estimated an annual wage of 980 *reales* for a mean expending of 1827 *reales*. In other words, in the southern half of Extremadura, the salary of a day laborer only covered 54% of the day-to-day expenses of an average family.⁷

This budget deficit, translated into anthropometric weakness, is due to various reasons, all of which converge in the strong concentration of land ownership. On the one hand, we must highlight the agroclimatic conditions of the region. Characterized by very dry summers and by poor and thin soils, Extremadura is one of the regions of Spain least equipped by nature for the development of traditional agriculture (Appendix 2). On the contrary, the concentration of rains between October and March, together with the moderation of winter temperatures, guarantee an abundance of fresh grass for much of the year. Hence, the livestock vocation of the region, but also the consolidation of a land ownership distribution model defined by the predominance of the latifundia. Such a predominance is perfectly reflected in the data offered for 1930 by the first rustic property cadastre drawn up in Spain (Carrión, 1932). According to these data, 62.8% of the entire registered surface in Extremadura belonged to only 1.8% of the owners in the region. The average surface owned by that 1.8% was 756 ha. Needless to say that we are facing an example of extreme concentration of land property.

This ownership model sinks its roots in the Middle Ages and is associated with four facts. The first is the situation of “military frontier” in which Extremadura lived from the installation of Muslim culture in Spain (8th century) until the definitive advance towards the south of the Christian armies from the north (12th century). This marginal situation generated an extremely weak network of human settlements in the region. On the other hand, most of Extremadura did not begin to be repopulated by the Christian armies until the last decades of the 13th century. The delay in the repopulation limited even more the demographic expectations of the region and contributed to enhance the livestock specialization of the vast area not yet humanized. In the same way, the territorial occupation formula promoted by the Christian kingdoms in Extremadura, characterized by the donation of large latifundia to military orders, noble families and councils, favored the consolidation of large property and reinforced the livestock option. For its part, the early and close link established between nobility and merino wool production, strengthened by the determined livestock orientation of the military orders, was decisive for incorporate Extremadura in the transhumance routes (Linares-Luján, 2012), a livestock management formula consisting of the seasonal transfer of sheep from the summer pastures, in the northern Spain, to winter herds, located mainly in the southwest of the country.

The Christian conquest thus outlined the great keys that, together with the poverty of the soil and climatic adversity, explain the predominance of the latifundia and the concentration of land ownership in Extremadura. These characteristics converge in the so-called *dehesa* system, a model of agrosilvopastoral exploitation supported by a savannah landscape and dominated by extensive livestock farming (mainly sheep and pigs), rainfed agriculture (mainly cereal) and forestry

(mainly acorns and cork) from a scattered forest composed mainly of holm and cork oaks. Distinguished by its productive versatility, but also by its low productivity and its limited capacity to increase the demand for labor given its special livestock orientation, the Extremadura dehesa has traditionally favored the eventuality of agrarian work⁸ and the proletarianization of the peasantry, that is, the conversion of the peasant family in salaried labor force. In such a situation, this form of adaptation of man to an adverse environment has historically limited the possibility of increasing the income of rural society (Linares-Luján and Zapata, 2003) and, consequently, the level of food consumption of agrarian population.

Unfortunately, for most of the period under study we do not have statistical data disaggregated at the regional level on the per capita income of agrarian workers in Extremadura. In fact, we do not even have homogeneous salary series, neither for Spain in general, nor for Extremadura in particular, until after 1955. However, the few estimates available at the national level, as well as the scattered news collected by the preserved sources for the region, allow us to attest to the serious economic and nutritional difficulties that the working class of Extremadura has been suffering since the mid-19th century.

We have already spoken, for example, of the budgetary imbalances observed by the provincial authorities in the interrogation carried out in 1849. This is not, however, the only testimony of the shortages that Extremadura’s day laborers had to suffer during the 19th century. In 1883, for instance, a new survey was sent to the provincial authorities by the so-called “Commission for Social Reforms”, a government institution created to study the living and working conditions of labor class. According to the responses from the province of Badajoz, day laborers’ wages were insufficient to cover “the negligible needs of the working family”. The economic situation of agrarian workers was especially “bad and distressing” during the winter, just when the demand for labor in the countryside was at its lowest point and when basic foods reached their highest prices (Comisión de Reformas Sociales, 1892: 329). In the province of Cáceres, wage of the day laborer was totally insufficient to sustain a typical family. Usually,

“(…) the economic condition of industrial workers, although not very advantageous, is medium, in relation to their wages (…). That of the agrarian workers is too bad, since their very small wage is barely enough to support the family (…). In the well-off classes the nature of the diet is mixed and generally healthy and nutritious. Meats are a great part of their eating habits. In the day laborer classes the diet is almost exclusively vegetable, consisting of the use of bread, potatoes, and various legumes. Such a method is enough for organic sustenance, but not to preserve the day worker with the necessary robustness to support his daily bodily tasks, this being the cause of his anticipated decrepitude” (own translation from Comisión de Reformas Sociales, 1892: 467–468).

It is convenient to keep in mind that, at the time of 1883, when the Commission of Social Reforms carried out the interrogation on the living conditions of the working class, a very important institutional change had taken place in the daily life of the agrarian workers. The General Law of Disentailment of 1855 had nationalized and sold to the highest bidder most of the lands administered by the municipalities and a good part of the lands of common use. Until then, the rural society of Extremadura had carried out an endless number of free or semi-free practices, essential to complement the income of the peasant family (hunting, fishing, extraction of stone, sand, firewood or charcoal, harvesting of fruits, mushrooms and medicinal herbs, intermittent crops in small plots, use of pastures and acorns for livestock...). We are talking, of course, about the extra income that historically had covered the

⁷ Central Archive of Spanish Ministry of Agriculture, “Interrogatorio sobre crédito territorial de 1849”, signature A204-001 (1st and 2nd Parts).

⁸ In the interrogation of 1849, the provincial authorities of Badajoz and Cáceres assigned day laborers an annual average of between 245 and 270 days worked (García-Sanz, 1980: 63).

differences observed in 1849 between wages and expenses within day labor families. The civil confiscation, therefore, estimated at almost 1 million ha. for the whole of Extremadura (Linares-Luján, 2002), had seriously harmed these families, “depriving them of the uses that the laws or customs granted them at modest prices or gratuitous” (Comisión de Reformas Sociales, 1892: 336). All of this occurred in a context characterized, according to the data available for some regions near Extremadura (Reher and Ballesteros, 1993; Moreno-Lázaro, 2006), by the upward trend in nominal wages, but also by the stagnation of real wages, a logical consequence of the increase in the prices of basic products to which the end-of-the-century agrarian crisis was giving rise.⁹

The arrival of the new century did not change the situation of peasantry. In 1902, considering of the greatest urgency to know the situation of day laborers in the provinces of Andalusia and Extremadura, the most affected by the latifundia’s regime, the Spanish government ordered the Commission for Social Reforms to prepare a new query on the living and working conditions of day laborers. In its letter of acceptance, the commission made clear the uniqueness of agrarian workers in Andalusia and Extremadura.

“In general, the situation of the Spanish worker has been considered the most disadvantageous of all those of the workers of the great nations. This is proven by Mulhall’s calculations in *The Progress of the World*: the nutritional needs of the Spanish worker require 67% of his salary, while the American worker only spends 21%. If the situation of agrarian workers were compared with that of industrial workers in our own country, it is possible that still other disadvantages would be demonstrated. Finally, if the situation of day laborers in Andalusia and Extremadura were compared with that of other regions of the Iberian Peninsula, very significant differences would surely also be appreciated” (own translation from Instituto de Reformas Sociales, 1905: 6).

The information finally published by the commission in 1905, limited to the number of municipalities that responded positively or negatively to each question, did not offer specific data, but it did confirm the situation of poverty in which day laborers in Extremadura continued to live. In their homes, the usual family diet was still clearly insufficient. This was also confirmed in 1912 by the Labor Inspector of Salamanca, José González Castro, who for several years had practiced the profession of doctor in different towns in Extremadura.

“When the family eats meat -the Inspector said- the very little that is thrown into the pot is for the father (...) The soup, with a shade of oil, is served in the morning, the *gazpacho* [cold tomato soup] at noon and at night the pot, composed of hard chickpeas and cooked pumpkin (or potato) blood sausage, with a lot of hot pepper, yes! That is the ordinary diet of a day laborer family. And if at least the quantity supplied the nutritional poverty of this diet, one could overlook such a sad life; but regularly the most lamentable scarcity is added to nutritional misery” (own translation from Polo-Benito, 1919: 49–50).

The rapid inflation inherited from World War I (1914–1918) aggravated this situation of systematic deprivation, a deprivation that,

⁹ Materialized in the massive arrival in Europe of primary products from overseas, cheaper than those produced in the Old Continent (Garrabou, 1985), the end-of-the-century agrarian crisis intensely affected the economy of Extremadura, specialized in the production of two of the goods most affected by the crisis: wool and cereal. In these circumstances, the severe droughts of the 1880s and 1890s, as well as the successive locust plagues suffered in Extremadura, did nothing but contribute to the rapid reduction of the cultivated area and the rise in prices of basic foods in the domestic market, raising the poverty levels of a large part of the rural population (Zapata, 1986; García-Pérez, 1998; Linares-Luján and Parejo-Moruno, 2015).

as José González-Castro suggests, was always much worse for women than for men. During the conflict, the sharp rise in prices, especially of basic foods such as bread, was linked to the rapid expansion of demand by the nations that, unlike Spain, participated in the war. The consequent possibility of exporting basic foods at a price higher than that of the Spanish market, generated an unusual situation of scarcity in cereal-producing areas which put upward pressure on inflation and had a negative impact on the purchasing power of the Extremadura’s population (Linares-Luján and Parejo-Moruno, 2019).

Consistent with data compiled by the renamed Institute of Social Reforms, the cost of living in the towns of the province of Badajoz increased by more than 50% between the fall of 1917 and the summer of 1920 (Baumeister, 1996). The municipal documentation of some of these towns contains numerous references to continuous rises in bread prices (“bread wars”) and the negative consequences of the imposition of maximum sales prices to try to stop them: black market, inflation and hunger (Linares-Luján and Parejo-Moruno, 2016). These references put us on the track of the food deficiencies endured by the recruits who were born under the long shadow of World War I. The problem is that they were also the ones who, having experienced a difficult childhood, seasoned by the Spanish flu pandemic (1918–1920), also suffered in adolescence from the scarcity caused by the Spanish Civil War (1936–1939) and, above all, from the post-war famine (1939–1952). This latter situation was a consequence of the agrarian policy maintained during the first years of the Franco dictatorship, defined by the iron interventionism of the markets and by the strong control of the workforce.

The economic interventionism of the first Franco regime was based on the belief that prices can be set by decree (Barciela and López-Ortiz, 2003). With a military conception of the markets, the new regime tried to “discipline” the process of price formation, hermetically closing the borders to foreign products and forcing the sale of national production, at rate prices, to the State. The political fixing of prices without considering the evolution of costs eliminated the incentives for production and contributed to diverting a good part of what was produced towards the *estraperlo*, a black market parallel to the official one in which basic products reached exorbitant prices (Carreras and Tafunell, 2004). Hence the scarcity during the so-called “years of hunger” and hence the need to complete the price intervention with the restriction of consumption through the “ration cards”, in force between 1939 and 1952.

In this inflationary situation, the new model of labor relations contributed to worsening the living conditions of wage earners in the countryside. Characterized by the creation of a corporate-type union structure and by the prohibition of exercising any type of resistance, the main objective of this model was to force the day laborer to enter the labor market in a disciplined manner (Barciela and López-Ortiz, 2003: 57). In this context, the harsh repression exerted in rural areas by the armed wing of the regime, the Civil Guard, generated in the agrarian population “the fear of having ideas” (Martínez-Alier, 1968). That fear was taken advantage of by the landowners to establish very low wages and impose leonine conditions at work without this translating into an increase in social conflict (Vilar-Rodríguez, 2009).

Social stability was favored by the pressure of an agrarian workforce that, between 1930 and 1950, went from representing 61% to 77% of the active population in Extremadura. The re-agrarianizing of the economic structure was accompanied by a worsening of the proletarianization process. The incentives to production that the black market generated for the large owners caused changes in the forms of exploitation, revaluing direct cultivation against the practice of leasing. Hence the crisis of sharecropping contracts maintained until then in Extremadura by the so-called *yunteros* (Pérez-Rubio, 1995), peasants without own land, but with work teams, housed as sharecroppers on the farmland of the dehesas. Thanks to the evictions promoted legally by the Franco regime, the sharecropping lands became farms cultivated by their owners with wage labor. The objective of the large landowners was

clear: to take advantage of the incentives of the black market to sell at high prices with the lowest possible operating costs. For the sharecroppers, the result was also clear: to swell the ranks of an agrarian proletariat that, growing in number, helped keep the wages of agrarian workers at very low levels.

The information collected in Extremadura for the design of the so-called *Plan Badajoz*, an ambitious irrigation project put into execution as of 1952, gives us clues about the consequences that the economic policy of the first years of Franco dictatorship had for the living standard of the Extremadura's agrarian population. According to these data, in 1948 the average daily salary of a day laborer throughout the year, including the harvesting, that is, the time of greatest demand for work, was 16.1 pesetas (henceforth pts). For its part, the expenditure on food of an average day laborer family of 5 members reached 20.8 pts per day. In consequence, the salary of the head of the family in the province of Badajoz covered only 77.4% of the reproductive expenses of a typical family (Pérez-Rubio, 1995: 308–309). Consistent with these data, compiled by Franco's technicians and, therefore, hardly suspicious of a downward bias, the situation of agrarian workers in the south of the region in the mid-20th century had significantly worsened compared to the mid-19th century. In fact, the interrogation of 1849 estimated an annual salary of 980 *reales* for an average day laborer and an annual expenditure on food of 945 *reales* for a typical family. In other words, the wage coverage of day laborer in terms of food consumption had decreased by 26.3% between 1849 and 1948. Needless to say, therefore, that for the agrarian population of Extremadura, the Civil War and the post-war period were lost years in nutritional terms.

It was then, however, after the war, that the cries of hunger left a greater imprint on the collective memory. A recent doctoral thesis (Conde-Caballero, 2018) collects numerous testimonies on this regard from the oral tradition. The monotonous diet of most of Extremadura's rural society, especially the working class, was then reduced to little more than a crust of bread, accompanied by a handful of vegetables, almost always chickpeas, watered with a minimal amount of oil, some soup with a lot of water and little meat and a very limited intake of fruits and vegetables. That was all. Eggs, fish or milk, foods consumed occasionally before the war, had practically disappeared from the narrow culinary world of the day laborer family. The little that remained of the meat, generally pork, was sometimes consumed in the form of chorizo or black pudding, but above all in the form of lard or bacon, the fattest part of the pig. The best quality pieces that came out of the traditional slaughter of the pig (*matanza*), as well as the milk or eggs produced by the few animals that some day laborers could afford to have in their own homes, were sold on the black market or used for exchange of other products, the so-called "gray market" (Rodríguez-Barreira, 2013: 151).

During the 1950s, Spain witnessed the end of international isolation and rationing. The new economic policy of the Franco regime discouraged the black market, offering more remunerative prices for producers and promoting technical modernization. This gradual restoration of the market economy stimulated the increase in the agrarian product, the growth of per capita income and the consequent increase in food consumption levels (Del Arco, 2020). In fact, in 1956 the whole of Spain recovered the levels of calorie and protein intake prior to the outbreak of the Civil War in 1936 (Cussó, 2005). However, it should be noted that these levels were not equally distributed among all social classes. The poorest, generally identified with day laborers, stayed at the end of the food consumption queue, eating menus below their energy requirements.

In Extremadura, the typical diet of agrarian workers in the mid-1950s had changed little compared to the previous decade: mainly bread, chickpeas and bacon, and to a lesser extent potatoes, goat milk, dried figs, melons or carob tree. If we also take into account that even in the 1950s, the civil governments of Cáceres and Badajoz were overwhelmed by the requests of the large landowners asking for

reinforcements in the surveillance of the crops to avoid the continuous thefts of necessity perpetrated by the poorer classes (Pérez-Rubio, 1995), it seems logical to conclude that in Extremadura the end of the post-war period did not mean the end of hunger and misery.

What did mean the end of the post-war was the massive arrival of the technologies of the green revolution. The cheapening of these technologies made it possible to implement techniques that saved labor in agrarian tasks. The incorporation of such technologies rapidly increased the productivity of labor. In Extremadura, the immediate consequence of this rapid improvement in yields was the departure of surplus workforce abroad (France, Switzerland and Germany) or to other areas of the country (mainly Madrid, Catalonia, the Basque Country and Valencia). Between 1951 and 1975 the region suffered the departure of more than 652,000 people, almost 48% of the Extremadura's population in 1950 (Cayetano-Rosado, 2007: 1263–1265).

Emigration was the main strategy of resistance against unemployment and poverty, but also the reason that explains the sustained growth of per capita income in the region as of 1960 (Fig. 3). This growth was accompanied by a continuous increase of real wages in the countryside (Maluquer and Llonch, 2005), an increase that undoubtedly had a positive impact on the nutrition of agrarian workers. On the contrary, the migratory hemorrhage, especially voracious with the day laborer population (Cayetano-Rosado, 2011), originated a process of "artificial biological selection" that left in Extremadura the weakest part of the agrarian population (Linares-Luján and Parejo-Moruno, 2013). Not in vain many of those who emigrated did so through what is known as "assisted emigration", that is, an emigration controlled by the issuing State and carried out after prior hiring by the destination companies. To sign the corresponding contracts, the emigrants had to pass extremely demanding physical examinations in the territories of departure and of arrival (Cayetano-Rosado, 1996). Hence, the artificial selection we are talking about. In this way, the migratory bleeding contributed to maintain and even to increase the height gap between agrarian workers and the rest of the labor force (Fig. 2).

This intensification of the anthropometric gap is consistent with the trajectory described by the wage series available for the period after 1955 (De la Fuente and Ruiz-Aguirre, 2020). Two important conclusions follow from such series. The first one is that, between 1955 and 1980, the salary level of all workers in Extremadura grew steadily (Fig. 4). The second one is that the salary gap between agrarian workers and the rest of the workers, always greater than 40%, increased after 1963, reaching 65% in 1980. This worsening of the wage difference can explain by itself the increase in the anthropometric gap that our height sample reveal since the cohorts born in 1960–1964 (Fig. 2), but it is also behind the massive emigration of agrarian workers and, consequently, of the artificial selection of which we have just spoken.

The data on available family income for the years of birth of the last recruits in our height sample reflect well the great distance that still existed between agrarian workers and the rest of the active population. Thus, for example, according to the 1980–81 Family Budget Survey (Instituto Nacional de Estadística, 1984), the average annual income of a household whose main breadwinner was an agrarian worker (406,915 pts) made it possible to cover the average expenditure on food of a typical family (217,656 pts). Life was much better, however, for the family of a non-agrarian worker, who earned an average annual amount (819,161 pts) that far exceeded the family spending on food (368,854 pts). The difference, therefore, was not only in the level, but also in the proportion of income allocated to nutrition: almost 70% more in the case of non-agrarian workers. We speak, therefore, of a significant food gap, although always starting from the general improvement of nutrition among all workers.

The 1980–81 Family Budget Survey itself allows us to observe this improvement. Faced with the importance of cereals and legumes in the diets described until then, the survey shows the progress of meat, milk, eggs, fruit and fish among the food expenses of families in the region. It

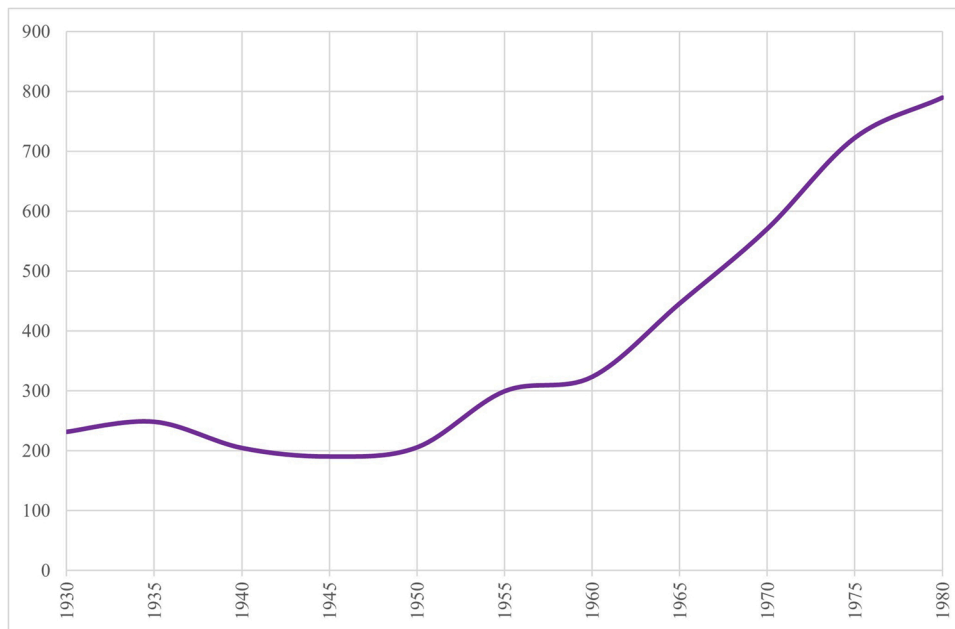


Fig. 3. GDP per capita in Extremadura (billions of 1995 pts).
Sources: Carreras et al. (2005: 1371).

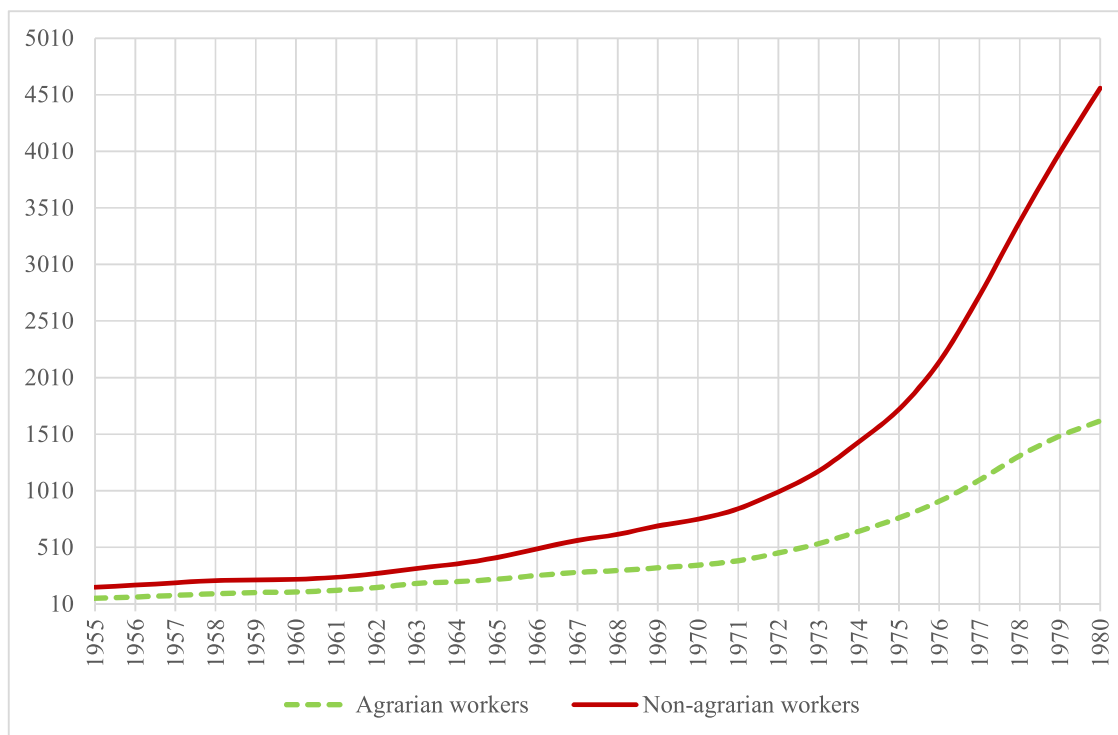


Fig. 4. Mean annual wages at current prices in Extremadura (thousands of pts).
Source: own elaboration based on De la Fuente and Ruiz-Agüirre (2020).

is the result of a practically completed nutritional transition. The problem is that such a survey does not offer information disaggregated by profession, which makes it difficult to know to what extent the agrarian population was also a beneficiary of the transition. The question is relevant because the distance in height between agrarian and non-agrarian workers increased since the birth cohorts of 1960–64. We have already talked about the artificial selection that emigration

generated, but, with the available sources, we cannot rule out the parallel incidence of a possible widening of nutritional differences because of the wage gap.

5. Conclusions

Based on a sample of almost 60,000 recruits, born between 1855 and

1979 and recruited between 1876 and 2000, this paper analyzes the evolution of anthropometric inequality in Extremadura, one of the most backward Spanish regions. The analysis focuses on the difference in stature that seems to have historically existed in Spain between agrarian workers and the rest of the active population. The results of our study confirm the existence of an anthropometric penalty among young people who carry out activities typical of agriculture and livestock. However, unlike other studies, this research reveals that the height gap between agrarian and non-agrarian workers not only does not decrease over time, but even increases as the average stature of the active population grows.

To explain this growth, our paper turns to anthropometric theory. According to her, the continued increase in adult male height in Extremadura is due to the concurrence of three improvements. These improvements contribute to anthropometric expansion by increasing the quantity and quality of nutrient intake (nutritional transition) and by reducing the energy expenditure caused by the disease (health transition) and the physical effort at work (technical innovation and structural change).

If those three variables explain the anthropometric growth registered by the Extremadura's active population since the last decades of the 19th century, it is logical to think that differences in nutrition, health and working conditions are what explain the anthropometric gap between the agrarian and non-agrarian workers. In this article we only delve into the nutritional differences, possibly the most important one when interpreting the height gap in the long term. The decision is quite opportune as the proximity of the rural population to food supply sources has been one of the reasons most used by anthropometric historiography to justify the presence of farmers among the tallest occupation groups in the traditional societies.

The case of Extremadura nuances this idea because in this region the concentration of land ownership is historically so high that most of the agrarian population is not represented by farmers but by landless workers with a limited access to nutritional sources. It is therefore not the distance to food but the property of the resources that produce them that makes the difference. With this starting point, the analysis of the nutritional gap that we make in this study first but briefly explores the historical roots of the structure of land ownership in Extremadura. These roots are linked, on the one hand, to the physical conditions of the region, adverse for traditional agriculture, although appropriate for extensive livestock farming. On the other hand, they are related to the circumstances in which the repopulation of the regional territory took place after the Christian conquest, a demographically limited repopulation that was, in addition, marked by the donation of extensive properties to the nobility, the military orders and the town councils. The scant consistency of the urban mesh that resulted from this form of settlement and the early relationship that institutions benefiting from the distribution of land ownership in Extremadura established with transhumance thus joined the region's poor agroclimatic aptitudes for reinforcing the livestock option and consolidating the presence of the latifundia in the region through the dehesa system.

The peasant proletarianization that causes the strong concentration of land ownership and the eventuality generated among the agrarian workforce by the limited capacity of the dehesa to increase the demand for labor explain the low level of income of rural society and the low level of food consumption of agrarian workers in the mid-19th century. The problem is that the nutritional gap caused by this fact, far from disappearing in the heat of contemporary economic modernization, has increased in Extremadura, at least until the end of the 20th century. It is here where the short-term reasons that our study puts on the table come

into play, reasons that range from economy to policy and ideology passing through technology or emigration.

Economic is, of course, the loss of purchasing power suffered by the agrarian population as a result of the end-of-the-century agrarian crisis, and economic is also the reason that explains the rapid increase in the prices of basic products, especially bread, after the beginning of World War I. Information from the surveys and studies carried out in Spain by the Commission (or Institute) of Social Reforms from 1883 ratify the importance of these two inflationary crises in the region and focus on the special impact of both recessions on nutritional conditions of the day laborer population.

Political is, naturally, the Law of General Disentailment of 1855 and the consequent reduction of free or semi-free use rights traditionally practiced in municipal and communal lands. Policy and ideology are also what lie behind the strong economic intervention of the first years of Franco dictatorship. The results of this intervention were clearly reflected in the exorbitant prices that the basic products on the black market reached, in the conversion of thousands of sharecroppers into salaried workers and in the general collapse of agrarian wages. The consequent worsening of food consumption levels among farm workers and day laborers has been widely echoed in oral tradition of Extremadura until now.

Regarding the incidence of technical change and migratory movements, our research reveals that the massive implantation of the green revolution in the Extremadura's countryside stimulated a massive migration that left in the region the physically weakest part of the agrarian population. And it is that the assisted emigration was always done based on extremely demanding physical examinations. Given that those who finally emigrated were the strongest and healthiest, the migratory hemorrhage suffered in Extremadura, especially voracious with the day laborer population, activated an artificial selection process that took away the tallest and left in the region the shortest agrarian workers.

The emigration of the 1960s and 1970s was fundamentally the result of the green revolution, but the available data also tells us about a prior wage gap between agrarian and non-agrarian workers that we cannot ignore. The economic difference could contribute to widening the anthropometric gap indirectly by stimulating the emigration and the consequent artificial selection. There is no doubt, however, that the salary gap itself was directly the cause of an important part of the nutritional gap recorded by our sample of heights during the last decades of the Franco dictatorship and the first years of Democracy. In this sense, the final conclusion cannot be other than the ratification of the economy as one of the keys to nutrition during childhood and youth and, therefore, as one of the determinant variables of the agrarian height penalty.

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CRedit authorship contribution statement

Antonio M. Linares-Luján: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing.
Francisco M. Parejo Moruno: Resources, Methodology, Data processing, Writing – review & editing. All authors have read and agreed to the

final version of the manuscript.

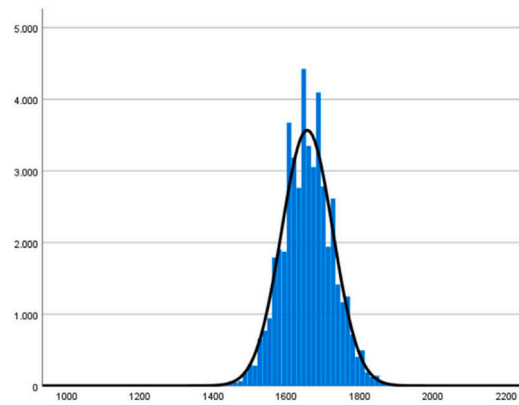
Conflicts of interest

None.

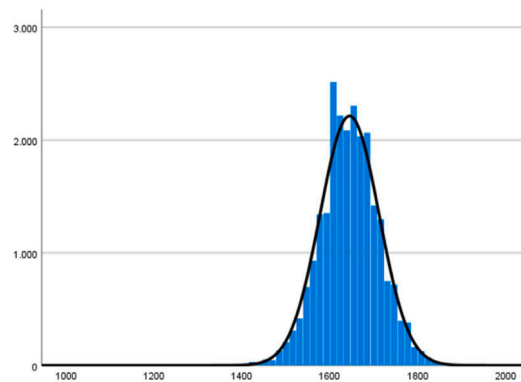
Appendix 1

Main descriptive data of sample Extremadura'30 (histogram, mean, standard deviation and number of records).

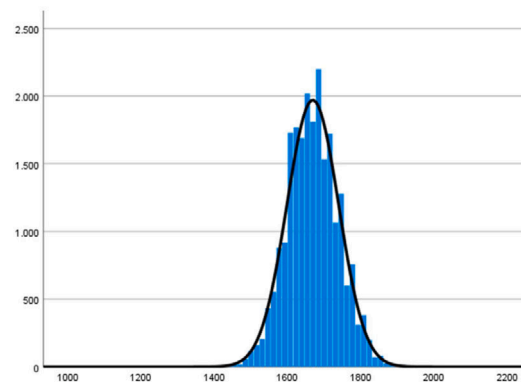
Total sample:
Mean: 165.61
Standard Deviation: 6.90
N: 58,485



Sample of agrarian workers:
Mean: 164.44
Standard Deviation: 6.70
N: 30,173



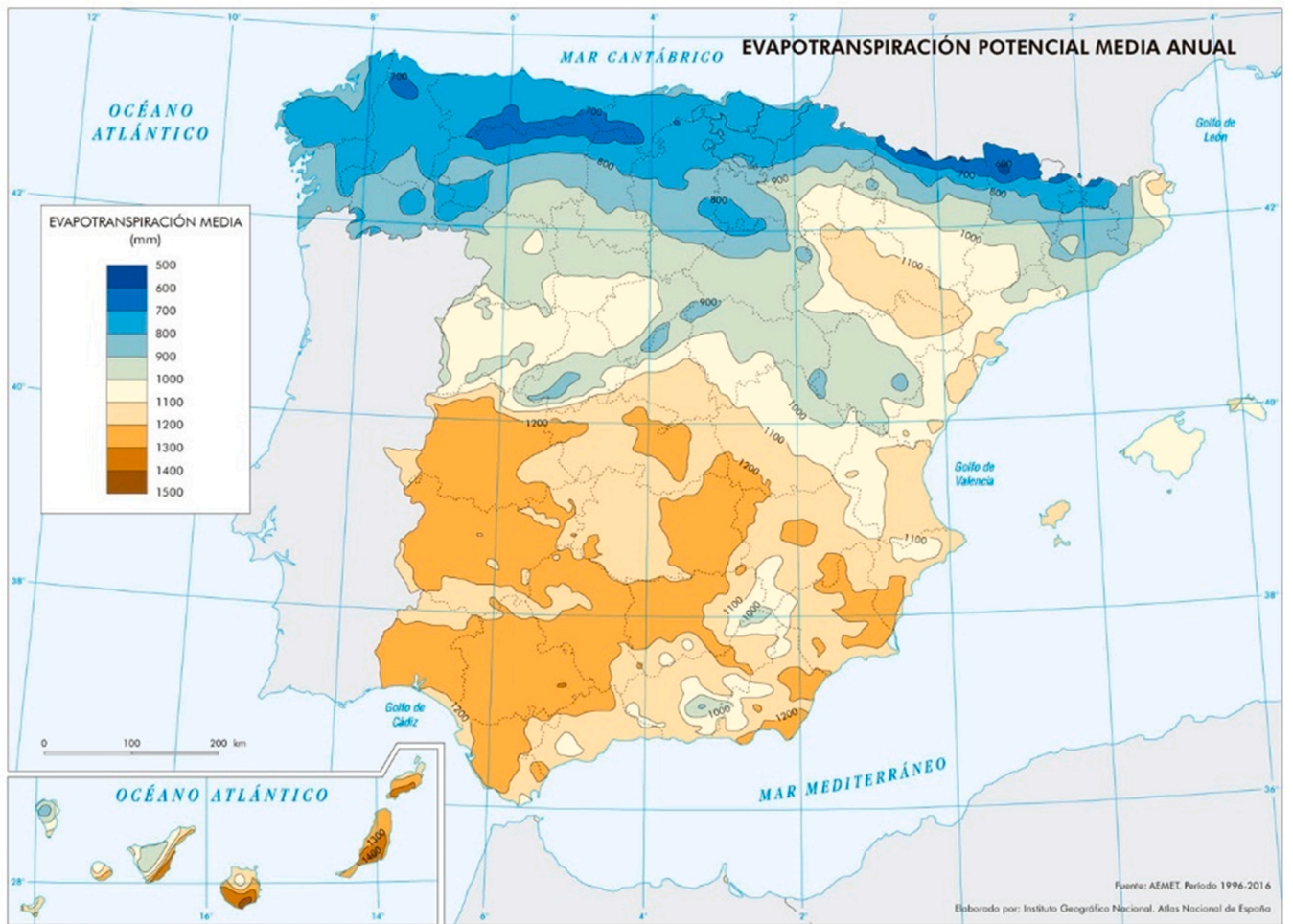
Sample of non-agrarian workers:
Mean: 166.86
Standard Deviation: 7,07
N: 28,312



Sources: see Fig. 1.

Appendix 2

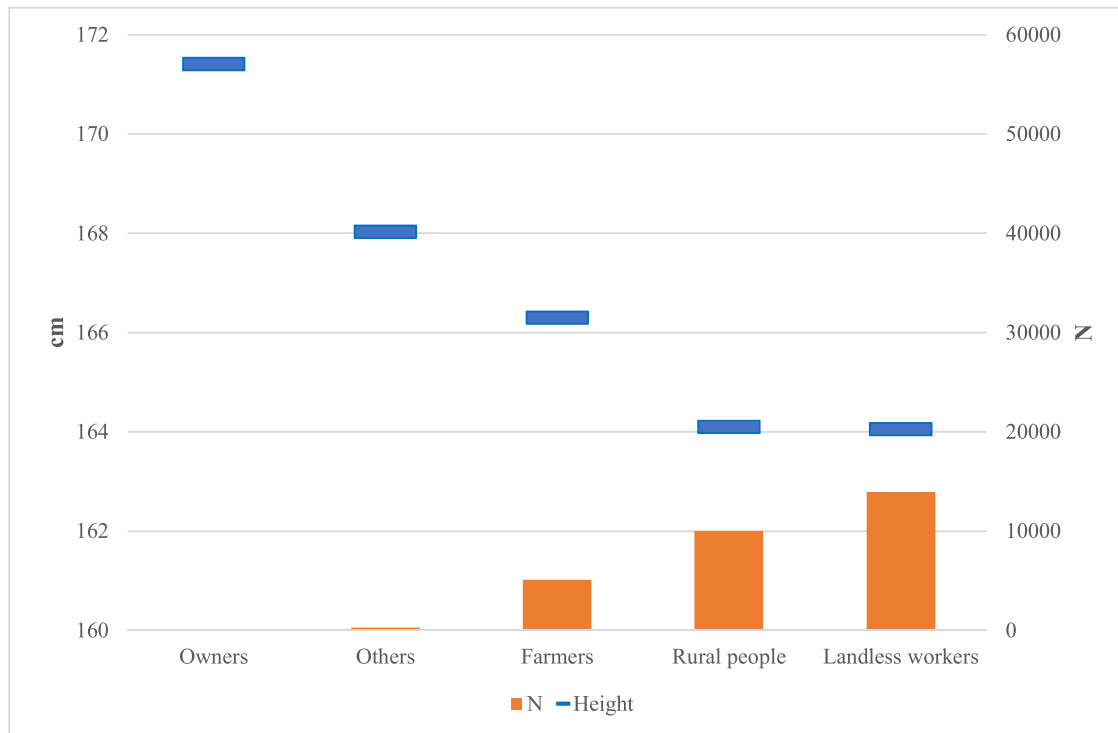
Mean potential evapotranspiration in Spain (mm).



Source: Atlas Nacional de España. https://atlasnacional.ign.es/wane/Archivo:Espana_Evapotranspiracion-potencial-media-anual_1996-2016_mapa_15571_spa.jpg#file.

Appendix 3

Mean height of the agrarian population included in the sample Extremadura '30 according to the categories distinguished by the ACDSs (cm and number of records).



Sources: see Fig. 1.

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