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RESEARCH ARTICLE

Height, Chest Size, and Household Composition in Late-Nineteenth-Century Catalonia

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Abstract

This article measures the impact of early-life household composition on adult height and chest size in men born in Catalonia in the late nineteenth century. It combines data from military drafts with census records, observing the same individual twice over his lifetime. For family composition characteristics I control for the number of siblings, intergenesic interval, parental occupation and educational level, fatherless or motherless families, and other relatives living in the household. I show that taller individuals were more likely to come from well-off families and that men who grew up in orphanages or in motherless households were shorter than their counterparts. Results also uncover that there was a negative association between height and the number of siblings and the age gap between them. However, this negative association is driven by having more brothers (instead of sisters). If we are to gain a fuller understanding of the factors that have influenced height, we need to consider the composition of the household as an explanatory variable.

Introduction

The past 150 years have witnessed a massive improvement in the health of people living in the Western world (Galofré-Vilà 2018). These improvements have led to rapid growth in the average height of the population and increased life expectancy. In 1908, the average life expectancy of a newborn boy in Spain was 40 years, and that of a newborn girl was 42 years, and their adult heights were 164 cm and 152 cm, respectively. By 2000, life expectancy had risen to 76 for males and 83 for females and their heights had risen steeply to 175 cm and 164 cm, respectively. The most recent data shows that by 2014, male Spaniards lived for 80 years and females for 86.[1] These changes have been due to improvements in diets and developments in medical knowledge, sanitary reforms, and technological changes, however, many of the macrolevel changes have impacted individuals through household-level changes.

[1]Historical male and female height data are from Quiroga-Valle (2002) and Galofré-Vilà and Harris (2020). Modern height data are from the *Instituto Nacional de Estadística*. Data on life expectancy are from the *Human Mortality Database*.

Children's growth is deeply influenced by household structure, which determines how food, care and affection, medical provisions, child labor, and housework are allocated to each child in a given household.

This article measures the impact of early-life household composition on adult height and chest size in men born and measured in Girona (Catalonia) in the early twentieth century. It provides a new dataset that tracks the early-life conditions of individuals from the age of 21, by means of combining data from military drafts with census records (the so-called *padrons* or General Registers of Residents [GRR]).[2] The aim of this is to observe the household conditions in which men grew up and capture the effects of family conditions on later life. I measure household conditions by the number of siblings living in the household (brothers or sisters), birth spacing (the intergenesic interval), parental occupation and educational level, whether the recruit grew up in a fatherless or motherless family, and whether his grandparents, aunts, other relatives, or servants also lived in the household.

The ability to track individuals twice in their life course is a very important advantage because direct or longitudinal information about an adult's family circumstances as an infant is very rare (Hatton 2017). Bailey et al. (2016) find that British children from larger families were shorter and less likely to survive in the first half of the twentieth century and Hatton and Martin (2009) determined that family size negatively affected stature in adulthood in 1930s Britain. There is also evidence that sibship size stunted the growth of British children also in the second half of the twentieth century (Kuh and Wadsworth 1989). In continental Europe most studies also document an historical negative association between family size and height, with evidence coming from East Germany (Baten and Böhm 2010), France (Olivier and Devigne 1983), Italy (Mazzoni et al. 2017), Sweden (Cernerud 1993), the Netherlands (Bras et al. 2010; Stradford et al. 2017; Van Bavel et al. 2011), and also outside Europe, in the United States (Roberts and Warren 2017). Beyond the historical literature, there is also evidence that in more recent decades sibship size is also negatively associated with children's growth in the developing countries (Desai 1995; Jordan et al. 2012).

Strikingly, despite the previously mentioned evidence, a recent study in Catalonia found that there was no historical early-life family effects on adult stature (Ramon-Muñoz and Ramon-Muñoz 2017), which is puzzling and surprising given the evidence in other places. Indeed, looking at the Catalan data (Girona), I find that early-life family conditions were also a powerful factor in determining adult stature in Catalonia and that, as in other countries, the different household conditions (and not just sibship size) in which men grew up uncover important findings. Overall I find that due to external pressures within the family, having an extra brother lowered adult height by half a centimeter. This result is also in line with the work from Bailey et al. (2016) who found that having an extra sibling accounted for 0.3 cm. However, while they could not determinate what mattered most, having sisters or brothers, my results show that having a sister, instead of a brother, almost had no effect. Also similar to Bailey et al. (2016) and Stradford et al. (2017), I find that the birth order effect is small and it disappears once I start controlling for other early-life family characteristics.

[2]For details on the RGG see the "Sources and Methodology" section.

Throughout the article I also show that parental occupation explains up to 5 cm of the individual's height. A difference that can be further increased in more unequal societies. For instance, Floud et al. (1990) showed a difference of 21 cm between Marine Society children and upper-class children who attended the Royal Military Academy at Sandhurst in the late-eighteenth-century England. In line with existing research, I also find that children deprived from maternal care (either because they grew up in an orphanage or they were motherless) become severely stunted. For instance, motherless children were 2 cm shorter than their counterparts, which is similar to the figure reported by Reher and González Quiñones (2003) for the early-twentieth-century central Spain and the 3.4 cm for the motherless Marine Society boys (Horrell et al. 1998).

The article unfolds as follows. The next section presents Girona, one of the four provinces of Catalonia, as a case study. "Sources and Methodology" presents the anthropometric dataset and how individuals at the age of 21 are linked with their early-life conditions. "Data" provides the main descriptive statistics, "Early-Life Family Conditions on Adult Height and Chest Size" and "Quantifying the Impact of Household Composition on Height and Chest Size" offer the unadjusted and adjusted results for the impact of early-life family conditions on adult stature and chest size, and the last section concludes.

Socioeconomic Situation

Girona is one of the four Catalan provinces, along with Barcelona, Lleida, and Tarragona. By 1900, Barcelona was the Catalan and Spanish engine of industrial production with a growing service sector, and agriculture made a major contribution to industrialization with a diversified economy based on family-type farms from rural provinces such as Girona. At the turn of the century, Girona, inhabited by nearly 300,000 people, accounted for 15 percent of the Catalan people that represented 11 percent of the population living in Spain. It was largely a rural place and only 16 percent of the population resided in the city of Girona (Garrabou 1985; Tafunell 2005).

The per capita agrarian production was 200 *pessetes*, which was similar to the levels reached in Tarragona (212 pts) and above those in Barcelona (135 pts), though they were lower than the levels in Lleida (443 pts) (Barciela et al. 2005). Land was mainly used for the cultivation of cereals and vegetables (62 percent), olives (15 percent), other intensive crops (14 percent), and wine (9 percent), and it was highly concentrated in few hands, as 4 percent of the owners owed 67 percent of the total land (Aracil et al. 1999; Estalella 1984). In 1900, agriculture employed 66 percent of the male population in a system of nonorganic farming (Barciela et al. 2005). This figure was above the Catalan mean (59 percent) but below the Spanish average (72 percent). The small but growing industry of Girona engaged 25 percent of the male labor force that worked mainly in textile manufactures (linen and cotton) and the production of paper (Clara 1977). The Catalan industry engaged a similar male labor force (25 percent) which was above the Spanish mean (15 percent). The male labor in the service sector of Girona (10 percent) was lower than the Catalan mean (17 percent) and the Spanish one (13 percent). And although female's work was unrepresented in the Spanish census (Nicolau 2005), participation of women in the labor market was small, but concentrated in the service sector.

When considering Catalan labor conditions in the past, it is important to emphasize the role of child labor. Around 1900, more than 50 percent of children aged 10 were employed in manual industrial jobs, and this figure rose to 60 percent in agriculture (Borrás Llop 1999; Martínez-Carrión et al. 2013). By comparison, at that time child labor of those aged 10–14 was not above 20 percent in Britain (Humphries 2010). The figures for the child labor reflect the extent to which Catalan children were a major economic resource for a family in response to either endemic seasonal economic pressure or a family crisis. A child's earnings provided income in normal times, beyond that of the primary "male breadwinner family," and supported the family in extraordinary situations, such as during the father's unemployment or illness, and also helped to support the dependent siblings.

Sources and Methodology

The Collection of Data

Beginning in the mid-nineteenth century, all Spanish men had to fulfill their military obligations, the first step being a medical examination at the age of 21 that noted the name and surnames of the potential recruit, date of birth (day, month, and year), and the names and surnames of his parents; his place of birth (town and province), occupation, and ability to read and write; and his height (in mm), weight (in kg), and chest size (in cm) (see figure S4). Chest measurements were taken beneath the prominence of the pectoral, in intervals of two ordinary breaths and with arms folded and men were measured without shoes. Unfortunately, in Girona, weight data was only recorded for those inspected in 1912 and 1913. The official who recorded the anthropometric values and the medical doctor also had to sign an attestation paper declaring the legitimacy of the measurements (figure S2). Because Spain operated under "universal conscription, a system under which nearly all young men eligible for military service were called for medical examination to determine their fitness," data are not suffering from basic issues of selection (Bodenhorn et al. 2017: 175).

I collected the details of all men inspected between 1912 to 1921 ($n = 1{,}579$) and born between 1891 and 1900.[3] I removed 138 cases from the original collection because the place of birth was not fully recorded, 184 men because they were born outside the province of Girona (but within Catalonia), 70 because they were born in Spain outside Catalonia, 9 in a foreign country, and 32 men who were born in Girona but migrated to another area between conception and the time of measurement. The growth profiles of those who were born in another place or migrated in early life might reflect the environmental and social conditions of the places they left, rather than their current residence. A total of 233 men were classified as *pròfugs* (fugitives), and I lacked their medical details and those of 16 men who were

[3]The last year of data entry is 1921 because this is the last year that *familysearch.org* digitalized the military records in Girona. From the 1,579 observations, 178 were collected in 1912, 1913 (182), 1914 (154), 1915 (149), 1916 (152), 1917 (148), 1918 (171) 1919 (137), 1920 (142), and 1921 (166).

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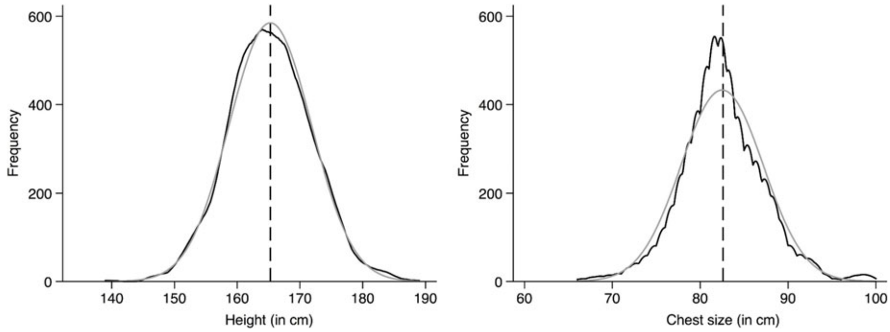

Figure 1. Height and chest size distributions.
Notes: The black line shows the kernel adjusted distribution and the gray one its hypothetical normal distribution. For a better visualization I removed one observation with a height below 135 cm and seven observations with chest sizes above 100 centimeters. Chest size was measured to the nearest centimeter, but such heaping does not affect the determination of the age at which the height profile peaks and only has a marginal effect on the determination of adult height.

called to pass the medical exam but whose medical reports could not be found. Finally, height was not recorded (or was not possible to read) for 253 observations. This narrowed down the collection of data, leaving 956 observations valid for analysis.

Although there was a minimum height and chest requirement to join the Spanish army, the medical inspections were conducted before a man was declared fit or unfit for military service (see figures S1 and S2). Indeed, figure 1 shows that height and chest size follow a normal distribution.

Matching Strategy

Of the 956 men in the data, 801 were successfully linked to the GRRs, allowing their household conditions to be directly observed around the time of their birth and during adolescence. The GRR is an administrative register of the neighbors of a municipality made by the city councils, is the only source of the official population census, and, *ex-novo*, is renewed every five years. The GRRs include information about the names, occupation, ability to read and write, and date and place of birth of the recruit and the recruit's parents (figure S4). These details were recorded for each member of the family and their position in the house (head of the household, father, mother, children, aunt, grandmother, etc.). The GRRs also specified whether the father or mother of the recruit was a widow and whether there were servants working in the house.

The GRRs for Girona have been digitalized and are available online through the genealogical website of *familysearch.org*. Among other historical sources, this website stores the GRR records and offers a search engine with which to identify individuals in the records. By using the *familysearch.org*'s search engine (see figure S3), I was able to find each individual by using the recruit's personal details based on six controls that met the search criteria: the name and surnames of the recruit, his year

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and place of birth, and the names of his parents (see figure S1). Matches were unsuccessful mainly if some pages of the GRRs had been lost. In some cases, I also found that the records were not properly transcribed by *familysearch.org*, but locate names directly looking at the GRRs. I focused on the GRRs of 1905 and 1910 subject to whether the man was born between 1891 and 1895 (linked to the GRR of 1905) or between 1896 and 1900 (linked to the GRR of 1910). I have therefore attached the details of the household composition in early life to each man aged 10–14 years old.

To corroborate that I was looking at the right families, as an additional robustness check, I also linked those born between 1891 and 1895 to the GRRs of 1910 and those born between 1891 and 1895 to the GRRs of 1915. Despite the fact that I never used this information (I used the information at 10–14 years as the one representative of the early-life family conditions), it might be important to note that the household composition can change between two GRRs (i.e., when an old member of the family passed away) and this information might be useful in further family research.

The Value of Height and Chest Measurements

While height and weight are widely (if not universally) recognized indicators of health, the value of chest size has not really been considered in the literature. Medical reports from the Spanish Army comment that chest size was measured to obtain an index of morbidity at measurement and recorded it to measure the "doubtful biological potential" of the recruit. Medical research shows that growth velocity in height peaks in the period after birth (around the first 1,000 days of life) and during adolescence (between the ages of 11 and 14), but chest expansion mainly occurs during adolescence, accelerating rapidly between the ages of 11 and 15. Therefore, other things being equal, if nutritional status decays, it will have a greater impact on growth during periods in a person's life when he might otherwise be growing more rapidly. Hence, while height is mostly affected by the environmental conditions during early infancy, similar to weight, chest size is more an indicator of net nutrition during puberty close to adulthood.

In figure A1, I also document a close correspondence between the height of 127 pairs of brothers ($R^2 = 0.26$), although the correlation is much lower in the case of chest size ($R^2 = 0.12$). Yet, in figure A2 I also note a weak association between height and chest size ($R^2 = 0.08$), implying that height only helps to predict around 8 percent of chest size. By comparison, in a subsample of 209 individuals where weight was recorded, the correlation between weight and chest size is more important ($R^2 = 0.54$) and is twice as large as the correlation between weight and height ($R^2 = 0.26$).

Data

The descriptive statistics in table 1 show that from one cohort to the next, the size and shape of men born and raised in Girona did not change much, with a mean height and chest circumference of 165 and 83 cm, respectively. The mean weight of those inspected between 1912 and 1913 was 58 kg, with an associated BMI of

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Table 1. Main descriptive statistics

	Mean	St. Dev.	N
Individual characteristics			
Height in the city of Girona	165.49	6.49	702
Height in the province of Girona, outside the city of Girona	164.75	6.89	254
Height in the province of Girona	165.29	6.58	956
Chest size in the city of Girona	82.68	5.15	697
Chest size in the province of Girona, outside the city of Girona	82.87	4.97	251
Chest size in the province of Girona	82.73	5.10	948
Household characteristics			
Birth order	1.76	1.16	1,225
Birth space (years)	3.61	2.54	517
Number of siblings	3.40	2.64	923
Number of siblings' boys	2.24	2.09	923
Number of siblings' girls	1.18	1.12	923
Without siblings (%)	8.60	n/a	n/a
Father's age at birth	32.87	6.90	659
Mother's age at birth	29.01	6.76	753
Father's age at first birth	29.02	6.21	658
Mother's age at first birth	25.18	6.31	752
Father able to read or write (%)	76.45	n/a	n/a
Mother able to read or write (%)	62.37	n/a	n/a
Father missing (mother household head) (%)	10.51	n/a	n/a
Mother missing (father household head) (%)	3.23	n/a	n/a
Grown up in a hospice (%)	2.22	n/a	n/a
Grandparents living in the house (%)	3.99	n/a	n/a
Aunt living in the house (%)	2.92	n/a	n/a
Servants in the house (%)	4.31	n/a	n/a

Note: I removed observations without details on the place of birth and that migrated to another place between conception and the age of 21.

21.[4] Within the same quinquennium, men born in Girona stood shoulder to shoulder with those in Catalonia (at 165 cm) but they were taller than their Spanish peers. For example, 162 cm in Castella i Lleó, Galícia (163), Extremadura (164), Andalusia (164), and Madrid (164); only being shorter than those born in the Canary Islands (167) (Quiroga-Valle 2002). They were shorter than the Swedes (at 172 cm), Britons

[4]The Body Mass Index (BMI) is a measure of weight standardized for height. It is the ratio of weight (in kilograms) to height-squared (measured in meters).

(170), and French (168) but were the same size as Italians (165 cm) (Hatton 2014). Mean heights in Girona were also similar to those reported by other authors in the provinces of Barcelona and Tarragona (Martínez-Carrión 2016; Martínez-Carrión et al. 2016). Between 1883 and 1886, the biggest chest circumferences in the 50 Spanish provinces were found in Santa Cruz de Tenerife (in the Canary Islands) and this was followed by the chest measurements of men born in Girona (Martínez-Carrión 2016; Martínez-Carrión et al. 2016).[5]

On average, there were three siblings per family, two brothers and one sister. The age gap between siblings was three and a half years on average. Mothers were present 95 percent of the time during the growing period and her average age when the child was born was 29 years. Fathers were present 89 percent of the time with an average age of 33 years when the infant was born. Fathers and mothers had their first child at the ages of 29 and 25 years old, respectively. Seventy-six percent of the fathers and 62 percent of the mothers were able to read or write, and around 2 percent of the time the children grew up in a hospice, 4 percent the grandparents lived with the family, 3 percent another relative lived in the family (i.e., aunt), and in 4 percent the house included servants. There was a difference in height of 0.7 cm, and in chest size of 0.2 cm between those born in the city of Girona and those outside (i.e., in more rural settings). A similar *urban premium* has been documented in southern Spain and other European countries around the same time (Martínez-Carrión and Moreno-Lázaro 2007).

Early-Life Family Conditions on Adult Height and Chest Size

The next subsections adjust the height and chest size of the recruits to a number of family characteristics.

Changes by Occupation

Between the recruit and his father and mother ($n = 1{,}904$), there were a total of 126 different occupations in the data. I coded them according to the HISCO classification.[6] The first category of *white-collar* workers were of high skill level (highly qualified nonmanual workers, HISCO codes 0 and 1), including undergraduate and graduate students, teachers, engineers, lawyers, architects, and notaries. The second group was *nonmanual*, who were of medium skill level (nonmanual skilled and unskilled, HISCO codes from 2 to 5), including scriveners, representatives/managers and soldiers; the third group was *farmers* (HISCO code 6), composed of agrarians and journeymen; and a final group, manual workers (skilled and semiskilled workers [HISCO codes 7–9]), included bricklayers, carpenters, locksmiths, bakers, tailors, and cobblers.

Figure 2 shows that height and chest size varied systematically with the recruit and his father's occupation. The tallest and heavier men were the highly qualified white-collar workers. They were taller by 2 cm in comparison to nonmanual, 3.3 cm to manual workers and 4.5 cm to farmers. Similarly, chest values for manual

[5]See Hatton (2014) for additional cross-national comparisons.

[6]For more details see, http://historyofwork.iisg.nl/

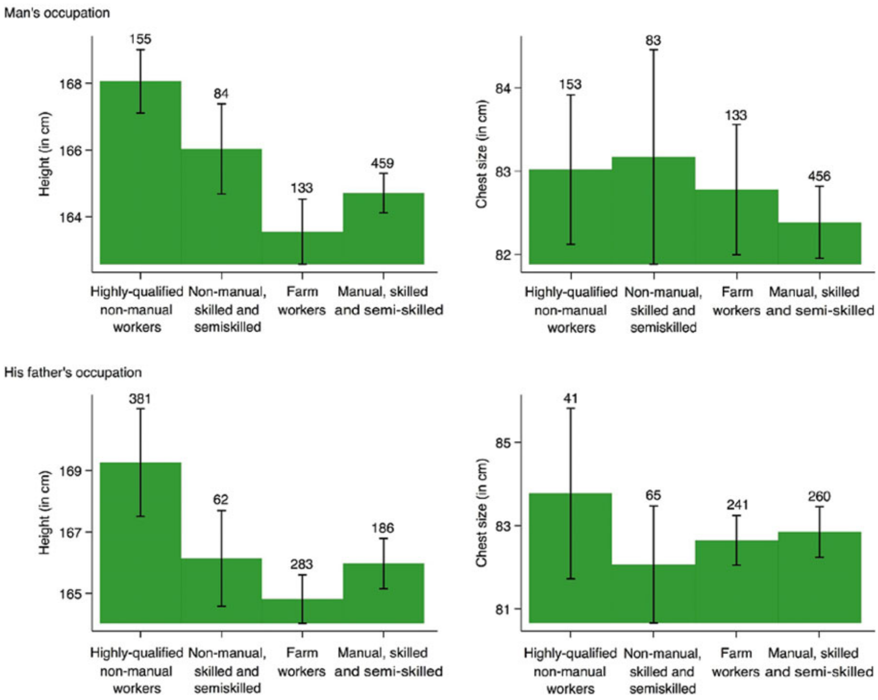

Figure 2. Changes height and chest size by occupation.

workers and farmers were below those of skilled occupations, suggesting that they were not only fed more poorly, but probably were more susceptible to diseases due to a poor nutritional status. The confidence interval for chest size in nonmanual workers is higher than in any other group, showing the greater heterogeneity of individuals within this group.

There was a *premium* for children whose fathers were engaged in white-collar occupations because as adults they grow to be, on average, 3.6 cm taller than the others and with higher chest sizes (1.3 cm).[7] As noted in the "Socioeconomic Situation" section, it is likely that the sons of farmers or manual workers were involved in child labor. Even though labor market participation could increase children's entitlements and therefore improve rather than detract from their basic welfare (i.e., increasing their bargaining power within the family), in the long term, they might have paid a high price as measured by their lower statures and chest sizes (Horrell et al. 1998).

Due the close connection between occupational structure and changes in height and chest size, it is important to ask whether there were prospects for social mobility, and, if so, if a recruit's own occupation could be a reliable guide to their parent's

[7]The occupation of the mother was mostly recorded as *su sexo* ("their sex" or "housewives"). Yet, although not reflected in the census data, it is likely that women also had some sources of income from working in agriculture or small firms (Nicolau 2005).

Table 2. Odd ratios in occupations

		His father's occupation			
		Highly qualified	Nonmanual workers	Farm workers	Manual skilled and semiskilled
Man's occupation	Highly qualified	76.19%	32.00%	9.64%	19.05%
		(32)	(24)	(24)	(48)
	Nonmanual workers	9.52%	20.00%	9.64%	9.13%
		(4)	(15)	(24)	(23)
	Farm workers	0%	5.33%	27.31%	6.75%
		(0)	(4)	(68)	(17)
	Manual skilled and semiskilled	14.29%	42.67%	53.41%	65.08%
		(6)	(32)	(133)	(164)
Odd ratios					
		His father's occupation			
		Highly qualified	Nonmanual	Farm workers	Manual skilled and semiskilled
Man's occupation	Skilled workers	85.71	52.00	19.28	28.17
		(42)	(75)	(249)	(252)

Note: Number of observations for each occupational category are in brackets.

occupation and employment prospects (i.e., if the sons of farmers could end up in more skilled occupations). Odd ratios are a tentative approximation with which to study the probability of a child ending up in a skilled occupation given any of the four occupational groups of his father. This analysis, however, is limited in the sense that I can only observe the occupation of the recruit at the age of 21 and his father's occupation when he was born, thus saying little about occupational mobility across the life span.[8]

Despite these limitations, table 2 illustrates a picture of low social mobility. If the father was white collar, the child ended up in the same occupational group 76 percent of the time, and if he was a nonmanual worker, the child also stayed in nonmanual occupations 20 percent of the time. Similarly, if the father was a farmer, then 27 percent of the time the child also stayed in the agricultural sector and if the father was a manual worker, 65 percent of the time the child also remained in this category.

Odd ratios are also helpful in measuring the association between an exposure (father's occupation) and an outcome (child's occupation), which sheds light on the probability of any recruit ending up in a skilled occupation (defined for

[8]Other limitations of the analysis are due to sample size. Although farmers and nonmanual workers were the most common jobs in the sample, only 0 or 4 of them ended in skilled jobs.

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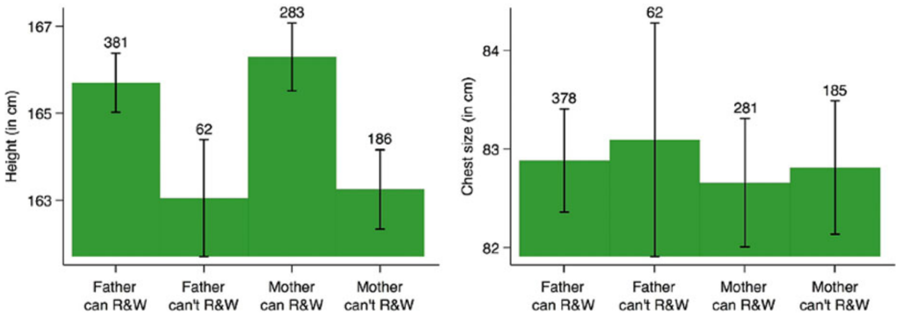

Figure 3. Changes in height and chest size by parental education.
Note: R&W stands for read and write.

white-collar and nonmanual workers) given his father's occupation. The predicted probability of being a skilled worker if the father was white collar was 86 percent and, if the father was a no*n*manual worker, 52 percent. If the father was a farmer, however, the prospect of having a skilled job was reduced to 19 percent and if he was a manual worker to 28 percent. There was thus very little social mobility for skilled occupations, with little chance to move from being a farmer or manual worker to a skilled occupation.

Changes in Parental Education

Figure 3 shows that when a father and mother were literate (defined as able to read and write) their child was on average 2.7 cm and 3.1 cm taller, respectively. Better educated parents might also be related to higher wages and this might be related to the provision of a better diet and less need for additional sources of income in the family, forcing fewer children to work. Goldin (1979) also argues that more highly educated parents might have stronger preferences about their children's education and school attendance.

Changes in Household Characteristics

Figure 4 shows that when a man grows up in an orphanage, he is shorter by 6.1 cm with a narrower chest size by 2.5 cm, showing the lack of parental attention and poor nutritional status. Men from motherless households were also shorter (2 cm) than the average recruit, although their chest size was the same as the reference group. Reher and González Quiñones (2003) also found that in early-twentieth-century Aranjuez (central Spain), motherless men were between 1 and 2.1 cm shorter. A similar result was found by Hernández García et al. (2009) in Zamora (in northwest Spain, close to Portugal). Also in industrial England, Horrell et al. (1998) found that motherless Marine Society boys were 3.4 cm shorter. Because mothers are the key agents mediating a child's relationship with their environment, the shorter stature of children when she is absent indicates a lack of maternal affection and care, and also a poorer and more unequal distribution of resources

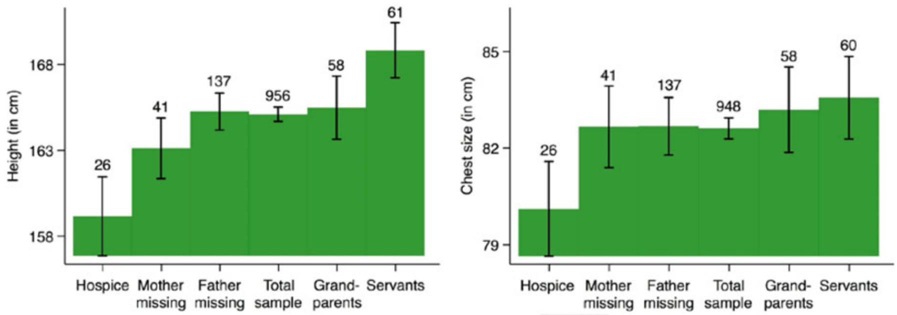

Figure 4. Changes in height and chest size by household characteristics.

within the household. The premature death of a parent can also have an adverse effect on school attendance and throw more children into the workforce.

The figure of a grandparent in the family only has a small effect, with men taller by 0.4 cm and having larger chest values by 0.6 cm. These results suggest that children who grew up with their grandparents could be taller, but that the impact of the grandparent's contribution to household income was rather limited. Nevertheless, there are other factors associated with the odds in favor of grandparental survivorship that might also affect their grandchildren's growth. Additionally, according to the "grandmother hypothesis" developed by Hamilton (1966), the existence of grandparents allows their daughters to have more children and tends to disadvantage younger children in favor of older siblings. Finally, children from well-off families who had servants were taller by 3.7 cm with a higher chest value of 1 cm.

Changes in the Number of Siblings

Figure 5 shows that there is a negative association between height and the number of siblings, where stature declines as the number of siblings increases. With the appearance of new infants, the earnings of the male breadwinners might be eroded because the resources are divided by more children. This competition for resources fits with Becker's argument that parents obtain utility from the "quantity" and the "quality" of children, and that they tend to maximize their utility subject to a budget constraint (see, e.g., Becker and Lewis 1973). Having more siblings also exposes them to a higher transmission of infectious diseases during the growing period. For instance, Pérez Moreda et al. (2015) argue that in Spain, the decline in family size diminished the probability of being infected by whooping cough. Hatton and Martin (2009) also argue that the size of the household is inversely related to cleanliness and hygiene, which predisposed children to sickness. Humphries (2010) observed that in late Victorian Britain, various growing conditions such as the age when starting work and years of schooling were also inversely related the number of siblings in the household. For instance, children without siblings started work at the age of 12 years, but boys who had one or more siblings started at age 10.

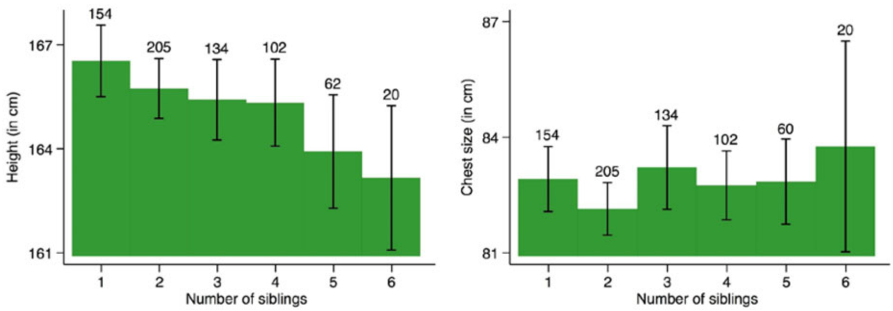

Figure 5. Changes in height and chest size by the number of siblings.

Changes in Birth Spacing

Finally, figure 6 controls height and chest size for the age gap between siblings (defined by the age difference between a child's immediate sibling). The larger the gap, the worse off a child could be in stature during a spacing period of four years. For a birth spacing of one year, a new child is 1.1 cm shorter than the previous one, and the new children are 1.5 cm shorter if the birth spacing is two years. To better understand this association, however, further work is needed to explore intra-household food allocation, infection patterns, and the allocation of maternal efforts for children of different ages. There is also a positive relationship between birth spacing and chest size. In historical England, Humphries (ibid.: 191) also found that "often children were marched into the labor force in rank order." If a potential recruit had a sibling soon after his own birth, he was most likely to be involved in child labor and contribute to the sibling's upkeep.

Quantifying the Impact of Household Composition on Height and Chest Size

After showing the unadjusted correlations, the estimating equation for the adjusted impact of household conditions in height and chest size is:

$$\begin{aligned} y_{it} = \alpha + \beta_1\,\text{Brother}_{l,it} + \beta_2\,\text{Sister}_{m,it} + \beta_3\,\text{Order}_{k,it} + \beta_4\text{Dad}_{o,it} \\ +\beta_5\text{Mom}_{p,it}+\beta_6\text{Girona}_i + \beta_7\text{Occupation}_{q,it} + \text{e}_{\text{it}} \end{aligned} \tag{1}$$

where the dependent variable, y_{it}, could be height or chest size for the individual i born in the year t and measured at the age of 21. Number of brothers (Brother) is the number of brothers that the man i had ($l = 1, \ldots, 7$) and number of sisters (Sister) the number of sisters that the man i had ($m = 1, \ldots, 6$). Birth order (Order) is the position k that the man i occupied between siblings ($k = 1, \ldots, 8$), father age at birth (Dad) is the age of the father when the man i was born ($o = 9, \ldots, 63$) and mother age at birth (Mom) is the age of the mother when the man i was born ($p = 9, \ldots, 51$). Girona's city as a place of birth (Girona) is a dummy equal to 1. Occupation is the occupation reported by the individual i (Occupation) under the HISCO classification as defined in the "Changes by Occupation" section ($q = 1, \ldots,$ 4) and e_{it} is the error term. I used robust standard errors and in columns 3 and 7 I

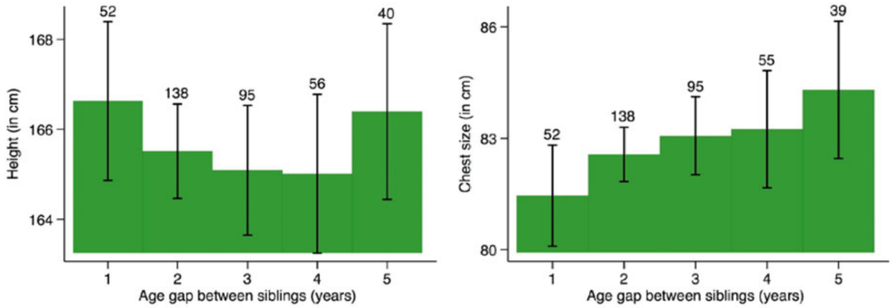

Figure 6. Changes height and chest size by birth spacing.

also control for nonlinear relationships with time dummies. I do not adjust sample sizes between models as the results are very similar quantitatively and qualitatively when adjusting them.

As table 3 displays, the number of brothers is important in shaping stature (columns 1–4), but it is having more brothers that has an effect, rather than more sisters, where having an extra brother is associated with being shorter by about half a centimeter. This point estimate is stable across different specifications and the inclusion of various controls such as other sibling and parental characteristics. The size of the effects are similar to the magnitude found by Bailey et al. (2016), although they could not determinate what mattered most, having sisters or brothers. It is possible that as boys grow up, they become an important source of family income. For instance, Borderías (2014) noted that in 1905 the work of two brothers aged between 8 and 15 years provided half of the household budget in Barcelona. By contrast, because most daughters did not work or worked in domestic service, food might be allocated first to boys. Similar also to Bailey et al. (2016) and Stradford et al. (2017), I find that the birth order effect is rather limited, particularly when I start controlling for other household components and parental characteristics. It is also very likely that birth order can be correlated with family size, as high birth orders can only be observed in large families.

The age of the father when the recruit was born is also important in explaining the recruit's adult stature, and a delay of 5 years accounts for nearly an extra centimeter in height. As parents grow older, they may increase their wealth or be promoted in their job. The effect of the age of the mother is much less (half a centimeter for a 5-year delay), but its negative sign highlights the problems associated with giving birth at an older age. Finally, taking white-collar workers as a reference, those who worked in farming were shorter by 4 cm, and manual and nonmanual workers by nearly 3 cm. These height differences by occupations are in line with those found in other regions of Spain, such as in Valencia (Galofré-Vilà et al. 2018).

The results for chest size (columns 5–8) are less informative. Yet, lack of explanatory power of early-life family conditions on chest size might not be so surprising, as while growth velocity in height peaks during early childhood (around the first 1,000 days of life) the chest expansion mainly occurs during puberty and therefore, as this article shows, is less likely to capture the early-life family conditions.

Table 3. Early-life family determinants of height and chest size

	Height				Chest size			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of brothers	−0.499**	−0.659**	−0.512*	−0.606**	0.006	0.120	0.182	0.095
	(0.248)	(0.283)	(0.282)	(0.297)	(0.178)	(0.209)	(0.213)	(0.222)
Number of sisters	−0.447*	−0.437*	−0.287	−0.460*	−0.133	−0.329*	−0.282	−0.327
	(0.229)	(0.251)	(0.255)	(0.261)	(0.177)	(0.195)	(0.197)	(0.207)
Birth order	0.170	−0.087	−0.196	−0.097	0.118	0.340	0.321	0.394
	(0.230)	(0.309)	(0.305)	(0.331)	(0.202)	(0.290)	(0.280)	(0.307)
Father age at birth		0.202***	0.179***	0.165**		0.003	−0.007	0.010
		(0.063)	(0.060)	(0.065)		(0.045)	(0.045)	(0.050)
Mother age at birth		−0.119**	−0.095*	−0.075		−0.012	−0.007	−0.023
		(0.058)	(0.056)	(0.063)		(0.050)	(0.049)	(0.054)
Urban place of birth (Girona's city)		0.655	0.537	0.309		−0.442	−0.487	−0.396
		(0.674)	(0.656)	(0.666)		(0.496)	(0.490)	(0.522)
Occupational group (Ref. Highly qualified nonmanual workers)								
Nonmanual skilled–unskilled				−2.221**				0.288
				(1.007)				(0.974)
Manual semiskilled–unskilled				−2.737***				−0.308
				(0.740)				(0.670)

(*Continued*)

Table 3. (*Continued*)

	Height				Chest size			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Farm workers				−3.906***				0.412
				(0.901)				(0.796)
Constant	166.393***	163.674***	162.680***	166.310***	82.751***	82.943***	83.305***	82.903***
	(0.468)	(1.619)	(1.742)	(1.664)	(0.388)	(1.259)	(1.319)	(1.344)
Number of men	787	607	607	533	783	603	603	529
R^2	0.011	0.040	0.082	0.070	0.001	0.009	0.029	0.014
Year dummies	No	No	Yes	No	No	No	Yes	No

Note: I am not including parental literacy as this was not available for the majority of the individuals (figure 5). However, when included data on parental literacy this is statistically significant. I am not including birth spacing as this is colinear with birth order and the number of siblings.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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According to twin studies, Chatterjee et al. (1999) also found that short-term environmental factors accounted for 60 percent of the variation in chest size at the time of measurement. Therefore, chest size, similar to weight, needs to be regarded more an indicator of net nutrition close to the point of measurement and less likely to reflect the cumulative early-life family conditions.

Conclusions

This article has explored the impact of various dimensions of family composition on height and chest size in late-nineteenth-century Catalonia. I argue that if we are to gain a fuller understanding of the factors that have affected height in the past, it is important to consider the early-life family characteristics as explanatory variables. Among many findings, I showed that sons of more well-off families with literate parents were expected to be taller. While those who grow up in orphanages or in motherless households were severely stunted. Moreover, I find a negative association between height and the number of siblings and that the larger the gap between siblings, the worse off a child could be. I also contextualized these findings in a regression model and found that having an extra sibling lowered adult height by nearly half a centimeter and that this result is driven primarily by having more brothers (rather than more sisters). Because chest size is an indicator of net nutrition status close to the point of measurement, it is less likely to reflect early-life family conditions, although, it shows potential for answering some questions in anthropometric history when weight data are unavailable.

The article also shows the extent to which longitudinal studies can untangle individual and period-specific effects from background and behavior to answer new questions. It is possible to link medical inspection records with census data, revealing the occupation of a recruit's parents, family composition, whether he migrated to another place, and the name of the street in which he grew (and potentially the building and the amount of taxes paid). All these links open new avenues for research. Indeed, it should be also feasible to link the military records to marriage records and death registers. It would also be possible to study how biology has changed and to study pairs of siblings more closely, controlling closely for genetic factors. It might also be possible to track families across time. Yet, sadly, similar historical data for sisters and mothers does not exist and we can only see them indirectly.

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Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ssh.2020.37

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