Historical recollection of anthropometric data from schoolchildren attending summer camps from 1887 to 1934 in Spain. Interpretations and comparison with coetaneous and modern references.

Running title:

Anthropometry from Spanish summer camps 1887-1934

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Abstract

Objectives: Around the aim of gaining knowledge on the secular trends in nutritional status of the Spanish population, we found a collection of historical records compiled by *La Institución Libre de Enseñanza* and their alumni association along 47 years. These data had been collected from boys and girls attending summer camps, with a policy of improving health of children with unfavourable socio-economic conditions. The objective is to extract all possible information about growth changes, and eventually any interpretation related to status of the originating families.

Materials and Methods: Primary data were collected from both unpublished manuscripts containing the original records and publications of the organising institutions. They had been gathered from 86 summer camps in Spain from 1887 to 1934. In these camps detailed anthropometric data were collected from every attendee, including body height and weight. The sample population amounts to 1791 boys and 1281 girls, between 7 and 16 years of age.

Results: Body height and weight, pooled by camp year, age and sex, displayed variable secular increases. A similar observation appears for the body mass index. As a complement, a comparison was done to contemporary published references from both Spanish and international studies.

Discussion: Height, weight and body mass index from the camps may be judged as retardation of growth and malnutrition by modern standards but it is not the case when coetaneous references are considered: no overall significant differences were found with respect to several publications from Spanish and European populations.

Keywords

historical anthropometric data; children; summer camp; BMI; body weight and height;

1. Introduction

In the final decades of the 19th century, Europe was consolidating its dominant role in the world and its major nations (United Kingdom, France and Germany) competed in colonial expansion over Africa and Asia. On the other hand, the United States was becoming an emergent power that started to dispute European colonial countries their economical and political dominance in the world. An example of this North-American expansionism was produced in 1898 when they grabbed from Spain the Cuban, Puerto Rican and Philippine territories. Spain, an old European nation plunged into a tangible decadence since the 17th century, was improving since mid-19th century on nearly all economic and social indexes. However, this progress was not satisfactory for the Spaniards, due to the difference with the booming countries in Western Europe, particularly France which was the reference against which continuous comparisons were set (Núñez Florencio, 1998).

Nutrition standards, chronic diseases and life expectance are some of the factors that may serve to define the differences between Spanish population and that from other, more developed, states in Western Europe. The interest in Spain for all those topics on hygiene and public health, particularly in the last decades of the 19th century, led into the surge of so-called *social medicine* (Hauser, 1902) which studies morbidity conditions derived from *a vicious organization of society*. This led to creation of several associations, societies, academies and institutes in order to solve problems of hygiene.

Statistical studies of the epoch are scarce and partial. They reveal that on the second half of the 19th century Spain had a mortality rate higher than the other Western European countries (Revenga, 1904). Regarding the child stage, the mortality rate was very close to 200 per mille, specially among the least favoured social classes (Comenge Ferrer, 1900). The reason was on hygiene conditions, the absence of a proper feeding and the incidence of some epidemics (scarlet fever, smallpox and diphtheria). There are reports of even 50% deaths among newborns. Hygienists recommended a healthy lifestyle, moderate exercise, good feeding habits, frequent washing of the body, etc. These approaches aimed at transforming Spain in a modern and civilised state, looking at Europe to exit the centuries-old backwardness.

In this context, both in Spain as in many European and American countries, a movement emerged aimed at protection, immunity and improvement of childhood, leading to a radical switch in pedagogy and in educational techniques and practice. As a response to this trend, on 1876 in Spain *La Institución Libre de Enseñanza* (ILE, The Free Educational Institution) was founded by a group of professors who had been expelled from university, on political and ideological motivation, by the conservative government led by Antonio Cánovas del Castillo. Article 15 of its statute (ILE, 1876) declares the institution to be *fully unconnected to any spirits or interests of religious communion, philosophical school or political party*. The main objective of ILE was *to educate their students* and to this aim they settled the principle of *maximal reverence due to the child* (ILE, 1934). This private educational institution brought together the pedagogical trends prevailing in Europe, established educational principles like coeducation of both sexes and collaboration between school and family, and in addition actively promoted physical exercise and outdoor activities for children (Felipe Maso, 2014).

On 1882, ILE founded in Madrid the *Museo de Instrucción Primaria* (Primary Instruction Museum), later named *Museo Pedagógico Nacional* (MPN, the National Pedagogic Museum). This institution was created in resemblance to others in Europe and was expected *to exert a direct influence on Spanish schools* and to discuss *problems associated to instruction, education and corporal development of the infant* (Royal Decree, 1882). MPN was a centre of educational research and innovation that reflected the pedagogical movements in Europe, disseminated methodological and conceptual advances in the educational sphere and tore up the social and pedagogical isolation which was characteristic of the Spanish society in the end of the 19th and beginning of the 20th centuries (García del Dujo, 1985). The Museum organised in 1887 the first summer school camp in Spain, under supervision of Manuel B. Cossío, as the first director of the Museum. Official establishment of such summertime stays came, however, five years later by the Ministry of Development (Royal Decree, 1892)

Worldwide, residential summer camps for students were first set up by the Swiss Walter Bion, who in 1876 took to the countryside several schoolchildren from impoverished families, with the aim that they could breathe fresh air and receive good nourishment. The example of these camps spread to other Helvetian towns, then to different European states (Germany in 1878, Austria in 1879, Belgium in 1886, etc.) and even to other continents, like Australia, Argentina, Japan, USA or Chile. Impact of these holiday lodgings for schoolkids was so powerful that even some symposia were celebrated, specific for this topic, like the 1st international congress on school camps held in Berlin 1881, or the one in Zurich, 1888, where Cossío himself informed on the first Spanish summer camp, of which he was director (Moreno Martínez, 2009).

To bring this first summer activity into reality, the Museum disseminated widely their project, made a plea for donations, chose the most suitable location to set the camp and established the protocol for choosing the children that would attend. According to instructions from the Museum, each teacher involved was to designate three or four of his pupils among the poorest and who needed to be treated for anaemia, were 9 to 13 years old and did not suffer any contagious diseases. (Despite this initial plan, they actually accepted children from 6 to 16 years old.) The final selection of 18 participants was in charge of the chief health inspector of municipal schools, together with doctors Luis Simarro and Rafael Salillas, anthropological study specialists (López Núñez, 1908).

These Spanish educational initiatives were, year after year, perfectly planned by the MPN. Once participants had been selected, the camp director requested the signature of parents or tutors in order to waive responsibility in the case of any accident or illness. Parents were additionally informed of the address for correspondence, the equipment needed for the stay and even some printed instructions about the way to properly tie up the luggage (booklet by Pintado Arroyo, n/d).

Both before and after travelling to the camp, anthropological forms were filled in with immediate physical results of each camper, including height, weight, chest circumference across thelion, and right and left handgrip strength, as indicated in the model in page 15 of the above-mentioned booklet. It was recommended that the schoolchildren attended the camp on three consecutive years, in order to ascertain the progress in their health. Other generic anthropological forms were also filled in for each participant (pages 16 and 17 in the same booklet), which thoroughly recorded ancestry, anatomical and physiological data, any abnormalities, etc. It is not odd that the MPN gave such a relevance to compilation of measurements and anthropological features, since the origins of Anthropometry go back to the 19th century and it was then when anthropometric measurements started to be applied in the educative field, until the so called Pedagogic Anthropometry or Paidometry was formally established.

MPN summer camps lasted till 1926. The initiative was followed first by *Corporación de Antiguos Alumnos del ILE* (AAILE, the Association of ILE Alumni) which in 1894 organised their own camp, picking as destination Miraflores de la Sierra (province of Madrid, central Spain) and, from the following year, San Vicente de la Barquera (province of Cantabria, northern coast of Spain) (Otero Urtaza, Navarro Patón & Basanta Camiño, 2013). This AAILE initiative never had any official endorsements and was financed by private subscription of members of *corporation, teachers, students and sympathisers of ILE's deed*. They also accepted paid campers who, in most cases, were *relatives of members of the Institution or students from their educational centre* (Rodríguez Pérez, 2004). Camp directors and technicians who accompanied the children were teachers, ILE alumni or sympathisers. Following the track of the MPN, diverse institutions all over the Spanish geography also organised summer school camps in Madrid, Granada, Barcelona, the Balearic Islands, Santiago, Oviedo, León, etc. (Salcedo y Ginestal, 1900; Rodríguez Pérez, 2004).

The beginning of the research reported in this paper dates back two decades, when we found in the National Library of Spain reports from the anthropometric examinations performed with schoolchildren attending the summer camps organised by the MPN between 1908 and 1921. The initial analysis of this material (González Montero de Espinosa, Marrodán, Moreno & Pérez Magdaleno, 2000) motivated the authors to pursue this line of work and search for data from all the camps organised by ILE. Consequently, the aims of the current report are specifically three. First, to rescue historical, unpublished files and to explore in detail the documentation contained therein. In this respect, special attention has been paid to analyse who (teachers and physicians) selected the schoolchildren that would attend the camps and to find out the profile and gender of the campists, as well as the kind of variables that were measured or collected. Second, to ascertain the secular trends of height, weight and body mass index (BMI), along the period between 1887 and 1934. Finally, we also intend to compare the anthropometric variables of the children participating in these camps with data from other studies published in the same period in Spain and Europe, as well as with more recent international reference values.

2. Material

2.a. Description of the sample population

The data source for the current work is the general anthropological forms from MPN along the 1887-1925 period, where information was recorded about ancestry, anatomical and physiological data, any abnormalities, etc. of every participant in the camps. In the same way, other anthropological forms have been collected from the same children, those called "immediate physical results". The latter contain, in addition to age and name, measurements from their height, body weight, chest circumference across thelion and handgrip strength in both hands, both when starting the camp and when leaving it at the end. Variables from "immediate physical results" forms have also been collected from attendants to AAILE camps between 1896 and 1934.

These data are primary, from the records of the MPN, and they have never been published in a processed form. They include the whole set of summer camps organised by ILE (1887-1925) and 65% of the camps organised by ILE Alumni (1894-1936) since it was impossible to locate all of their records.

The whole sample consists of 3072 individuals: 1791 males and 1281 females, all originating from schools in Madrid. When summer school camps were started the aim was to deal with 9 to 13 year old schoolchildren, as it has been mentioned in the introduction, but later on they were extended in practice to a wider age range, including from 6 to 17 year olds. However, the small number of children below 7 and above 16 has led us to exclude them from the current analysis.

As reflected in table 1, we could access full information pertaining to ILE camps, with the exception of the second camp (1888). However, it has not been possible to collect variables from all summer stays set by AAILE since the Giner de los Ríos Foundation was closed and only half the documents could be accessed. Additionally, as can be appreciated in the table, inclusion of girls in the camps was delayed, starting in 1891 for ILE and 1896 for AAILE. Furthermore, it may be noted that the AAILE "immediate physical results" forms are lacking data for height or age in several years from 1921, which seriously hinders the analysis of anthropometric variability in the second decade of the 20th century.

Table 1

Listing of years with available data (shaded cells).
a: age data not recorded; h: height data not recorded; f: no females in sample

	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902
ILE	■ f		■ f	■ f	■	■ f	■	■	■	■	■	■	■	■	■	■
AAILE										■	■	■	■ f			■ f

	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
ILE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
AAILE	■ f	■ f		■ f					■		■	■	■			

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934
ILE	■	■	■	■	■	■	■									
AAILE			■ a h		■ a h	■ a h	■ h	■ h			■ h	■ h			■ a h	■ a h

Table S1 (see supplementary material) describes in detail composition of the sample, with respect to organising institution, year, camp, age and gender. Again, it may be perceived how girls joined the camps later than boys, until by 1907-10 the global ILE+AAILE sample started having approximately the same number of both sexes.

Given the somewhat limited number of data for some ages or camp years, we decided to pool them in periods of 4 consecutive years, here called the cohorts. Nonetheless, it must be mentioned that some of the cohorts have a lower amplitude due to lack of accessible data. For instance, the 1887-90 cohort only includes data from 3 years, and 1927-30 just from two years. The 1931-34 cohort also has only two years, but no data could be included in the analysis since ages of the children had not been recorded.

2.b. Other studies in the literature with comparable data

With the intention of analysing nutritional status and a possible growth delay among camp attendees, their anthropometric measurements at camp entry have been compared to reference samples. Such a comparison has been done, on the one hand, against Spanish and European series studied in coetaneous times and, on the other, to more current international references. In many cases, the references lack some key information like the date of measurement, instruments used for measuring, way to calculate the age, size of the sample population or its socio-economical status.

We will first describe the essential features of the reference studies based on Spanish populations.

Olóriz (1896) measured a total of 7396 males and 8098 females, including adults, from diverse origins all over Spain but mainly Madrid, mostly with low socioeconomic status. For comparison with our study we extracted the data from 7 to 16 years old, yielding 873 boys and 310 girls.

Martín (1902) collected data in 1898 from boys 5 to 15 years old in Granada city. He split this population in two sets: the "A" set were 161 boys from working-class families, while the "B" set were 125 boys from middle class families; no girls were included. Only data from 7 years old and above have been retained here for comparison, comprising 100 boys in the A set and 151 in the B set.
Blanco "A" (1912) took his measures between 1904 and 1908, with 600 boys from Madrid (nearby the Daoiz neighbourhood), 6 to 13 years old. Only data from 7 years up have been retained here for comparison.
Blanco "B" (1920) collected data on March 1919 from primary schools all over Spain: 453 boys-only schools, 83 girls-only schools and 37 mixed schools. Ages were from 4 to 14 years old. Only data above 7 years old have been retained here for comparison, totalling 9065 males and 2209 females.
Morros (1934) measured boys and girls from León, whose parents were also from that province, with diverse socioeconomic status. 30 individuals were measured for each age and sex, between 6 and 14 years old. Only data from 7 years up have been retained here for comparison.

We have also collected, for reference and comparison, several published analyses on children populations from diverse locations in Europe around the period corresponding to the summer camps object of the current study.
Quetelet (1871) described a sample of Belgian individuals, since birth to adult age. Weight data, for both sexes, provide the average of those measured on 1835 and 1840 (page 346).
Bowditch (1877) reports in the "A" set measurements from 8858 schoolchildren (5235 boys and 3623 girls) between 5 and 18 years old. They were living in Boston but were born in Ireland from both Irish parents. The "B" set were children living in Boston but were born in Germany from both German parents, with measurements from 1337 schoolchildren (752 males and 585 females) from 5 to 18 years old.
Godin (1903) collected a sample population of 100 male individuals, between 13 and 17 years of age, sons of military officers and born within the French territory and colonies, particularly in Algeria.
Kirkoff (1906) studied 4874 males between 11 and 20 years old in Sofia, Bulgaria. They were attending the military school of HRH the Prince of Bulgaria. Measurements were started in August 1900.
Variot & Chaumet (1906) measured in 1905 schoolchildren from Paris, between 100 and 190 individuals depending on age and sex. They proceeded from schools, dispensaries and external consulting rooms.
Cardoso & Caninas (2010) took measurements in 1910 on a Portuguese schoolchildren population, 10 to 16 years of age, split in two groups: group "A" corresponds to 2257 males from middle- to high-class families, while males in group "B" were 979 individuals from working class.
Moraes Manchego (1913) measured body height of 1819 Portuguese males and weight of 1261 males, both between 6 and 17 years old.
Sigalas (1913) measured 1500 children of both sexes in the region of Bordeaux (France), from young infants to 15 years old.

Ogórek (2016) was aiming at checking biological consequences of the First World War and reported on former studies with schoolboys in Kraków. The original measurements had been taken between 1928 and 1931, with 1471 boys from 10 to 13 years old.

Friant (1931) reported on two studies performed along 1927 to 1931; the first one with 50 boys from 7 to 10 years of age, the second with 50 boys from 10 to 13 years, both from primary schools in 10 towns in Moselle (France).

Paciorek (2010) published Polish standards for physical development of children. Tables had been prepared in 1938 by R. Barański, J. Bogdanowicz and Z. Łomnicki from data compiled by the Central Statistics Office in 1930. Note: we suspect that data from both sexes may have been swapped, since values reported for girls are higher than for boys; however , no amendment has been done.

Chura (1934) reported on two sets of data from Slovak schoolchildren between 6 and 14 years old: the first measured in 1931 the stature of 3931 (1903 males, 2028 females) and body weight of 3875 children (1867 boys, 2008 girls). The second set, measured in 1932, includes stature of 5823 (2764 boys, 3059 girls) and weight of 5982 (2855 males and 3127 females).

Athayde (1933) measured 500 children, 6 to 13 years old, from primary schools in two neighbourhoods of Porto (Portugal).

Fessard, Laufer & Laugier (1935) measured in 1932 body height and weight of schoolchildren in Paris, betwwen 5 and 14 years of age.

WHO (2007) is a retrospective report by the World Health Organization, using data from national health surveys carried out in the 1970s, mainly from USA. They include height and BMI values, however they do not include weight data over 5 years of age.

3. Methods

3.a Preprocessing of data

Measurements examined in the current work are those which were taken when the children entered the camps. As has been noted, data from below 7 and over 16 year olds have been removed for the analysis. In a first attempt, the average values for each age, sex and cohort were calculated for the anthropometric variables body height, weight and calculated body mass index. These data are presented in tables S2 to S4 (see supplementary material). By way of example, the trends in male height and female weight are also graphically presented in figures S1A and S1B. A lack of an ascending trend along the cohorts was perceived; this does not allow reliable conclusions to be extracted from the simple examination of the average values for each group. Given this observation, and to gain further knowledge about the reasons behind it, a second approach was to ascertain the dispersion of individual data in detail. As an example of such a distribution, figure S2 displays values for 12 year old boys height (A) and 12 year old girls weight (B). A strong dispersion was observed in all groups. This is obviously influenced by the lack of experimental design, the current study being an analysis of historical data from different sources rather than one systematically designed ahead of the measurements being taken.

Once the dispersion of data was verified, the use of means calculated for each cohort was abandoned. Instead, all data pooled into cohorts were subjected to a calculation of linear regression. The abscissa value (denoted by k) was a correlative index related to the years that form each cohort (k=0 for the 1887-1890 cohort, k=1 for 1891-1894, and so on).

Given the limited availability of reference publications, we chose several values of the k parameter (table 2) that would represent the set of cohorts more closely comparable to the references, and each of them was interpolated in the equation of the regression line for each age and sex, to provide the value (height, weight, ...) assigned to those cohort sets (in place of the original means that had been disregarded as a significant way of representing the populations). In this way, the overall trend defined by the regression line is what is assigned to each cohort, in order to compare them to the published references. So, as reported in table 2, to compare with data from Olóriz (1896), Martín A and B (1902), and Blanco A (1912) a value of 3.5 was chosen for the abscissa k, which corresponds to cohorts between 1895 and 1910. To compare with Blanco B (1920) and Morros (1934), k=10 was selected, matching cohorts from 1919 to 1930. Results of interpolation in the regression lines for each age were those used in preparing the figures where comparison with the reference series is displayed. It is important to stress that symbol legends in figures indicate the year of publication of the reference study and not the years when their measurements were taken, which in several cases is considerably preceding and has hence been mentioned in the figure footnote.

Table 2

Correlation between the cohorts and other studies in the literature (left and right: Spanish and European populations).
The *k* value is that of the abscissa variable (cohort) in the linear regression of the data. Parentheses surround cohort years and k values that are outside the data range of the summer camps object of this study, and hence are not reliable for extrapolation.

Matching cohorts	***Reference value of k***	***Spanish references***	***Cohort***	***k***	***European references***	***Reference value of k***	***Matching cohorts***
			(1871-1874)	(–4)	Quetelet		
			(1875-1878)	(–3)	Bowditch		
			(1879-1882)	(–2)			
			(1883-1886)	(–1)			
			1887-1890	0			
			1891-1894	1			
		Olóriz	1895-1898	2		3.5	1895-1910
		Martín	1899-1902	3			
1895-1910	3.5	Blanco A	1903-1906	4	Godin Variot Kirkoff		
			1907-1910	5	Cardoso		
			1911-1914	6	Moraes Sigalas		
			1915-1918	7	Ogórek		
		Blanco B	1919-1922	8			
			1923-1926	9			
1919-1930	10		1927-1930	10	Friant Paciorek	10	1919-1930
		Morros	(1931-1934)	(11)	Chura Athayde Fessard		
					WHO		

4. Results

4.a. Height

The raw data obtained from the different camp records were used to calculate mean value and dispersion for each sex, age and cohort (collected in table S2). As it has been discussed in the methods section, these data were subjected to linear regression. The results of regression from height values versus cohort, separate for each age and sex, show a slight secular increase, of variable amplitude (figure 1). As is also presented in the methods section, representative values for both cohort sets (1895-1910 and 1919-1930) were obtained by interpolation in the respective regression lines, in order to compare with available bibliographic references. Such comparison is shown in figure 2.

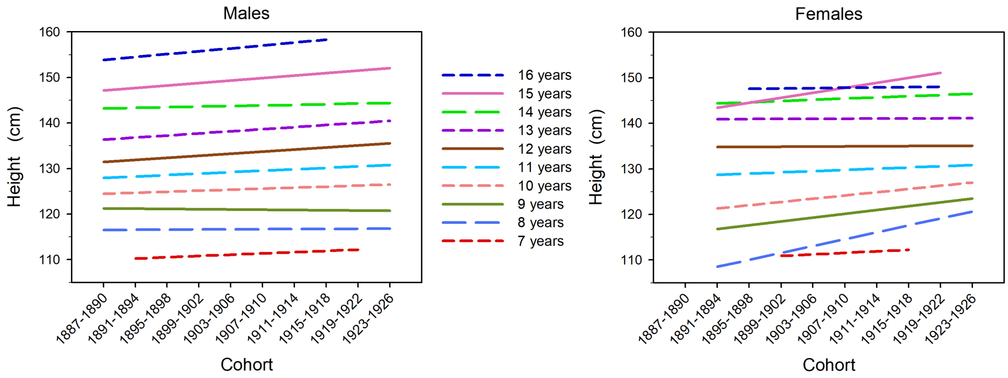

Figure 1: Regression of the body height data for each age, along the cohorts.

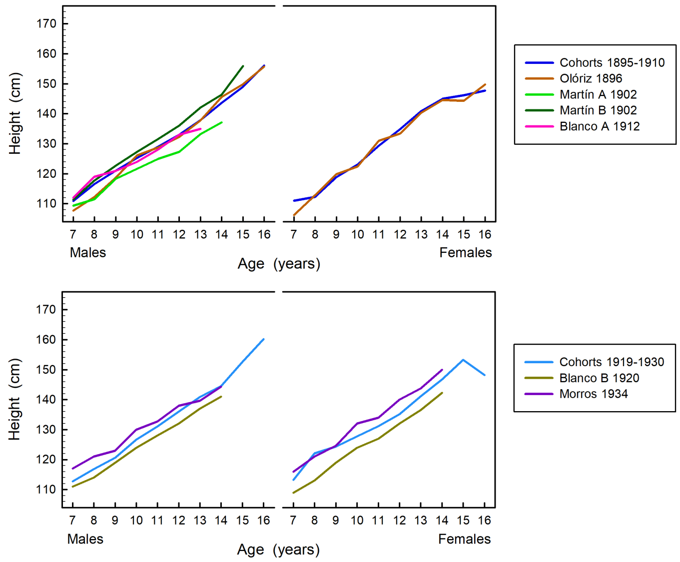

Figure 2: Body height values obtained from the regression lines, for two sets of cohorts in this study, in comparison with available references of Spanish populations matching each period. Note: Martín measured children in 1898, with group A being from working class families and group B from middle class. Blanco's measures were taken between 1904 and 1908 for group A, on 1919 for group B.

For comparison with girls in the 1895-1910 cohort set, the only available data in the literature were those from Olóriz (1896). We can observe a close similarity with data from the current study for all ages, something that could be expected since the female data from Olóriz come from San Alfonso School, a charity catholic centre in Madrid, and municipal schools in the provinces of Madrid, Granada and others. Hence, in both cases data correspond to girls with a low social extraction. We then looked for published studies from European populations (figure S3); all of these display higher values than those from the Spanish camps.

In the case of a later cohort set, from 1919 to 1930, more references are available to compare with (figure 2, bottom). Values from the present study were higher than those from Blanco (1920) which came from female-only and mixed schools spread all over Spain. The unexpectedly lower values found by Blanco may reflect the status of the girls but may also be biased by his method of setting the age (see the discussion section). In addition to all these considerations, it must be added that measurements were taken by the respective teachers in each school and not by the same team for the whole population under study, which may introduce some variation or bias in the values. The comparison with European reference studies (figure S3) shows, as with previous cohort set, that the camps are below all the references, with the exception of Quetelet whose study is much older than the other references

For boys in the former cohort set (1895-1910) a comparison may be established with three previously published references (figure 2, top): Olóriz (1896), two subpopulations from Martín (1902), and Blanco (1912). Sample "A" from Martín, consisting of boys from low socioeconomic status, is positioned clearly below values from the camp cohorts in the present study, while the "B" sample from the same author, with higher status, surpasses camp data at all ages. This may be interpreted as the 1895-1910 cohorts object of this work being mid-way between both economical situations, despite children were selected for the camps supposedly based on a precarious familial status. Similarly to what has been observed for girls, boys in these cohorts had heights similar to those reported by Olóriz (1896). The same happens with data from Blanco (1912), in this case measured by the author himself in the anthropometric laboratory at Museo Pedagógico Nacional in Madrid.

Also for boys, but in the 1919-1930 cohort set, the same observation as for girls is repeated, i.e. the average values are positioned between references from Blanco (1920) and Morros (1934), the latter presenting the highest statures (figure 2, bottom). The explanation may therefore be the same as described for girls. Once again, and for both cohort sets, values reported by European analyses surpass those from the camps (figure S3).

4.b. Weight

The raw body weight data from the camps were used to calculate mean value and dispersion for each sex, age and cohort (collected in table S3). Results obtained from the regression lines display the expected secular increase (figure 3), which is more evident than in the case of height (figure 2). As described under Methods, representative values for the two cohort sets (1895-1910 and 1919-1930) were interpolated from the regression lines in order to obtain data that is comparable to the existing references in the literature. This comparison is displayed in figure 4.

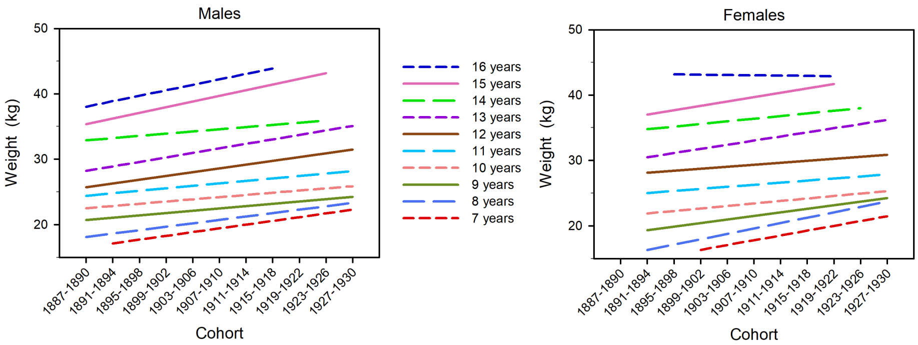

Figure 3: Regression of the body weight data for each age, along the cohorts.

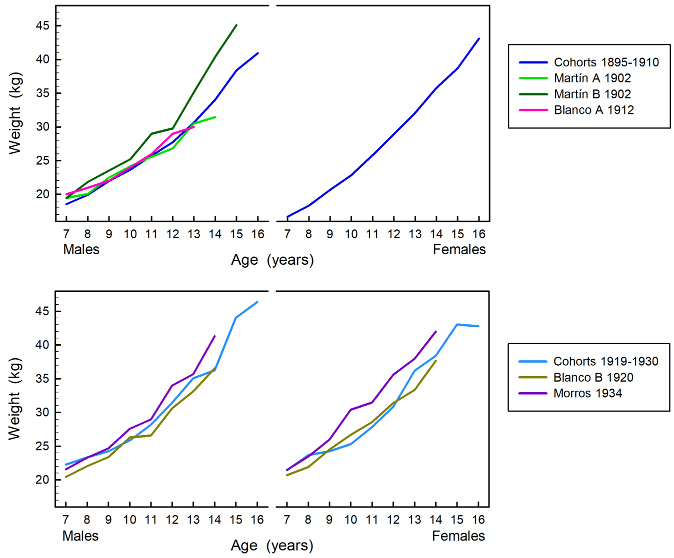

Figure 4: Body weight values obtained from the regression lines, for both cohort sets in this study, in comparison with available references of Spanish populations matching each period. Note: Martín measured children in 1898, with group A being from working class families and group B from middle class. Blanco's measures were taken between 1904 and 1908 for group A, on 1919 for group B.

In the female series from the 1895 to 1910 cohorts, there are no bibliographic references available in Spain, since their studies were run only with boys, but for the later 1919-1930 cohorts we can use references from Blanco (1920) and Morros (1934); the first shows similar values, while the second widely surpasses those from these camp cohorts for all ages. Several European references provided the possibility of comparison for both periods. Similarly to what had been observed for height, weight of European girls was superior to those of the Spanish camps (figure S4), with the exception of those measured by Quetelet whose study is much older than the other references.

For the male series, the former 1895 to 1910 cohort set may be compared to two contemporary studies, Martín (1902) and Blanco (1912), the former one with two subpopulations (figure 4, top). Martín's sample "A", from low extraction families, overlaps with values from the current cohort, while sample "B", with higher socioeconomic status, renders values above the camp cohorts for all ages. Data from Blanco (1912) are also quite similar to those found in the study object of the current research. For males in the 1919-1930 cohorts, values are intermediate between both references, Blanco and Morros, the latter being the highest. It is relevant to note that there is a 14 year distance between both references and also that the population size is double in the first one. These considerations could influence the observed difference. Once again, the data are below those from the European references from the respective periods (figure S4).

4.c. Body mass index

The raw data from the camp records were used to calculate mean value and dispersion of the calculated BMI (collected in table S4) for each sex, age and cohort.

Among the usual parameters for estimating nutritional condition is the body mass index (BMI). In all available sources, including those from the camps analysed in the current study, such datum is not reported, with the exception of references from WHO (2007) that do include BMI data (although, rather surprisingly, they do not include body weight).

For the camps, since the individual data were available, we could calculate the BMI for each child and then the average BMI for each age and gender group. On the contrary, most publications here used as reference report only the average weight and height for each age and sex group, rather than values from each individual. Consequently, the only choice is to calculate an "average" BMI from each average weight and height. As discussed below, we suspect that this may introduce some deviations in the comparative interpretation of results.

To these estimated BMI mean values a regression analysis was applied, similarly to what has been described above for height and weight. Results along the cohorts, separately for each age and sex group, display a secular increase, marked for boys and not so much for girls (figure 5). Once again, the result from interpolations for each cohort is analysed in comparison to BMI values calculated from the bibliographic references (figure 6).

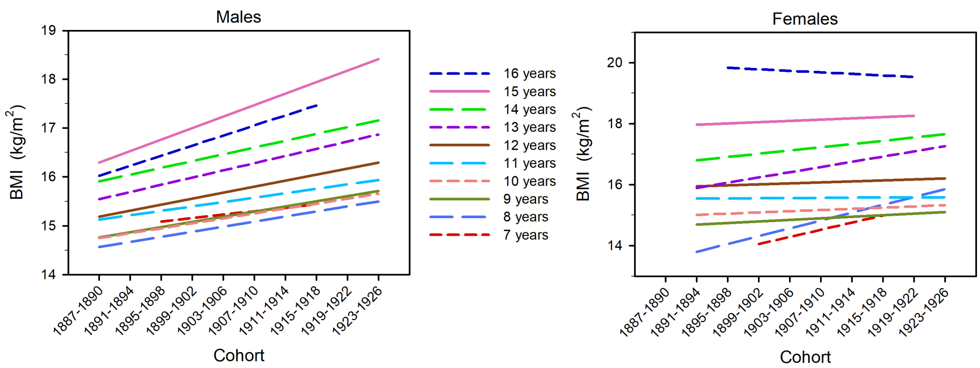

Figure 5: Regression of the body mass index for each age, along the cohorts.

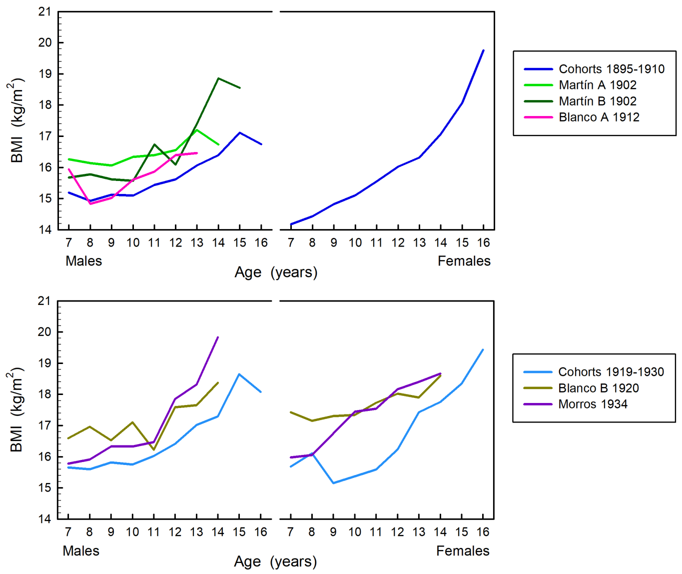

Figure 6: Body mass index obtained from the regression lines, for both cohort sets in this study, in comparison with available references of Spanish populations matching each period. Note: Martín

measured children in 1898, with group A being from working class families and group B from middle class. Blanco's measures were taken between 1904 and 1908 for group A, on 1919 for group B.

Given the lack of female data in references from the 1895-1910 period, comparisons cannot be established for BMI with the first cohorts. The second cohort set (from 1919 to 1930) may be compared to references by Blanco (1920) and Morros (1934), both fully exceeding values from the camps at all ages.

With respect to males, the former cohorts (1895 to 1910) may be compared to publications by Martín (1902) and Blanco (1912). Both subpopulations measured by the first author, from low and high socioeconomic status, surpass data from the camp cohorts. Blanco's data are also higher than those from the camps, with the exception of 8 and 9 year old boys. Data from boys in the 1919-1930 cohorts are as well below all the contemporary references. Among these, boys measured by Morros (1934) exceed by far those from the camps.

When compared to European samples of the respective periods, BMI from the camps are positioned below all the references, with the highest difference found for girls in the 1919-1930 cohort set (figure S5). Exceptions are girls from Quetelet and Moraes' boys, which overlap with data from the camps.

The fact –somewhat unexpected after the separate analysis of height and weight– that BMI values were rather lower for the camps than in the Spanish reference publications may be reflecting the premise that children selected to attend the camps were picked based on less favoured socioeconomic status. It must be stressed that BMI is an anthropometric index directly related to nutritional status of the individual and reflects an acute malnutrition when the value is below the established limits. With respect to reference values defined by the World Health Organisation (WHO, 2007) the mean BMI values found for the campists of both sexes match percentile 15 in all ages, which would currently be interpreted between mild and moderate malnutrition.

4.d. Exploration of possible bias related to dispersion and to calculation from averages

It has already been mentioned that most of the published references do not report individual records, but average values for each group, and hence BMI values were only available as calculations from the average weight and height for each age and sex. This led us to suspect a possible bias in the results, when being compared to data from the camps which are BMI values for each individual. Since individual data were available only in the case of the study by Morros (1934), we decided to use this one as a test case. We could calculate the individual BMI values and compare their average to the BMI calculated from mean weight and mean height. This was hoping to uncover some bias associated to the latter method. What we found is a closely similar result, with just about 1% difference between both methods, for boys between 7 and 14 years. Therefore there seems to be no misinterpretation for statistical reasons.

As an additional exploration of the observations, we also investigated the degree of dispersion of individual data, to explore its possible influence on the trends in BMI, weight and height along the age (fig. S6). The idea was to perceive whether dispersion in BMI could be much stronger than dispersion in weight or height and, in that case, whether that would be the cause for the marked and unexpected difference found only in BMI but not in height or weight, between values from the camps and the published Spanish references. This analysis was run in parallel for males in the Morros' study and males in the coetaneous camp cohorts, 1919-1930. No clear difference in trend could be observed regarding dispersion of the three magnitudes and, furthermore, variations were similar in both populations. There seems hence not to be any reasons to believe that the way of calculating average BMI values has introduced any bias in the differences discussed above.

We may take advantage of this analysis to appreciate some interesting trends: the progress in body height displays a somewhat higher slope in the camp cohorts, while the slope for weight is lower in the camps than in boys from the study by Morros. Consequently, the increase in BMI with age is quite less noticeable among the camp boys than in boys measured by Morros. Additionally, the difference is stronger for higher ages and very subtle in the youngest. It is also interesting to note a curvature in the secular trend of BMI, in contrast with a linear increase in weight and height (fig. S6, insets); however, such an apparently different degree of linearity could not be quantitatively confirmed by the statistical analysis, maybe due to the inherent dispersion of the sample population (with 30 boys per age in the case of Morros).

4.e. Prevalence rates of under-nutrition

One additional way to characterise the status of the populations is the analysis of key measures of under-nutrition, judged against the modern references of WHO (2007) and Cole, Flegal, Nicholls & Jackson (2007). We evaluated, for data from the summer camps, the three indicators against WHO: stunting (height for age ≤ -2SD), underweight (weight for age ≤ -2SD) and wasting (BMI for age ≤ -2SD). With respect to Cole *et al.*'s references, we used the BMI threshold for moderate (or grade 2) thinness, hence including severe (grade 3) thinness as well, for each age and sex.

The prevalence of stunting is higher than 50% for nearly all the camp cohorts, ages and sexes (figure S7). Furthermore, no trend of improvement may be appreciated when progressing along the time series. Retarded growth is more conspicuous among girls before 1911, though this may be questionable given the restricted number of individuals in those samples.

With respect to underweight, there is a limitation in the analysis since WHO did not include weight data over 9 years old. Assuming this, a slight secular improvement seems apparent, once again debatable due to the small sample sizes (figure S8).

The prevalence of wasting is, in contrast, relatively low (under 25%) among the camp children, according to both WHO and Cole *et al.*'s thresholds (figures S9 and S10).

5. Discussion

As far back as 1976, WHO asserted that auxological studies permit to analyse anthropometric parameters that not only illustrate the patterns of body growth but also entail biological indicators of life quality and of the development of a population. There are frequent demonstrations of the secular trends in male adults (particularly conscripts), but also some studies –even if not so many–dealing with the evolution in children, that may provide interesting information. There is also an overall scarce information on the growth of female individuals.

It is well known that human growth responds to both genetic and environmental factors, but it is the latter that are to a greater extent responsible for the positive changes linked to the increase in body size. Particularly since the last quarter of the 19th century, the surging movement among hygienists compelled campaigns of improvement on hygienic habits as well as quality of food and nutrition, which brought as a consequence significant changes in the progression of growth and health in general.

From the contrast among the Spanish series it may be inferred that socio-economical differences exert a stronger influence on body growth than the geographical provenance within the country. This situation is in accordance with the work by Puig Roig (1919) who analysed the growth of Spanish children of both sexes living in the *Charity House* at Barcelona. These children, abandoned by their parents, proceeded from different Spanish provinces (Barcelona, Gerona, Lérida, Tarragona, Zaragoza, Castellón and Valencia) and presented body height and weight much below the standard for their age, even below those from the camps in the current study. We have not included comparison with Puig Roig's series in the results section since his groups over 10 years old include very few individuals. A further supporting evidence for the consideration that socio-economic condition has larger relevance than the origin is that children from the camps are positioned intermediate between the two subpopulations from Granada separated according to their status (Martín A and B).

As it has already been presented in the results section, Spanish campists are located below all the European schoolchildren in nearly all parameters, with the exception of Quetelet's series (1871) which is one of the most ancient (weight data were taken in 1835 and 1840). Two possible causes may be suggested for this: first, the socio-economic situation in Spain was relatively low among the neighbour countries and second, the camp children were drawn from unfavoured social settings, therefore their corporal magnitudes were below the Spanish average for that epoch. These two hypotheses are endorsed when we ascertained that, even in the short lapse of the camp sojourn, children noticeably increased their weight and BMI (González Montero de Espinosa, López-Ejeda & Marrodán, 2018). Studies performed on young adults also manifest that stature of Spaniards was below their counterparts in other European countries (Martínez-Carrión, 2012). On the other hand, comparison among the European samples highlights that Portuguese schoolkids with high socioeconomic status possess higher stature and weight than their compatriots from a poorer class (samples "A" and "B" from Cardoso, 2010, respectively) and

that, for instance, Bulgarian boys attending an elite military school (Kirkoff, 1906) are among the tallest in all European series.
Much likely all the former considerations may be linked to the uneven economical development and welfare in the European continent in the epoch under analysis, without ruling out the possible effect of factors linked to genetic constitution, degree of heterosis and consanguinity. Indeed, Spain is one of the European countries with a higher rate of consanguinity, which has been decreasing faster but with more delay than in the rest of Europe (Calderón, 2000). Finally, it is worth noting that the work edited by Bodzsaŕ & Susanne (1998) include an analysis of the secular patterns of change during growth in diverse European countries along the 19th century and the initial decades of the 20th century. In all them a parallelism is evident between the increase in body parameters and the improvement in hygienic, nutritional and educative conditions, stressing the value of anthropometry as a very useful tool in estimating the degree of development of human populations.
An additional factor affecting the comparison of results among different sources is the way the age of children was quoted, which in most cases was not explicitly stated. For instance, Blanco in his 1920 article indicated that schoolchildren included under each age group were those who had reached or would reach that age within the 1919 calendar year. This is different from the usual criterion, i.e. the age that has been reached (birthday passed) at the moment of the study. In consequence, at the moment of measurement (in March) Blanco assigned 7 years of age to children who had turned that age in the first trimester on that year but also to those who would turn 7 during the ensuing nine months (and would qualify as 6 in other studies). Indeed, data in Blanco (1920) were even below those from the camps, which could be affected by his children being younger. In contrast, the study in 1912 by the same author, where the age assignment is not explained, displays body weight and height similar to those from the coetaneous camps.
A common reference in studies dealing with growth and nutritional studies are the data compiled by the World Health Organization and used as standards even in the common paediatric practice (WHO, 2007). These references were prepared from data originated in the First National Health and Nutrition Examination Survey (NHANES I) which was carried out in the 1970s. Even though the figures are not so recent, they widely surpass the stature of children in the camps, as well as that of the historical European series here examined as reference. In accordance to this, the proportion of chronic malnutrition or retarded growth, estimated from the WHO reference (2017), extends to more than half of the camp children. This rate of malnutrition has been examined in more detail, by age and its degree of severity, in a recent article (González Montero de Espinosa *et al.*, 2018). This work considered the influence of the stay in the summer school camps on the reduction of short stature for the age.
With respect to BMI, the values from WHO are much closer to the averages reported for all the historical series examined. Since this index is a ratio between stature and weight, a low height for the age and a low weight for the age are somehow compensated. Indeed, prevalence of wasting in the different camp

cohorts is overall rather lower than prevalence of stunting, which was also evidenced in the former report (González Montero de Espinosa *et al.*, 2018), in which it was also detected that overweight and obesity affected a negligible proportion of the children attending the camps.

The thresholds for slimness defined by Cole *et al.* (2007) are equivalent to those proposed by WHO in adults, having been adjusted for the age and obtained from a large sample including data collected across different years and countries: Brasil (1989), the United States of America (1963-80), the United Kingdom (1978-93), the Netherlands (1980), Hong Kong (1993) and Singapore (1993). This reference is recommended by the International Obesity Task Force (IOTF) to establish the nutritional status from the BMI value. Their application to our camps renders results mostly identical to the WHO reference.

To finish, it is important to note that the present study carries some limitations, inherent to the absence of a global experimental design and the nature of the sources. Among them, the historical documents that have been analysed do not include a record of the instruments or the precise technique used to collect the anthropometric measurements. The criteria for quoting the age is often not specified and may introduce some bias (as discussed above). Additionally, such measurements were taken in each camp and year by different persons, whose qualification in anthropometry we cannot know. The sample size in the female series is limited, or even nonexistent in the oldest cohorts. Furthermore, the number of data is diverse across the cohorts and age groups. Finally, while for the camps the BMI are calculated for each individual, in the Spanish and European historical series used for comparison the BMI is calculated from the average weight and the average height for each group.

Conclusions

Along the 43-year period examined in this study, body height of the schoolchildren attending the camps underwent a slight secular increase, with variable magnitude depending on age and sex. On the other hand, when we compare with tables from WHO, which are the current standard for assessing growth, it is evident that body height from boys and girls of those camps were notably lower and would be classified nowadays as chronic malnutrition or a severe retardation of longitudinal growth. This, of course, reflects the changes in style of life and welfare in our current society after so many years, and reinforces the importance of using references appropriate for the epoch and subpopulation in any study.

With respect to body weight, secular increase was more noticeable than for height, and more pronounced yet in the male series. The same trend in sexual differentiation was displayed for the body mass index. Overall, the stronger influence on body measures has been found to be from socioeconomical status, both among Spanish and European populations. In comparison to either the WHO references or Cole *et al.*'s thresholds, the prevalence of wasting (acute malnutrition) for camp children of all ages and both sexes is smaller than for retarded growth.

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Data sharing and accessibility

The original data were transcribed from the records of ILE and AAILE camps and are the basis of this study. Compiled data used for making the tables and figures in this article are openly available in Zenodo (repository of The OpenAIRE project by the European Union) at http://doi.org/10.5281/zenodo.3242652

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Note: The major previously published studies on Spanish population which are used as reference when discussing the present results were written by authors with compound surnames. For brevity, in the text and in figure legends we have reduced the citation to the first surname. For instance, Blanco Sánchez is cited as Blanco.

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Supplementary material for

Historical recollection of anthropometric data from schoolchildren attending summer camps from 1887 to 1934 in Spain. Interpretations and comparison with coetaneous and modern references.

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Table S1

Distribution of the sample population, by year, camp, age and sex.

m: males; f: females; T: total (both sexes); I: camp managed by ILE; A: camp managed by ILE Alumni

Age:	7				8				9				10				11				12				13				14				15				16				Totals per year			Totals per cohort		
Sex:	m		f		m		f		m		f		m		f		m		f		m		f		m		f		m		f		m		f		m		f		m	f	T	m	f	T
	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A	I	A						
1887					1				2								6				5				2				1				1								18	0	18	72	0	72
1888																																									0	0	0			
1889					1								5				4				8				3				3				2								26	0	26			
1890									1				3				6				10				4				1				2				1				28	0	28			
1891							2		3		2		6		2		4				7		1		6		1		2												28	8	36	92	26	118
1892													5				4				5				6				6				2								28	0	28			
1893									1				1		3		5				5		3		2		2		3		1		2		1						19	10	29			
1894	1								2				3		1		1		2		1				5		1		3		4		1								17	8	25			
1895					1								4				1		1		2		1		1				6		1		3		2		1				19	5	24	118	28	146
1896		3				1			1	1		1		2			4	1				3	1		1	2							5	1	1		1		2		26	5	31			
1897		2				2			1	2	1		2	4	2	1	3	2	2		3	2	1		3	1	1		1	6											34	8	42			
1898						2				2			1	6	1		1	4	3	2	3	1	2		3	7	1		2	1	1			5				1			39	10	49			
1899						2				3				3			1	3	1		1	4	3		3	3	2		3	7	1		2		1			6			41	8	49	106	39	145
1900			2				1						3				2		2		5		5		2						1										12	11	23			
1901							2				1						4				3		2		3		5		2						1						12	11	23			
1902					1	2			2	2	2			3	1		2	3			3	7			2	1	1		4	3	4		2	4					1		41	9	50			
1903	2				1	1	2			3			1	2	1		3	1	1		3	7	3		3	8	2		2	1				3	1						41	10	51	141	47	188
1904		1	1		2	4			1	6	3						1	5	1		2	5			3	4	3		2	4	2				1						40	11	51			
1905							1		4				1		3				1		2		1		4				2		3		2		1				1		15	11	26			
1906		1			1	2	1		1	5	2		2	7	4		3	8	2		5	3	2		1	5	2			1	2										45	15	60			

1907	1								2		2		1		1		2		4		3		2		5		3		1		3				3						15	18	33	68	69	137
1908					1								1		2		1		1		2		6		3		2		5		3		1		3				2		14	19	33			
1909	1				1		2		2				1		1		4		4		3		4		2				1						1				3		15	15	30			
1910			1		1				1		3		4				4		4		4		4		5		4		5										1		24	17	41			
1911	3	4	1	3	5	7	3	4	5	4	4	4	8	7	8	9	10	11	10	1	11	6	13	1	6	7	6	6	4	11	5	1	1	5				1			116	79	195	398	317	715
1912			1		3				6		6		11		2		10		8		12		11		12		13		4		5				1						58	47	105			
1913		5		1		1	3		3	6		8	6	13	9	7	12	11	3	3	10	11	10	9	10	7	12	6	9	2	11	4	3	1	3	4		1	1	1	111	95	206			
1914	3	2	3	3	4	7	5	1	11	1	9	2	9	5	6	7	8	12	13	5	13	13	9	1	5	9	4	6	1	8	3	6	2		3	3				7	113	96	209			
1915		1		1	4	3	3	8	7	7	8	3	15	9	17	8	10	6	8	5	9	6	10	3	8	14	7	4	4	2	1	4		1	2	2		1			107	94	201	263	254	517
1916			1						5		3		5		9		16		17		12		10		7		10		7		6		2		1				1		54	58	112			
1917	1		3		10		1		7		7		5		9		7		9		9		14		8		5		2		2		2								51	50	101			
1918	2		3		3		4		14		1		12		10		6		9		5		10		5		9		3		4				2		1				51	52	103			
1919					2		2		5		4		15		5		13		11		7		11		5		11		3		3		2		1						52	48	100	172	163	335
1920					2		1		9		3		9		6		8		10		8		11		6		5				5				1						42	42	84			
1921	1				1		3		7		5		10		5		11		4		7		12		3		7		3		3				2						43	41	84			
1922					1				1		3		7		5		8		5		8		4		6		8		3		4		1		2				1		35	32	67			
1923							1		4		1		6		7		5		7		3		5		3		2		3		2		1								25	25	50	179	184	363
1924					1						6		11		10		9		5		9		7		1																31	28	59			
1925		3				5		3	1	4		16	1	6	7	8	11	9	11	6	11	13	8	6	5	12	10	12	2		2										83	89	172			
1926		1		1		6		2		7		7		7		12		5		8		7		8		7		4													40	42	82			
1927																																									0	0	0	94	77	171
1928																																									0	0	0			
1929		5		2		8		6		10		8		6		9		12		7		5		8		7		3													53	43	96			
1930		4		2		7		4		10		4		6		8		5		8		8		4		1		4													41	34	75			
1931																																									0	0	0	88	77	165
1932																																									0	0	0			
1933																																									44	36	80			
1934																																									44	41	85			
sum	15	32	16	13	47	60	37	28	109	73	76	53	174	86	137	69	210	98	159	45	219	101	186	40	162	95	139	45	103	46	82	15	39	20	34	9	4	10	13	8						
	47		29		107		65		182		129		260		206		308		204		320		226		257		184		149		97		59		43		14		21							

Table S2A

Body height (mean and standard error of the mean) for males

age	7		8		9		10		11		12		13		14		15		16	
cohort	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM
1887-1890			116.7	0.1	122.1	2.1	123.1	2.5	126.5	1.2	130.8	1.1	134.3	2.4	140.5	3.2	142.5	1.9	150.0	
1891-1894	109.4				119.6	1.5	124.9	1.5	131.0	1.4	134.5	1.3	138.8	1.7	143.4	2.9	152.6	5.5		
1895-1898	112.9	2.5	118.3	1.5	120.7	1.2	125.9	1.1	130.2	1.0	131.5	2.0	136.8	1.9	144.4	2.4	147.4	2.4	152.7	3.2
1899-1902			119.4	3.9	122.4	2.2	124.0	1.4	128.3	1.7	132.1	1.8	135.4	2.9	141.8	2.0	148.6	2.2	159.8	3.9
1903-1906	105.9	1.4	115.3	1.2	122.0	1.9	122.4	1.1	125.9	1.6	131.2	1.2	138.9	1.7	145.3	3.2	154.1	2.3		
1907-1910	111.3	3.9	111.2	5.4	115.6	3.0	126.9	2.6	130.3	1.5	131.7	2.3	135.2	2.2	141.3	3.0	145.6			
1911-1914	112.1	1.6	116.2	1.0	120.7	1.1	127.6	0.9	130.4	0.7	136.0	0.9	140.8	1.2	147.2	1.5	153.6	3.0	157.1	3.8
1915-1918	113.1	3.1	116.8	1.2	121.9	1.0	124.7	0.8	130.1	1.1	134.5	1.1	138.9	1.2	140.2	2.1	144.1	5.7	156.4	1.2
1919-1922	110.5		118.8	1.8	119.3	1.1	125.7	0.8	129.3	0.9	133.0	1.2	138.7	2.1	145.9	2.9	143.6	4.7		
1923-1926			122.6		121.7	1.8	126.9	1.1	132.0	1.1	136.1	1.5	141.6	3.0	139.6	4.2	166.7			
1927-1930																				

Table S2B

Body height (mean and standard error of the mean) for females

age	7		8		9		10		11		12		13		14		15		16	
cohort	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM
1887-1890																				
1891-1894			105.6	2.8	116.4	5.4	118.7	2.2	125.4	6.7	133.0	2.1	140.8	2.0	143.8	3.0	151.0			
1895-1898					125.0	3.3	128.8	2.8	128.8	2.6	130.6	1.9	133.6	2.7	138.0	3.8	141.1	2.7	143.5	4.1
1899-1902	109.1	0.3	114.3	0.2	119.9	0.6	125.0		135.1	7.6	136.5	2.7	136.9	1.8	144.4	1.8	145.1	5.8	152.4	
1903-1906	106.0		112.6	0.8	115.3	1.7	124.2	1.6	129.5	1.9	138.0	1.3	136.7	2.3	147.1	1.9	147.5	2.0	151.8	
1907-1910	119.3		109.4	3.9	116.7	2.8	120.1	2.2	128.4	2.0	132.0	1.9	141.0	2.9	143.6	2.7	146.4	2.0	147.6	1.2
1911-1914	113.1	1.8	117.8	1.3	121.5	1.0	125.2	1.0	130.9	1.1	136.3	0.8	143.7	1.1	147.2	1.0	138.0	1.5	148.5	1.0
1915-1918	110.3	1.6	117.1	1.8	121.9	1.2	125.2	0.8	129.9	1.0	135.5	1.0	142.6	1.3	145.7	1.9	152.6	1.7	148.6	
1919-1922			117.1	1.5	122.0	1.5	125.7	1.0	129.1	1.2	133.6	1.1	138.1	1.2	143.9	1.9	148.6	3.2	142.1	
1923-1926			125.1		124.8	2.2	127.7	1.0	132.3	1.4	135.2	1.4	138.7	1.7	147.6	2.4				
1927-1930																				

Table S3A

Body weight (mean and standard error of the mean) for males

age	7		8		9		10		11		12		13		14		15		16	
cohort	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM
1887-1890			20.8	0.6	20.9	0.5	23.2	1.0	24.9	0.6	25.7	0.6	27.9	1.3	31.4	2.8	32.3	1.3	36.0	
1891-1894	20.0				21.7	0.9	22.4	0.5	25.5	0.7	27.8	0.6	29.2	0.9	31.0	1.3	39.0	5.0		
1895-1898	19.8	0.5	20.9	1.1	21.3	0.7	23.5	0.5	25.0	0.5	25.5	0.7	28.9	0.9	35.2	1.7	36.5	1.5	37.2	0.8
1899-1902			20.6	1.2	22.8	0.8	22.9	0.6	25.3	0.8	27.7	1.0	29.6	1.5	33.3	1.4	37.8	1.0	43.6	3.8
1903-1906	16.8	0.5	20.0	0.5	22.8	0.8	22.2	0.6	24.0	0.9	26.9	0.7	32.5	1.1	36.3	1.9	42.3	2.1		
1907-1910	16.5	0.5	17.7	1.5	21.1	1.2	25.8	1.2	27.4	0.9	28.8	1.5	29.4	1.4	32.5	2.2				
1911-1914	19.2	0.7	20.7	0.5	22.7	0.6	25.6	0.5	27.4	0.5	30.2	0.5	33.4	0.8	37.5	1.1	43.9	2.5	44.3	5.8
1915-1918	21.9	2.3	20.9	0.6	23.1	0.5	24.1	0.4	26.4	0.7	28.5	0.6	32.3	0.9	32.5	1.1	37.2	5.9	41.3	4.3
1919-1922			22.3	1.4	21.8	0.7	24.2	0.4	26.3	0.6	28.1	0.8	30.3	0.8	33.5	1.6	35.9	4.1		
1923-1926	21.5	1.2	24.0	1.4	23.6	0.5	26.0	0.5	27.8	0.5	32.3	0.9	35.7	1.2	34.0	3.4	47.9			
1927-1930	24.0	1.5	24.1	1.1	26.6	1.0	27.3	0.9	30.3	1.1	32.0	1.9	37.7	2.0						

Table S3B

Body weight (mean and standard error of the mean) for females

age	7		8		9		10		11		12		13		14		15		16	
cohort	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM
1887-1890																				
1891-1894			16.3	0.9	20.7	0.3	18.5	0.6	26.0		26.1	1.4	29.0	0.8	34.2	2.5	39.0			
1895-1898					21.5	1.3	25.5	1.5	24.2	0.7	26.6	1.3	27.6	2.3	30.8	0.9	36.2	2.5	42.3	2.2
1899-1902	16.6	0.6	19.0	0.6	21.2	0.9	25.0		28.0	3.1	25.9	1.7	27.8	1.5	34.2	2.0	37.7	3.5	44.0	
1903-1906	16.3		18.5	0.8	19.4	0.9	21.8	0.3	23.9	1.5	27.8	1.4	26.8	0.7	32.6	1.1	37.7	2.4	43.0	
1907-1910	19.5		18.1	1.5	19.0	0.8	21.8	0.9	21.8	0.9	22.8	0.6	27.2	0.9	32.6	1.7	35.1	1.0	39.9	1.2
1911-1914	19.2	0.8	19.1	0.4	18.0	0.4	18.8	0.5	20.4	0.2	22.2	0.5	25.6	0.3	28.7	1.1	37.2	0.9	41.8	0.6
1915-1918	15.9	1.2	17.4	1.0	19.0	0.5	19.7	0.3	20.6	0.4	22.9	0.5	26.1	0.4	29.4	2.6	38.1	0.8	38.0	
1919-1922			19.6	0.4	18.8	1.0	20.8	0.4	22.0	0.2	21.9	0.1	24.4	0.3	29.0	0.5	35.6	1.9	36.3	
1923-1926	22.0		22.4	1.0	18.6	0.5	19.8	0.9	22.8	0.3	22.2	1.1	26.1	0.2	39.4	1.7				
1927-1930	22.2	1.9	19.1	1.1	19.8	0.6	21.9	0.7	24.6	0.6	29.2	1.0	34.2	2.1						

Table S4A

Body mass index (mean and standard error of the mean) for males

age	7		8		9		10		11		12		13		14		15		16	
cohort	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM
1887-1890			15.3	0.5	14.0	0.5	15.3	0.3	15.6	0.3	15.0	0.2	15.4	0.3	15.8	0.7	15.9	0.4	16.0	
1891-1894	16.7				15.2	0.4	14.3	0.3	14.9	0.4	15.4	0.3	15.1	0.3	15.1	0.4	16.5	0.9		
1895-1898	15.6	0.3	14.8	0.3	14.6	0.3	14.9	0.3	14.8	0.3	14.8	0.4	15.5	0.3	16.8	0.4	16.7	0.4	16.0	0.9
1899-1902			14.4	0.1	15.3	0.7	14.9	0.3	15.4	0.3	15.8	0.3	16.0	0.3	16.4	0.4	17.1	0.3	17.0	0.9
1903-1906	15.3	0.6	15.0	0.3	15.2	0.3	14.8	0.3	15.1	0.2	15.6	0.2	16.8	0.5	17.1	0.4	17.8	0.5		
1907-1910	13.3	0.5	14.3	0.2	15.7	0.2	16.0	0.5	16.2	0.5	16.5	0.6	16.0	0.4	16.1	0.6				
1911-1914	15.0	0.3	15.3	0.2	15.5	0.2	15.6	0.2	16.1	0.2	16.3	0.2	16.8	0.2	17.2	0.3	18.4	0.5	17.9	1.5
1915-1918	17.0	1.0	15.2	0.2	15.5	0.2	15.5	0.1	15.5	0.2	15.7	0.2	16.6	0.3	16.8	0.3	17.5	1.3	16.8	1.5
1919-1922			15.7	0.7	15.3	0.3	15.3	0.2	15.7	0.2	15.8	0.2	15.8	0.4	16.2	0.4	17.3	0.6		
1923-1926					16.1	0.4	15.5	0.2	15.9	0.2	16.2	0.3	16.6	0.6	17.2	0.7				
1927-1930																				

Table S4B

Body mass index (mean and standard error of the mean) for females

age	7		8		9		10		11		12		13		14		15		16	
cohort	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM	m	SEM
1887-1890																				
1891-1894			13.9	0.3	15.3	1.8	14.6	0.6	14.9		14.8	0.7	14.6	0.4	16.8	0.9	17.1			
1895-1898	13.9	0.5			14.4	0.2	15.3	0.6	16.0	0.2	16.0	0.5	16.0	1.4	16.7	0.8	18.1	0.6	20.1	0.6
1899-1902			14.5	0.4	14.7	0.5	16.0		15.3	0.1	16.2	0.4	16.1	0.3	17.3	0.5	18.9	0.6	18.9	
1903-1906	14.5		14.6	0.4	15.1	0.3	15.0	0.4	14.6	0.6	15.8	0.7	15.2	0.5	16.4	0.6	17.3	0.7	18.7	
1907-1910	13.7		15.0	1.1	14.4	0.2	15.1	0.3	15.8	0.3	15.9	0.4	16.1	0.6	17.4	0.8	17.5	0.4	19.2	0.6
1911-1914	15.0	0.3	14.8	0.2	14.9	0.2	15.3	0.2	15.5	0.2	16.3	0.2	17.5	0.3	17.4	0.3	19.1	0.6	20.6	0.6
1915-1918	14.8	0.4	15.4	0.3	15.1	0.2	15.3	0.2	15.6	0.2	16.4	0.3	17.1	0.3	17.7	0.5	17.5	0.7	17.2	
1919-1922			15.8	0.7	15.1	0.3	15.1	0.2	15.6	0.2	16.0	0.2	16.5	0.3	17.0	0.5	18.0	1.2	18.0	
1923-1926			16.3		15.0	0.5	15.3	0.3	15.6	0.2	15.8	0.3	16.7	0.7	18.1	0.8				
1927-1930																				

Figure S1

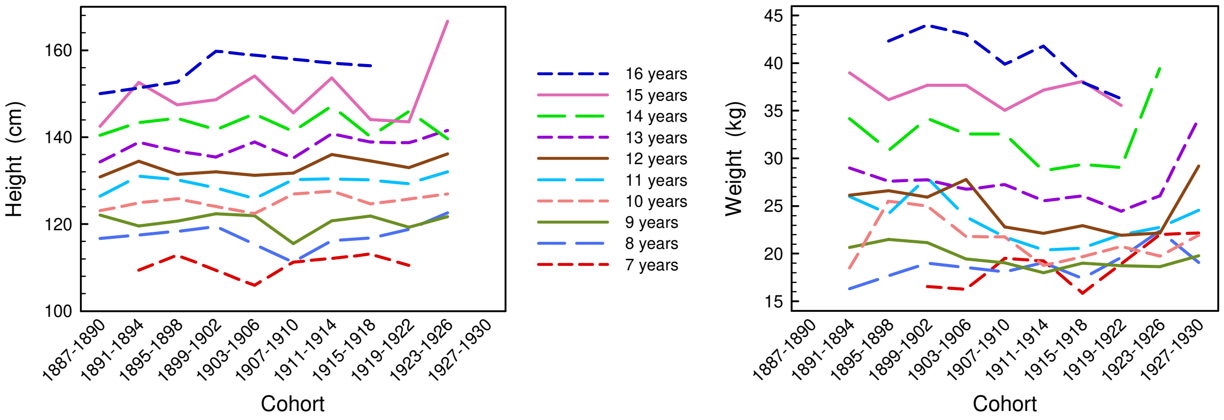

Figure S1: Evolution along the cohorts, for each age, of mean height of boys (A) and mean weight of girls (B).

Figure S2

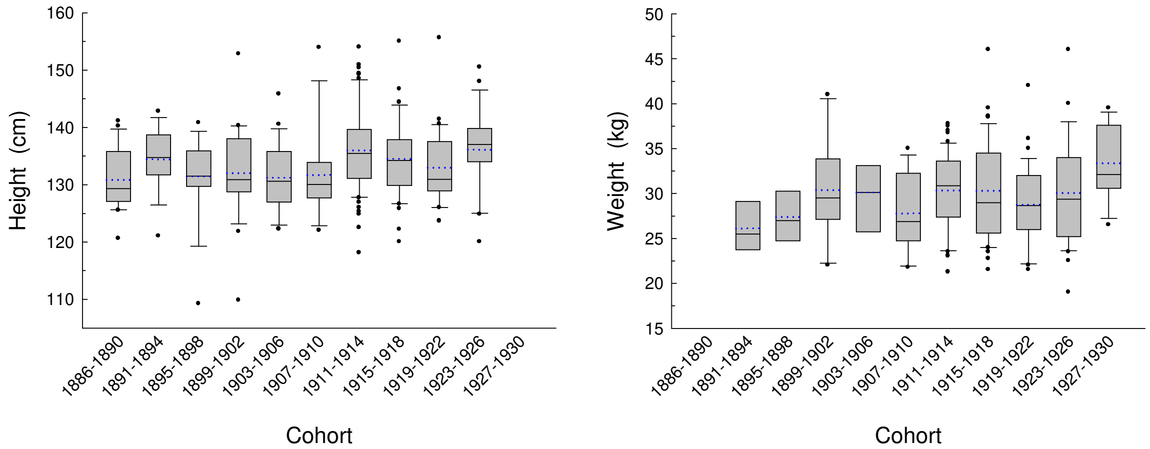

Figure S2: Some examples of the dispersion of data along the cohorts: body height of 12 year old boys (A) and body weight of 12 year old girls (B). Boxes extend from p25 to p75 percentiles, with the median (p50) as the central line. Whiskers mark p10 and p90, and the dots display all the outliers beyond that interval. Blue dotted lines are the means.

Figure S3

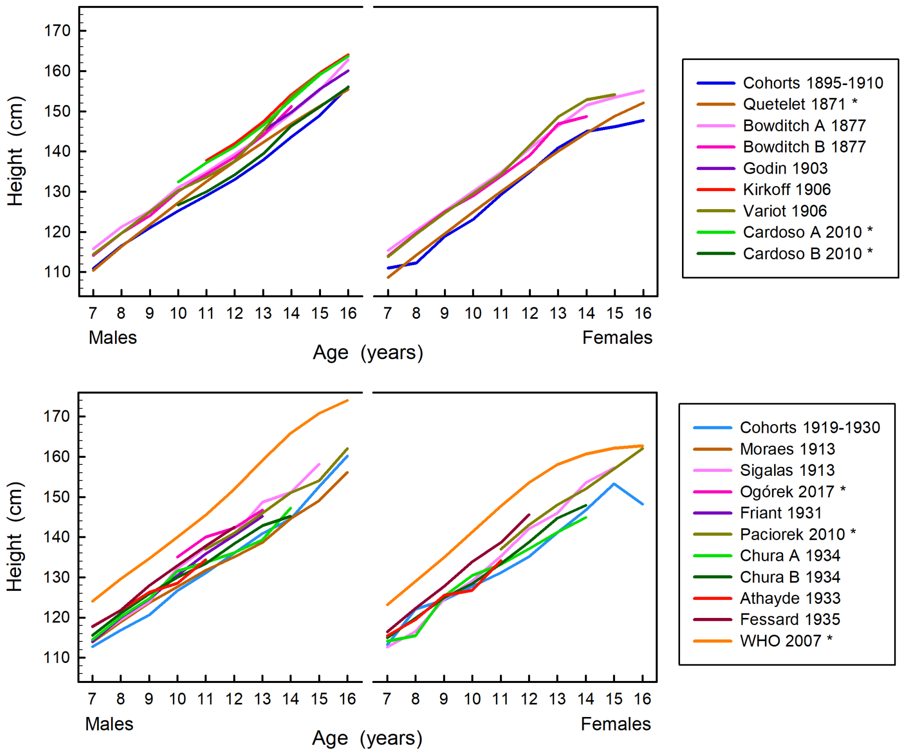

Figure S3: Body height values for two sets of cohorts in this study (same as in fig. 2), here in comparison with available European references matching each period. Note: the dates quoted are those of the published articles: some of them correspond to data measured several years before: Quetelet in 1835 and 1840, Cardoso in 1910, Ogórek in 1918, Paciorek in 1930, Chura in 1931 (A) and 1932 (B), WHO in the 1970s.

Figure S4

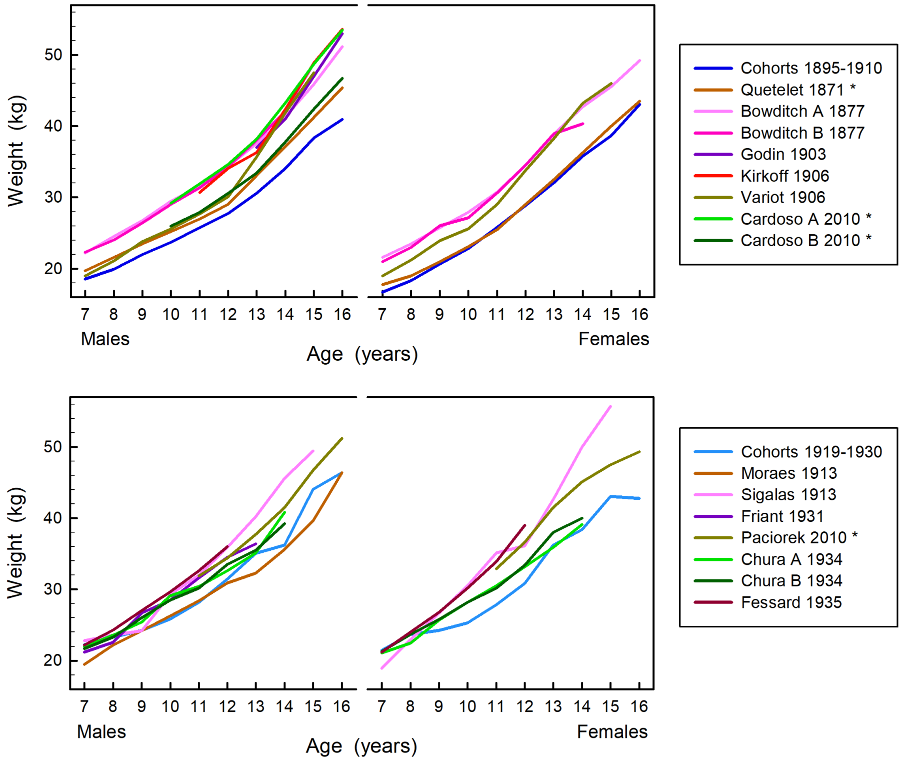

Figure S4: Body weight values for two sets of cohorts in this study (same as in fig. 4), here in comparison with available European references matching each period. Note: the dates quoted are those of the published articles: some of them correspond to data measured several years before: Quetelet in 1835 and 1840, Cardoso in 1910, Paciorek in 1930, Chura in 1931 (A) and 1932 (B).

Figure S5

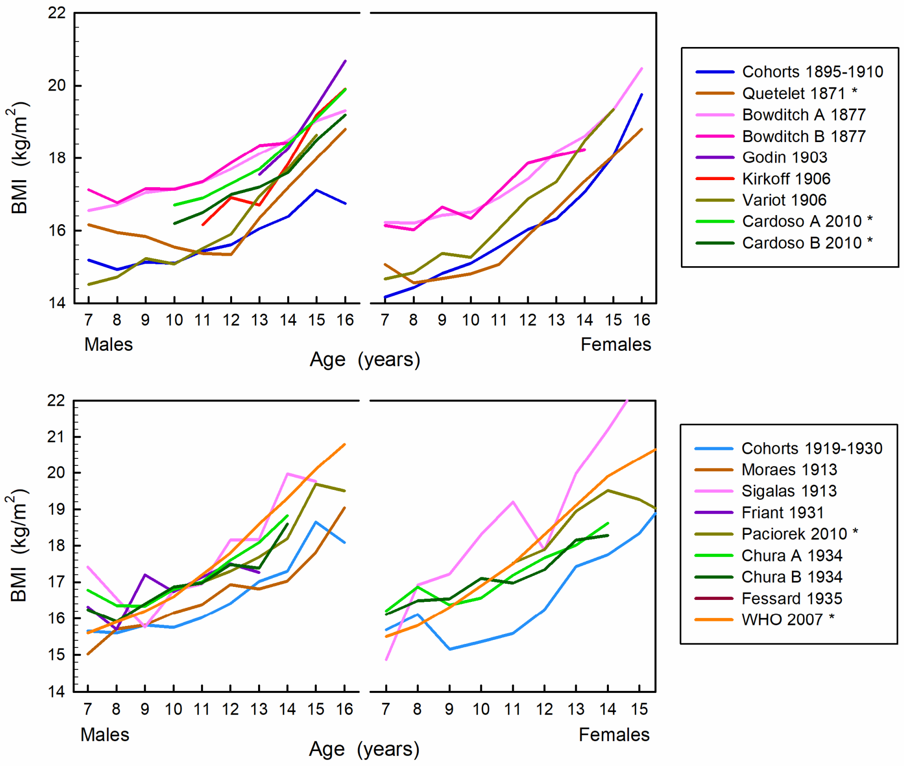

Figure S5: Body mass index for two sets of cohorts in this study (same as in fig. 6), here in comparison with available European references matching each period. Note: the dates quoted are those of the published articles: some of them correspond to data measured several years before: Quetelet in 1835 and 1840, Cardoso in 1910, Paciorek in 1930, Chura in 1931 (A) and 1932 (B), WHO in the 1970s.

Figure S6

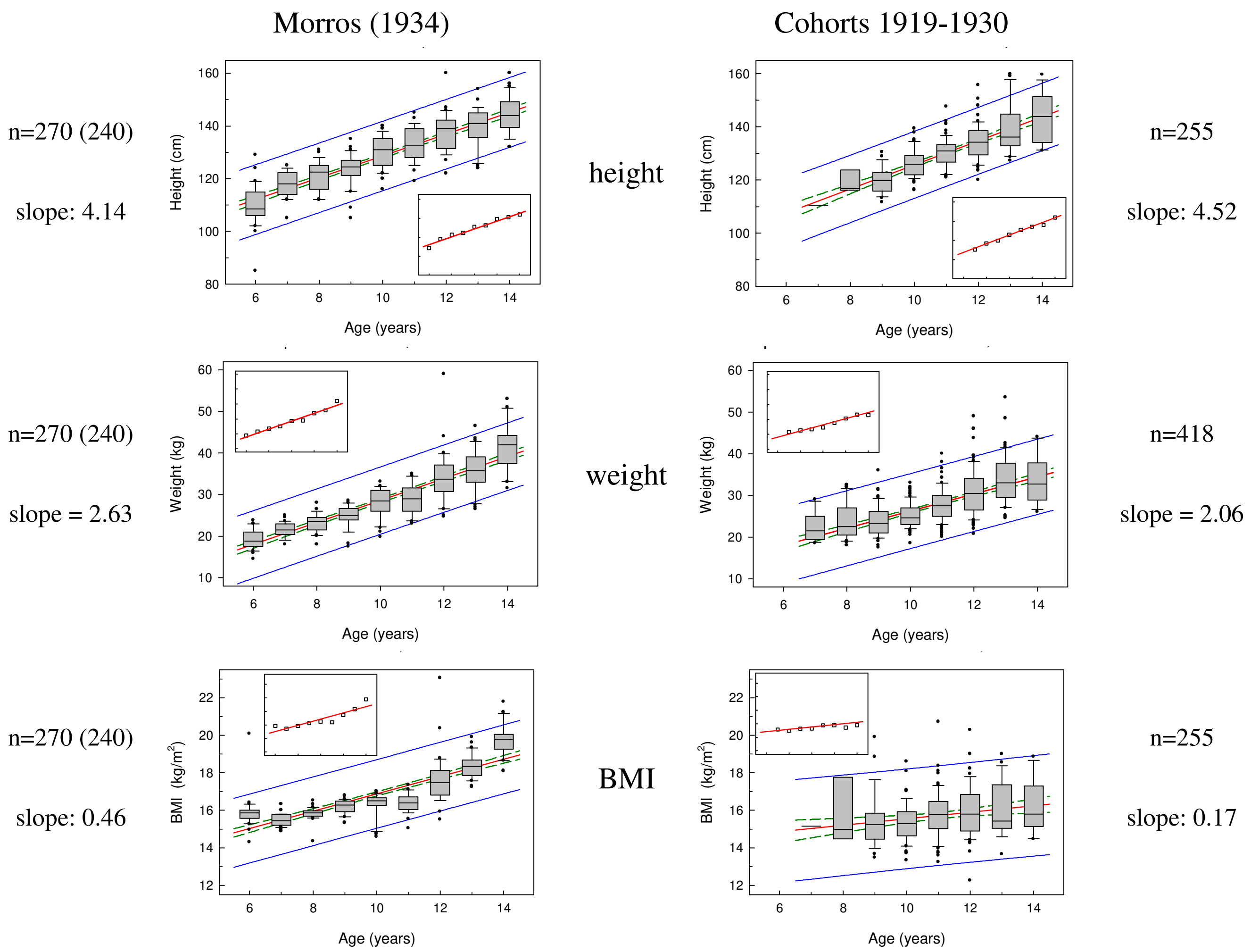

Figure S6: Analysis of data dispersion, comparing the work of Morros (1934) with the cohorts from the camps in the matching period. All these plots are based on individual values for boys, of body height, body weight and BMI calculated from them. Boxes are drawn with percentile values p25, p50 (median) and p75; whiskers represent p10 and p90; single points are the outliers. Red line is the result of linear regression to all data; green lines delimit the 95% confidence interval, while blue lines the 95% prediction interval. The insets show just the medians and the regression line, for a better comparison and appreciation of slope. Samples from Morros had 270 boys for the total population displayed, but 240 in the 7-14 year old range comparable to the cohorts.

Figure S7

Height, males

cohort \ age	7	8	9	10	11	12	13	14	15	16	n=
1887-1890		100	33	63	88	87	100	100	100	100	72
1891-1894			83	67	71	67	74	64	50		91
1895-1898	40	33	71	68	75	93	76	67	85	100	115
1899-1902		60	43	89	67	73	86	89	88	50	102
1903-1906	100	82	55	77	81	81	75	75	60		141
1907-1910	50	67	100	57	73	92	87	75	100		68
1911-1914	60	59	75	49	70	64	67	67	42	50	391
1915-1918	50	60	45	67	64	76	71	89	80	100	261
1919-1922	100	67	77	66	68	77	75	78	100		172
1923-1926		0	60	61	40	61	56	80	0		87
1927-1930											0
n=	32	81	151	233	276	284	227	147	57	12	

colour key:

- 100%
- 75 to 99%
- 50 to 74%
- 25 to 49%
- 1 to 24%
- 0%
- no data

Height, females

cohort \ age	7	8	9	10	11	12	13	14	15	16	n=
1887-1890											0
1891-1894		100	100	100	100	100	100	60	0		26
1895-1898			50	67	88	100	100	100	100	100	27
1899-1902	100	100	100	100	33	80	100	67	50	0	39
1903-1906	100	100	100	75	80	67	100	43	67	0	47
1907-1910	0	100	80	100	85	88	67	67	86	83	69
1911-1914	50	43	55	65	71	67	47	54	23	56	312
1915-1918	71	50	59	71	75	74	54	53	14	100	252
1919-1922		50	47	76	90	87	81	67	50	100	163
1923-1926		0	43	54	65	85	75	50			91
1927-1930											0
n=	23	48	94	167	173	200	161	97	42	21	

Figure S7: Prevalence of stunting, qualified as HAZ < –2, i.e. body height below the –2SD threshold according to the reference defined by WHO (2007) for the age and sex. Values are percent and colours code the interval of those values. The thick black rectangle delimits data belonging to a population of significant size (arbitrarily set at 100 individuals). The bottom row and the rightmost column quote the total size of population for that age or cohort, respectively.

Figure S8

Weight, males

cohort \ age	7	8	9	10	11	12	13	14	15	16	n=
1887-1890		50	100								72
1891-1894	0		50								89
1895-1898	20	20	71								115
1899-1902		60	57								102
1903-1906	100	64	53								139
1907-1910	100	100	60								68
1911-1914	50	48	53								391
1915-1918	25	50	41								259
1919-1922	100	33	68								172
1923-1926	0	25	25								174
1927-1930	0	14	13								76
n=	42	105	176	255	305	310	249	146	57	12	

colour key:

- 100%
- 75 to 99%
- 50 to 74%
- 25 to 49%
- 1 to 24%
- 0%
- no data

Weight, females

cohort \ age	7	8	9	10	11	12	13	14	15	16	n=
1887-1890											0
1891-1894		100	100								24
1895-1898			50								27
1899-1902	100	100	67								39
1903-1906	100	100	80								47
1907-1910	0	50	80								69
1911-1914	50	43	58								312
1915-1918	88	50	45								254
1919-1922		50	60								163
1923-1926	0	0	33								177
1927-1930	25	29	33								71
n=	29	60	126	203	199	226	181	96	42	21	

Figure S8: Prevalence of underweight, qualified as WAZ < –2, i.e. body weight below the –2SD threshold according to the reference defined by WHO (2007) for the age and sex. Note that WHO does not provide weight values for ages over 9. Values are percent and colours code the interval of those values. The thick black rectangle delimits data belonging to a population of significant size (arbitrarily set at 100 individuals). The bottom row and the rightmost column quote the total size of population for that age or cohort, respectively.

Figure S9

BMI, males

cohort	age 7	8	9	10	11	12	13	14	15	16	n=
1887-1890		0	33	13	19	26	22	40	80	100	72
1891-1894	0		0	36	36	28	44	71	50		89
1895-1898	0	0	0	16	31	36	41	20	38	67	114
1899-1902		0	14	22	27	23	21	33	13	50	102
1903-1906	0	0	5	15	10	26	21	17	0		139
1907-1910	50	0	0	0	0	8	33	58	100		68
1911-1914	13	0	11	5	9	10	9	23	8	50	389
1915-1918	0	0	3	2	19	18	17	24	40	50	257
1919-1922	0	0	5	10	23	23	40	56	0		172
1923-1926		0	0	0	0	13	22	20	0		87
1927-1930											0
n=	31	80	149	232	275	282	225	146	57	12	

BMI, females

cohort	age 7	8	9	10	11	12	13	14	15	16	n=
1887-1890											0
1891-1894		0	0	33	0	50	75	25	0		24
1895-1898			0	0	0	20	50	0	0	0	27
1899-1902	0	0	0	0	0	10	13	0	0	0	39
1903-1906	0	0	0	13	20	33	57	43	33	0	47
1907-1910	0	0	0	0	8	25	22	0	0	0	69
1911-1914	0	0	12	2	22	19	13	23	0	0	312
1915-1918	13	0	0	4	17	15	11	18	14	0	255
1919-1922		0	0	10	3	16	19	33	17	0	163
1923-1926		0	0	8	9	10	33	0			91
1927-1930											0
n=	24	48	94	167	172	200	163	96	42	21	

Figure S9: Prevalence of wasting, qualified as BMIZ < −2, i.e. body mass index below the −2SD threshold according to the reference defined by WHO (2007) for the age and sex. Values are percent and colours code the interval of those values. The thick black rectangle delimits data belonging to a population of significant size (arbitrarily set at 100 individuals). The bottom row and the rightmost column quote the total size of population for that age or cohort, respectively.

Figure S10

BMI, males

cohort	age 7	8	9	10	11	12	13	14	15	16	n=
1887-1890		0	33	13	13	22	22	40	40		72
1891-1894	0		0	36	29	17	28	57	50		90
1895-1898	0	0	0	16	19	36	35	13	23		114
1899-1902		0	14	22	13	5	14	22	0		102
1903-1906	0	0	5	15	5	11	18	17	0		139
1907-1910	50	0	0	0	0	0	20	42	100		68
1911-1914	7	0	6	5	3	3	0	15	8		389
1915-1918	0	0	3	2	7	13	5	18	20		257
1919-1922	0	0	0	10	10	3	10	33	0		172
1923-1926		0	0	0	0	4	22	20	0		87
1927-1930											0
n=	31	80	149	233	275	282	225	146	57	12	

BMI, females

cohort	age 7	8	9	10	11	12	13	14	15	16	n=
1887-1890											0
1891-1894		0	0	33	0	50	75	50	0		24
1895-1898			0	0	0	20	50	100	0		27
1899-1902	0	0	0	0	0	10	13	67	0		39
1903-1906	0	0	0	13	20	33	57	71	33		47
1907-1910	0	0	0	0	8	19	22	83	14		69
1911-1914	0	0	12	2	22	13	13	46	0		312
1915-1918	13	0	0	2	15	13	11	47	14		253
1919-1922	0	0	0	10	3	16	19	60	50		163
1923-1926		0	0	4	9	10	33	50	0		91
1927-1930		0	0	0	0	0	0	0			0
n=	24	48	94	167	172	200	161	96	42	21	

Figure S10: Prevalence of wasting, qualified as grades 2 or 3 of thinness defined by Cole *et al.* (2007) for the age and sex. Values are percent and colours code the interval of those values. The thick black rectangle delimits data belonging to a population of significant size (arbitrarily set at 100 individuals). The bottom row and the rightmost column quote the total size of population for that age or cohort, respectively.