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Secular trend and regional differences in the stature of Italians

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The recruitment is a precious source of data

The individual-level data are drawn from the Italian military archives, which contain detailed information on the conscripts for the military service. Medical examinations were performed on all young men of conscription age to check their physical fitness for military service. National compulsory recruitment of young men was established in 1863 (birth cohort 1842), two years after the Italian unification. Compulsory draft was abolished in 2005, having been replaced by a voluntary enrolment program. Data for the 1980 birth cohort were the last to have been released by the Ministry of Defence.

Several data were recorded during the examination, including health status and anthropometric and socio-economic characteristics. In detail, among the others: the place of birth (province and municipality, or foreign born), the place of residence (province and municipality, or resident abroad), the date of birth, height, weight, thoracic perimeter, the reasons for exemption from medical inspection, the result of the physical and psychological examination (fit, unfit, or deferred to the next draft), the reason for being declared unfit, marital status, educational attainments, type of job, a synthetic health profile, and a measure of general intelligence.

Draft data offer several important advantages, for scholars interested in analysing the effect of the socio-economic development on anthropometric measures. First, due to the compulsory nature of military service in Italy, they provide nearly complete coverage of the population subject to the military draft. Notice that the data on stature pertain to all of the conscripts, even if they did not meet the minimum height required for military service. Second, more than 120 years of data are recorded, allowing the study of secular trend. Third, the available measures are the outcomes of a detailed physical inspection by a medical team and do not suffer the distortions typically associated with self-reported measures. This is important because people tend to underreport their weight and over-report their height, resulting in underestimation of BMI and related measures (see Danubio *et al.*, 2008).

Military data are not without problems, however. First, only men were subject to military conscription, so we have no information on women. Second, medical examination was most often performed when the young men reached the age of 19–20 years, and when recruits were 18 years of age from the 1960 birth cohort. This may still be a relatively early age and adult height may not have been reached by a non-negligible fraction of conscripts, especially in areas of the country lagging behind economically. Third, our data were originally collected for administrative purposes, so they are affected by the change of the selection criteria. Finally, other problems in draft data include missing records and accuracy of measurements (rounding and heaping in measured height and weight).

The most important issue for the scholars concerns data availability. The registration from original paper material, recorded at the draft, to an electronic database requires special agreement with the Defence and, over all, founding. In the meantime, the most of the original material is also deteriorating waiting for an appropriate project for the preservation and the exploitation, and some is already lost.

Secular trend and regional differences

Figure 1 shows secular trend of height for Italian conscripts born between 1854 and 1980 (Arcaleni, 2006). Both measures are graphed, height at the medical examination and centred at 20 years. Although medical examination was most often performed when the young men reached the age of 19–20 years, it was occasionally performed at a younger age or an older age, depending on the particular needs of the military. However, from the 1960 birth cohort onward, all medical examinations were performed when recruits were 18 years of age. Before the 1927 birth cohort, there were no data for Navy conscripts, although such individuals accounted for 2%–3% of all conscripts.

Overall, stature increased by 12.19 cm (from 162.39 to 174.58 cm), indicating an average growth of 0.97 cm per decade. The national trend followed an S-shaped pattern: after a long initial period in which the mean height increased slowly, a phase of accelerated increases started with the generations born in the 1940s, followed by a change in the concavity of the stature curve for the cohorts born in the early 1950s, and a final phase of diminishing rates of increase. Decreasing growth rates characterizing the second half of the 20th century could partially be explained by a composition effect. The percentages of conscripts resident in regions (characterized by very high statures) decreased, whereas the percentages of conscripts resident in southern regions (characterized by higher-than-average birth rates) increased, resulting in reduced national average growth rates. The distribution curve for data on the stature has undergone changes in shape and position (Arcaleni, 1998). Recent data suggest a moderate shift toward positive skewness caused by the increased proportion of recruits with high and very high statures (from 0.6% to 20.1% of people were at least 180 cm tall) and the decreased proportion with short and very short statures (from 33.5% to 1.4% of people who were shorter than 160 cm).

The war-related deprivation seems not to have adversely affected the height. On the contrary, throughout this period, the highest rates of growth were recorded for the generations born in the 1940s and 1950s. Severe deprivations caused by World War II, such as malnutrition and disease, were immediately followed by a long cycle of economic growth, during which children were nearly able to reach their physical potential for growth. This evidence corroborates the auxological theory about the recovery capacity of children after periods of severe deprivation (Tanner, 1989). Adoption of the standardized estimates, centred at 20 years (Costanzo, 1948), has an appreciable effect on data for the 1896–1900 birth cohorts, who were drafted earlier (down to 17 years) because of World War I, correcting for an apparent height decrease of more than 2 centimetres.

Correcting for age-based differences reduces the 'perspective error' typical of military anthropometric data due to two factors: the young age of the conscripts who were still growing at the time they were measured and the secular growth anticipation trend (that means that young men reach earlier their final adult height) (Tanner, 1968). This allows us to infer that the increase in Italian observed height data is a real gain of definitive stature (except for the residual growth coming after 20 years of age) and that anticipation of growth is a modest component of the secular height trend.

Data for the 1927–1980 birth cohorts reveal that stature increased in all areas of Italy during this period, albeit with remarkable regional differences in both percentage and absolute increases in height. Such increases were higher in southern areas, which were initially characterized by statures that were lower than the national average. This evidence confirms the existence of a compensation effect in populations in which socio-economic conditions were initially substandard. In Figure 2 all regional trends are plotted: the persistent gap between central-northern

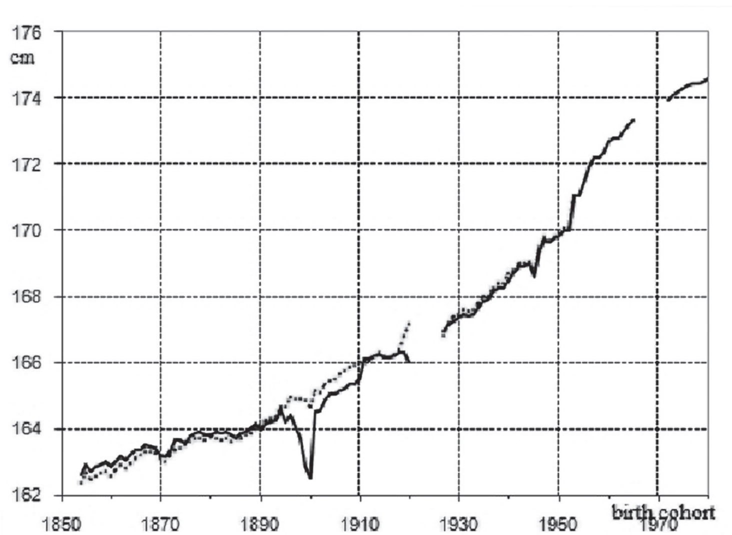

Fig. 1 - Stature measured during medical check-up (black solid line) and stature standardized at the age of 20 (red dotted line) for the 1854–1980 birth cohorts of conscripts (source: ISTAT).

regions (highest statures) and southern (the lowests) is evident. The rank of regions according to height for the 1980 birth cohort is almost the same as that for the 1927 birth cohort: recruits from Friuli and Sardinia remain the tallest and shortest, respectively. That depends on the fact that in Italy still there are substantial differences in genetic endowments at regional level.

Despite growth rates in southern Italy that were higher than those in the other regions, the regional variability has not yet vanished (the difference has decreased from 8.94 cm to 6.42 cm). This moderate process of convergence is the result of two main factors, the accelerated rate of height increases observed in the South and a decreased (but positive) rate of growth in northern and central Italy, starting from cohorts born in the 1950s. This second fact is strongly related to the massive emigration from southern Italy to northern and central Italy which started in the early 1950s and reached its peak during the second half of the 1960s (Golini, 1978).

Lanari (2011) estimates absolute β -convergence for the cohorts 1950 and 1980, as Italian provinces with the lowest initial height showed a tendency to catch up (by a convergence rate of 2.66 per cent per year). She comments that the speed of reduction of well-being disparities of the economy, expressed by stature, is assumed to depend on the social and economic environment. Nevertheless, her results also indicate that, excluding the effects of migration (from South to North) on stature increase significantly reduces the speed of convergence. These findings indicate that migrations may explain about 20-25 percent of the high speed of convergence of stature across areas of Italy in the 1950s and 1960s.

The trends in average statures followed a common S-shaped pattern in almost all regions. At present, the majority of Italian regions are approaching growth rates close to 0 cm/year; only some northern regions (Piedmont and Lombardy), central regions (Marches, Latium and Umbria) and southern regions (Sicily and Sardinia) still report increasing growth rates. This suggests that heights for most regions are gradually converging towards their limiting levels, which are related to the theoretical genetic endowments of the residents. Nevertheless regional indicators show that a difference still

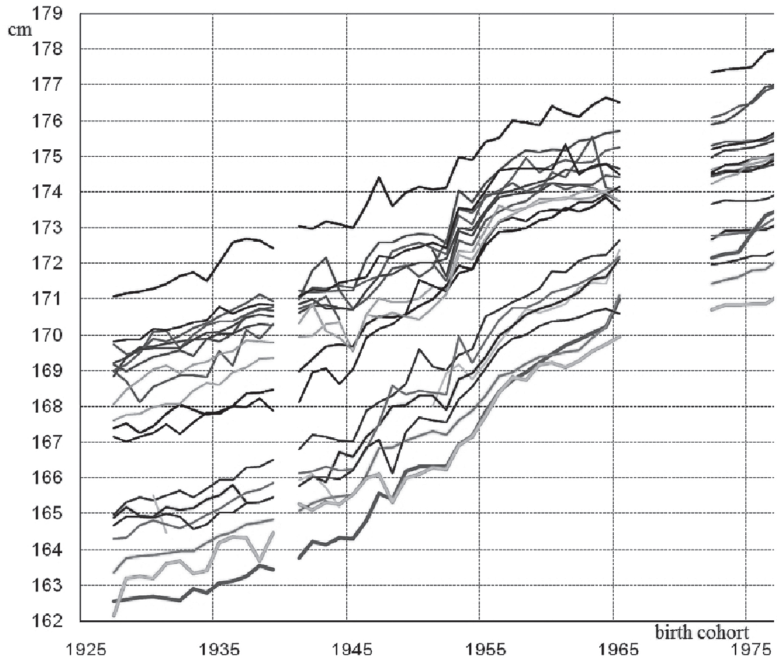

Fig. 2 - Mean stature of conscripts by Italian regions of residence: 1927–1980 birth cohorts (source ISTAT). The colour version of this figure is available at the JASs website.

exists. It can be easily demonstrated that the main available indicators of social and economic disadvantage are negatively correlated with height (Arcaleni, 2006; Peracchi & Arcaleni, 2011). This evidence strongly suggests that, in southern Italy, the potential for increased height due to improved living standards has not yet been fully exploited and that the height difference between the South and the northern and central regions cannot be entirely attributed to differences in genetic endowments.

Adult height and early-life environment

Living conditions during the growing years, especially in early childhood, influence body height through their impact on net nutrition, i.e. the balance between the supply of nutrients and the demands of metabolism, physical exertion, and disease (Silventoinen, 2003; Steckel, 2009). Thus, adult height is a useful marker of the economic and disease environment in childhood.

Several recent papers have explored the relationship between adult height and early-life environment trying to establish the respective role of income and diseases. As indicator of childhood environment, a positive association between mother's education and adult height, infant mortality, GDP per capita, and average protein and calorie consumption are found to explain part of the variation in adult height. Postneonatal mortality is also found to be strongly negatively associated with height. In particular, infant mortality seems to dominate the relationship between adult height and early-life environment (see Peracchi & Arcaleni, 2011 for literature review). Bozzoli and colleagues (2009) develop a formal model of selection and stunting which predicts that, at sufficiently high mortality levels, selection can dominate stunting, leaving a taller population of survivors.

Peracchi & Arcaleni (2011) examine the respective role of income and diseases for recent cohorts of Italian males. They use individual-level information on 18 year old conscripts born between 1969 and 1978 and regional- and provincial level information on childhood environment (in particular, infant mortality rates, and income or consumption per capita). The Italian socio-economic environment in the '70s and '80s showed taller conscripts, lower BMI, lower infant mortality rates, higher incomes in the northern areas; shorter conscripts, higher BMI, higher infant mortality rates, lower incomes in the southern ones. They found that both infant mortality and income or consumption appear to matter. In particular, economic conditions appear to matter more than disease burden for height, while the opposite is true for BMI and the probability of being overweight or obese. However, early-life environment appears to matter more for height than for BMI and related measures (being obese or overweight).

The results are consistent with the evidence in Bozzoli *et al.* (2009), that, in rich low-mortality settings, the negative long-term effects of disease on survivors ('scarring') dominate the positive selection effects. This analysis goes into deep to the province level, trying to explain regional variability. Using detailed province-level information, results show that income per capita is a proxy for a variety of environmental indicators that are highly correlated with economic conditions. Among these, particularly important appear to be the incidence of infectious diseases, such as chickenpox, pertussis and scarlet fever, and the quality of the housing stock (especially the availability of toilet). This suggest a potentially important role for sanitation and policies aimed at preventing infectious diseases and improving the quality of the housing stock.

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