

Occupation, Literacy, Anthropometric Traits, and Life Expectancy of Italian Men Born 1900–1910: Evidence From Military Conscription Registers

Journal of Aging and Health
2025, Vol. 37(1–2) 54–63
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DOI: 10.1177/08982643231220436
journals.sagepub.com/home/jah



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Abstract

Objective: The aim is to explore the role of anthropometric traits and sociodemographic characteristics on human survival.

Methods: Anthropometrics and sociodemographic data of 1944 conscripts born in the first decade of the 20th century in rural municipalities of Calabria (Southern Italy) who underwent medical examinations for military service were collected. Medical examinations were linked to individual survival data.

Results: Height and type of occupation influenced life expectancy. For taller men, the risk of mortality increases by about 20% when compared with men with middle height, while farmers exhibited a significant survival advantage compared to those with other working experiences.

Discussion: Height and type of occupation were associated with human mortality. These results are likely to be related to the effect of healthy dietary patterns and physical activity on life expectancy. Further studies are needed to understand to what extent these results obtained in a rural context can be generalized to other contexts.

Keywords

life expectancy, height, chest circumference, occupation, military registers, Italy

Introduction

One of the most important demographic phenomena of our time is the progressive increase of life expectancy (Aburto et al., 2020) reported since about the middle of the 19th century in industrialized countries (Canudas-Romo, 2010; Gavrilova and Gavrilov, 2010; Guerreschi et al., 2003; Oeppen and Vaupel, 2002). In 1861, life expectancy in Italy was about 30 years, which increased to 82 years in 2011 (Passarino et al., 2016). Currently, Italy is the fifth nation in the world for life expectancy with an average of 84.01 years (81.90 for men and 85.97 for women) (<https://www.nicerx.com/best-healthcare-countries/> accessed on 14 May 2023). Several studies showed that healthy aging and longevity in humans are determined by a combination of genetic and environmental factors (for a review see: Passarino et al., 2016). Several findings showed the existence of a negative correlation between stature and longevity (i.e., higher people are

predisposed to higher mortality rate than shorter ones) (He et al., 2014; Salaris et al., 2012; Samaras et al., 2003). For instance, it

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has been reported that males born in the early decades of the 20th century in mountain villages of Sardinia (Italy) had a stronger robustness—calculated mostly from data on chest circumference—and showed a higher proportion of long-living people (Fermi, 1934; Pes et al., 2013), making noteworthy the analysis of these anthropometric traits also in other populations. Height is a highly heritable trait, although the extent of variation that could be attributed to environmental factors remains controversial (Muthurulan and Capellini, 2019; Silventoinen et al., 2017).

Literacy (i.e., the ability to read and write) is another factor often associated to life expectancy. Individuals with higher educational attainment seem to have lower morbidity of major chronic illnesses (e.g., heart disease and cancer) and lower mortality or premature death (Adler and Ostrove, 1999) as well as a longer life expectancy (Ross and Wu, 1995; Yamashita and Kunkel, 2015).

Moreover, also the type of occupation has been linked to life expectancy. Literature indicates that higher socioeconomic groups live longer (Arpino and Solé-Auró, 2017; Cambois et al., 2011; Majer et al., 2010). An exception seems to be represented by farmers who could be only self-employed managers, only manual workers, or both. Some authors reported that manual workers, including farm workers, have more lifelong adverse experiences and live shorter than other occupational groups, comprising farm managers (Cambois et al., 2011; Martikainen, 2001). Conversely, it was demonstrated that farmers had the longest life expectancy compared to other manual worker groups in the early 20th century in the United States and Sweden (Gavrilov and Gavrilova, 2015; Dribe and Eriksson, 2018). Moreover, it has been reported a similar mean age of death among Japanese farmers and nonfarmer workers (87.3 ± 6.9 and 87.5 ± 7.4 , respectively) although farm workers have a reduced late-life dependency (Haruyama et al., 2020). These conflicting results underline the importance of analyzing the life expectancy of farmers versus nonfarmers also in other rural realities.

Italian military registers offer a unique opportunity to analyze the effects of anthropometric traits (i.e., height and chest circumference), occupation, and literacy on longevity, considering that the military service was compulsory for all Italian men born between the years 1861 and 1985 who were 18 years old (Gürsel, 2008; Wilcox, 2011). In the present study, we used data extracted from military conscription registers of four rural villages (i.e., Bocchigliero, Luzzi, Rogliano, and Rose) located in the province of Cosenza (Calabria region, Southern Italy), an area characterized by high genetic homogeneity and negligible levels of immigration due to geographical, historical, and social reasons (Bruno et al., 2022; Montesanto et al., 2007). The conscripts included in the sample were born between 1900 and 1910. The information extracted from military conscription registers (i.e., age, height, chest circumference, occupation, and literacy) was cross-referenced with the date of death reported in the death certificate present in the registry archives of the four municipalities to investigate the

relationship between life expectancy and height, chest circumference, literacy, and occupation. In particular, based on the literature above discussed, we hypothesized that a shorter stature, a wider chest circumference, a higher education (i.e., literate vs. illiterate), and the type of work (i.e., farmer vs. nonfarmers) were positively associated with longevity in Italian men born in the early 20th century.

Materials and Methods

Sample Cohorts

The present study was carried out in four Calabrian municipalities (Bocchigliero, Luzzi, Rogliano, and Rose; province of Cosenza, Calabria region, Southern Italy), for a total of 1944 conscripts born between 1900 and 1910 who underwent a medical examination for the military service. Given that military service in Italy was compulsory for all men born between the 1861 and 1985 who were 18 years old (Gürsel, 2008; Wilcox, 2011), the conscripts' data analyzed in the present study were obtained from military registers provided by the Archivio di Stato of Cosenza and, therefore, refer to young men aged 19 or 20 years old. Indeed, all conscripts underwent a medical examination in which their data were measured and transcribed on the military registers in individual files reporting the conscript's enrollment number, name, surname, father and mother's Christian name, date of birth, height and chest circumference, literacy (i.e., the ability to read and write), and occupation at the time of the visit. Conscripts at the time of military medical examination were classified as unskilled farmworkers, construction workers, craft workers (including industrial workers), commerce employees (including transport operators), administration and high-school occupations, landowners and managers, and lower-skilled workers (together with a number of non-specialized tasks, such as porters).

All-cause mortality data were retrieved from the death certificates of the municipality where the conscripts lived at the time of the military visit. At the time of data collection, the cohort was extinct as the last death occurred in September 2013.

To avoid inconsistencies due to local usage of children's names or to spelling errors, the procedure of individual linkages (i.e., the linkage between the data reported on military registers with those coming from the municipalities) was performed manually as previously suggested (Salaris, 2009). Such juxtaposition of data was simplified by the fact that in Italy, based on their own population registers, all municipalities sent to their provincial or regional military district, year by year, a list of all living men who had been born in their town 18 years earlier. Therefore, each individual's military file contains precise personal information about the conscript summoned for the medical visit ($n = 2363$). A total of 419 of these subjects were excluded because they died before the visit ($n = 35$), underwent the medical visit in another military districts ($n = 17$), abroad/legally absent

($n = 50$), or draft evader ($n = 317$) at the time of the visit. For 541 conscripts, the death certificates were not available in the registry archives of the four municipalities and five subjects were excluded because they died during the World War II. The final sample was composed of 1398 conscripts with a linkage coverage level of nearly 72.2%.

Statistical Analyses

Survival data were analyzed to test the association between height, chest circumference, literacy, occupation parameters at age 20, and individuals' survival (all-cause mortality). We examined the survival patterns of the conscripts conditioning their survival to age 30 to exclude deaths at younger ages that, most likely, occurred for stochastic or accidental factors (e.g., infectious diseases, accidents, violence, and military deaths), yet not directly related to longevity ($n = 35$). This should minimize the effect of such errors on cumulative survival probability. To this purpose, Kaplan–Meier survival curves were obtained for groups of conscripts defined according to these corresponding variables using the log-rank test to compare crude survivals. Quantitative variables (i.e., height and chest circumference) were categorized in quartiles (Q1–Q4). As it regards occupation, conscripts were grouped into unskilled farmworkers, craft workers (mainly including tailors and shoemakers), industrial, commerce, and transport workers, lower-skilled workers (including shepherds and laborer), administration and high-school occupations (including teachers and students), and landowners and managers. For literacy, conscripts were classified as literate (i.e., able to read and write) and illiterate (i.e., not able to read and write) at the age of 20. To quantify the association between anthropometric traits (i.e., height and chest circumference) and survival, we compared the hazard functions of conscripts belonging to the highest (Q4) and lowest quartile (Q1) with the middle ones (Q2–Q3, reference category) using a Cox regression model. The same model was also adjusted with respect to the conscripts' year of birth to take into account a possible cohort effect.

Results

General Characteristics of Conscripts

Table 1 summarizes the information on anthropometric traits (i.e., height and chest circumference), occupation, and literacy taken at age 20 for conscripts with complete survival data. The mean height was 1.63 ± 0.06 m, whereas the mean chest circumference was 0.83 ± 0.05 m. Most of conscripts were unskilled farmworkers (56.2%), construction workers (0.2%), craft workers (21.2%), commerce employees (8.9%), administration and high-school occupations (5.6%), landowners and managers (0.3%), and lower-skilled workers (7.9%). Most of the conscripts were also literate (68.0%).

Of 1363 conscripts who underwent medical examinations for military service and analyzed in the present study,

Table 1. Height, Chest Circumference, Occupation, and Literacy Taken at Age 20 for Conscripts With Complete Survival Data Born in the Area Under Investigation Between 1900 and 1910.

Conscripts' characteristics ($n = 1363$)	
Height (m)	$1.63 \pm .06$
Chest circumference (m)	$0.83 \pm .05$
Occupation ^a	
Administration and high-school occupations	71 (5.2)
Landowners and managers	4 (0.3)
Commerce employees	120 (8.9)
Craft workers	285 (20.9)
Lower-skilled workers	105 (7.9)
Construction workers	3 (0.2)
Unskilled farmworkers	755 (56.2)
Literate	913 (68.0)
Illiterate	429 (32.0)

Note. Data are presented as mean $\pm$ SD or n (%).

^a21 missing data on occupation.

900 were considered "healthy" and then enrolled in the army; 384 conscripts were considered temporarily unfit for regular military service, while 79 were rejected. In these last two cases, the most frequent causes include weakness of constitution ($n = 382$, 82.5%), visual and acoustic defects ($n = 16$, 4.2%), skeletal deformities ($n = 15$, 3.9%), and infectious diseases ($n = 12$, 3.1%). Other less frequent causes include trauma, neurological, heart, and thyroid problems (6.3%).

Figure 1 shows information on anthropometric measurements taken at age 20 for the analyzed cohorts. For height, the cutoff values were 1.59 and 1.67 m for the lowest (Q1) and highest (Q4) quartile, respectively. For chest circumference, the cutoff values were 0.80 and 0.86 m for the lowest (Q1) and highest (Q4) quartile, respectively.

Anthropometric Characteristics and Mortality

Figure 2 shows Kaplan–Meier survival functions obtained for conscripts with respect to anthropometric traits.

Tall men (Q4) showed a significantly reduced chance to attain advanced ages compared to Q1 (short men) and Q2–Q3 (intermediate height) categories (p -value = 0.018, Figure 2(a)). The observed median time of survival was 75.5 years for Q1, 76.5 years for Q2–Q3, and 75.5 years for Q4. No significant association was detected between chest circumference and all-cause mortality (p -value = 0.350, Figure 2(b)). The observed median time of survival was 75.8 years for Q1, 76.0 years for Q2–Q3, and 75.6 years for Q4.

Occupation, Literacy, and Mortality

Panel A in Figure 3 shows the Kaplan–Meier survival functions of conscripts with respect to the type of occupation at the age of the military visit.

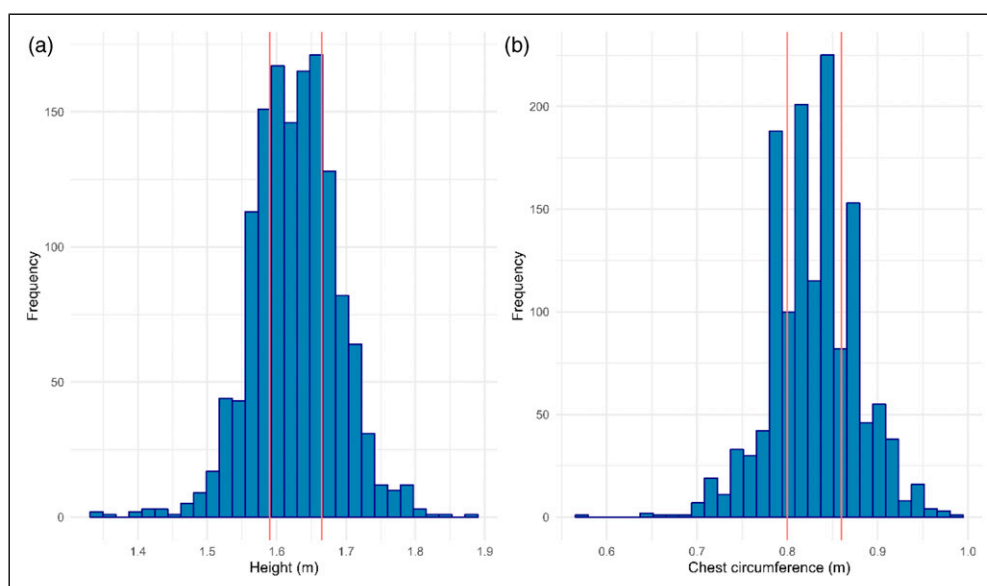


Figure 1. Frequency distribution of height (a) and chest circumference (b). Vertical red lines in both panels indicate the lower (Q1) and the upper (Q4) quartiles of the analyzed anthropometric variable.

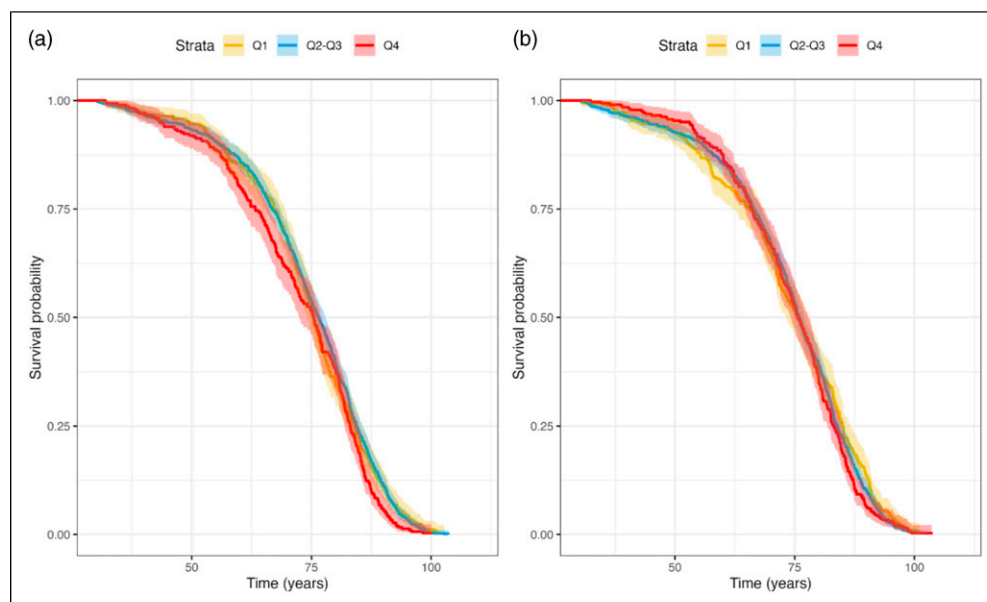


Figure 2. Kaplan–Meier curves displaying the estimated survival probability for four different groups of conscripts based on height (a) and chest circumference (b). The lowest quartile, Q1, is illustrated in yellow, Q2–Q3 is illustrated in blue, and the highest quartile (Q4) is illustrated in red.

Conscripts classified as farmers showed a significant survival advantage with respect to the other types of occupation (p -value = 6.0×10^{-4} , Figure 3(a)). The observed median time of survival was 77.2 years for farmworkers, 76.7 years for administration and high-school occupations, landowners and managers, and construction workers (these three categories were merged due to their low frequency),

76.4 years for lower-skilled workers, 75.7 years for commerce employees, and 72.3 years for craft workers.

Kaplan–Meier survival functions of conscripts with respect to the literacy (literate vs. illiterate) at the age of the military visit are reported in Figure 3(b). Literate conscripts did not show a significant survival advantage with respect to the illiterate conscripts (p -value = 0.400, Figure 3(b)). The

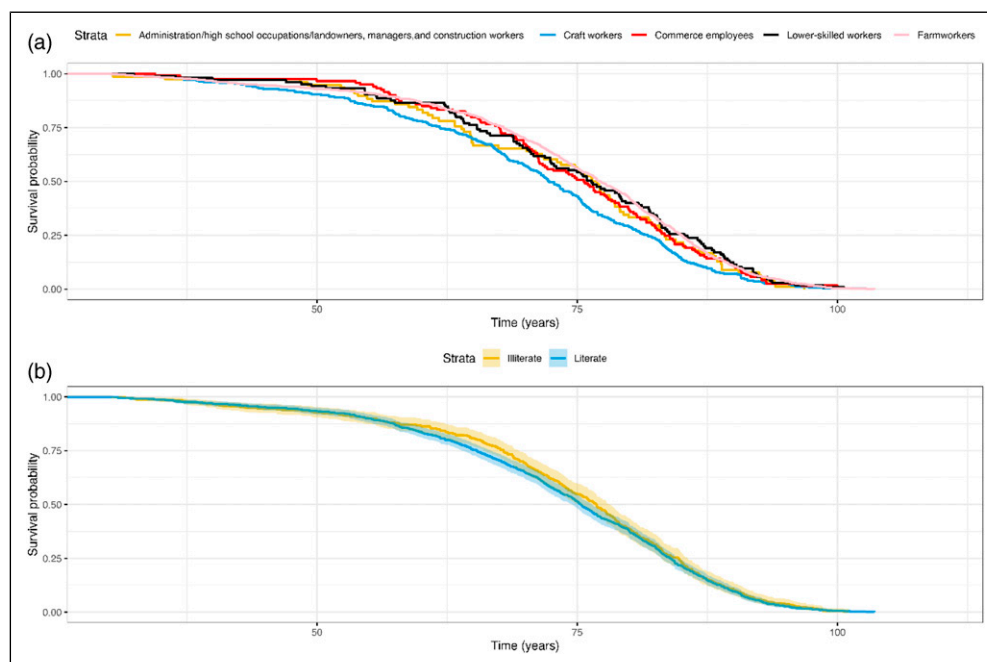


Figure 3. Kaplan–Meier curves displaying the estimated survival probability for four different groups of conscripts based on type of occupation i.e., survival probability for four different groups of conscripts based on (a) type of occupation and (b) literacy (literate vs unliterate).

observed median time of survival was 75.3 years for literate and 76.8 years for illiterate conscripts.

Cox Regression Model

To quantify the effect of the anthropometric traits, occupation, and literacy on mortality after 30 years of age, a multivariate Cox regression model was adopted. In Table 2, the maximum likelihood estimation of the parameters of this model and the hazard ratio (HR) for mortality risk are reported.

Tall men exhibit a significant mortality increase of about 20% (HR = 1.21; 95% CI: 1.05–1.39) when compared with men with middle height (p -value = 0.007). For short men, the estimated HR was not significantly different from 1 (HR = 1.07; 95% CI: 0.93–1.23; p -value = 0.351). Conscripts classified as farmers showed a significant survival advantage compared to the nonfarmers (HR = 0.83, 95% CI: 0.74–0.93, p -value = 0.002), while literacy did not significantly affect the survival of conscripts over time. Also, adjusting the analysis for cohort effect the results remained substantially unchanged. To note, by varying the previously adopted height cutoff values (using quintiles), the effects of height on mortality after 30 years of age remained almost constant (HR = 1.18, 95% CI: 1.02–1.36, p -value = 0.027). More importantly, survival analysis carried out among men surviving to age 50 years showed that the previously reported associations were also observed at older ages when the potential effect of stochastic factors (e.g., infectious diseases, accidents, and violence) or unreported deaths becomes low

(HR = 1.16, 95% CI 1.01–1.33, p -value = 0.041 for taller men [Q4]; HR = 0.82, 95% CI 0.73–0.92, p -value = 0.00077 for farmers).

Discussion

Historical military records represent a unique opportunity to characterize the effects of some anthropometric traits (e.g., height and chest circumference) and sociodemographic characteristics (e.g., literacy and occupation) on survival. In Italy, military service was compulsory for all men who were born between 1810 and 1985 (Gürsel 2008; Wilcox, 2011). In this study, anthropometric and sociodemographic data observed during military medical examinations performed between 1920 and 1930—when the subjects were around 20 years of age—were linked with mortality data to examine the effects of these traits and characteristics on life expectancy after 30 years of age.

In the second half of the 19th century and in the first two decades of the 20th century, Italy experienced a higher level of infant mortality with respect to other countries of northern and western Europe. For instance, in Italy during the second half of the 19th century, immediately after national unification, the probability of dying before the fifth birthday was well over 40% and it was just as high in Spain. In the same period, the probability of dying between 0 and 5 years of age was around 20% in Norway and Sweden, around 25% in England, and 30% in France (Ramiro and Sanz, 2000a, 2000b; Vallin, 1991). The decline in infant and child

Table 2. Cox Regression Model for the Relationship Between Anthropometric Traits, Occupation, and Literacy on Mortality After 30 years of Age for Conscripts Born Between 1900 and 1910.

Variable	HR (95% CI)	p-Value
Height		
Q1 vs Q2–Q3	1.07 (0.93–1.23)	0.351
Q4 vs Q2–Q3	1.21 (1.05–1.39)	0.007
Chest circumference		
Q1 vs Q2–Q3	0.94 (0.82–1.08)	0.407
Q4 vs Q2–Q3	1.07 (.93–1.23)	0.331
Literacy (literate vs unilliterate)	1.01 (0.89–1.14)	0.901
Occupation (farmers vs nonfarmers)	0.83 (0.74–.93)	0.002

mortality observed from the end of the 19th to the beginning of the 20th century was observed in most parts of the European countries. In Italy, this decreasing trend was also more pronounced and faster than in other European countries, except for the period including the World War I, the Spanish influenza in 1919, and in Calabria the earthquake of 1908 (Pinnelli and Mancini, 1999). The primary medical reasons for this mortality decline were generally given as the lessened impact of infectious and parasitic diseases linked to improved nutrition, better personal hygiene, and improved public sanitation. The spread of pasteurization of milk through Italy in the late 19th century played an important role in the decline of infant mortality (Pinnelli and Mancini, 1999).

Our study demonstrates that tall men (height >1.67 m, as far as that population is concerned) exhibit a significant mortality increase of about 20% when compared with men with middle height. More importantly, the same phenomenon was also observed even when survival was studied from the age of 50 years when the effect of stochastic factors (e.g., infectious diseases, accidents, and violence) or unreported deaths becomes low.

A similar result was obtained in the population of Sardinia (Salaris et al., 2012), in which the authors found that short conscripts (<161.1 cm) showed lower mortality rates than taller ones (>161.1 cm). The association between increased height and decreased survival could be due to several biological factors. First, tall stature is mainly determined by the activation of the growth hormone (GH)—insulin-like growth factor 1 (IGF-1) axis (Baron et al., 2015) that increases the risk of cancers (Tidblad, 2021) and thus reduces longevity. A confirmation of the involvement of GH-IGF-1 axis in human longevity derived from the observation that patients with Laron syndrome (Laron, 2004), a recessive autosomal genetic disease characterized by the inability to GH response, showed both a reduced stature (nanism) and an increased longevity as well (Rahmani et al., 2022). Second, a greater height is associated with higher levels of C-reactive protein (Mendall, 2000), that in turn is associated with a higher chance of dying for all-cause mortality and especially for heart disease (Chen et al., 2022). Third, taller people have more DNA damage than

shorter people (Giovannelli, 2002) and their higher number of cells increases the risk of exposure to free radicals and carcinogens (Salaris et al., 2012; Samaras, 2008). Interestingly, Zoledziewska et al. (2015) identify two genetic polymorphisms on *GHR* and *KCNQ1* genes, whose variability was associated with short stature. In the light of our results, this evidence suggests the need to conduct whole-genome sequencing studies also on the Calabrian population to identify variants associated with short height and, possibly, with life expectancy.

American economist and Nobel laureate Robert Fogel has used the positive correlation between people's adult stature and their risk of mortality to argue that improvements in nutrition (as reflected in increasing body height) mainly driven the increases in life expectancy observed since the 19th century in Europe (Fogel, 2004). It is important to point out that in this case height is associated with longevity because its increase through the decades is associated with improved nutrition, cleaner water, and environments but it also arrived together with vaccination and improved medical assistance. Thus, the positive association between height and longevity we observe through decades in the 20th century is completely different from the correlation between height and longevity we can see among individuals born in the same period and in the same environment. In this case, with similar nutrition and external dangers, we see a negative correlation as we report in our study.

Animal studies of different strains and breeds within biological species of rats, mice, and dogs also demonstrated that animals with smaller body size live longer within a given species (Li et al., 1996; Michell, 1999; Miller et al., 2000; Patronek et al., 1997; Samaras et al., 2003). In particular, dogs also show marked differences in their expected lifespan in connection with body mass. Giant breeds (>50 kg) have an expected lifespan of 6–8 years, while small breeds (<10 kg) can live on average up to 14–16 years (Jimenez, 2016). IGF-1, the main effector of GH, is a major determinant of dog size and genetic variations in IGF-1 are major determinants of small size in dogs (Sutter et al., 2007). Consistently with this observation, it has been found that in humans height in mid-life was positively associated with mortality and was associated with fasting insulin level and the longevity genotype of

FOXO3, a downstream effector of insulin/IGF-1 signaling pathway (He et al., 2014).

Moreover, we showed that farmer conscripts showed a significant survival advantage compared to those with no farming experiences. Our results are in line with those of Gavrilov and Gavrilova (2012, 2015) and Dribe and Eriksson (2018) who demonstrated that farmers had the longest life expectancy compared to other manual worker groups in the early 20th century providing a strong link between working on a farm, access to food, and survival at advanced ages. The survival advantage of farmers may be due to the fact that they are generally physically active (Davis-Lameloise et al., 2013; Osuji and Omejua, 2012; van den Berg et al., 2010), have almost always fresh vegetables available (Davis-Lameloise et al., 2013; van den Berg et al., 2010; Machida and Yoshida, 2018; Morimoto et al., 2008), and tend to be non-smokers (Levêque-Morlais et al., 2014; Roux et al., 2017; Blair et al., 2005), pointing out to the role of healthier environments characterizing farms in the period under investigation as also suggested by Preston et al. (1998). It should be noted that in the Calabria region the Mediterranean diet was widely spread (Moro, 2016), commonly related to healthy and longevity (Guasch-Ferré and Willett, 2021; Di Daniele et al., 2016). This food regime is characterized by a high consumption of farmers' products (e.g., fruit and vegetables, vegetable oils, and starch) and a little intake of meat (Guasch-Ferré and Willett, 2021; Di Daniele et al., 2016). The reason that a low intake of animal protein is beneficiary can be explained by the study by Levine and co-workers who showed that during middle age high levels of animal proteins promote cancer, overall mortality, and possibly diabetes through a process that may involve, at least in part, regulation of circulating IGF-1 and possibly insulin levels (Levine et al., 2014). Thus, our results are probably due to a lucky combination of diet, physical activity, and stochastic factors that made the farmers of the early 20th century a successful category in terms of survival.

Our results suggest that there is not a significant association between chest circumference and all-cause mortality in Calabrian conscripts. This data is not in line with the previous findings on male born in the early decades of 20th century in mountain villages of Sardinia (Italy) which showed an association between life expectancy and stronger robustness (mostly calculated from data on chest circumference) (Fermi, 1934; Pes et al., 2013). These contrasting results are probably due to the different methodologies adopted since we have used the net chest circumference data without crossing it with other body measures of robustness.

Finally, we found no differences in life expectancy between literate and illiterate conscripts. However, in the military records we examined, literacy skills were reported together (i.e., ability to write and read: yes/no) and this aspect may have influenced the results. For example, Yamashita and Kunkel (2015) reported that reading was the stronger predictor of health than other literacy skills (i.e., writing and calculation) in a sample of 6853 Italians. Further studies are needed by

consulting more recent and detailed military registers, in which the level of schooling was also reported, to better understand the effects of educational levels on life expectancy. Another limitation of our study is that we examined the military records of only four municipalities. Given that Calabria is characterized by high geological variability (e.g., mountain, hills, plains, and sea villages) which influenced the type of work carried out in the past decades (e.g., herding, agriculture, and fishing), future research should extend the analyses to other areas of this Italian region. It is likely that the survival advantages of farmers with respect to nonfarmers become negligible when other districts are analyzed (Singh and Siahpush, 2014).

Moreover, from the death certificates of the conscripts we were unable to extract the precise cause of death. Studies that cross data from military registers with more recent and reliable death certificates are necessary to understand whether the variable objects of our study are associated with specific causes of death and not only with all-cause mortality.

To sum up, our study demonstrated that height and type of occupation at the time of military medical examination (19–20 years old) influenced the life expectancy of Calabrian conscripts born between 1900 and 1910. For taller men (height >1.67 m), mortality increase by about 20% when compared with men with middle height has a significant reduced chance to attain advanced ages compared to short- and intermediate height men. Moreover, farmers showed a significant survival advantage compared to those with no farming experiences. It is important to point out that the villages which we analyzed were all part of rural areas. Further studies are needed to understand whether these differences were maintained over the other decades and to estimate the weight of genetic and environmental factors in determining the reported survival benefits.

Acknowledgments

We thank all municipalities that provided a strong support for data collection and in particular Alfonso Benevento (mayor of Bocchigliero), Manfreda Tedesco (ex-mayor of Luzzi), Mario Bria (ex-mayor of Rose), and Giuseppe Gallo (ex-mayor of Rogliano). The work has been made possible by the collaboration with Gruppo Baffa (Sadel Spa, Sadel San Teodoro srl, Sadel CSrl, Casa di Cura Madonna dello Scoglio, AGI srl, Casa di Cura Villa del Rosario srl, Savelli Hospital srl,) and Casa di Cura Villa Ermelinda in the frame of the agreements TECNOLOGIE AVANZATE PER IL MIGLIORAMENTO DEI SERVIZI ALLA PERSONA and TECNOLOGIE AVANZATE PER L'INDAGINE DELLE RELAZIONI TRA UOMO ED AMBIENTI DI VITA.

Author Contributions

A.M. and F.B. designed this study. M.A.A., P.A., E.P., D.B., T.S.C., P.C., and S.G. collected data. F.B., M.A.A., and A.M. carried out the statistical analyses. A.M. and F.B. wrote the manuscript. G.P. and G.F. reviewed and edited the manuscript. All authors have read and approved the final manuscript.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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