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Living standards in settler South Africa, 1865-1920*

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Abstract

We construct an anthropometric measure of living standards for White South Africans covering 55 years using five different military sources. Accounting for different selection across the forces, we find that prior to industrialisation, White South African males were amongst the tallest in the world. Rural living standards declined in response to natural disasters in the 1880s and 90s with those with the lowest living standards moving off the land and into the cities. We find a slight improvement in living standards after 1900 across all regions and occupations. During industrialisation, White males in South Africa continued to exhibit the highest living standards in the world as represented by their stature. Convergence to other nations in the early twentieth century shows, however, that while there may have been no industrialisation penalty, industrialisation did not lift living standards the way it did elsewhere.

Keywords. anthropometric, South Africa, stature, height, living standards

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1 Introduction

Living standards in South Africa surrounding the turn of the 20th century have been significantly understudied across all race groups. What little that does exist is taken from diaries, traveller accounts, extrapolation from later 20th century data or from specific regional data. This lack of evidence is due to a dearth of disaggregated demographic and economic data that we would typically use to shed light on living standards. The acceptance of the validity of adult stature as a window into early childhood living conditions coupled with the acceptance of military personnel height records as adequate representation of the population (under certain conditions) has led to a number of studies using such data to inform on living conditions around the turn of the 20th century globally. In the absence of GDP data and published health records, height has become an important indicator of living standards (Steckel, 1995; Komlos, 1994).

In this paper we use height information from the attestation forms of three South African war period military forces: the Boer War, World War I and World War II to determine the living standards of White settlers born in South Africa between 1865 - 1920 and to compare those to other colonies for which there is similar data. Within the subcategory of settler societies, we now have anthropometric living standards measures for Argentina, Australia, Canada, Chile, New Zealand and the United States (Salvatore, 2004a; Steckel and Floud, 2008; Inwood et al., 2010; Cranfield and Inwood, 2015; Llorca-Jaña et al., 2020; Llorca-Jaña et al., 2021). This is the first paper to explore living standards through anthropometric measures for South Africa.

Colonial South Africa had long been treated as the Cinderella of the British settler colonies. For close on 50 years, Britain neglected her South African colonies, leaving them poorer as measured by GDP, less developed and under financed relative to Australia, Canada and New Zealand (Feinstein, 2005, p. 6, Greyling and Verhoef, 2015, Magee et al., 2016a). However, there are also similarities to the other colonies. Large numbers of immigrants originated in Britain and Ireland, settlement extended to the rural frontier, the economy was dominated by agriculture, and industrialisation occurred later than in Europe. Industrialisation, when it began, commenced rapidly in South Africa following the discovery, first, of diamonds followed by gold

in the underdeveloped interior. The sudden change in South Africa's economic fortunes led additionally to substantial political uncertainty, culminating in a devastating war followed by the creation of the nation in 1910.

The dramatic final decades of the nineteenth century and first decades of the twentieth led to large scale migration of settlers to urban areas into semi and unskilled jobs servicing the booming mining industry. At the same time, increased transportation networks through what had been largely isolated rural areas allowed the expansion of agricultural exports. In all, the South African settler economy underwent a substantial transformation precisely over the years in which servicemen in the three major confrontations affecting South Africa were born, making South Africa a useful laboratory for further examination of living standards during industrialisation.

The use of military data to represent population living standards is not new although it is contentious (Bodenhorn et al., 2017; Zimran, 2019; Fourie et al., 2020). Bodenhorn et al. (2017) argue that historical military forces are highly selected. Firstly, armed forces often imposed height restrictions. Secondly, enlistment in the forces may often have been the result of a lack of other income earning options leading to counter cyclical selection into the armed forces especially if the armed forces pay was lower than the market wage. Thirdly, the nature of warfare changed dramatically over the period our data covers and hence the demand for height may have changed over the period (Fourie et al., 2020). If we are to use military records to inform about population living standards we need to be clear about the extent to which our data are representative. To deal with the first issue we use a truncated regression. For the second, we argue that the World War I and II enlistments are broadly representative of the male settler population aged 20-49 in South Africa due to the high enlistment proportion as well as the wave of patriotism that flowed through the certain parts of the population. Nevertheless we reweight the data based on the population distribution and we provide a robustness check. For the final issue we believe that as the demand for soldiers increased given the changing nature of warfare from hand to hand combat and cavalry to the use of machine guns and other more automatic weapons our enlistees become more and more representative of the population. Our international comparison is with armed forces from other British colonies and in that sense we are comparing very similar groups.

We use regression analysis in order to establish the relationship between heights and various correlates of height simultaneously. Our truncated regression results show that White South Africans born in the late 1860s were very tall, signifying high biological living standards as determined by childhood nutritional intake. Due to the limited development of the economy, we believe this stature advantage resulted from the nature of the pastoral economy as well as the abundance of wild animals in the countryside which together led to a high protein diet. Living standards decreased in the 1880s and 1890s due to both internal and external factors. Drought, locusts and rinderpest in the 1880s and 90s made rural life particularly difficult. The poor global economic conditions played their part too with an economic depression in the 1880s and 90s. This pattern is similar to findings in New Zealand and Argentina ([Salvatore, 2004a](#); [Baten et al., 2009](#); [Inwood et al., 2010](#)). After the end of the Boer War (1899-1902) and the subsequent investment in gold mining, biological living standards began to recover slowly in the first two decades of the twentieth century. Our results show that, as now commonly found, men born in rural areas were consistently taller than those born in urban areas and men in farming or careers requiring education were taller than those in less skilled urban jobs.

Finally, settler South Africa had the highest biological living standards in the British settler empire at the turn of the twentieth century. By the end of the period of analysis this height advantage dissipated somewhat as other countries began to catch up. The increased economic activity across the countryside most likely played a role here as resources shifted toward capital and farming intensified. The weak development of the health sector simultaneously would have exacerbated the effects.¹

Our findings complement earlier attempts to measure standards of living using historical reconstructions of gross domestic product ([Fourie and Van Zanden, 2013](#); [Greyling and Verhoef, 2015](#)). Our advantage is that we can disaggregate these long-run trends in income at a regional and population level. Our anthropometric evidence also supplements the fledgling demographic history literature in South Africa by adding a dimension of life quality beyond what we know

¹This decline in access to protein coupled with the decline in living standards as the agricultural sector becomes market oriented is seen in Argentina as well, see [Salvatore and Baten \(1998\)](#); [Baten et al. \(2009\)](#); [Salvatore \(2019\)](#)

about life expectancy and life span. Our findings complement those of [Cilliers and Fourie \(2012\)](#) who show an increase in life span from the second half of the nineteenth century. Yet our finding of high early life living standards contrasts with the low life expectancy found in [Simkins and Van Heyningen \(1989\)](#) and [Wickens \(1930\)](#). Understanding this contrast is an avenue for future research. Because of a lack of data we cannot comment on Black living standards over this period. For slightly later births years see [Inwood and Masakure \(2013\)](#) and [Mpeta et al. \(2018\)](#).

The paper proceeds as follows: section 2 describes the settler experience with particular focus on how this might affect living standards, section 3 discusses the data used, selection into the armed forces and provides descriptive statistics, section 4 provides the regression results and looks at trends in height by covariates, section 5 compares settler South African heights to heights in other British colonies and section 6 concludes.

2 The settler experience, 1865-1920

The birth years of the men in our data span the transformation of the South African economy from primarily agricultural, with relatively low and declining per capita GDP for Whites to rapidly industrializing with high growth rates following the discovery of minerals ([Greyling and Verhoef, 2015](#); [Magee et al., 2016a](#)). In this section we describe this economic transformation, highlighting geographic and political differences across the country and focusing on their correlations to living standards at the time. In the absence of traditional economic and demographic measures of living standards we rely on this history to inform our subsequent data analysis.

We divide the country into six geographical regions whose social and economic conditions changed over time, depicted in figure 1: The Western Cape, Eastern Cape and Northern Cape all fall under the Cape Colony ruled by Britain; Natal on the east coast, also a British colony; the Orange Free State and the Transvaal (also known as The South African Republic), the two independent Afrikaner/Boer republics. Prior to industrialisation, the dominant economic center was Cape Town in the Western Cape with the city serving as a revictualling station for passing ships on their way to Asia as well as the main market for the population in the interior. Almost

all of the Cape Colony's manufacturing took place in and around Cape Town ([Hobart Houghton, 1971](#), p. 2, [Worden, 1992](#)). The immediate hinterland benefitted from access to the international market via Cape Town. A wealthy wine and agricultural industry developed in the Western Cape to serve the growing city and ship demand ([Boshoff and Fourie, 2010](#); [Du Plessis and Du Plessis, 2012](#); [Fourie, 2013](#)). The Western Cape was the wealthiest part of South Africa at this time, however during the 1860s it experienced an economic depression and came to benefit substantially from the diamond discoveries of the 1870s ([De Kock, 1924](#), p. 103, [Greyling and Verhoef, 2015](#)).

Elsewhere, economic growth was more limited because of distance to the main port and weak transport infrastructure ([Fourie, 2013](#)). Eastwards along the coast from Cape Town communities became increasingly rural as the land lent itself well to sheep farming ([Giliomee, 2003](#), p. 194). Afrikaans (Dutch-descended) settlers dominated the pastoral economy while English settlers concentrated themselves in the eastern Cape towns ([De Kock, 1924](#), p. 89-91). The port towns of Port Elizabeth and East London served the growing farming communities in the eastern parts of the Cape Colony. While substantially smaller than Cape Town, they were home to several small manufacturing enterprises and served as the closest access to the interior of the country. Moving over the mountains from the south western Cape into the interior, the dry land of the Northern Cape was mostly conducive to sheep farming, particularly after the arrival of the hardy Merino sheep ([Hobart Houghton, 1971](#), p. 4). The Natal Colony along the eastern side of the country was predominantly agricultural, farms were smaller and the climate was well suited to agriculture. The major towns were Pietermaritzburg inland and Durban on the coast, the inhabitants were mainly English speaking. After the development of the gold mining and transport industries Durban became South Africa's major port.

Although records are scarce, to the best of our knowledge the economy of the two Boer republics, the Transvaal in particular, remained at a basic subsistence level, the farmers employed few modern farming techniques and relied to a large extent on hunting to satisfy some of their food requirements ([Goodfellow, 1931](#), p. 130). The Orange Free State relied similarly on pastoral activities and subsistence farming, however there were also small pockets of wheat cultivation

serving the local area. Both countries did support fledgling manufacturing sectors to meet local, rural demand (De Kock, 1924, p. 286-87). Because of the vast distance these republics were from the Cape and the lack of adequate transportation, these farmers were to some extent cut off from the economy of the Cape, not to mention the global economy (Wilson, 1971, p. 108, van Heyningen, 2005). This by no means implies they were poor, just that they had little access to certain kinds of material possessions.

Housing was basic in much of the country side (Wilson, 1971, p. 112, van Heyningen, 2005). In the Transvaal in particular many families lived a semi-nomadic life moving seasonally in search of pasture and living in their wagons and tents. Meals amongst the Boers consisted of stewed meat with either home-made bread from self-cultivated wheat or maize porridge both for breakfast and for dinner. Levels of educational attainment appear to have been poorest in the Transvaal, somewhat better in the Orange Free State and, while still poor in the Cape interior, better than in the Boer Republics (Malherbe, 1925, p. 256, Wilson, 1971, p. 112).

Trade within South Africa consisted of manufactured products either made in Cape Town or imported from Europe to the interior of South Africa, both to the farmers in the Cape interior as well as to the Boer Republics. Exports consisted chiefly of low-quality wool by the 1850s as well as animal hides, skins, ivory and cattle from the interior to the ports and then on to the world (Visser, 2011). Since wool was the chief export commodity from the interior of the country, the ox-wagon remained a cost effective method of transportation and hence the main mode of transportation even beyond the discovery of diamonds.

Ultimately, little is known about the comparative nineteenth-century living standards of the European immigrants and their descendants. Real wages for Whites in the Cape Colony and Natal are thought to have been comparable to Amsterdam and London in the eighteenth and nineteenth centuries (De Zwart, 2011; Du Plessis and Du Plessis, 2012). No estimates are available for the two Boer republics, though the fact that migrants generally moved from the Cape to the interior suggests that living standards could not have been much lower. Indeed, Trapido (1980, p. 356) notes the high levels of wealth in the Transvaal by the 1870s driven by the value of their land holdings.

Diamonds, gold and industrialisation

The slow pace of frontier development received a huge shock in 1867 with the discovery of diamonds in the semi-colonised region of Griqualand West. Hordes of prospectors came to the area, many bringing their families. The town of Kimberley expanded rapidly; by 1877 it held 18,000 people (Wilson, 1971, p. 114). Conditions were poor, vegetables and fresh meat were hard to come by and Kimberley was rife with disease (Wilson, 1971, p. 114, van Heyningen, 2005).

In time the growth of Kimberley and the demand for mining equipment, food, clothing and manufactured goods had impacts throughout the country. Both Afrikaans land owners in the OFS and African tenant farmers began to target their production to the growing market in Kimberley (Bundy, 1988, p. 204). Produce was brought to the town via ox-wagon as the only mode of transport until 1885, benefiting transport riders. The impact on farmer and transport rider living standards is unclear: on one hand people would have experienced higher incomes from market activity and transport riding, on the other less land became available for pastoral activities and presumably less time as well possibly resulting in poorer caloric consumption.

The introduction of capital intensive mining techniques required capital equipment from the already industrialized countries and to that end, finally, the railway out of Cape Town was extended to Kimberley in 1885 and joined to the Port Elizabeth railway at De Aar (Hurwitz and Williams, 1962, p. 42). By the 1870s, South Africa's coastal cities were integrated into global commodity markets (Boshoff and Fourie, 2010). Substantial public investment in railways connected the interior to these global markets (Gwaindepi and Fourie, 2020). Herranz-Loncán and Fourie (2018) calculate that between 1870 and 1900, railway expansion accounted for up to a quarter of South Africa's GDP growth.

For the Orange Free State (and Basutho) farmers, the change in the mining technology and the extension of the railway meant the end of their short lived income generating opportunity, although transport riding continued to be lucrative in the Transvaal until 1906 (Van Onselen, 1982, p. 114-115). By contrast, the farming community of the South Western Cape was able to capitalise on the extension of the railway (Marincowitz, 1985, Feinstein, 2005, p. 49). The

surge in demand for produce from the Western Cape further awakened the productive capacity of that region and along with increasing supply into the interior of the colony, producers began to actively target markets in Europe (Goodfellow, 1931, p. 111).

The 1870s saw an economic boom in South Africa followed by two decades of crises despite the discovery of gold in 1886 (Greyling and Verhoef, 2015). Agriculture, still the largest employer, suffered severe adverse shocks: drought beginning in the 1880s, a mid-1890s outbreak of locusts and the arrival of the cattle-killing disease rinderpest in 1896 (Ballard, 1986). While deaths of settler cattle were far lower than that of African cattle, the impact was still substantial with 50% of herds being wiped out (Ballard, 1986).

While the discovery of diamonds helped start South African industrialization in the 1870s, it was the discovery of vast and deep gold bearing ore in the south of the Transvaal that transformed Cinderella from neglected step-sister to belle of the ball. The rapid growth of gold mining, and with it the town of Johannesburg, spurred the growth of agriculture and industry in the Transvaal although it also contributed to rising political tension between the Transvaal and the British run Cape.

The worsening political atmosphere culminated in the outbreak of the Second Anglo Boer War in October 1899. Although a British victory seemed inevitable, Boer guerilla warfare led the British to respond with a scorched earth policy and concentration camps for Boer women and children. The two final years of the war had devastating impacts on the people in the concentration camps, particularly in the former Boer republics with high illness and death rates (Van Heyningen, 2009; Du Plessis and Fourie, 2016). Conditions in these camps partially contributed to the Boer surrender in 1902.

While the Boer War years were unarguably calamitous for living standards in the Boer republics, the rapid post-war growth brought recovery for some although not all White settlers. The gold mining sector began to surge, railway expansion continued to improve access to rural areas of the country, and local manufacturing flourished. However, poorer settlers who had been tenant farmers or squatters on the land shifted into unskilled occupations in the towns both as a result of the devastation wrecked by the War as well as the changes in the agricultural sector as

landlords sought to take advantage of new economic opportunities. These “poor Whites” continued to experience poverty until government programs successfully alleviated some of this poverty in the 1920s and 1930s. Therefore while the trend in the economy was positive, there were stark differences in incomes and experiences across the settler community.

Health and public health

Information on health and the physical quality of life is sparse for Whites until the early 20th century censuses and for Blacks until the end of apartheid. [Simkins and Van Heyningen \(1989\)](#) describe the conditions under which the Cape Colony began collecting statistics on mortality in the early 1890s. Prior to 1890 there was no public collection of health data. The 1891 Cape Colony census contains the first records of health in South Africa. Health statistics in the rest of the country were first collected after the Union of South Africa in 1910. In this section we summarise what the literature argues living conditions were like for White South Africans over the period of interest.

As noted in the previous section, all throughout the period, large portions of society remained agricultural even while there was large scale movement of people to the cities. While there is little in the way of official data for the nineteenth century, we have several accounts of life in the countryside made by travellers throughout South Africa. These accounts often suggest that rural life was harsh, that homes were simple, that luxurious amenities did not exist, and that education was severely lacking ([Lacy, 1900](#)). In short, people inhabiting the countryside were poor and looked poor. From this we may guess that their biological quality of life was poor too.

These texts have been taken as the truth in informing what we know of the interior of South Africa. Yet as ([Fourie, 2014](#)) have shown for the eighteenth century Cape Colony, such texts do not always hold up to quantitative evidence. Might it be that the quality of life in the nineteenth century was higher than acknowledged too?

[van Heyningen \(2005\)](#) notes conflicting accounts of Boer wealth toward to the end of the nineteenth century. There are anecdotal reports of drab housing, consistent with that in [Wilson](#)

(1971, p. 112). However [van Heyningen \(2005\)](#) also notes that the lists of items from Boer homes burned during the Boer War include musical instruments, books and furniture. She also suggests that exposure to contagious disease would have been limited due to the population's isolation and that this may have had a positive effect on living standards, something that has been found to be true in other isolated populations ([Baten and Murray, 2000](#); [Tassenaar, 2019](#)). Indeed, cholera was unheard of and apart from the advent of bubonic plague in 1901 which was limited to Cape Town and which affected the Coloured population much more severely than the Whites, there was little in terms of communicable disease until the 1918 influenza, a pandemic that also disproportionately affected the poorest ([Fourie and Jayes, 2021](#)).

While some remained wealthy, the Boer War and capitalisation of the countryside caused some of the poorer settlers to leave culminating in what was known in the first three decades of the twentieth century as the “poor Whites” problem. In the 1930s a Commission was established to document the nature of the problem with commissioners finding evidence of malnutrition, childhood tape worm, enteritis and sub-acute scurvy.

Although the 1930s Carnegie Commission is informative, the commissioners of the Carnegie Commission, which took place primarily in the Cape, believed their findings to be equally applicable to the rest of the country and equally relevant to periods 30 years earlier. We have however noted that a lot changed over 55 years and it is not evident that economic and social conditions would have remained constant over this period. Therefore while the suggestion is that the rural population was living in abject poverty, subsisting on maize porridge that remained luke warm over the coal stove for days on end, we believe there is a need for further investigation.

The experience of the urban population presents a different set of questions. Although Cape Town had been settled for already 200 years it had no public health provision until the 1890s when the Colony first invested in sanitation infrastructure and created a department of public health linked to a statistical office. The first comprehensive census in 1891 and compulsory registration of births and deaths including cause of death from 1895 showed that the quality of life in Cape Town lagged that of other settler colonies – life expectancy at the Cape was 45.3 years and 48 years for men and women compared to 51.1 and 54.8 in Australia at the same time.

Infant mortality rates at the Cape were 150 per 1000 children born, substantially higher than at the equivalent time in Australia where rates were 127 per 1000 for males and 108 for females (Simkins and Van Heyningen, 1989). Nevertheless, as Cilliers and Fourie (2012) show, life spans in the Cape were increasing from the mid 1800s onward.

Much less is known about health in the Transvaal and Orange Free State before and after the Boer War until the collection of the first national census in 1911. Both republics did collect a census in 1891. The quality of these censuses is, however, disputed. Nevertheless, the high mortality rate in South Africa relative to other British colonies continued into the 1920s as shown in Wickens (1930), where South African mortality rates are as high as in England and substantially higher than in Australia and New Zealand. It is into this morass of conflicting evidence that we bring data on height to shed additional light on conditions bracketing the turn of the twentieth century.

3 Data

In order to understand the level and change in living standards of the settlers over the period of industrialisation, we digitize and transcribe 35 671 attestation forms of recruits from five different armed forces in South Africa recruited between 1890 and 1945: the Cape Mounted Police, the South African Constabulary, sixteen additional small regional forces stationed across the Cape Colony, and the South African armies in World Wars I and II.

The Cape Mounted Police (CMP), before March 1904 simply known as the Cape Police, was raised in terms of Act No. 12 of 1882 as a military police for the Cape Colony. It was the first state run police force in the colony and its purpose was general law enforcement across the colony. At the outbreak of the Boer War the regiments were incorporated into the imperial forces. Although not much is known about the recruitment criterion, we anticipate that the recruits to this service were highly selected and therefore above average height. Recruits had to be able to ride a horse which implies some sort of wealth in terms of access to a horse and were mainly recruited from rural areas. We discuss concerns with selection later on.

Britain established the South African Constabulary (SAC) in September 1900 to help administer the two newly conquered territories of the Free State and the Transvaal (formerly the South African Republic) (Fourie et al., 2017). It remained in place until 1908. Although intended to be a peace-keeping police force, hostilities between the Boers and British would not cease for another 22 months, and the Constabulary became a pseudo-military regiment. 95 of the 8873 recruits would perish while recruited to the SAC. As with the CMP, recruits to the SAC needed to be able to ride a horse, again with the implication of some sort of wealth to allow access to a horse. Therefore these recruits are likely to have been taller than average.

A third source comes from the attestation forms of sixteen local forces that were raised at the start of the twentieth century all across the Cape Colony which we refer to as All Other Forces (AOF).² Unlike the two rural police forces, these forces operated mainly in the towns and were recruited from the towns with 70 % of the recruits coming from Cape Colony cities. Since these recruits were mainly urban we anticipate them to be shorter than average given the unsavoury conditions in urban areas globally at the time.

World War I and II recruits provide the final two data sources. We use a sample of more than 7 000 World War I and just over 11 000 World War II attestations from Inwood and Masakure (2013). The WWI attestation papers include all personnel whose surname begins with B. The WWII papers consist of a 4 % random selection of file boxes (Inwood and Masakure, 2013).

We remove all observations of individuals born outside the borders of the Transvaal, Orange Free State, Natal and Cape Colony, and remove the repeated entries of those that enlist more than once. We include only those who were recruited between 1890 and 1945, those individuals born between 1865 and 1920, those older than 20 years and younger than 50 when recruited. We have a final sample of 6 972 South African-born White recruits. We divide these into five cohorts

²These are the Bechuanaland Rifles (DD1.332), Cape Garrison Artillery (DD1.332), Cape Medical Corps, A Company (DD1.332), Cape Medical Corps, B Company (DD1.332), Cape Town Highlanders (DD1.332), D.E.O.V. Rifles (DD1.332), First City Volunteers (DD1.333), Kaffrarian Rifles (DD1.333), Kimberley Regiment (DD1.333), Oudtshoorn Volunteer Rifles (DD1.333), P.A.O. Cape Field Artillery (DD1.333), Prince Alfred Volunteer Guard (DD1.333), No. 5 Mounted Rifle Club Nqamakwe (DD1.334), Cape Peninsula Rifles (DD1.334), Royal Naval Volunteer Reserve (DD1.334), and the Uitenhage Volunteer Rifles (DD1.334).

of ten years each and a final cohort of six years for the tabular analysis and 10 cohorts of five years each with one of 6 years for the graphical analysis.

Table 1 provides a summary of the sample characteristics over 5 ten-year and one six-year birth cohorts by force of enlistment, region of birth, adult occupation, population density as given by the size of the town of birth and religion (religion for WWII only). The table provides the percentage of each variable coming from each category in that variable. For example, by looking at source share we see that in our first birth cohort the largest share of the sample comes from the World War I recruits, followed by the Cape Mounted Police. Over time the largest share of recruits shifts ever more to World War I until it is overtaken by the World War II share once recruits born from 1900 are enlisting.

The Eastern and Western Cape dominate in the early birth cohorts. However that dominance is eroded over time as the sample share shifts to reflect the White geographic population distribution by the time of WWII recruitment with the Transvaal taking over as the largest source of recruitment.

We classify occupations based on Armstrong's occupational social classification tables in [Armstrong \(1972, p. 215\)](#). We have five categories: middle class and professional which includes doctors, lawyers, accountants and engineers; farmers; skilled workers which includes all those working in a job requiring some education or in-house training; semi-skilled workers which are jobs requiring some but less training; and unskilled workers such as laborers. Over time there is a notable decrease in the share of agricultural workers enlisting, reflecting a relative decline in the importance of agricultural employment. There is a corresponding increase in the share of skilled workers enlisting in the forces, again reflecting the shift in the occupational share of the population (discussed below). We see small shifts in the other categories but the main shift is from agriculture to skilled work, where skilled work is of the artisanal sort.

With the information on town of birth we divide our sample into five population density groups: those from the rural areas; towns of up to 999 inhabitants, towns of between 1000 and 1999 inhabitants; towns of between 2000 and 9999 inhabitants and towns of 10 000 inhabitants or more. At the start of the period we see a fairly uniform distribution of recruits from all densities.

This distribution shifts to a dominance of both those born in rural areas and those born in large cities over the smaller towns. Most likely this reflects a shift of the population from smaller towns to larger cities as the country industrialised.

Finally we look at religion as a proxy for language group and hence what we might loosely classify as English and Afrikaans. Here we have only data from World War II. Much of the discussion focuses on Anglican (and Wesleyan) and Dutch Reformed believers as this is the main religious distinction between English and Afrikaans speakers. The first period for which we have religion data sees a dominance of the Dutch Reformed over the Anglican/Wesleyan reflecting the distribution within the population. Among the younger recruits, however, we see less enthusiasm for the war from Afrikaans speakers. The share of Dutch Reformed is a little over 30 %, compared to around 55 % in the population. In addition to the main English and Afrikaans religions we see an increase over time in the enlistment of emigrant groups and their offspring as the share of Catholic and Jewish recruits increases.

Selection to the armed forces

Military records have become staple data in the analysis of living standards through height (Margo and Steckel, 1983; Fogel and Lindert, 1986; Sandberg and Steckel, 1987; Komlos, 1987; Mandemakers and Van Zanden, 1993; Steckel and Haurin, 1994; Steckel, 1995; Mokyr and Ó Gráda, 1996; Komlos, 1998). They are often the only source of historical height data. There are, however, some caveats when using military data to represent the population. The first is that armed forces have historically enforced a height restriction and hence the armed forces tend to exhibit mean heights greater than the general population (of males usually). Second is concern about the economic conditions prevalent when an individual chooses to enter the armed forces. Bodenhorn et al. (2017) posit that when job opportunities in the economy are good, fewer and lower quality men enlist in the armed forces in cases where the armed forces pay wages lower than the market wage, and we get negative selection as in a Roy model Borjas (1987). When opportunities are conversely poor, better quality men are likely to enlist. The implication is that

the representativeness of volunteer enlistments may vary with labour market conditions. Third, as warfare technology has changed, the restrictions on height have declined as armies have relied less on cavalry and more on modern machine warfare ([Fourie et al., 2020](#)).

It is worth noting here that there are two sets of selection concerns: the first being whether the sample we have adequately represents the armed forces; the second is whether the armed forces adequately represent the population. To the extent that the sample we use is a random selection of all who enlisted, our WWI and WWII samples are representative of all recruits due to the random nature of the collection of the records. For the earlier three forces we have the entire population of enlistees.

While we argue that the sample we have certainly represents the White armed forces population we cannot make the claim that the armed forces population represents all Whites in South Africa. It is clear that the three early forces cannot represent the entire population due to the nature of their selection for the force. WWI, while being in all likelihood fairly representative of English-speaking males in South Africa, was most likely not representative of Afrikaans-speaking males, following only 12 years on from the Boer War ([Nasson, 1994](#)). Approximately 30% of the eligible White male population enlisted in World War I, coming predominantly from all classes of English society in South Africa ([Great Britain War Office, 1922](#), p.379, 756 [Nasson, 1994](#), [Nasson, 1997](#)). Enlistment in both WWI and WWII was voluntary as the government understood that Afrikaans-speakers would resist conscription. Nevertheless, the WWII enlistment was somewhat more representative with between 33 and 40% of the eligible White population enlisting in World War II, half of whom were Afrikaans-speakers ([Bureau of Census and Statistics South Africa, 1960](#); [Grundlingh, 1999](#); [Lambert, 2008](#)).

In table A.1 we compare the sample characteristics for WWI and WWII recruits from table 1 to the population characteristics from the relevant census years so that we are comparing men with similar birth years. To facilitate the comparison we average across several census years where data are available. The sample and census years are listed in the first row followed by the corresponding birth years in the second row. The census data is from [Bureau of Census and Statistics South Africa \(1960\)](#). We combine the sample region data into four provinces to

correspond to the census data.³

The table shows that in both the WWI and WWII samples the Cape is over-represented relative to the population with the Transvaal being underrepresented. Agricultural workers are underrepresented in the sample while skilled industrial workers are over-represented.⁴ Towns of between 1000 and 9999 dwellers are over-represented in the sample.⁵ Our sample underrepresents the Dutch Reformed as expected given the antipathy toward WWII among some Afrikaans-speakers. We use the population proportions from table A.1 to construct weights that we apply to our data in the regression analysis that follows.

Mean heights

Table 2 shows mean heights and their standard deviations by birth cohort. Overall we see a decrease in height from a high of 175.4 cm in the 1865-74 cohort until they reach their lowest of 173.7 cm for the 1895-1904 cohort, increasing thereafter to end at 174.9 cm for those born 1915-1920. This replicated in figure 2.

Across the cohorts, the two horse riding forces, the CMP and SAC, are tallest as we expect given the preference for soldiers to be able to ride and to possess their own horse (although we have few observations for the SAC in 1885-1894 and the CMP in 1895-1904). The AOF is shortest, a negative indictment on the quality of life in Cape urban areas given the Roy model assumption of negative selection most likely does not hold at this period in the Cape's economy. WWI recruits' heights appear to decline gently over time and once the WWII force reaches substantial numbers, heights increase ever so slightly for the last two cohorts.⁶

Looking now at regional origin, across the cohorts soldiers from the Western Cape are shortest.

³The census is only available at aggregate level, hence we adjust the sample to match the data published in the census.

⁴Occupation data is for 1921 only and 1904 in the absence of data for 1911 and 1918.

⁵Town size data is for 1936 and 1951 in the absence of data for 1946.

⁶Between the birth years of 1898 and the first few years of the 1900s our sample may indeed suffer from selection bias. Our WWI sample ends with the birth year of 1897, the WWII recruits we have between 1898 and 1905 are older than the average age at enlistment and there may well be some selection biasing heights in those years. The implication for our results is minimal since we consider the entire 55 year period.

Men from the more rural provinces are taller. Within those there is a decrease in height for enlistees from the OFS and Tvl born during the Boer War who are more likely than those in other regions to have experienced the scorched earth policy mentioned in section 2.

As expected, agricultural workers and the educated classes are tallest. The least educated professions of skilled, semi-skilled and unskilled workers are the shortest. While these mean heights are consistent with what we expect for occupation categories, ideally we would have the father's occupation as that is a clearer indication of family income at birth. We have only a person's own occupation and since the period we look at is a period of great volatility there is no reason to assume a man's occupation was the same as that of his father. Nevertheless, we may assume that most farmers are following in their father's footsteps and that professionals and middle class workers have had some exposure to wealth that allows them to undertake that career choice. For the industrial working classes, this is less clear. We can see in the data that there is substantial movement from the countryside into working class jobs.

Recruits from rural areas and small towns are taller than those from larger towns, consistent with our description of life in South Africa in section 2. Dutch Reformed are the tallest, consistent with these being majority Afrikaans-speakers living predominantly in the countryside. They are followed by the Anglicans and Wesleyans.

4 Regression analysis

The description of the data sources in the previous section is only able to offer a bivariate discussion as well as highlighting the presence of selection into the three earliest forces. The averages in table 2 therefore are subject to bias. We now turn to regression analysis in an attempt to mitigate that bias and to separate out height changes over time by characteristic while controlling for other correlates.

We run truncated regressions of height (at 160.02 cm as per [Cranfield and Inwood \(2007\)](#); [Inwood and Masakure \(2013\)](#)) on birth cohort, region, town size and occupation using weights derived from the population censuses. Table 3 presents results for the entire sample; the sample

with controls for armed force; for each of the forces individually; and for WWI and WWII combined. The reference birth cohort varies across the columns depending on the sample size in each cohort. Column one shows results from a regression of height on birth cohort, region of birth, occupation and size of town of birth without controlling for armed force with the reference category being the 1885-1894 cohort. The cohort coefficients replicate the raw data in figure 2 although more modestly, with men born 1895-1904 the shortest, and a height increase thereafter.

The regions coefficient replicates the mean heights in table 2. Recruits from the Western Cape, the omitted category, are shortest. Certainly, the other regions were all less urbanised than the Western Cape and had much more access to wild origin protein than those people in the longest settled areas.

The omitted occupational category is farmers and we find, as expected, farmers and middle class and professional workers are the tallest. These men are also the most likely to be following in their father's footsteps so that their occupation also likely gives an indication of conditions at their birth. Skilled, semi-skilled and unskilled workers are all shorter. Here there is likely more occupational mobility, with men in these jobs less likely to be doing the same work as their fathers (Cilliers and Fourie, 2018). In some cases men in these jobs will have relocated from the rural areas. Figure 3 plots the the predicted heights from regressions of height on occupation by whether the person was born in an urban or rural area and by type of occupation. The figure indeed shows that rural born farmers are tallest, the rural born working class (the people we earlier termed "poor Whites") are shorter and experiencing a drawn out decline in living standards that farmers are not experiencing, while the urban born working class are shortest.

We find strong evidence of an urban penalty; those living in cities of 10 000 or more inhabitants are approximately two centimetres shorter than those living in rural areas. There does not appear to be much penalty for those living in towns smaller than 10 000 inhabitants. This is because there are only few of these towns and they would have had a farming focus whereas the larger towns would have been the ones suffering from crowding and disease, leading to lower living standards.

In column 2 we control for the force a soldier enlisted in and the cohort result becomes weaker

as expected due to the selection on height in the two horse riding forces. We find all forces are shorter than the SAC and CMP. The results on region, occupation and town remain largely as in column 1.

When we split the sample into each attestation force we lose the large cohort effect on height that we see in the combined data whether due to selection or sample size. We recombine the WWI and WWII data in the final column (column 8) where we once again see the decrease in height as the nineteenth century ends, although this is not significant, and the increase in heights during the early 1900s. In all cases the urban penalty remains, the regional results remain where there are sufficient observations within a force and farmers and agricultural workers are tallest with a height penalty for those in the least skilled trades.

Robustness check: Further exploration of selection effects

Throughout this paper we have referred to the criticism from [Bodenhorn et al. \(2017\)](#) regarding the use of military attestation records to represent population living standards. WWI and WWII were exceptional periods in military history where enlistments reflected much more than alternative labor market conditions. We argue that our WWI and WWII data are not subject to the usual caveats regarding labor market conditions at time of enlistment due to the patriotic fervour among parts of the population as well as the high proportion of men who enlisted in both wars. To test this argument more explicitly we narrow our sample down to only those men who enlisted in 1915 and 1940 (the earliest and largest group of enlistees in each war). We argue that by looking at only one year from each conflict we have enlistees who were subject to the same economic conditions and that any differences in average height between birth cohorts is due to differences in living standards at birth and not economic conditions at enlistment.

Table 4 provides the results of weighted truncated regressions for WWI enlistees in 1915 (column 1) and WWII enlistees in 1940 (column 2). Although our sample is now precariously small, we find the same overall pattern of taller individuals earlier in the sample, declining heights till the turn of the century and increasing heights thereafter. The regional, occupational and

population density results remain largely as in table 3 although we do lose power. These results reinforce that the results found in table 3 are a valid representation of White living standards in South Africa between 1865 and 1920.

Correlates of stature over time

The full effect of the movement of people into urban areas and any other changes that took place following the development of the mining sector on living standards may well be hidden in the regressions. It is worth investigating in some detail the evolution of stature for different groups over time.

Figures 4-6 show the marginal effects from a truncated regression of height on birth cohort interacted with region of birth, town size at birth and occupation. Each graph shows the predicted value of cohort height for people with each particular characteristic. Figure 4 shows height over time across the six regions we use in this study.⁷ All six regions experience a declining trend in living standards from the 1860s until the turn of the twentieth century, although at different rates, and then a slow reversal of this decline.

The most physically well off at the start of the study are those in Natal, the Eastern Cape and the OFS. While the OFS experiences a brief increase in stature the other two are on a decreasing path. The OFS was predominantly rural at the start of the period of study with good quality soil, adequate rainfall and proximity to the diamond fields of Kimberley. Nevertheless, this region suffered, as elsewhere, the effects of drought, rinderpest and political uncertainty from the late 1880s until the Boer War, taking longer than elsewhere to begin its recovery. Simultaneously farmers here began to experience increased competition for produce from the Western Cape as the Cape Town railway link to Kimberley was completed.

This Western Cape/OFS competition is reflected in the Western Cape heights: a slow and

⁷There may be some concern that this graph does not depict changes to living standards but rather some selection in where people settle. This is only likely if the parents of the men with the most potential to be tall are relocating from, for example, the Western Cape to somewhere like the OFS or Transvaal and that those men who would have been tallest in the Western Cape turn out to be shortest in their new homes reducing both the mean heights in the Western Cape as well as in their new homes. This seems quite unlikely.

steady decline until 1884, a slight improvement and then decline heading to the turn of the century followed by an increase in the first two decades of the twentieth century as Cape Town and the Western Cape once again became important economic centres. Natal and the Eastern Cape exhibit a similar pattern while the Northern Cape is more volatile.

The other independent republic, the Transvaal, largely avoided the international downturn of the 1880s but then struggled to recover from the ravages of the concentration camps and scorched earth policies of the Boer War. While living standards did improve they took longer to recover than in the British ruled areas.⁸ By the 1910s White living standards in the Transvaal began to improve more rapidly.

Figure 5 shows that the working class (skilled, semi-skilled and unskilled) were shorter than those in farming although all experienced a height increase after the War. Recall that some of those in the industrial trades are more likely to have moved to towns in search of better alternatives to squatting or tenantry on the land. Their lower heights might rather reflect their poverty as tenants and land squatters rather than an urban penalty (see again figure 3).

Finally, we consider the urban penalty in figure 6. Those born in rural areas are consistently among the tallest. They are at times overtaken by those born in small towns and this may well reflect a data error where people report being born in the nearest town when they were born in rural areas. It is also feasible that small towns experience no physical quality of life penalty, having easy access to land and wild protein. From the beginning of the sample period there is a clear urban penalty: those in towns of 10 000 inhabitants or more are between 1 and 2 centimetres shorter than the next group. There is some reduction of this penalty by 1920 as incomes, access to food and public health provision improve in the inland urban areas. All town sizes suffer the decline in living standards we have seen from the 1880s until the Boer War and all see improvements in physical living standards after the War until the end of the sample.

⁸Van Onselen (1982, p. 117-118) notes that with the development of Johannesburg, locations close to the mines saw an increase in crowding and with that an increase in unsanitary living conditions.

Trends in cohort and composition of characteristics

While the evidence we've shown so far shows all groups experiencing similar height evolutions, we nevertheless consider the trends in stature by quantile as well as the effect of changes in sample composition on average heights. Figure 7 plots the cohort coefficients with confidence intervals relative to those born 1895-1899 by quantiles. The figure shows a general decline in heights at the end of the nineteenth century and then a small increase again. The additional detail from the quantiles suggests that there is some catch-up by the shortest men to the taller for the last three cohorts. The overall implication is that the trend of declining heights and therefore living standards until 1900 and then the recovery observed across all cohorts is the same across the height distribution, further supporting the evidence from figures 4-6 that the trend in heights was a national trend and not just limited to certain sectors of the settler community. In table 5 we conduct a basic demographic decomposition analysis to determine the role of the compositional change of the population in height changes over time (Eloundou-Enyegue et al., 2021). We rely on the following two equations to determine the effect of population composition versus the effect of actual height changes within groups on overall height changes:

$$\text{Composition change} = \frac{\sum_{i=1}^K \frac{\overline{height}_{it} + \overline{height}_{i(t-1)}}{2} * \left(\frac{N_{it}}{N_t} - \frac{N_{i(t-1)}}{N_{t-1}} \right)}{\overline{height}_t - \overline{height}_{t-1}}$$

$$\text{Actual change} = \frac{\sum_{i=1}^K \frac{\left(\frac{N_{it}}{N_t} + \frac{N_{i(t-1)}}{N_{t-1}} \right)}{2} * \left(\overline{height}_{it} - \overline{height}_{i(t-1)} \right)}{\overline{height}_t - \overline{height}_{t-1}}$$

where K is the number of categories within a characteristic, N is the total number of people in a given cohort, N_{it} is the number of people within a category of the characteristic within a cohort and t represents cohorts. The composition and actual change values sum to one so that each gives a percentage that it contributes to the total height change between cohorts.

The analysis shows that the change in heights, while reflecting some change in composition, is actually driven by changes in heights across all characteristics (the largest percentage of the

height changes is given by actual height changes). Particularly among the twentieth century birth cohorts, the change in composition often lowers heights from what they would have been if the population had remained static.

The decline due to composition is not enough to cancel out the overall increase in heights for the entire population over time. Certainly, after the end of the Boer War, living standards increased across the board in South Africa as the economy began to industrialise in response to the development of the gold mining industry.

5 International Comparison

White South African soldier living standards bracketing the turn of the twentieth century reflect what we have to come expect from the conclusions of the large literature analysing living standards across population density, occupations and geographic factors. A further interesting discussion is the comparison of South African heights with the international experience. Does South Africa's relative economic neglect reflect in its biological living standards? Here we focus our comparison on a set of British settler colonies who also participated in World Wars One and Two. The White populations of these colonies (and Britain) shared many demographic characteristics, similar patterns of military recruitment and they collected similar information on near identical personnel records.

The data we use are from [Cranfield and Inwood \(2015\)](#) for Australia (World War I), [Cranfield and Inwood \(2007\)](#) for Canada (World War I and II), [Bailey et al. \(2016\)](#) for England and [Inwood et al. \(2010\)](#) for New Zealand (World War I and II). As with the South African data, the Australian and Canadian World War I data is a sample of enlistees with surnames beginning with the letter B. The Canadian World War II data consist only of enlistees who died and whose surnames begin with B, F, M, or S. The English data contain a sample taken from file W0363 from the British Army Service Records. The New Zealand data come from the personnel records of New Zealanders serving in World Wars I and II. Records for survivors were obtained from Archives New Zealand, records for casualties were constructed from the Roll of Honour of New Zealand

men, the data consist of all usable records.

We run regressions of height on the same occupation categories as in the South African data, as well as city size, religion and language (in the case of the Canada WWII) where available. We then calculate the predicted heights for each occupation from those regressions. Figure 8 compares South African farmers to those in Australia, Canada and New Zealand for those birth cohorts for whom we have data. South Africans begin tall relative to the rest of the sample with heights decreasing during the difficult 1880s and 1890s. However South Africans remain taller than all other countries in the sample, with other countries experiencing a similar decline in the 1880s-90s. From the turn of the twentieth century South African rural heights begin to increase again as do those of the comparison countries. Figure 9 shows the heights for middle class/White collar workers. Once again, South Africans are on average the tallest, however some New Zealand and Canadian WWII birth cohorts are just as tall and sometimes taller, nevertheless toward the end of our sample period South African heights diverge rapidly from the group.

Finally, figure 10 provides a comparison of the heights of laborers. Once again the South Africans are tallest followed by New Zealanders. In particular, South African laborer heights increase during the period of industrialisation and as figure 3 shows, this is not all entirely due to the shift of the rural born into industrial occupations. Together, the three figures show that South African biological living standards were highest across this group of countries for a substantial period of time, a finding not expected given its economic circumstances. Although South Africa was poor as measured by per capita GDP initially (even for Whites), it did not reflect poorly on White living standards at a time when living standards would have been determined predominantly by nutrition and the disease environment.

A component of this White height advantage likely results from the exploitation of the Black population, something Britain and the other settler colonies in our comparison group were unable to do given the lower proportions of the indigenous populations in those colonies.⁹ The effect this exploitation had on White living standards is hard to quantify under current data constraints, however the easy access to large cheap Black labor supplies certainly contributed to high White

⁹80 % in South Africa, up to 20 % in the other colonies and non-existent in Britain.

biological living standards. Cheap farm labor could have absolved White males from hard physical labor. The biological living standard is one more measure of the inequality between Whites and Blacks induced by the redirection of resources away from Blacks ([Wilson, 2011](#); [Inwood and Masakure, 2013](#); [Mpeta et al., 2018](#)).

We know however that by the middle of the twentieth century White South African's height advantage relative to these other settler colonies had all but been erased ([Henneberg and Van den Berg, 1990](#)). We speculate that this may be due to the lag in the development of a public health sector in South Africa coupled with a decrease in the access to wild protein as the country side geared itself toward more commercial farming ([Salvatore, 2004b](#)). It may also be that economic growth rates in South Africa were not high enough to facilitate a rapid increase in White living standards despite preferential treatment for Whites all through this time.

6 Conclusions

In the absence of disaggregated income data this paper uses military attestation records to shed light on White living standards in South Africa between 1865 and 1920 ([Steckel, 1995](#); [Komlos, 1998](#)). Combining five sets of enlistment data spanning three military conflicts we find that living standards were high by 1865 but decreased unilaterally as the nineteenth century wore on. They began to increase again after the turn of the twentieth century. We find the usual urban penalty on height suggesting lower living standards in urban areas. We find farmers and the educated classes had the highest living standards with a substantial penalty for the lower skilled trades. Regionally, we find the more rural areas to have higher biological living standards even though their material forms of wealth may have been lower.

Our study takes into account selection concerns regarding the types of individuals who enlist in the armed forces ([Bodenhorn et al., 2017](#)). We note that WWI and II enlistments comprised over a third of the young adult male population, mitigating some selection concerns. Nevertheless, we weight our sample according to the population distribution given in the early twentieth century censuses.

Although South Africa was poorer in terms of aggregate GDP per capita than the other British colonies ([Magee et al., 2016b](#)), South African White men had among the highest living standards in the world at the time of our study. In comparison to other British colonial recruits, White South African men of all classes are taller than men in Australia, Canada and New Zealand, as well as England. We argue that South Africa's lack of economic development resulted in a large rural-based population which maintained a high nutritional standard, particularly regarding protein intake. When this protein intake is threatened we see a decline in living standards. We note that such high living standards may well have come at the expense of the Black population in South Africa for whom we unfortunately have no data that overlap with our time period. We hope that future work will be able to push back comparisons of White and Black standards of living earlier into the nineteenth century.

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Table 1 Sample characteristics in percent by year

	1865-1874	1875-1884	1885-1894	1895-1904	1905-1914	1915-1920
<i>Source share</i>						
AOF	12.08	14.93	5.54	0.00	0.00	0.00
CMP	31.21	23.31	1.90	0.00	0.00	0.00
SAC	6.04	7.46	0.00	0.00	0.00	0.00
WWI	50.67	54.29	86.35	23.33	0.00	0.00
WWII	0.00	0.00	6.21	76.67	100.00	100.00
<i>Region</i>						
W. Cape	26.17	31.90	24.01	23.44	19.66	19.52
E. Cape	44.30	39.57	31.30	25.89	20.45	16.69
N. Cape	8.72	9.30	8.41	6.33	6.57	7.39
Natal	4.70	4.60	8.98	6.44	8.09	9.72
OFS	7.05	4.81	8.77	11.00	9.19	8.22
Tvl	9.06	9.82	18.52	26.89	36.03	38.46
<i>Occupation class</i>						
Middle-class	2.68	2.25	2.72	2.22	3.47	3.07
Agriculture	31.21	24.64	19.96	16.56	12.23	9.22
Skilled	56.04	60.12	65.47	67.11	70.60	73.50
Semi-skilled	6.38	7.46	7.95	8.33	9.25	9.22
Unskilled	3.69	5.52	3.90	5.78	4.44	4.98
<i>Town size</i>						
Rural	18.46	17.48	22.52	28.56	30.43	30.90
<1000	12.42	12.37	10.01	5.56	3.83	3.99
1000-1999	15.44	13.80	13.75	16.44	14.18	11.30
2000-9999	25.17	19.33	15.39	12.00	10.16	11.13
>10000	28.52	37.01	38.33	37.44	41.39	42.69
<i>Religion</i>						
Anglican			21.49	28.84	28.79	27.41
Dutch Reformed			61.98	37.83	34.08	36.71
Wesleyan			4.96	13.91	13.51	13.62
Catholic			3.31	6.96	6.51	6.48
Jewish			0.83	1.59	3.35	3.07
Other			7.44	10.87	13.76	12.71
Observations	298	978	1949	900	1643	1204

Notes: All numbers are per cent. AOF is All Other Forces, CMP is Cape Mounted Police, SAC is South African Constabulary, WWI is World War One, WWII is World War II recruits.

Table 2 Mean height by birth cohort

Birth cohort	1865-1874	1875-1884	1885-1894	1895-1904	1905-1914	1915-1920
Total	175.36 (6.51)	174.50 (6.40)	174.06 (6.31)	173.67 (6.74)	174.55 (6.49)	174.91 (7.23)
<i>Force height</i>						
AOF	174.33 (6.02)	172.18 (5.64)	172.64 (5.85)			
CMP	175.79 (6.23)	176.19 (5.87)	178.25 (5.58)			
SAC	178.54 (6.15)	176.53 (7.14)				
WWI	174.97 (6.76)	174.13 (6.47)	174.01 (6.26)	173.20 (6.14)		
WWII			174.68 (6.97)	173.82 (6.91)	174.55 (6.49)	174.91 (7.23)
<i>Region height</i>						
W. Cape	173.55 (6.25)	173.39 (6.71)	173.10 (6.43)	172.26 (6.70)	173.34 (6.43)	174.64 (6.26)
E. Cape	176.43 (6.26)	174.56 (5.95)	174.09 (5.96)	174.28 (6.57)	174.74 (6.41)	174.92 (6.34)
N. Cape	175.58 (6.86)	175.22 (6.07)	173.41 (6.35)	174.01 (6.89)	175.31 (6.66)	175.67 (7.28)
Natal	177.26 (6.01)	174.58 (7.53)	173.59 (6.18)	175.18 (7.01)	175.65 (6.15)	176.19 (7.76)
OFS	175.02 (7.09)	176.88 (7.35)	175.54 (6.61)	174.48 (6.49)	175.51 (6.55)	174.10 (6.30)
Tvl	174.46 (7.14)	175.94 (5.84)	175.08 (6.38)	173.54 (6.77)	174.46 (6.53)	174.75 (8.03)

Notes: Standard deviation in parentheses. AOF is All other forces, CMP is Cape Mounted Police, SAC is South African Constabulary, WWI is World War I, WWII is World War II recruits. From 1900 all recruits are for WWII.

Table 2 cont. Mean height by birth cohort

Birth cohort	1865-1874	1875-1884	1885-1894	1895-1904	1905-1914	1915-1920
<i>Occupational class</i>						
Middle-class	177.16 (5.02)	175.84 (7.32)	176.24 (6.77)	173.83 (6.48)	176.02 (6.44)	175.98 (6.86)
Agriculture	176.02 (7.03)	176.75 (6.17)	175.09 (6.20)	176.08 (6.20)	176.56 (5.71)	175.94 (6.54)
Skilled	175.29 (6.29)	173.93 (6.36)	173.75 (6.18)	173.16 (6.77)	174.18 (6.50)	174.76 (7.45)
Semi-skilled	173.46 (6.12)	172.27 (5.90)	173.36 (6.46)	173.35 (6.03)	174.28 (6.38)	174.51 (6.10)
Unskilled	172.84 (6.38)	173.12 (5.56)	173.97 (7.48)	173.16 (7.61)	174.19 (7.69)	175.27 (7.35)
<i>Town size</i>						
Rural	176.22 (6.44)	176.82 (6.16)	174.98 (6.38)	174.65 (6.56)	176.00 (6.52)	175.58 (6.39)
<1000	177.47 (7.33)	174.61 (6.92)	174.01 (6.21)	175.46 (6.61)	175.02 (6.84)	175.63 (6.12)
1000-1999	175.63 (6.55)	174.57 (5.96)	175.44 (6.16)	174.50 (6.43)	174.39 (5.70)	176.14 (7.30)
2000-9999	175.52 (6.79)	175.34 (6.25)	174.19 (6.17)	174.11 (6.55)	174.42 (6.32)	175.12 (6.12)
>10000	173.60 (5.56)	172.90 (6.18)	172.98 (6.23)	172.16 (6.83)	173.52 (6.56)	173.98 (8.02)
<i>Religion</i>						
Anglican			174.19 (7.35)	173.26 (7.33)	174.24 (6.47)	174.73 (6.53)
Dutch Reformed			175.06 (7.11)	174.67 (6.49)	175.12 (6.44)	175.84 (6.57)
Wesleyan			174.52 (7.85)	173.78 (7.09)	174.44 (6.22)	174.35 (10.05)
Catholic			174.31 (2.82)	172.19 (7.44)	173.15 (6.44)	172.63 (6.16)
Jewish			165.10 (.)	167.64 (5.17)	173.15 (6.78)	170.44 (7.18)
Other			174.27 (6.08)	174.33 (6.17)	174.85 (6.79)	175.46 (6.74)

Notes: Standard deviation in parentheses. AOF is All other forces, CMP is Cape Mounted Police, SAC is South African Constabulary, WWI is World War One, WWII is World War II recruits. From 1900 all recruits are for WWII.

Table 3 Regressions of height on birth cohort by armed force, weighted by population distribution

	All	All	SAC	CMP	AOF	WW1	WW2	WW1&WW2
<i>Birth cohort</i>								
1865-1874	1.028*	0.510	1.324	0.654	2.348*	2.267**		1.229
	(2.34)	(1.10)	(0.71)	(0.70)	(2.14)	(3.03)		(1.79)
1875-1884	0.353	-0.121				1.629**		0.589
	(1.25)	(-0.40)				(2.77)		(1.17)
1885-1894				1.729	0.486	1.499**	0.445	0.525
				(1.46)	(0.62)	(2.79)	(0.65)	(1.27)
1895-1904	-0.0494	-0.784						
	(-0.13)	(-1.94)						
1905-1914	0.968*	-0.000622					0.726*	0.728*
	(2.38)	(-0.00)					(2.30)	(2.41)
1915-1920	1.551***	0.576					1.385***	1.342***
	(3.69)	(1.24)					(4.16)	(4.21)
<i>Region</i>								
E. Cape	0.707**	0.707**	-1.084	-1.431	2.060*	1.171**	0.760*	0.874***
	(2.96)	(2.96)	(-0.48)	(-1.83)	(2.25)	(3.07)	(2.10)	(3.33)
N. Cape	1.223***	1.140***	0.730	-0.440	0.177	1.133*	1.247*	1.265***
	(3.54)	(3.31)	(0.25)	(-0.42)	(0.13)	(2.00)	(2.47)	(3.34)
Natal	1.807***	1.792***	3.315	1.971	16.02**	1.466**	2.166***	1.828***

	(5.30)	(5.23)	(1.13)	(0.67)	(2.80)	(2.73)	(4.59)	(5.14)
OFS	1.175***	1.229***	6.776	-3.042		2.351***	0.557	1.266***
	(3.51)	(3.66)	(1.63)	(-0.72)		(4.47)	(1.23)	(3.66)
Tvl	1.215***	1.195***	3.845	3.264	0.288	2.296***	0.872**	1.293***
	(5.02)	(4.91)	(1.60)	(1.23)	(0.13)	(5.36)	(2.70)	(5.06)
<i>Occupation</i>								
Middle-class	0.213	0.244	3.116	-2.392	-1.543	0.917*	-0.0335	0.287
	(0.94)	(1.07)	(1.67)	(-0.90)	(-1.15)	(2.54)	(-0.11)	(1.22)
Skilled	-1.825***	-1.764***	2.917	-2.723**	-6.795**	-1.037*	-1.836***	-1.618***
	(-6.01)	(-5.82)	(1.17)	(-2.87)	(-2.76)	(-2.30)	(-3.88)	(-4.96)
Semi-skilled	-2.261***	-2.190***	-5.083	-2.589	-6.349*	-2.738***	-1.531*	-2.019***
	(-5.17)	(-5.02)	(-1.21)	(-1.61)	(-2.46)	(-3.79)	(-2.45)	(-4.32)
Unskilled	-1.010**	-0.941**	-4.298	-1.866	-2.922	-1.213*	-0.649	-0.872*
	(-3.21)	(-3.00)	(-1.11)	(-1.50)	(-1.86)	(-2.20)	(-1.48)	(-2.56)
<i>Townsize</i>								
<1000	-0.426	-0.417	-0.313	0.443	-1.098	-0.870*	0.0534	-0.546
	(-1.48)	(-1.45)	(-0.11)	(0.52)	(-0.45)	(-2.02)	(0.11)	(-1.74)
1000-1999	-0.401	-0.298	2.791	-1.157	0.577	-0.491	-14.17	-0.242
	(-1.29)	(-0.95)	(1.25)	(-1.18)	(0.29)	(-1.29)	(-1.15)	(-0.70)
2000-9999	-1.199*	-1.191*	9.845	-4.693	1.535	-1.984	-1.146	-1.054*
	(-2.34)	(-2.33)	(1.35)	(-1.84)	(0.33)	(-1.71)	(-1.85)	(-2.00)

>10000	-1.508*** (-9.71)	-1.398*** (-8.95)	0.263 (0.17)	-1.643* (-2.40)	-0.120 (-0.12)	-1.369*** (-5.49)	-1.614*** (-6.32)	-1.456*** (-8.76)
Attestation	-0.0252 (-1.72)	0.00605 (0.10)	0.141 (0.35)	0.0869 (0.91)	0.0678 (0.24)	0.322* (2.22)	-0.691*** (-5.28)	-0.249** (-2.60)
<i>Force</i>								
SAC		3.011** (2.95)						
CMP		2.212* (2.49)						
AOF		-0.375 (-0.61)						
WWII		0.311 (0.22)						6.334** (2.76)
Constant	175.6*** (424.28)	175.0*** (174.43)	172.2*** (49.09)	178.9*** (169.20)	175.2*** (82.51)	167.7*** (63.69)	202.9*** (38.24)	178.3*** (104.13)
sigma	6.476*** (101.04)	6.456*** (101.16)	6.350*** (12.36)	5.712*** (25.29)	5.546*** (20.63)	6.372*** (60.97)	6.526*** (73.36)	6.499*** (95.17)
Observations	6896	6896	91	358	289	2557	3601	6158

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Reference categories: Western Cape, agricultural workers, rural areas and WWI.

Cohort reference categories adjust depending on the cohorts present in each force: In columns 1 and 2 the reference cohort is 1885-1894, columns 3, 4 and 5, 1875-1884 and columns 6, 7 and 8, 1895-1904

Table 4 Robustness check, homogeneous labor market characteristics

	WWI	WWII
	Enlistment 1915	Enlistment 1940
<i>Birth cohort</i>		
1865-1874	2.814*	
	(2.08)	
1875-1884	-0.919	
	(-1.44)	
1885-1894		0.923
		(1.11)
1895-1904		
1905-1914		0.760*
		(2.02)
1915-1920		1.383***
		(3.41)
<i>Region</i>		
E. Cape	2.088**	0.381
	(2.98)	(0.87)
N. Cape	1.589	0.979
	(1.55)	(1.57)
Natal	1.796*	2.404***

	(2.03)	(4.32)
OFS	4.530*** (4.45)	0.656 (1.20)
Tvl	1.894* (2.25)	0.456 (1.15)
<i>Occupation</i>		
Middle-class	0.417 (0.61)	-0.110 (-0.29)
Skilled	-0.694 (-0.72)	-1.966*** (-3.49)
Semi-skilled	-2.973 (-1.96)	-1.726* (-2.29)
Unskilled	-1.974 (-1.47)	-0.331 (-0.60)
<i>Townsize</i>		
<1000	-0.354 (-0.39)	0.729 (1.20)
1000-1999	0.575 (0.72)	-8.928 (-0.60)
2000-9999	1.961 (0.82)	-0.508 (-0.67)

>10000	-0.236 (-0.48)	-1.529*** (-5.01)
Constant	172.1*** (181.97)	175.6*** (310.01)
sigma	6.262*** (31.72)	6.557*** (61.96)
Observations	719	2507

Reference categories: Western Cape, agricultural workers and rural areas.

Cohort reference categories in column 1 is 1885-1894, column 2 is 1895-1904

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5 Decomposition Results: Contributions of compositional change and actual height change to total observed height changes

Cohort	Region		Class		Town size		Height change
	Composition Change	Actual Change	Composition Change	Actual Change	Composition Change	Actual Change	
1875-1884	0.15	0.85	0.20	0.80	0.22	0.78	-0.860
1885-1894	-0.54	1.54	0.19	0.81	-0.07	1.07	-0.452
1895-1904	-0.12	1.12	0.22	0.78	-0.09	1.09	-0.368
1905-1914	-0.01	1.01	-0.11	1.11	-0.10	1.10	0.776
1915-1920	0.03	0.97	-0.12	1.12	-0.06	1.06	0.403

Notes: Composition refers to the percentage of the total change in height between two successive cohorts due to the change in the composition of that variable. Actual refers to the percentage of the total change in height due to actual changes of height within those categories. A positive coefficient means a positive contribution to a height increase, a negative means a negative contribution to a height increase and vice versa.

Figure 1: Map of regions



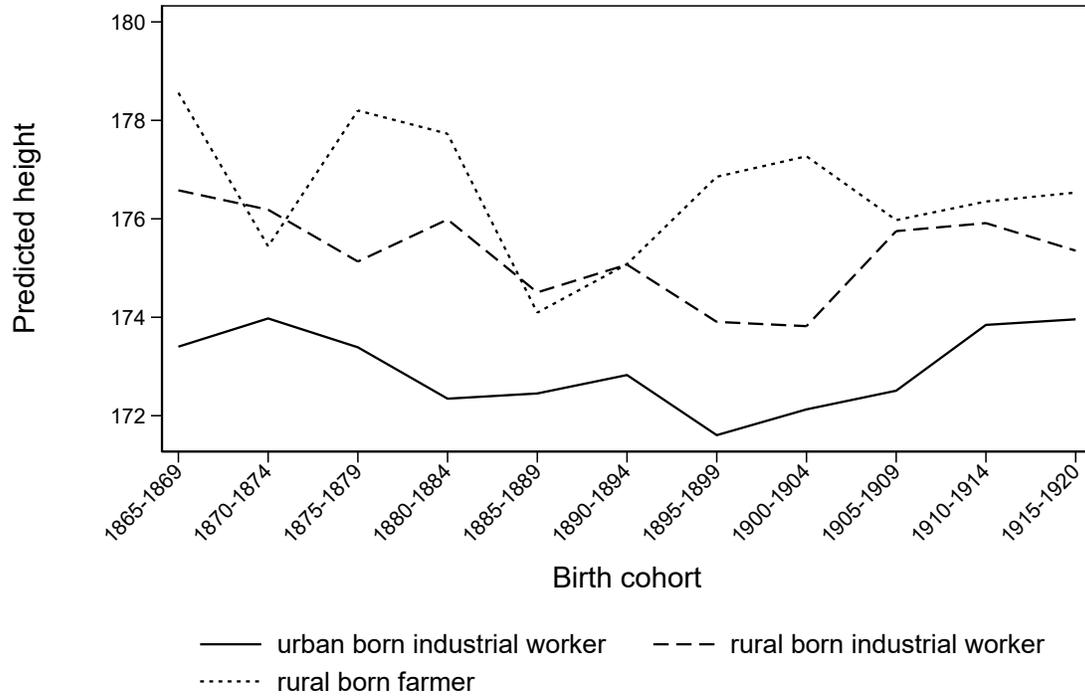
Source: [Frith \(2010\)](#), Transvaal boundary added by authors

Figure 2: Height by birth year



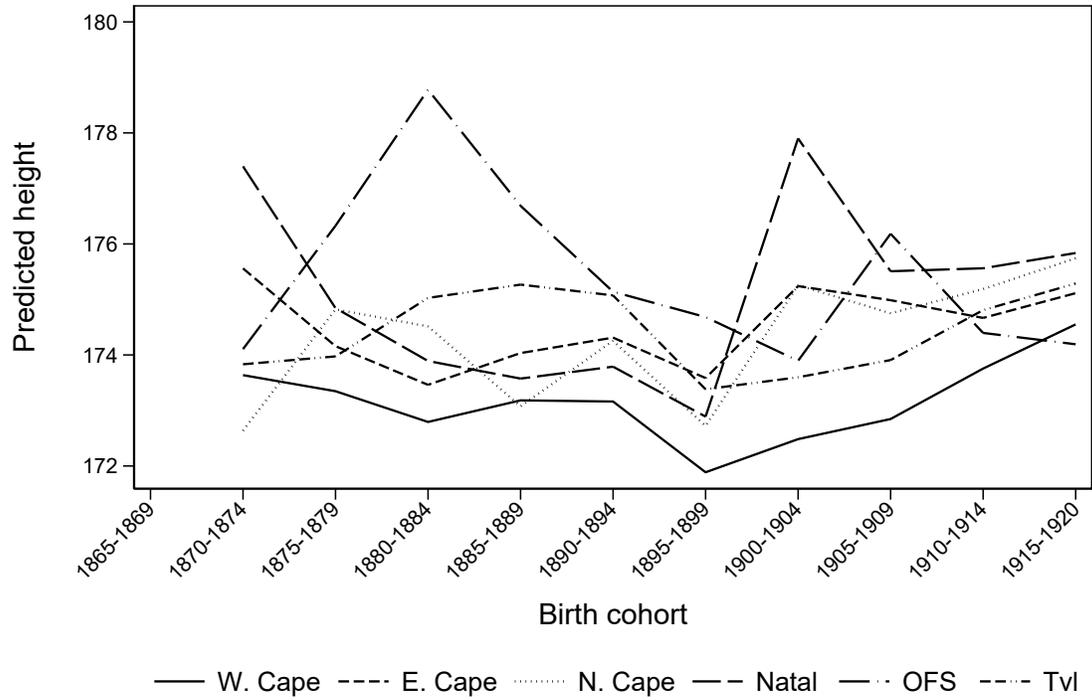
Notes: Data include all forces.

Figure 3: Mean height comparison of rural and urban born farmers and working class



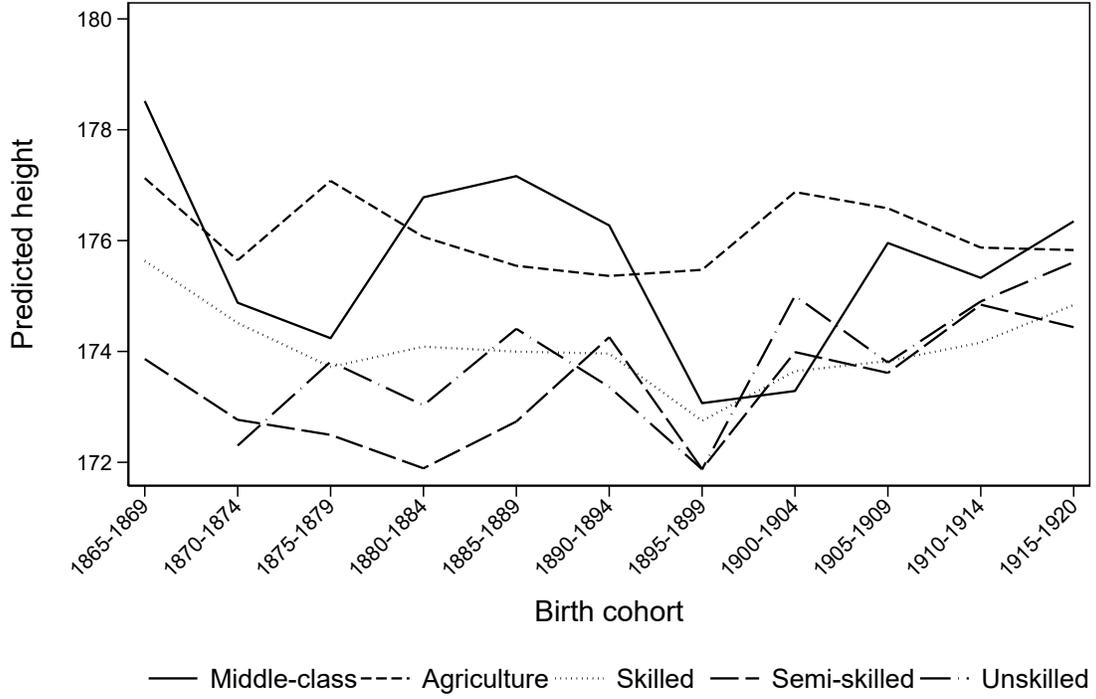
Notes: Coefficients are from 3 separate regressions controlling for armed force: farmers born in rural areas, working class born in rural areas, working class born in urban areas. There are a few observations of farmers born in urban areas, they are not included here, there is a lot of variation in their heights over time but generally they do experience the urban penalty.

Figure 4: Predicted height by birth cohort and region



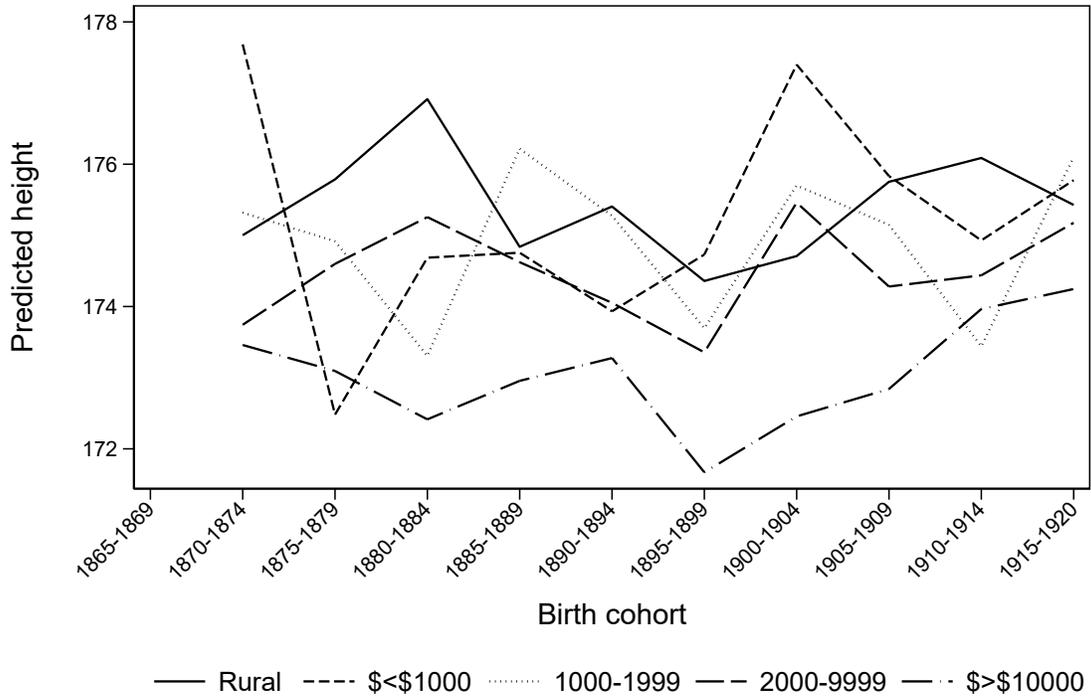
Notes: Data include all forces, 1865-1869 excluded due to too few observations.

Figure 5: Predicted height by birth cohort and occupation



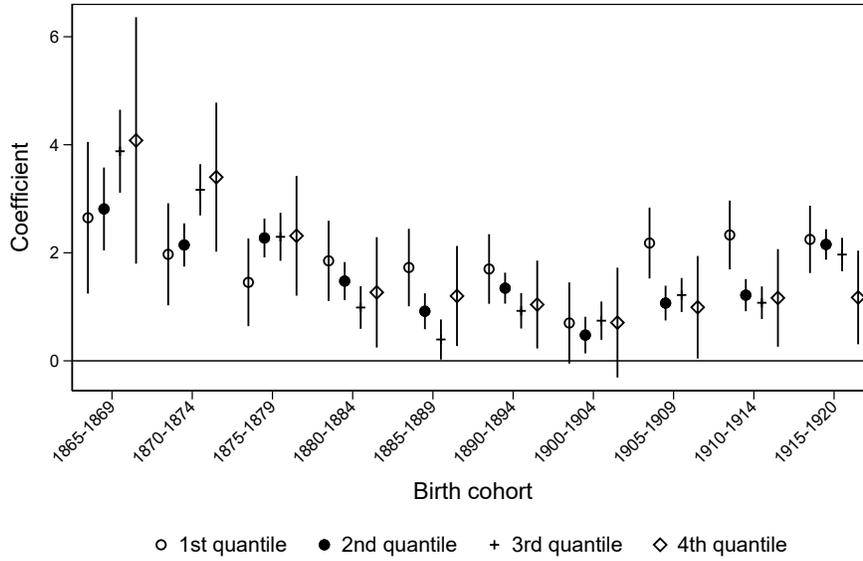
Notes: Data include all forces.

Figure 6: Predicted height by birth cohort and town size



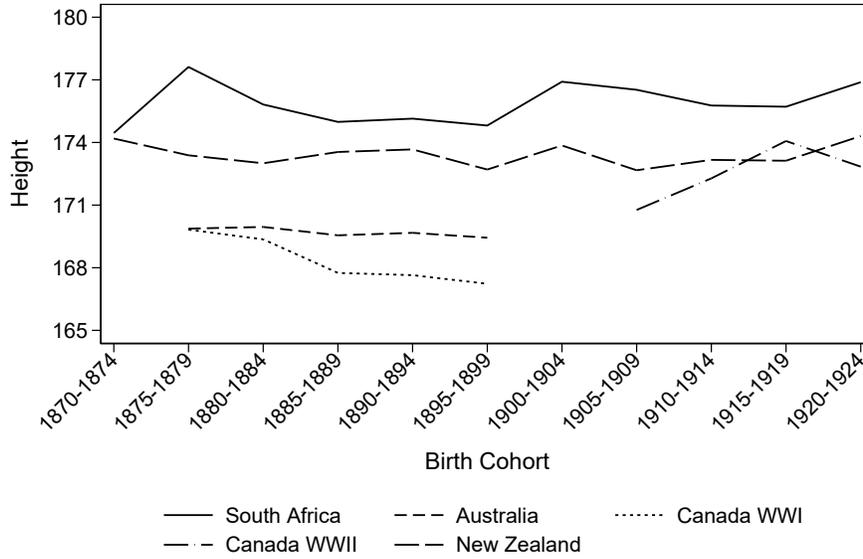
Notes: Data include all forces, 1865-1869 excluded due to too few observations.

Figure 7: Coefficients by cohort and quantile with confidence intervals



Coefficients of the cohort variable from a regression of height on cohort, region, occupation, town size and armed force by quantile. Reference cohort is 1893-1899. Interpretation of significance is within a quantile, eg. For those in the lowest 25 % of height, the 1865-1871 cohort is not significantly taller than the 1893-1899 cohort but the 1914-1920 cohort is.

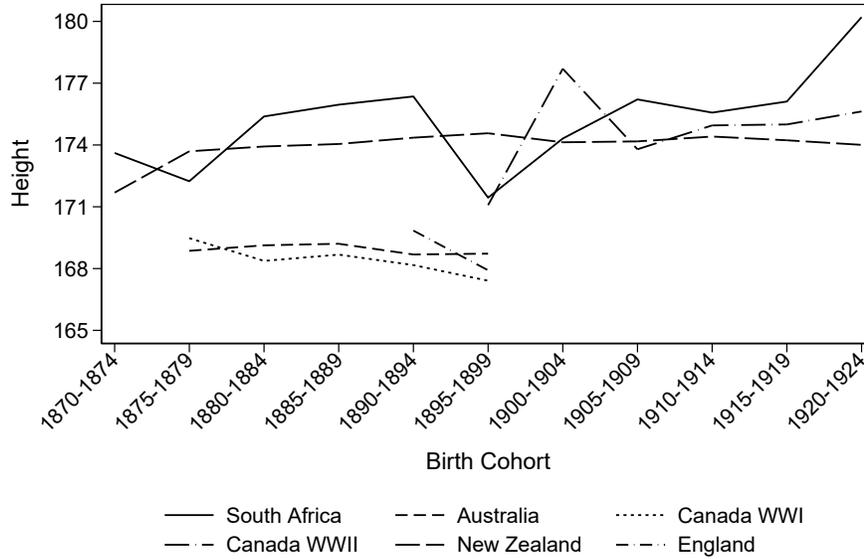
Figure 8: International comparison: Predicted farmer heights



Source: South Africa [Inwood and Masakure \(2013\)](#), Australia [Cranfield and Inwood \(2015\)](#), Canada [Cranfield and Inwood \(2007\)](#), New Zealand [Inwood et al. \(2010\)](#).

Heights are predicted values from regressions of height on birth cohort (all countries), occupation (all countries), religion (South Africa, Australia, Canada), city size (South Africa, Australia, Canada WWI) and language (Canada WWII). South Africa contains only Whites, New Zealand does not include Maori.

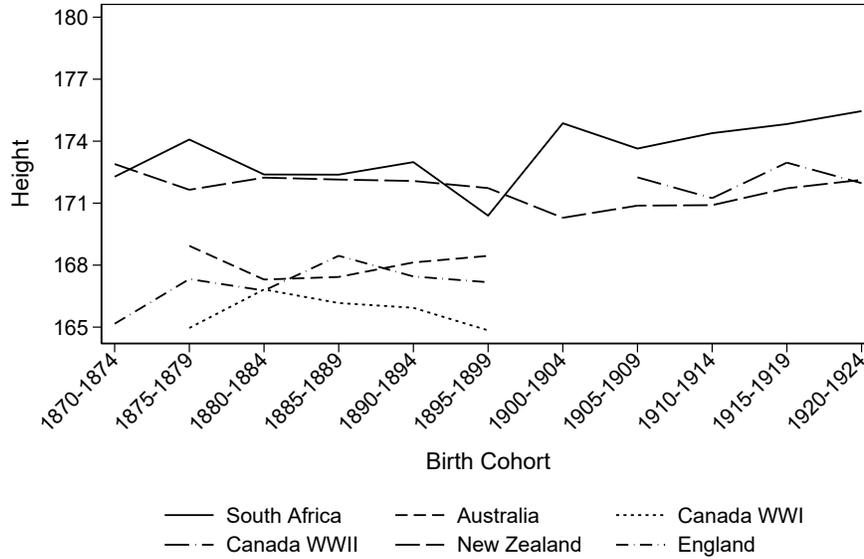
Figure 9: International comparison: Predicted middle class (White collar) heights



Source: South Africa [Inwood and Masakure \(2013\)](#), Australia [Cranfield and Inwood \(2015\)](#), Canada [Cranfield and Inwood \(2007\)](#), New Zealand [Inwood et al. \(2010\)](#).

Heights are predicted values from regressions of height on birth cohort (all countries), occupation (all countries), religion (South Africa, Australia, Canada), city size (South Africa, Australia, Canada WWI) and language (Canada WWII). South Africa contains only Whites, New Zealand does not include Maori. England sample divided only into White collar and not White collar.

Figure 10: International comparison: Predicted Labourer heights



Source: South Africa [Inwood and Masakure \(2013\)](#), Australia [Cranfield and Inwood \(2015\)](#), Canada [Cranfield and Inwood \(2007\)](#), New Zealand [Inwood et al. \(2010\)](#).

Heights are predicted values from regressions of height on birth cohort (all countries), occupation (all countries), religion (South Africa, Australia, Canada), city size (South Africa, Australia, Canada WWI) and language (Canada WWII). South Africa contains only Whites, New Zealand does not include Maori. England sample divided only into White collar and not White collar.

Table A1 Population and sample characteristics in percent by census year

Source:	WWI sample	Census 1911, 1918, 1921	Census 1904 [†]	WWII sample	Census 1936, 1946
Spans birth years:	1867-1896	1862-1901	1855-1884	1886-1920	1887-1926
<i>Province</i>					
Cape	63.61	42.91		47.62	37.63
Natal	8.93	8.43		8.17	9.59
Transvaal	18.21	35.60		34.77	43.51
Orange Free State	9.24	13.06		9.43	9.27
<i>Occupation[‡]</i>					
Middle and professional	2.8	4.45	10.40	3.14	7.17
Agricultural	21.67	36.48	35.85	12.49	26.22
Skilled	64.5	46.92	40.28	70.23	52.44
Semi skilled	7.38	6.29	8.73	9.05	7.21
Unskilled	3.65	5.85	4.74	5.08	6.96
<i>Town size*</i>					
Rural and < 1000	31.84	37.34		35.24	43.97
1000-1999	15.15	0.01		13.56	0.34
2000-9999	16.66	6.40		11.07	7.15
>=10000	36.35	56.24		40.13	48.77
<i>Religion</i>					
Anglican				28.1	16.51
Dutch Reformed				36.58	54.07
Methodist (Wesleyan)				13.34	7.35
Roman Catholic				6.48	4.79
Jewish				2.84	4.46
Other				12.66	12.83

Source: Census data is from *Union Statistics for 50 Years*, (Bureau of Census and Statistics South Africa, 1960). [‡] census comparison year for occupation data is 1921 only as data not available in other years. [†] 1904 included for the occupation comparison in the absence of 1911 and 1918, however 1904 available only for the Cape Province. * Town size population years are for 1936 and 1951 in the absence of data for 1946.