Height, Health and History: A Reassessment

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Abstract

This paper illustrates that there persisted a definite gap between the heights and living standards of lower and upper class Britons in the latter half of 19th century. Through observing scale data on aggregate nutritional status up to the age of 18, this paper is able to make strong inferences about living standards experienced by both poles of the social hierarchy. By analysing pooled cross-sectional data from 1865-1879, this paper finds that, despite some narrowing, there persisted a gap of around 2 inches between the mean heights of the British upper and lower classes.

I. Introduction

In 1990, Roderick Floud, Kenneth Wachter, and Annabel Gregory brought new life to the economic and anthropometric history of the British industrial revolution.¹ Their book, Height, Health and History, was a ‘pioneering project’ which saw the collection of data on over 100,000 British military recruits born between 1750 and 1880.² By utilising the recruits’ height data as a proxy for nutritional status, Floud, Wachter and Gregory were able to illustrate a ‘dramatic’ contrast between the heights and living standards of 14-year-old boys drawn from the upper and lower classes, from Sandhurst and the Marines Society respectively, from the mid-18th to mid-19th

centuries. This paper aims to extend the work done by Floud, Wachter and Gregory, by tracking the height differentials of 18-year-old recruits to both the Sandhurst Military Academy and the Royal Marines Society between 1865 and 1879. My research illustrates that, even at a later stage of economic development, whereby ‘catch-up-growth’ of the lower classes could be achieved, there persisted a difference in the mean heights of social groups: with those drawn from the higher social strata being nearly 2 inches taller at the end of my observed period. Nevertheless, despite there being a definite gap between recruits to Sandhurst and the Royal Marines in the 1860s and 70s, the gap across the period actually narrowed: the mean height of Marines rose whilst the mean height of Sandhurst recruits plateaued. These findings permit the inference that the nutritional status and living standards of the lower classes was improving both relatively and absolutely, when compared to their upper-class counterparts. This, I argue, is as a result of rising real GDP per capita, nutritional status and overall improved living standards for the lower classes, whilst the upper classes received relatively little marginal aggregate nutritional benefits from greater wealth.

The rest of this paper is organised as follows. Section II of this essay will outline the rationale behind using the aggregate nutritional status of recruits as a proxy for living standards. Section III will briefly illustrate the historiographical context surrounding living standards in the 19th century. Section IV shall provide a description and critique of both the data and the method of data collection employed in this study. Section V contains the overall interpretation of the data including a theoretical framework outlining causation. Concluding remarks are found in Section VI.

II. Living Standards and Height

In Economic History, the measurement and interpretation of living standards in a historical context has presented scholars with significant theoretical difficulties, leading to heated debates in the literature. Any historical comparison of relative living standards, whether based on monetary income, ‘nutritional status’, or more recently comparative HDI, has its respective drawbacks. Nevertheless, nutritional

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3 Floud, Watcher and Gregory illustrate an 18.35cm (6.83 inches) difference between 14-year-old officer cadets from at Sandhurst Military Academy: Floud, Wachter, and Gregory, "Height, Health and History," 225.

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status presents a method whereby most theoretical discrepancies can be mitigated against. Nutritional status, unlike nutrition, is a net measure which represents the energy used for growth once the demands of body maintenance, resistance to disease, leisure and work have been satisfied.\(^5\) Height is a cumulative measure of nutritional status from birth until the age at which terminal height is reached (around 18-20 in most modern economies).\(^6\) Nutritional deprivation, illness, exhaustion and even phycological factors can negatively influence an individual’s nutritional status, and, if sustained over a period of time, can cause an individual’s growth to be stunted.\(^7\) Sharpe notes that children who have experienced only a temporary decline in their nutritional status have the potential for significant catch-up growth if the child is adequately cared for; yet, if the effect on nutritional status is sufficiently severe or prolonged (or both), then the child would have to exert more calorific energy in order to adequately recover.\(^8\) Interestingly, Schneider’s research into the longitudinal catch-up growth of the children determined that there was ‘no substantial difference between the [potential] catch-up growth of either gender’.\(^9\) Additionally, Sharpe and Steckel both note that ethnicity and genetics do not influence average height across comparisons of averages for most populations.\(^10\) Hence, stature is a comprehensive and sufficient measure of living standards in the form of nutritional deprivation across both geographical location and time. Therefore, by interpreting the pooled cross-sectional height data of recruits from 1865-1879, one can illustrate the development of living standards throughout the period with some degree of confidence in the identified methodology.

III. Living Standards in the 19th Century

The historiography surrounding living standards in the 19th century is split between two contending groups: the optimists, who stress that, following the dawn


\(^6\) The age at which terminal height can deviate, with those who exposed to a greater workload and epidemiological stress reaching terminal height later in life (typically no later than 20, but could be as late as 22-23 in extreme cases): Cinnirella, "Optimists or Pessimists?" 326.

\(^7\) Floud, "Changing Body," 11-12.


of the Industrial Revolution, a broad rise in real wages contributed to a rise in both aggregate nutritional status and living standards of the lower classes; and contrastingly, the pessimists, who argue that industrialisation brought forth a deterioration in living standards resulting from the negative externalities arising from inequality and rapid urbanisation.\(^{11}\) Although it is not disputed that nominal wages were on the rise from the dawn of the Industrial Revolution,\(^{12}\) the methods utilised by optimists in order to calculate real living standards draw from estimates surrounding long run living costs and can thus be controversial and somewhat easily disputed (as noted above).\(^{13}\) More recently, scholarly opinion has tended to support the notion that nutritional inequality (income inequality leading to declines in average stature) can be traced from the mid-18\(^{\text{th}}\) century to around the mid-1860s (with only a brief recovery in the 1810s and 1820s), after which there was a reduction in nutritional inequality from the second half of the 19\(^{\text{th}}\) century.\(^{14}\) To this, the research I have conducted goes some way in confirming the contention that there was a convergence in living standards of the upper and lower classes in the latter half of the 19\(^{\text{th}}\) century, which was precipitated by a decline in nutritional inequality.

### IV. Data and Methodology

As noted above, Floud, Wachter and Gregory utilised height data of 14-year-old recruits from both Sandhurst and the Marine Society to test whether there existed height differentials between the classes of Britain in the mid-18\(^{\text{th}}\) to mid-19\(^{\text{th}}\) centuries. Concluding that there persisted a ‘dramatic’ contrast of around 20cm between the two identified classes, Floud, Wachter and Gregory then went on to draw further conclusions regarding the upbringing of said children, chiefly concerning the lower classes found in the Marine Society.\(^{15}\) However, by concentrating their efforts on confirming and identifying causality of height differences in 14-year-old recruits, Floud et al had failed to identify whether these differences persisted into maturity. This paper aims to account for the omissions made by Floud, Wachter and Gregory by measuring if class-based height differences persisted when said children had fully developed. By focusing on the development of individuals’ height into maturity, i.e. a point close to or near to final terminal height (18 years old), one can identify and


\(^{12}\) Cinnirella, "Optimists or Pessimists?" 326.

\(^{13}\) Floud, "Changing Body," 7.

\(^{14}\) See: Cinnirella, "Optimists or Pessimists?"; Horrell, Meredith, and Oxley, "Measuring Misery"; Sharpe, "Short Stature."

\(^{15}\) Floud, Wachter, and Gregory, "Height, Health and History," 196-97.
Height, Health, and Human History: A Reassessment account for catch up growth and thus avoid overlooking any potential for the relatively stunted children of the lower classes to ‘catch up’ with their taller upper class counterparts.\textsuperscript{16} At 18 years old individuals of both classes are likely to be more independent from their parents; furthermore, those individuals from the lower classes are likely to have been generating their own income. Thus, the distribution of nutritional income for lower-class men would have primarily benefited them. Therefore, if a lower-class individual’s income was sufficient, they theoretically could catch up with their upper-class counterparts. Hence, capturing an older subset of recruits can be seen as accounting for the real differences of individuals upon achievement of terminal height, which, in conjunction with an adequate theoretical framework, allows us to test nutritional deprivation and relative living standards.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{taking_measurements.png}
\caption{A ‘private gentlemen’ having his measurement taken at Sandhurst}
\label{fig:measurements}
\end{figure}


Given restrictions surrounding the documentation of height data in the 19\textsuperscript{th} century, military recruitment registers and army description books provide a cornucopia of information ranging from name, to occupation, to place of birth, and,

\footnote{The age of 18 was chosen given the availability of data for this age. What must be noted is that it is likely that some of the individuals who had experienced stunted growth could have continued to grow beyond this age. This unfortunately means that there persists some potential for a more detailed and precise analysis of height differentials at terminal height, but, due to the rarity of data for recruits above the age of 18 (preferably of men in their mid-20s) I was unable to capture this.}
importantly for this paper, recorded height. Utilising this pooled cross-sectional scale
data across an adequately long time period allows for a powerful illustration of height
differences between classes. Sandhurst was chosen given the respective makeup of
the recruits, which Floud describes as being drawn from families of ‘the aristocracy,
the professions, and the upper ranks of the military and navy’, hence being
adequately representative of the upper classes. Regrettably, due to the age
specification of individuals in the Marine Society not meeting the required level, as
recruits did not join the Marine Society after the age of 18, height data could not be
collected from the records of the Marine Society.\textsuperscript{17} Instead, troops from Royal
Marines were chosen as an acceptable substitute, given that the Marine Society was
a feeder school into the Marines and that the individuals were typically drawn from
the lower/working classes.\textsuperscript{18} The Royal Marines could even be said to provide a more
representative sample of the broader working class population of Britain given that
their recruitment was nationwide and thus the respective cohorts were not limited to
isolated regions.\textsuperscript{19} Regarding the data itself, there is the potential for sampling issues
for both institutions, specifically, an upper bound height bias due to height
restrictions in the army, as well as the propensity of individuals to wear shoes/boots
when being measured (see figure 1). Nevertheless, Zimran’s findings support the
notion that selection biases tend not to eliminate the main findings of a sample
population across a sufficient period, whilst the propensity for soldiers to either wear
or not wear footwear is likely to have been random; therefore, neither factor should
harm the credibility or representativeness of the data.\textsuperscript{20} Regarding the data’s broader
representativeness of the population as a whole; although being limited to just men
the inferences drawn should be at least representative of the existence of a relative
difference in height between classes for both sexes. However, what must be noted is
that research surrounding the long run wage gap between the genders and the
distribution of household nutritional income suggests that the women of the lower
classes could have potentially experienced a greater extent of nutritional deprivation

\textsuperscript{17} The Marine Society recruited boys aged between 8-16 from deprived areas of London and acted as
a ‘feeder school’ into Royal Marines.
\textsuperscript{18} Floud, Wachter, and Gregory, “Height, Health and History,” 225.
\textsuperscript{19} As with the Marine Society which limited its membership to boys drawn from ‘pitiful’ origins in the
slums of London: ibid.
\textsuperscript{20} See: Ariell Zimran, “Does Sample-Selection Bias Explain the Antebellum Puzzle? Evidence from
Height, Health, and Human History: A Reassessment over the course of both childhood and adult life.\textsuperscript{21} Hence, further research would be needed to allow for more clarity regarding the existence of an exacerbated difference in height differentials between women of different social classes.

In accordance with the central limit theorem, the mean heights of each institution could be extrapolated to reflect the best estimate of the respective populations. In order to gain an accurate picture of height differentials, a sufficient sample size would thus be needed in order to give credibility to any mean heights drawn from data. The aim was to collect 52 data values per year (1865-1879) per institution for a total of 1,300 data points.\textsuperscript{22} A systematic sampling technique was used for both sources. Although this is not as robust as random sampling, given the scarcity of the data for some years it was necessary to obtain a sufficient (or at least close to sufficient) sample size.\textsuperscript{23}

\textbf{V. Interpretation}

Across the observed period one can conclude that the average height of 18-year-old cadets at Sandhurst plateaued, while the average height of the


\textsuperscript{22} 1870, 1872 and 1873 having not been recorded for the Sandhurst registers due to a lack of data, whilst 1868 and 1879 having also not been recorded from the Royal Marines description books again due to a lack of sufficient data.

\textsuperscript{23} For the Sandhurst registers (RMC WO151), given the alphabetical ordering or the data, 2 values were taken per year per surname initial. The first value was to be taken from the first intake of the year, with the second taken from the final intake of the year. For years with only one intake or years in which sufficient values only appearing in one intake then said values were taken in turn. Given that some surnames did not have sufficient values for every year (or any in the case of V and Q) 223 entries remained unaccounted for (out of a required 624). Hence, supplementary values were taken from surname initials drawn at random using Excel’s randomise function. For the initials selected, every sufficient value (excluding those already taken) were extracted. This was repeated until the sufficient (or as close to sufficient) number was achieved. For the Royal Marines description books (ADM158) the chronological ordering of the Chatham data led to the systematic taking of every entry sufficient value. Each Portsmouth book was specific to a single surname initial hence the same systematic technique employed for the Sandhurst registers was used until the sufficient (or as close to sufficient) number of values was extracted.

Although some, such as Clark et al, would argue that the certain surnames could be attributed to social status hence undermining the reliability of the sampling technique; given the scarcity of sufficient data it was necessary to take all surname initials with indifference, as the surnames were randomly selected this should in turn be without bias towards any particular social group within each institution, and, therefore, not skew or harm the credibility of the data: Gregory Clark et al., """"The Son Also Rises : Surnames and the History of Social Mobility,"""" in \textit{Princeton Economic History of the Western World} (Princeton, New Jersey: Princeton University Press, 2014), 88-105.
lower/working classes in the Royal Marines rose both relatively and in absolute terms when compared to their upper-class counterparts (see figure 2 trendlines). Despite this, there persisted a gap between the two classes which narrowed towards the end of the period (see figure 2 trendlines); this indicates that although social nutritional inequality had improved, a marked difference persisted (see graph 1). In 1865 the average height of a Sandhurst cadet stood at around 174cm, a full 5.6cm above that of the average Royal Marine at 168.4cm. This difference, by 1875, had waned to a still sizeable 4.4cm, with the average height of a Sandhurst cadet falling by around half a centimetre to 173.5cm while the average height of a Royal Marine rose to 169.1cm. By 1878, the last year of comparable data, the difference had narrowed further, with the average height of a Sandhurst cadet being around 174.2cm whilst the average height of a Royal Marine had risen to 171.1cm - a difference of 3.1cm (see graph 1). Overall, the mean height of marines rose by about 1 cm while the heights of those at Sandhurst remained the same, the gap between the two narrowing by about 1cm. The standard deviations for the Sandhurst and Royal Marine recruits’ averages across the observed period at 5.9cm and 3.3cm respectively were quite narrow given the nature of the data (mean heights of individuals). Figure 3 illustrates the pooled cross sectional mean heights of recruits across the observed period. The error bars noted in figure 3 indicate the accuracy of the data to at least a 90% level, which provides sufficient confidence that the error bars represent the average population for the social strata nine times out of ten. When including the error bars into our analysis the difference between the mean heights still persists. Figure 2 represents a scatter chart of all the observed data points for both the Marines and Sandhurst recruits whilst also including a trendline illustrating the relative convergence of the two social classes. As indicated in figure 2, the trendline for Sandhurst recruits indicates a slight decline in average height, but nevertheless, the extent of the decline is not to be regarded as economically significant given its small value (0.0029 cm per year), and the likelihood that if the observed period was extended this value would become closer to 0 or indeed become positive. The trendline for the Royal Marines, by contrast, indicates an economically significant rise over the observed period (see figure 3). The Marines see an average yearly rise of around 0.064cm which could be regarded as both economically and historically significant. This finding indicates that the lower classes experienced relative gains in their nutritional status. Their living standards thus improved in this later stage of economic development, leading to convergence with their upper-class counterparts. If said gains were perpetuated beyond the observed period then one should see a complete convergence between the average heights of those in the upper and lower classes.
Figure 2: Scatter chart of Heights of Marines and Sandhurst Recruits (including trendline and trendline equation).

Source: RMC WO 151/2; ADM 158/15, 16, 125, 130, 157, 176, 183, 201.
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Figure 3: Pooled Cross Sectional Mean Heights for Marines Recruits and Sandhurst Cadets (including error bars).

Source: RMC WO 151/2; ADM 158/15, 16, 125, 130, 157, 176, 183, 201.
*Error bars indicate a 90 per cent confidence interval
## Table 1: Average Height of Recruits per year, including difference in mean heights (in cm and inches).

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean Marine Recruits</th>
<th>Standard Deviation</th>
<th>Mean Sandhurst Cadets</th>
<th>Standard Deviation</th>
<th>Difference in mean heights (cm)</th>
<th>In inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1865</td>
<td>168.43</td>
<td>4.58</td>
<td>174.00</td>
<td>6.93</td>
<td>5.56</td>
<td>2.17</td>
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<tr>
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<td>168.19</td>
<td>3.37</td>
<td>173.80</td>
<td>6.21</td>
<td>5.62</td>
<td>2.19</td>
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<tr>
<td>1867</td>
<td>168.51</td>
<td>3.48</td>
<td>173.02</td>
<td>6.45</td>
<td>4.52</td>
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<td>N/A</td>
<td>172.67</td>
<td>6.22</td>
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<td>N/A</td>
</tr>
<tr>
<td>1869</td>
<td>170.27</td>
<td>2.67</td>
<td>172.53</td>
<td>5.97</td>
<td>2.26</td>
<td>0.88</td>
</tr>
<tr>
<td>1870</td>
<td>169.85</td>
<td>2.71</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>1871</td>
<td>169.03</td>
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<tr>
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<td>167.66</td>
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<td>174.15</td>
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<td>2.53</td>
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<td>N/A</td>
<td>171.48</td>
<td>5.38</td>
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<td><strong>Average</strong></td>
<td><strong>169.04</strong></td>
<td><strong>3.29</strong></td>
<td><strong>173.45</strong></td>
<td><strong>5.93</strong></td>
<td><strong>4.71</strong></td>
<td><strong>1.84</strong></td>
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</table>

Source: RMC WO 151/2; ADM 158/15, 16, 125, 130, 157, 176, 183, 201.
Wallace

The convergence between the aggregate nutritional statuses of the lower class relative to that of the upper classes can be linked to rising overall living standards. From around the mid-1850s Britain was experiencing relative GDP growth of around 2% per annum. 24 This growth, judging by the comparative results between Sandhurst and the Marines, likely fed back into the lower strata of the population in the form of rises in real wages and living standards. 25 As a result, the children of lower class individuals likely saw a rise in real nutritional status across their childhood. A rise in the real wages of the poor may have resulted in a reduced reliance on supplementary income, which, in some instances, could involve hard labour for the children of working-class individuals, potentially contributing towards stunting and overall reduced stature. Moreover, rises in real wages could have seen a diversification and growth in food intake away from the ‘psychological minimum’ which would have likely contributed towards a greater intake of nutrients and vitamins essential to natural and catch up growth, allowing for a relative convergence. 26 Furthermore, as the children of the lower classes began to become independent wage earners (from around 14-18) they in turn would have individually benefited from the rise in real wages. Those who had experienced stunted growth as a child would have an enhanced ability to supplement their own nutritional intake and subsequently convert this into catch up growth. Across the lower-class population this rise in aggregate nutritional status can be linked with a real rise in relative living standards, which can be seen with the narrowing of height differentials between the upper and lower classes. Hence, through extrapolation from aggregate nutritional status we can infer a rise in real wages and general living standards of the lower classes in the latter half of the 19th century. By contrast, the children of the upper classes likely did not see any real benefit from any rise in their parents’ wealth given that it is assumed that their nutritional status would have been sufficient for natural growth throughout their development. Hence, any gains would have likely been individual and very marginal. This theoretical framework indicates a real rise in living standards for the lower classes and goes some way in explaining the relative convergence in stature between those of the lower working classes and their upper-class counterparts.

26 Ibid; Thompson, English Working Class, 314-16.
VI. Conclusion

To conclude, this paper has illustrated that, at a later stage of development, there persisted a definite gap between the heights and, by proxy, living standards of the lower and upper classes of Britain in the latter half of 19th century. Through observing scale data on aggregate nutritional status up to the age of 18 we are able to extrapolate our sample populations and make inferences about living standards experienced by both poles of the social hierarchy. Analysing pooled cross-sectional data from 1865-1879 allows us to conclude that there persisted a gap of around 2 inches between the mean heights of the upper classes and those the lower classes. Nevertheless, this paper has also gone some way in identifying a relative trend towards convergence between the two classes with the height differentials narrowing by around 1cm across the 15-year period. Consequently, one can infer that the relative rise in stature of the lower classes is representative of a real rise in living standards for the lower classes, which can be attributed to rising real wages and an enhanced nutritional status throughout the individual’s growth development. The relative stagnation of the upper classes’ height across the period can be attributed to the decreasing marginal benefit of greater wealth to the aggregate nutritional status of individuals from the upper social classes. In order to assess the validity of these claims, further research should focus on establishing causal links between the factors impacting the height of marines and their outcomes in terms of nutritional status. In 2015 the World Health Organisation found that globally there were 156 million children who have stunted growth; thus the real importance and necessity of historical research into nutritional status, nutritional inequality and ultimately living standards has never been greater.27 Future research is needed in order to develop adequate policies to combat the challenges arising from industrialisation, urbanisation and inequality, especially in the developing world.

Bibliography

A. Primary Source

Royal Military Collage, Sandhurst, registers:
- RMC WO 151/2

Royal Marines Chatham Division:
- ADM 158/
  - 15

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- 16

Royal Marines Portsmouth Division:
- ADM 158/
- 125
- 130
- 157
- 176
- 183
- 201

B. Secondary Sources


Height, Health, and Human History: A Reassessment


