Taller, Better, Faster, Stronger:

Anthropometric Living Standards of 19^{th} Century Canadians

By

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Abstract

Investigating historical living standards is akin to sewing a quilt from rare fabrics. Finding the material is difficult enough, but creating a unified picture requires careful deliberation and attentive care on the part of the researcher. Records of fiscal measures like real wages and GNP per capita, as well as biological indicators like infant mortality and life expectancy, are in short supply for periods preceding the 20th century. This paper, however, will investigate an alternative measure of historical living standards; anthropometrics and the study of stature. Stature will serve as a proxy measure of both fiscal and biological factors affecting worker welfare. The approach will be brought to bear on the Canadian experience, using data obtained from historical admission records for Kingston Penitentiary, and examined in both a time series and multivariate regression context. Statistically significant results among dummy variables will be sought in order to determine which attributes most affected heights, and subsequently, may help explain changes in 19th century living standards among Canada's working classes.

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1. Introduction

There is no uniform definition of living standards.[1] The factors that shape and change a man's well being over time are numerous, varied and do not affect all men equally. Consideration must be given to financial determinants, like GNP per capita or real wages, as these indicate a man's potential for consumption. Environmental factors like public sanitation, air quality and potable water must also be accounted for. Market forces, including food prices, rent and inflation can force workers to re-arrange their consumption bundles. Finally, biological changes in nutrition, the disease environment and energy expenditures are an integral part of determining how well a man lived. Deciding which of these factors should form an overall basket to describe living standards is not an easy task. Beyond finding the right mix of determinants however, lies a more difficult task; living standards are not easily measured. There is no defined scale, no uniform set of calculations and no standard against which living standards can be measured. As a result, competing claims exist as to how to assess historical living standards. Most promising among these choices is Anthropometric economic history and the study of stature.

Stature captures the effects of multiple welfare determinants instead of relying on examining single factors in isolation. Stature reflects the efficacy with which the body is able to process nutrients, meaning that examining the final attained heights of adult males can indicate if impediments existed between different segments of society. Changes in height can indicate if nutritional intake decreased for certain workers, or if living in urban

[1] Throughout this paper, the term 'living standards' refers to a worker's level of utility or welfare.

areas were more detrimental to a worker's health. Moreover, stature is cumulative, and represents changes to a worker's quality of life during formative growth years, right up to adulthood. Finally, adult heights follow a normal distribution, permitting a more precise examination of changes in living standards by examining heights based on deviations from the normal curve. Traditional fiscal measures have significant shortcomings, and rely heavily on estimated data and backcasted information. Studies of stature however, have a robust pool of data that was carefully assembled by a variety of institutions and governments from the 18th century onwards.

Prison records provide the least biased data pool for examining heights. While a variety of other data sources are available for anthropometric analysis, namely military recruitment records, these alternate records tend to suffer from statistical truncations because of minimum height requirements imposed by most western militaries. Prison records however, do no discriminate based on height. Kingston Penitentiary records serve as the data set for this investigation. They offer a significant amount of detail beyond height, which will be organized as a series of dummy variables for a multivariate OLS regression analysis. Birth cohort, complexion, occupation, birthplace, religion and trial county will all be examined in an effort to understand who among the Canadian population fared best throughout the 19th century, and who was at a relative disadvantage. Moreover, an overview of mean average heights, organized by birth cohort will serve to illustrate the overarching height trend for the Canadian working population during the 19th century. Together, these analyses reveal that the average Canadian worker saw a decline in their living standards, as proxied by their height, but that the disparities were not equally distributed amongst the population. In fact, occupation, birthplace, complexion, religion and trial country all proved to be statistically significant for at least one dummy variable in each category. The dummy groups and the intercept group will be examined, using evidence gleaned from previous anthropometric studies, to determine what attributes made them relatively more or less successful in attaining greater average heights. Canada was a growing as a nation throughout the 19th century, but the average height of the population seems to indicate that the benefits were slow to affect the average worker. Indeed, it appears that the growing pains of a maturing country were borne by its working men.

2. Literature

The measurement of historical living standards has undergone a significant shift since the initial application of anthropometric methods to economic history thirty years ago. The question of assessing living standards is an inherently difficult task, as the myriad of tangible and intangible factors affecting living standards complicates measurement by economic historians. Traditionally, GNP per capita and real wage data were used to measure living standards, because national accounting practices and records appeared to permit simpler measurements. These production-based measures of income were assumed to reflect worker well being by indicating a worker's potential access to material resources. However, subsequent investigations have revealed that these measures may not capture a broad enough spectrum of information to accurately indicate changing historical living standards. Biological factors like nutritional intake, worker energy expenditure, and differences in urban and rural lifestyles are not readily captured by financial data, but had a significant impact on worker living standards. As a result, this paper seeks to demonstrate that anthropometric measures are the most encompassing measure of worker utility. The following presents an overview of existing literature to this effect.

2.1 Traditional Measures of Living Standards

Anthropometric economic historians regard traditional fiscal measures of living standards as too narrowly defined to be the sole measure of worker well being. Prior to the rise of anthropometric economic history, GNP per capita traditionally served as the baseline measure of living standards. Originally conceived in the 1930s by Simon Kuznets, GNP was originally meant to be one part of a larger system of measuring worker welfare. Kuznets had proposed a series of refinements to the national accounting system to "incorporate nonmarket activities, occupational costs, leisure, costs of urban civilization and income inequality."[2] But the inclusion of this wider array of measures was never realized because of pressing practical considerations. As Richard Steckel noted, the urgency of the Great Depression necessitated a streamlining of GNP and so it was reduced to a more narrow approach based on market production.[3] In the absence of a more encompassing measure of worker welfare, GNP per capita came to be the standard measurement tool for assessing living standards. While increasing levels of GNP were meant to represent increasing income, and therefore access to shelter, food and medical care, the supposition that this reflects the total standard of living is flawed.

GNP fails to capture non-fiscal factors, which had significant impacts on worker well being. In the traditional approach to measuring living standards, it is assumed that

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[2] Steckel, "Stature and the Standard of Living," p. 1904.
[3] Steckel, "Strategic Ideas in the Rise of the New Anthropometric History and Their Implications for Interdisciplinary Research," p. 813.

material gains result in a higher quality of life for workers.[4] Material gains can only be derived from GNP insofar as those gains can be measured as part of national production. But economic historians largely agree that living standards are not limited solely to how much income a worker is able to bring home to his family. Significant factors like income equality, nutritional intake and lifespan present themselves as worthy of consideration. As much of the anthropometric literature notes, GNP is unable to capture such variables. Conclusions on the standard of living based solely on trends in GNP risk grave error if the workers' length of life [or overall health] deteriorated.[5] The misleading trend conclusions offered by GNP are best illustrated when examined in parallel with biological measures. Timothy Cuff noted that "final attained heights of Americans began to fall during the 1830s, and continued to diminish until late in the 19th century, even though during this same period, GNP rose continuously."[6] These divergent results indicate that while financial measures increased for 19th century American workers, their welfare suffered setbacks on a biological level, leaving no clear conclusion as to how to surmise living standards. As a result, the literature regarding historical living standards generally demonstrates that GNP measures in isolation tell only one part of the story. Further compounding the shortcomings of GNP per workers, is the nature of data collection in the period preceding the 1930s, when the national accounting methodology was first laid out.

[4] Horrell and Humphries, "Old Questions, New Data, and Alternative Perspectives: Families' Living Standards in the Industrial Revolution," p. 850.
[5] Lindert and Williamson , "English Workers' Living Standards During the Industrial Revolution: A New Look,", p. 20.
[6] Cuff, "Historical Anthropometrics – Theory, Method and the State of the Field," p. 2.

Historical GNP measures require large amounts of estimation and numerous assumptions to construct complete datasets. Until national accounting standards were developed, the necessary data were not specifically recorded or centrally collected by federal governments. Despite this, by the 1940s, economists began extending GNP methodology into past periods in an effort to develop a picture of historical living standards. To accomplish this, economists relied heavily on combining census data, market prices and other sources with methods of imputation and interpolation, and subsequently constructed data series of GNP for dozens of countries.[7] Beyond the use of approximations in place of strict GNP measures, these historical forecasts were further hobbled by data integrity problems arising from decentralized historical records. Prior to the 1930s, benchmark estimates from federal censuses were available for every ten years, but annual data were almost non-existent. As well, price data required to convert nominal measures to real terms were incomplete, further complicating historical estimates.[8] This demonstrates, again, that GNP per worker is inadequate as a sole measure of living standards. Instead, it is more instructive to view GNP as complementary to biological measures.

Fiscal measures serve as proxy measures of access to nutrition and material goods. Increases in height are connected to income through consumption; income acts as a determinant of food consumption, thereby inextricably linking GNP and biological indicators of the standard of living.[9] Ideally, the income of both a worker and the earnings

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[7] Steckel, "Stature and the Standard of Living," p. 1904

[8] Steckel, "Strategic Ideas in the Rise of the New Anthropometric History and Their Implications for Interdisciplinary Research," p. 813.

[9] Komlos, "The Secular Trend in the Biological Standard of Living in the United Kingdom, 1730-1860," p. 116.

of his father would be accounted for in a regression analysis. Because family income heavily influences purchases of basic necessities such as food and medical care, stature is ultimately a function of access to resources and the ways those resources are mediated through the family.[10] Fiscal measures then, are a part of the larger picture presented by final attained heights in determining changes in living standards. They play a supporting role as a determinant of final heights, much like measures representing public health or worker energy. Viewed in this light, fiscal measures cannot be used as the sole measure of living standards, as they offer more robust results when viewed as an input to final stature. Anthropometric history, because it encompasses a wider array of factors, including fiscal factors, therefore presents itself as the most suitable measurement methodology for assessing changes in welfare.

2.2 Anthropometric Measures of Living Standards

Anthropometric history proponents argue that final attained heights offer the broadest base of analysis for examining historical worker welfare. The approach acknowledges outright, the inherent multidimensionality of living standards. Furthermore, researchers assert that the several (causal) dimensions are orthogonal to one another, and in principle, they ought not to be collapsed into a single indicator.[11] An individual's height reflects the body's ability to utilize nutrients, the intensity of labour, the disease environment, as well as access to material goods.[12] The advantage of these indicators is that they are sensitive

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[10] Steckel, "Strategic Ideas in the Rise of the New Anthropometric History and Their Implications for Interdisciplinary Research," p. 813.
[11] Einaudi, "On the Significance of Anthropometric History," p. 99.
[12] Nicholas and Steckel, "Heights and Living Standards of English Workers During the Early Years of Industrialization," p. 940.

to externalities not captured by GNP alone, but which have a substantial impact on the living standards of workers.[13] Each of these inputs presents a useful metric for assessing historical living standards, but individually, they fail to provide a concise overview. The concept of measuring results in terms of height as a proxy for health, rather than using only the inputs to health has the advantage of incorporating the supply of inputs to health, as well as the demands on those inputs.[14] Thus, increasing final attained height trends over time are meant to suggest increases in nutritional efficiency, or improved public services, and an improved standard of living overall. Further to this, the use of heights offers a significant temporal advantage over the sole use of fiscal measures, as the height represents a cumulative reflection of health changes from adolescence to adulthood.

Nutrition during formative growth years has a significant impact on final attained height, and has shaped the way economic historians investigate living standards. Since the rise of anthropometric economic history in the 1980s, the focus of investigation has primarily been the final attained heights of males, based on birth cohorts. Organization by birth cohort is an acknowledgement on the part of researchers that inputs to final height are most susceptible to change during the early years of a man's life. Adult stature

> …reflects health conditions throughout the growth years and is a cumulative indicator of net nutrition over that portion of the life course. Thus, for populations with similar genetic growth potential, adult height is an indication of physical well being, comparable over time and between different social groups.[15]

Living standards in a worker's childhood have a significant impact on the standard of living that they will realize later in life. The aggregate nutritional, health and socio-

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[13] Crafts, "Some Dimensions of the 'Quality of Life' during the British Industrial Revolution." p. 619.
[14] Steckel, "Stature and Living Standards in the United States," p. 270.
[15] Cuff, "Historical Anthropometrics – Theory, Method and the State of the Field," p. 1.

economic status of a family, as well as the equality of distribution of food and wealth within the family structure would affect the ability of a worker to reach his full final height. At first glance, this kind of biological line of inquiry might be assumed to be a more recent historical development for anthropometrics. Interestingly, this school of thought, and the foundations of anthropometry in general have a long history, with their roots being traceable to the 17th century.

Two centuries of scrutiny and revision lends further credence to anthropometry being the best methodology to assess worker welfare. L.R. Villerme, a French doctor, undertook the oldest study that linked heights and living standards in 1829. His observations of French soldiers lead him to the conclusion that

> …human height becomes greater and growth takes place more rapidly, other things being equal, in proportion as the country is richer, comfort more general, houses, clothes and nourishment better and labour, fatigue and privation during infancy and youth less; in other words, the circumstances which accompany poverty delay the age at which complete stature is reached and stunt adult height.[16]

Later advances in understanding the effect of environmental factors on heights followed this first linking of living standards to final attained height. The rapid urbanization and industrial environment brought on by the first industrial revolution spurred anthropometric investigations into the conditions of poor children in working class areas of Britain. Concurrently, advances in germ theory, and the growing evidence of the preventative and curative properties of medicine, led investigators like Charles Roberts to develop frequency distributions of stature. Methodological refinements continued throughout the 19th century, and into the twentieth, most notably in the United States

[16] Floud, Wachter and Gregory, *Height, Health and History*, p. 2.

during the Great Depression in the form of Longitudinal Studies of Child Health by Harvard University researchers.[17] As a result, when the initial studies of anthropometric economic history began to emerge from authors like Robert Fogel, working with the National Bureau of Economic Research, these historians were not creating a field, so much as they were bringing an economic focus to an established vein of social science research. Anthropometrics therefore enjoys a rich pedigree as a discipline. A final important point though, is that while the methods of inquiry were carefully developed from the 17th century, anthropometry has also enjoyed the distinct advantage of having a large set of historical data that researchers can easily draw upon.

Anthropometric history has the advantage of having an abundant evidential basis of which only a small fraction has been analyzed until now.[18] The body of knowledge spans from records collected from the mid 1700s onwards, often as part of an identification or registration scheme for soldiers, students, slave cargoes, oath takers or travelers.[19] Figure 1 illustrates the various sources of data:

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[17] Steckel, "Stature and Living Standards in the United States," p. 273.
[18] Einaudi, "On the Significance of Anthropometric History," p. 99.
[19] Steckel, "Stature and Living Standards in the United States," p. 274.

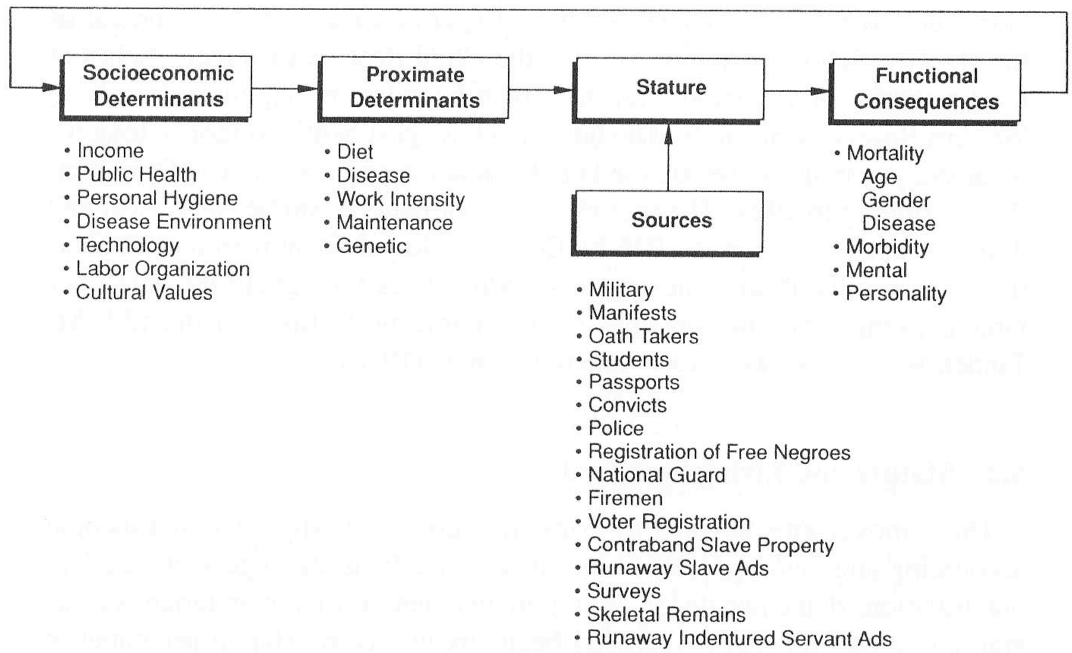

Figure 1: Sources of Historical Height Data

The original purpose of gathering this information was for identification. However, the consistency and rigor with which they were gathered by authorities presents current economic historians with an unintended benefit; an almost complete historical record that requires little estimation or reconstruction. In addition, the consistency of record keeping between North American and European nations allows for legitimate comparisons to be made between changes in living standards during distinct time periods. To date, most work has focused primarily on the economies of the United Kingdom and the United States, leaving comparatively little work done on other major western nations. This paper will subsequently focus on the application of anthropometric ideas and methods to the Canadian experience in the 19th century.

2.3 Trends in Canadian Heights: Results from Cranfield and Inwood

To date, only two significant studies have investigated historical living standards in Canada. The first, by Trevor Dick at the University of Lethbridge, examined birth cohorts of Northwest Mounted Police recruits from 1873 to 1900. While his investigation warrants some attention in understanding the Canadian experience, his data choice of police recruits presents a statistical challenge. NWMP recruits faced a minimum height requirement, which results in a truncated sample of heights that deviated from the established normal curve. This subject will be further touched on in this paper's methodology section. To understand historical changes in Canadian living standards, Dick's military records are superseded by another dataset. Jack Cranfield and Kris Inwood, in their paper "The Great Transformation: A Long-Run Perspective On Physical Well Being in Canada", used a collection of datasets from the 19th century to assess living standards in Canada. Among these are military records from South African War Enlistments and First World War Enlistments, but more interestingly, it includes a sizeable amount of data examining prisoner admissions to Kingston Penitentiary.

According to Cranfield and Inwood, the mean height by decadal cohort declined between the 1820s and 1870s, suggesting setbacks in welfare, as seen in Figure 2.[20] The benefit of prisoner data will be discussed in more detail in the methodology section of this paper, but briefly, the advantage of using prisoner data is that it does not suffer the truncation problems of military records.

[20] Cranfield and Inwood, "The Great Transformation: A Long-Run Perspective On Physical Well Being in Canada," p. 206.

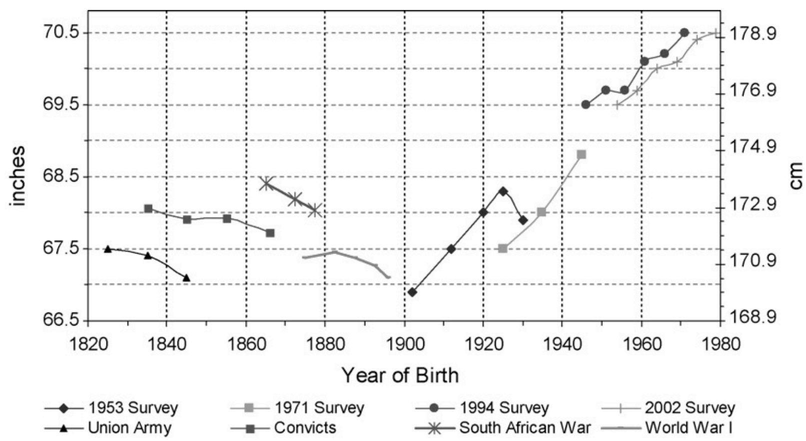

Figure 2: Results from Cranfield and Inwood

While prisoners witnessed a less pronounced drop than that seen by other groups later in the 19th century, it presents a quandary for economic historians. While it can be seen that living standards declined, there is little to indicate what caused such declines and if all demographic groups were equally affected. Therefore, the remainder of this paper will be devoted to investigating which groups among the working population enjoyed the greatest relative successes and disparities in comparison to their peers. As well, when those groups who suffered reductions in final heights are identified, this investigation will postulate possible causes that led to these changes in height, and by proxy, in welfare.

3. Data

The primary concern of anthropometric historians is one of sample bias. As noted previously, height records were routinely collected from the 18th century onwards, but only a few are large and centralized enough to make them viable datasets for investigating living standards. 19th century slave manifests serve as one of the richest records of heights, as height was crucial to slave pricing standards in the American south and elsewhere, but fail to be applicable to the scope of this paper. For the Canadian context, military records (conscription and recruitment) and penitentiary records are the most viable sources of height information. This paper, for reasons to be explained in the following section, has put aside military records in favor of penitentiary records.

3.1 Military Records – Truncation and QBE

Military records have traditionally served as a mainstay of anthropometric research. Given that they are among the most precise and complete of the possible data sources, they appear to be an ideal source of data for researchers. Looking more closely at military enlistment rules, however, reveals that soldier heights are likely to be systematically biased upwards. Outside of major conflicts, military organizations depended on volunteer enlistments, and usually imposed minimum height requirements.[21] The exclusion of men below the minimum height requirement in volunteer armies, presents a high possibility of height data being upwardly biased. Rather than follow the normal curve these heights are likely to be skewed or truncated below the minimum cutoff. The severity of the truncation would vary from country to country, based on the prevailing cutoff point. For example, Mokyr and Ó Gráda found little difficulty using East India Army data in their study of British and Irish recruits, because the minimum cutoff was only 60 inches.[22] But the problem remains; military minimum height requirements present a statistical challenge to sample unbiasedness. Interestingly, this problem, while pronounced, is not insurmountable for seasoned anthropometric historians.

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[21] Steckel, "Strategic Ideas in the Rise of the New Anthropometric History and Their Implications for Interdisciplinary Research," p. 809.
[22] Mokyr and Ó Gráda, "Heights of the British and the Irish c. 1800-1815: Evidence from Recruits to the East India Company's Army" p. 46.

Military heights deviating from the normal curve can be approximated to the normal using the Quantile Bend Estimate (QBE) technique. While this technique will not be pursued in this paper, it is worth noting as a significant part of anthropometric investigation on the whole. Originally outlined by Wachter and Floud, the QBE accounts for the absence of the missing heights by deflating the denominator of the ratio of sample points above a given level to total sample points. For height levels, however, the count of observations in the denominator is augmented, eventually reaching a denominator which straightens out the bend, provided the underlying distribution is a good approximation to the normal.[23] Previous work by Wachter and Trussel confirm that adult heights are remarkably close to a normal distribution, which makes the QBE a robust method for measuring final attained heights, even with minimum height requirements in place.[24] As a result, almost all major studies involving military heights have come to rely on QBE to reduce upward biases in height data, by up to an inch overall.[25] The QBE presents a serviceable workaround to the problem posed by military height truncations, but in essence solves a problem that need not be faced by researchers in the first place. Given that judges would sentence criminals regardless of their stature, penitentiary records offer a less biased data pool for anthropometric investigation.

Penitentiary records demonstrate fewer statistical problems than other data sets. The use of prison records is generally acknowledged to be a preferred option of anthropometric historians, as convict samples help to eliminate measurement biases

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[23] Floud, Wachter and Gregory, *Height, Health and History*, p. 119.
[24] Wachter and Trussel, "Estimating the Covariates of Historical Heights," p. 2.
[25] Dick's QBE revised estimates revealed a reduction in the mean average height of his subjects of up to an inch.

because their data are "broadly representative of the working classes."[26] Moreover, Kingston's position as the first and largest prison in Canada through the mid 19th century meant that prisons represent a broader geographic sample as well. Cranfield and Inwood's data indicate that a substantial number of their inmates were transfers from Dorchester Penitentiary in New Brunswick, Halifax Prison, St. Vincent De Paul Penitentiary in Laval, and New Westminster in British Columbia.[27] While this paper is not making the argument that army rosters would not be as geographically diverse as prison height records, this diversity helps to add a further robustness to how well the data can describe changing Canadian living standards. Taken together, the benefits afforded by the use of prison data are such that they will be the sole focus of this paper, and military records, while useful, will not be explored.

3.2 Data Cleaning and Dummy Variables

Cranfield and Inwood's Kingston Penitentiary data spans from 1875 to 1892, and is organized by admission dates. The rosters of information yielded data on 4,502 inmates, ranging in age from nine years old to 87 years old. Essential prison admission details, namely height, age, crime committed and year incarcerated make up half of the data found in the rosters. More interestingly, the other half of the data includes ancillary details about inmates, which when controlled for in OLS regressions, is expected to yield the most explanatory results regarding stature changes over the 19th century. Prison admissions officials noted each inmate's complexion, place of birth, religion, occupation,

[26] Nicholas and Steckel, "Heights and Living Standards of English Workers During the Early Years of Industrialization," p. 942.

and the county they were tried in. While these details were recorded to identify prisoners in the absence of photographs, they subsequently offer a wealth of information for modern econometric regressions. However, the raw data in its original form presented too much disorganized information to be able to draw sufficient conclusions. A number of adjustments and considerations were brought to bear on the data prior to its analysis, so as to provide more robust analyses and conclusions.

The OLS regression to be run on the data took the following form:

$$H = \beta_0 + \beta_1(Cohort) + \beta_2(Complexion) + \beta_3(Occupation) + \beta_4(Birthplace) + \beta_5(\mathrm{Re}\,ligion) + \beta_6(County)$$

Height serves as the dependant variable, and each of the independent variables listed in brackets above, represents a category of independent dummy variables. Each inmate was recorded as being in one of six decadal birth cohorts from the 1820s to the 1870s, as having one of four complexion types and as having one of six occupation types. In addition, each inmate was recorded as being born in one of seven regions, ascribing to one of four types of religions, and being tried for their crimes in one of three types of counties. Assigning dummy variables provided a more concise view of the regression results, and permitted more accurate comparisons to be made when examining the results of the multivariate regression.[28] Following the completion of coding, the full data set was reduced based on several important considerations. Foremost among these was to limit the age range of inmates. As Cranfield and Inwood noted in their study, males aged 18 to 20 are often still growing, and diminution of stature can begin as early as 50. As a result, all inmates under the age of 21 and over 49 were removed, subsequently reducing the number of examined records by 1,421 to a new total of 3,081. Further to this, 131

[28] Over two hundred unique occupations and trial county names were found among the data, and failing to assign these to dummy categories would have made any analysis unfeasible.

additional records were dropped, either because the inmates were women or had no listed occupations. This reduced the final record count to 2,950. Following these reductions, an initial regression was run in order to generate residuals, and determine potential outliers.

The initial regression run on the convict data revealed a small number of outliers. The regression results, to be reviewed in the next section, provided a basis from which to generate an interquartile range (IQR) for both residuals and heights. The results of the IQR indicated that outliers for both the residuals and heights existed, and accuracy could be improved by their removal. The results can be found in Table 1 and Table 2 below:

Interquartile Range (Residuals)

Statistic	Value(s)	
Mean	67.69	
Median	67.78	
Std. Dev.	0.5607	
N	2950	
IQR	0.943	
	Low	High
Inner Fences	65.81	69.58
#Mild Outliers	9	0
%Mild Outliers	0.31%	0.00%
Outer Fences	64.4	71
#Severe Outliers	0	0
%Severe Outliers	0.00%	0.00%

Table 1

Interquartile Range (Heights)

Statistic	Value(s)	
Mean	67.69	
Median	67.75	
Std. Dev.	2.471	
N	2950	
IQR	3.25	
	Low	High
Inner Fences	61.13	74.13
#Mild Outliers	24	9
%Mild Outliers	0.81%	0.31%
Outer Fences	56.25	79
#Severe Outliers	0	0
%Severe Outliers	0.00%	0.00%

Table 2

In total, 41 outliers were dropped based on this assessment, leading to a final record count of 2,909 inmates to be examined. A second IQR was generated for the residuals and heights after all preceding outliers were dropped, and indicated that no further records were required to be removed. With the final data set prepared, a second OLS regression was run, and revealed which groups among the Canadian working population fared best in relation to their peers during the course of the 19^{th} century.

4. Methodology and Results

Both time series and cross sectional analyses are integral parts of understanding changing historical living standards. Time series results are simplistic, but present a high level view of height trends across time, leading to broad initial conclusions about changing living standards between birth cohorts. The cross sectional analysis answers the question of who fared best, and who did not. Both of these examinations provide some insight into where which groups witnessed the sharpest relative declines in welfare over time, and in comparison to the intercept group. These results offer the potential for inferring causality in some cases, but by no means present definitive results to explain changing welfare.

4.1 Time Series – North American Birth Cohorts

Anthropometric economic historians primarily focus on time series trends for a variety of reasons. The primary motivation is one of simplicity; if Anthropometric data can be taken as a proxy indicator of living standards, then the time series view presents a snapshot of changes for a general population over time. Moreover, a time series approach allows for economic historians to begin investigating proximate causes for declining statures by overlaying height trends with significant historical events or legislation. Among notable examples in anthropometric economic history, the English Industrial Revolution and its socioeconomic effects, namely dismal working conditions, high incidences of disease in urban environments and rising produce costs, can be plainly seen in height trends analyzed by Paul Johnson, Nicholas Steckel and Stephen Nicholas.[29] As well, the use of time series analysis allows researchers to draw comparisons on national trends between nations of similar economic compositions to determine if isolated national factors are responsible. To this end, this paper will examine the time series of Canadian height changes, and compare them to a baseline measure derived from Robert Fogel's work on American heights of the same period.

The time series analysis indicates a marked decline in average heights between birth cohorts in the 1820s to those in the 1870s. Figure 3 demonstrates that mean final heights fell by approximately half an inch over a fifty year span, despite a brief recovery.

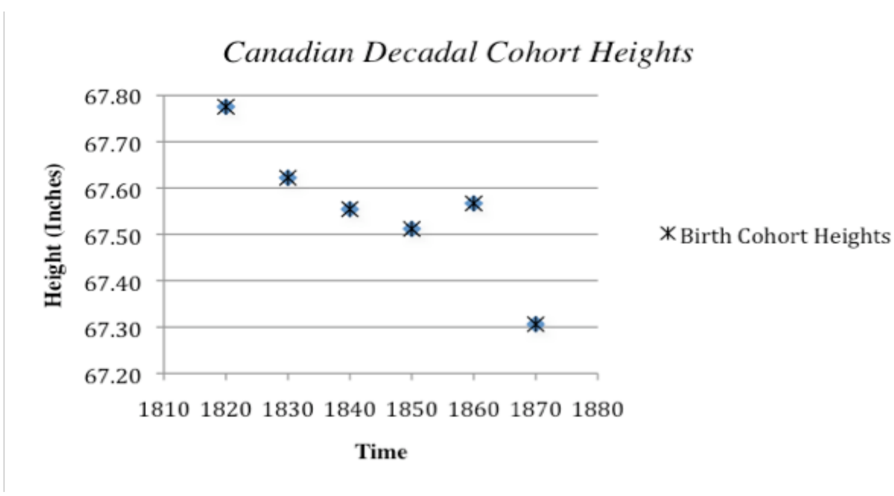

Figure 3

[29] The mean average height of male convicts fell from 65.83 inches in 1821 to a height of 64.63 inches in 1856. Found in Nicholas and Steckel, "Heights and Living Standards of English Workers During the Early Years of Industrialization," p. 942.

Given that heights are a proxy indicator of living standards, this indicates a decline in historical living standards over the course of the 19th century for Canadian workers.[30] This overview is a starting point for an investigation into historical living standards. An important secondary step is to determine if this is an isolated national decline, or if this change is representative of a wider economic trend between nations. Given that there is an extensive body of knowledge regarding the anthropometric history of the United States, it seems reasonable to use American data as a baseline comparison measure. Robert Fogel has done extensive work to trace mean final heights of American working class males from 1710 to 1930, and his results are largely consistent with those seen above. Figure 4 demonstrates that American heights declined approximately 1.5 inches by birth cohort, from 1820 to 1860, with a recovery between 1860 and 1870.[31]

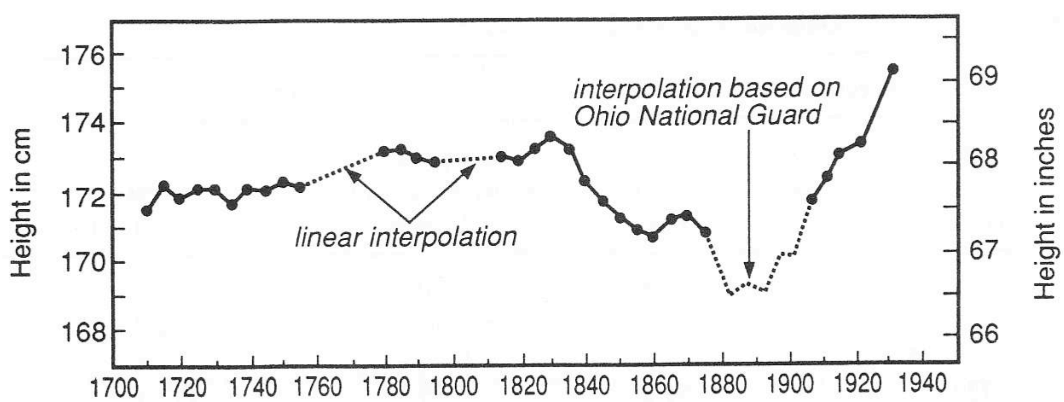

Figure 4: Results from Fogel

[30] It should be noted that the earlier decades of the century had fewer observations than those towards the middle and end of the century, and so are more susceptible to bias. It is possible that the decline was less pronounced, but the trend remains in place despite the reduced sample sizes for the 1820s and 1830s.
[31] Steckel, "Stature and Living Standards in the United States," p. 288.

The American data indicate that a continent-wide decline in heights was occurring, and was by no means limited to Canada. While the American data exhibits more volatility, possibly stemming from a larger population, more urban density and greater industrialization, the trends remain consistent with one another. With the Canadian data appearing to not be anomalistic, a deeper analysis is needed to determine who among the Canadian population fared comparatively better or worse than their fellow man.

4.2 OLS Regression Results – First Regression and Corrections

As previously stated, the OLS multivariate regression equation took the following form:

$$H = \beta_0 + \beta_1(Cohort) + \beta_2(Complexion) + \beta_3(Occupation) + \beta_4(Birthplace) + \beta_5(\mathrm{Re}\,ligion) + \beta_6(County)$$

The results of the first regression, run before any outliers were removed, are presented in Table 1 of the Appendix. The results for this initial regression are not as crucial as the subsequent diagnostics that arose from the results. Following this initial regression, an Information Matrix Test was run to test for heteroskedasticity between the errors. Given that the p-value in Table 3 was statistically significant at the 10% level the null assumption of homoskedasticity had to be rejected, suggesting the data needed further cleaning:

Cameron and Trivedi's Decomposition of IM-Test

Source	Chi2	df	p
Heteroskedasticity	284.70	219	0.0019
Skewness	27.18	24	0.2962
Kurtosis	9.93	1	0.0016
Total	321.00	244	0.0006

Table 3

In addition to these results, the residuals generated by the initial regression and the dependant Height variable were tested for normality using a Shapiro-Francia W test for each variable. The results in Table 4 and Table 5 revealed that neither was normally distributed:

Shapiro-Francia W' Test for Normal Data (Residuals)

Variable	Obs.	W'	V'	z	Prob>z
Residual	2950	0.96701	39.136	5.624	0.00001

Table 4

Shapiro-Francia W' Test for Normal Data (Height)

Variable	Obs.	W'	V'	z	Prob>z
Height	2950	0.99689	3.687	2.748	0.00299

Table 5

To address these non-normal distributions, two separate steps were taken. In the case of the residuals, robust standard errors were run in the second OLS regression. In the case of heights, the removal of the outliers restored normality to the distribution, based on the Shapiro-Francia W test results seen in Table 6:

Shapiro-Francia W' Test for Normal Data (Height)

Variable	Obs.	W'	V'	z	Prob>z
Height	2909	0.99901	1.178	0.408	0.34162

Table 6

With normality restored, outliers removed and the data in its final form, a second OLS regression was run, with no changes to the initial equation. The results, while not radically different from the initial findings, can be taken as being more robust, and having better predictive power in assessing changes in living standards.

4.3 OLS Regression Results – Second and Final Regression Results

The results of the second regression can be found in Table 2 of the Appendix. When compared to the results of the first regression, the only notable difference is that the 1870 birth cohort is not statistically significant in the second regression. Outside of this, the two present similar results. Each regression has an intercept that represents a white protestant farmer, who was born in Ontario the 1830s and tried in a rural county. This intercept result is consistent with Cranfield and Inwood's original study, as well as a similar anthropometric study undertaken by Kenneth Sokoloff in 1995. Sokoloff found his intercept value was representative of a farmer who was born and resided in a rural area of New England.[32] The results indicate that across all the dummy categories, at least one statistically significant coefficient emerged from the regression. More importantly, it demonstrates that the trends seen in the time series analysis were not even distributed amongst the Canadian population. Certain birth cohorts, complexions, occupations, regions, and religions appear to have been disproportionately affected. First among these is the dummy variable representing the 1860s birth cohort.

Those prisoners born in the 1860s witnessed the only statistically significant height decline of any birth cohort; they were 0.35 inches shorter than the intercept group. This result appears to be in line with the time series results, where heights declined almost 40% over the course of the decade. Pinpointing a cause of this decline is not

[32] Sokoloff, "The Heights of Americans in Three Centuries: Some Economic and Demographic Implications," p. 143.

entirely possible. Certain concurrent statistics help to narrow the range of possible causes however. First, the composition of the prison population in the 1860s gives some insight as to who was being primarily affected. Table 7 shows the changing composition of the prison population over the course of each cohort:

Prison Population Composition

	1820	1830	1840	1850	1860	1870
Ontario	20%	26%	40%	47%	58%	59%
Quebec	12%	15%	13%	16%	8%	4%
Maritimes	0%	2%	2%	3%	2%	3%
US	8%	13%	11%	13%	13%	17%
UK	48%	39%	30%	18%	16%	14%
Europe	12%	5%	3%	2%	3%	4%
Other	0%	0%	0%	0%	0%	0%
N	25	254	646	1151	697	136
Canadian	32%	43%	54%	66%	68%	65%
Migrant	68%	57%	46%	34%	32%	35%

Table 7

By the 1860s, the population was predominantly Canadian-born, and of that subgroup, most were from Ontario. In conjunction with the population composition, estimates of Canadian economic growth from the 1860s suggest that the Canadian economy was expanding throughout the 1850s, and to the end of the 1860s.[33] If economic gains were being made on aggregate for the nation, then it suggests that an alternate source caused the biological insult that resulted in reduced heights. A possible explanation may lie in the physical health of the mothers of these men. These would have faced a number of biological difficulties during their adolescence and pregnancies, possibly leaving their sons less able to attain a full final height in their lifetimes. The generation preceding the

[33] Estimates by Firestone indicate that GNP per capita grew from $68 in 1850, to $98 in 1860 and grew to $125 by 1870. Found in *The Economic Development of Canada* By Richard Pomfret, p. 63.

1860s was one characterized by large migrations from Europe, notably from Ireland to escape a series of famines. More importantly though, the preceding generation was one of epidemics, especially Typhus and Cholera. Cholera, for example, arrived in 1832 and epidemics in 1832, 1834, 1849, 1851, 1852 and 1854 killed 20,000 people in Upper Canada. Typhus also swept through much of Upper and Lower Canada in 1847. Overall, it is impossible to determine if these epidemics impacted the cumulative nutritional status of men born in the 1860s. However, they seem more likely to be responsible than any fiscal or immigration-based causes, given the prevailing population composition and economic growth estimates for the 1860s. This group is not the only one for which finding a possible explanation for decreasing heights is difficult though; the dark complexion group presents a mystery based on the recorded prisoner data.

Prisoners with dark complexions were 0.29 inches shorter than the intercept group. The prisoners that made up this dummy variable were defined as having dark, brown or 'swarthy' complexions, but not prisoners defined as having negro or octoroon complexions. Delineating between these two dummies is important because of the possibility of an upward bias presented by the negro/native dummy group. A majority of members of this group are listed as having negro complexions, and as having been born in the US. This suggests that a large portion of this group may be comprised of former slaves who made their way to Canada before and after the abolition of slavery.[34] Given that a slave's stature was seen as indicative of his labour productivity, slave height distributions were slightly skewed.[35] The relative difference between the dark group and

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[34] Of the 155 members of this group, only 128 were defined as negro, and of these 67 were from the United States.
[35] Komlos and Alecke, "The Economics of Slave Heights Reconsidered," p. 438.

the negro/native group coefficients indicate that the negro/native group fared slightly better, giving some credence to an upward bias in that group. Despite this separation, the vagueness of the naming conventions for the dark complexion group offers little to in the way of explanations or possible effects that contributed to the results in the regression. In contrast to this, the precise recording of occupations in inmate records affords some insights into the height reductions of a different group of prisoners.

The specificity of skilled worker data may give some insight into their height discrepancies. Skilled workers were 0.36 inches shorter than their counterparts in the intercept group. Occupations within this group included carpenters, moulders, tinsmiths and other labour intensive jobs, which may lend some explanation to the height differential, based on previous studies centered on these professions. Often, many of the factors coming together to affect skilled labourers heights can be attributed to effects stemming from living in urban environments. Economic historians often cite diseases, hygiene and the changing relative prices of food in cities as reducing urban worker welfare. Indeed, 559 of the 832 skilled labourers within the data set were tried in urban counties, suggesting the majority of these prisoners resided and worked in urban environments. Changes in the price of food and rent in cities would often prompt urban workers to rearrange their consumption bundles, often to the detriment of their biological well being. Cramped housing, and starchy foods were far more prevalent in urban environments than in rural ones. As a result, urban disamenities likely impacted the final heights of skilled workers. The height discrepancies for skilled workers, however, are small when compared to those seen between birthplaces.

Regional height differences are among the most pronounced of all the variables run in the OLS regression. Three birthplaces proved to be significant; Quebec, the United Kingdom and Europe. European and UK born male workers were 0.76 and 0.81 inches shorter than the intercept group respectively. These results are the less surprising of the regional height differences. Height trends in Europe had been on the decline since the closing of the 18th century. In 1770, British male convicts stood at 66.4 inches tall, and their height declined steadily through the early years of the industrial revolution, reaching 65.7 inches in 1815.[36] Heights continued to drop, from 65.83 inches in 1821 to a height of 64.63 inches in 1856.[37] British heights had been in decline for nearly eight decades, indicating that substantial impediments for British-born citizens existed to reaching a taller final height. This trend was also not isolated to the UK, as continental Europe had been witnessing the same types of declines. Heights among soldiers within the Habsburg Monarchy had been in decline since the mid 18th century, with soldiers' final average heights falling by nearly seven centimeters up to the mid 19th century.[38] These declining trends in Europe and the UK indicate that significant negative factors were impacting these immigrant populations, and had been for sometime. Therefore, a strong likelihood exists that Canadian workers born in either Europe or the UK between 1820 and 1870 as indicated in the Kingston data, started off at a disadvantage compared with their Ontario-born counterparts. However, their disadvantage was less than that of their Quebec-born contemporaries.

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[36] Nicholas and Steckel, "Heights and Living Standards of English Workers During the Early Years of Industrialization," p. 942.
[37] Johnson and Nicholas, "Male and Female Living Standards in England and Wales, 1812-1857: Evidence from Criminal Height Records," p. 477.
[38] Komlos, "Stature and Nutrition in the Habsburg Monarchy: The Standard of Living and Economic Development in the Eighteenth Century," page 1155

Quebec-born workers suffered the worst height truncations in Canada; they were approximately 0.82 inches shorter than their Ontario counterparts. Closely related to this, and warranting a pairing with the Quebec findings, is the finding that Roman Catholics were also shorter than the intercept group. Roman Catholics were found to be 0.32 inches shorter, but this result is better understood when the relationship between Quebec-born workers and Roman Catholicism, is kept in mind. 289 of the 372 Quebec-born inmates were Roman Catholic, indicating that their height changes may be more related to being born in Quebec, than to being Catholic. Inwood indicates in earlier works that Quebec height disparities arise from two distinct sources. The first is the population distribution and density that characterized the province. In rural areas, population density was unusually high, while the major urban centers of Montreal and Quebec City were known to have distinctly unhealthy environments.[39] This suggests that biological impediments, possibly related to public health or sanitation, or the disease environment stemming from housing in close proximity, might be at least partially responsible.

Inwood's second assertion is that income inequality may have played a significant role in restricting Quebec worker heights. If substantial inequality was persistent, income for the majority of the working class would have been insufficient to provide nutrition in order to attain the maximum mean height. Conversely, the additional income accruing to the rich would not increase the heights of these rich individuals, whose nutritional needs were already being met.[40] More formally, regressions of average height on the Gini coefficient suggest that that average height is particularly sensitive to the income

[39] Cranfield and Inwood, "The Great Transformation: A Long-Run Perspective On Physical Well Being in Canada," p. 209.
[40] Steckel, "Heights and Health in the United States," p. 165.

distribution; an increase of 0.1 in the Gini coefficient reduces average adult height more than three centimeters.[41] If this were the case throughout the majority of Quebec, then the average height would be more depressed, as suggested by Inwood. These results for Quebec, and for the preceding statistically significant dummy variables all indicate that the overarching height decline in Canada during the 19th century was borne disproportionately by certain demographics and regions of the country. These results, however, indicate that the differences in height, and by extension living standards, were relative, and not absolute. The intercept group represents those workers who saw their final average heights drop the least over time, and as a result, enjoyed the highest relative standard of living.

4.4 OLS Regression Results – Who succeeded in relative terms, and why?

White protestant farmers born in the 1830s in Ontario, and tried in a rural county had the greatest relative success in terms of height declines. Among these variables, the most explanatory was the occupation of farmer, and so for the purposes of this analysis, the effects on height are attributed more to occupation than to the other dummy variables that helped to make up the intercept. Farmers have traditionally demonstrated higher average final heights in anthropometric history investigations, and a significant body of evidence exists to this effect. Farmers were found to have significantly better nutritional intake than other professions, especially those living in urban areas. The primary reason for this was that farmers were generally sheltered from changing relative food prices. In many cases, Agricultural workers were paid in kind, using non-fiduciary compensation for their

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[41] Steckel, "Heights and Income Per Capita," p. 10.

labour.[42] The biggest advantage enjoyed by farmers, however, was geographic proximity to food sources. Urbanization resulted in a distinct nutritional disadvantage for those who lived in towns because they paid higher prices for fresh produce, meat and dairy products. Food prices for urban workers included farmer's prices, as well as transportation and retail costs for their delivery and distribution in urban centres.[43] The hardship imposed by increased prices was further augmented by the inability to transport meat and dairy products over long distances, and to acquire seasonal produce out of season, as refrigeration and preservation techniques were not economical until the 1870s.[44] These problems were far less severe for farmers.

Fresh produce and meat were readily accessible for farmers. Transportation costs and mark-ups were less than those faced by other workers, and preservation of meats and dairy were less necessary for farmers with local access to dairy and livestock. This allowed for more fresh produce and protein in a farmers diet, and increased caloric intake. Urban workers, by comparison, often substituted away from expensive fresh produce and meat, in favour of starchy vegetables, breads and processed food. The end result of a readjustment of their consumption basket was a decline in caloric intake, and therefore, a decline in mean final heights. This is the most compelling evidence to help explain the success of farmers during the 19th century. Assumptions can be made that, while the data indicate those tried in urban counties fared better, farmers would generally live in rural areas, thereby reducing instances of exposure to disease due to higher

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[42] Lindert and Williamson , "English Workers' Living Standards During the Industrial Revolution: A New Look,", p. 4.
[43] Komlos, "Shrinking in a Growing Economy? The Mystery of Physical Stature during the Industrial Revolution," p. 790.
[44] Ibid, p 790.

population density. But information on Canadian population densities are not readily available, and even Inwood noted that, in the case of Quebec for example, rural areas could sometimes exhibit higher population density than expected. Given the tenuousness of proving rural environments definitively influenced changes in height and living standards, it will be set aside. Instead, farmers succeeded where others did not, largely because they were better able to access protein and nutrients, and therefore enjoyed a better biological standard of living.

5. Conclusion

Canada in the 19^{th} century was undergoing monumental changes. Between 1830 and 1870, the nation grew from a disparate collection of colonies, to a strengthened confederation with further geographic ambitions. As politicians enjoyed significant victories for the Dominion, the population was, in a sense, on the decline. This was a decline, not in wages or material goods, because records and data for these indicators are difficult to obtain, but in welfare. To determine an overall picture of historical living standards, anthropometrics and stature present themselves as the most encompassing measurements of welfare. Final mean heights for men born between 1820 and 1870 declined by half of an inch over the course of the 19^{th} century, indicating that Canadian workers were suffering reductions in their standard of living. Prisoners from across the country, from all walks of life and representing a slew of occupations were part of this trend. However, all workers did not equally share the impact. OLS regressions reveal that white protestant farmers born in the 1830s in Ontario and tried in a rural county were the tallest, relative to others within the Kingston Penitentiary data. Their success, more than anything else, appears to have derived from their proximity to produce, meat and dairy, preventing the need to rearrange their consumption bundle. Others were not so lucky. Those prisoners born in the 1860s, with dark complexions, and unskilled workers could not hope to reach the same average final heights as white farmers. As well, those born in the UK and Europe suffered from the biological legacy of the industrial revolution. Substantial declines in height beginning in the late 18th century carried forward into the 19th, and manifested themselves in prisoners born overseas. Even for those born within Canada, regional differences were significant, especially for those prisons that were born in Quebec. Overall, the decline in heights could have been substantially worse, like those seen in the UK and continental Europe. The decline in Canadian living standards was comparably slight, but notable. Those workers, who were instrumental in building the foundations of modern economic growth in Canada, did not immediately realize the benefits of the growth that would propel the economy forward. Instead, they bore the brunt of the difficult work, nutritional and living conditions that would not change significantly until the end of the 19th century. Until that point, declining heights and living standards would go hand in hand, and Canada's growing pains would be borne by its workers.

Appendix: Multivariate Regression Results

RESULTS INCLUDING OUTLIERS

Variables	**Height in Inches**				
	Coefficient	**t-statistic**	**P > |t|**	***N***	**Avg. Height**
Independent Variables					
Intercept	**68.68752**	**290.67**	**0.000**	**-**	**-**
Dummy Variables					
Birth Cohort					
1830s*	-	-	-	256	67.83
1820s	0.1057378	0.22	0.829	27	67.90
1840s	-0.2912489	-1.63	0.104	660	67.62
1850s	-0.2522600	-1.48	0.139	1165	67.73
1860s	**-0.4114746**	**-2.22**	**0.027**	**706**	**67.61**
1870s	**-0.4650508**	**-1.75**	**0.080**	**136**	**67.74**
Complexion					
Light*	-	-	-	2084	67.75
Dark	**-0.2637322**	**-2.35**	**0.019**	**684**	**67.41**
Native/Negro	0.0036261	0.02	0.986	156	68.08
Other	-0.5525590	-1.11	0.267	26	67.63
Occupation					
Farmer*	-	-	-	188	68.12
Unskilled	-0.2281449	-1.20	0.230	1562	67.70
Skilled	**-0.4537799**	**-2.29**	**0.022**	**846**	**67.48**
Entrepreneur	0.0271343	0.09	0.932	86	68.00
Professional	-0.1217031	-0.49	0.621	210	67.79
Sailor	0.3477405	0.95	0.343	58	68.19
Birthplace					
Ontario*	-	-	-	1364	68.08
Quebec	**-0.9382915**	**-6.11**	**0.000**	**376**	**67.01**
Maritimes	0.2038502	0.67	0.505	72	68.24
United States	-0.1606081	-1.12	0.264	370	67.90
United Kingdom	**-0.9246028**	**-7.73**	**0.000**	**663**	**67.21**
Europe	**-1.024617**	**-3.98**	**0.000**	**98**	**66.96**
Other	-1.408971	-1.54	0.125	7	66.61
Religion					
Protestant*	-	-	-	1815	67.89
Catholic	**-0.2953358**	**-2.91**	**0.004**	**1071**	**67.40**
No Religion	-0.3128008	-0.81	0.418	41	67.37
Other Religion	**-1.657369**	**-3.22**	**0.001**	**23**	**66.02**
Trial County					
Rural*	-	-	-	1150	67.71
Urban	0.1907035	1.99	0.146	1703	67.69
Unknown	-0.1049384	-0.40	0.686	97	67.45

Table 1

Those statistics appearing in **bold** are statistically significant at the 10% level.

Those appearing with an asterisk represent dummies that were dropped, and are included in the intercept results.

RESULTS WITH OUTLIERS REMOVED

Variables	Height in Inches					
	Coefficient	**Robust Std Err.**	**t-statistic**	**P > |t|**	***N***	**Avg. Height**
Independent Variables						
Intercept	68.56452	0.2321172	304.74	**0.000**	**-**	**-**
Dummy Variables						
Birth Cohort						
1830s*	-	-	-	-	254	67.83
1820s	0.0322227	0.5126180	0.07	0.947	25	67.79
1840s	-0.2044423	0.1733332	-1.20	0.231	646	67.70
1850s	-0.1764562	0.1657870	-1.09	0.278	1151	67.79
1860s	**-0.3543897**	**0.1818057**	**-2.00**	**0.045**	**697**	**67.65**
1870s	-0.4076383	0.2642621	-1.61	0.107	136	67.74
Complexion						
Light*	-	-	-	-	2054	67.81
Dark	**-0.2874279**	**0.1078696**	**-2.68**	**0.007**	**675**	**67.44**
Native/Negro	-0.0671663	0.2062030	-0.34	0.734	155	68.03
Other	-0.3000717	0.4273529	-0.62	0.533	25	67.90
Occupation						
Farmer*	-	-	-	-	187	68.07
Unskilled	-0.1589503	0.1832777	-0.88	0.379	1544	67.74
Skilled	**-0.3553100**	**0.1894800**	**-1.89**	**0.059**	**832**	**67.55**
Entrepreneur	0.2310640	0.3044654	0.76	0.447	83	68.23
Professional	-0.1678740	0.2409724	-0.71	0.475	205	67.77
Sailor	0.3277403	0.3500035	0.94	0.347	58	68.19
Birthplace						
Ontario*	-	-	-	-	1352	68.06
Quebec	**-0.8187040**	**0.1394720**	**-5.59**	**0.000**	**372**	**67.10**
Maritimes	0.1739624	0.2979995	0.60	0.549	72	68.24
United States	-0.0986265	0.1345699	-0.72	0.471	368	67.94
United Kingdom	**-0.8135985**	**0.1182562**	**-7.12**	**0.000**	**649**	**67.31**
Europe	**-0.7649150**	**0.2594736**	**-3.02**	**0.003**	**89**	**67.33**
Other	-1.337297	0.7809088	-1.54	0.124	7	66.61
Religion						
Protestant*	-	-	-	-	1799	67.92
Catholic	**-0.3230493**	**0.0950294**	**-3.34**	**0.001**	**1057**	**67.44**
No Religion	-0.5430567	0.4397680	-1.46	0.143	40	67.19
Other Religion	-0.4085130	0.7685916	-0.64	0.523	13	67.56
Trial County						
Rural*	-	-	-	-	1133	67.75
Urban	0.1677283	0.0905223	1.84	0.166	1680	67.74
Unknown	-0.0892985	0.2385216	-0.36	0.718	96	67.53

Table 2

Those statistics appearing in **bold** are statistically significant at the 10% level.

Those appearing with an asterisk represent dummies that were dropped, and are included in the intercept results.

References

Crafts, N.F.R., "Some Dimensions of the 'Quality of Life' during the British Industrial Revolution." *The Economic History Review*, No. 4 (Nov. 1997): pp. 617-639.

Cranfield, Jack and Kris Inwood, "The Great Transformation: A Long-Run Perspective On Physical Well-Being in Canada," *Economics and Human Biology*, (2007): pp. 204-228.

Cuff, Timothy, "Historical Anthropometrics – Theory, Method and the State of the Field," in J. Komlos (Ed.), *The Biological Standard of Living on Three Continents*, San Francisco: Westview Press, 1995: pp. 1-18.

Dick, Trevor, "Heights, Nutrition, and Per Capita Income: Canada, 1870-1915," in J. Komlos (Ed.), *The Biological Standard of Living on Three Continents*, San Francisco: Westview Press, 1995: pp. 123-132.

Einaudi, Giulio, "On the Significance of Anthropometric History," in J. Komlos (Ed.), *The Biological Standard of Living in Europe and America*, London: Variorum, 1995: pp. 97-109.

Floud, R., K. Wachter, and A.S. Gregory, *Height, Health and History: Nutritional Status in the United Kingdom,* Cambridge: Cambridge University Press, 1990.

Horrell, Sara and Jane Humphries, "Old Questions, New Data, and Alternative Perspectives: Families' Living Standards in the Industrial Revolution." *The Journal of Economic History*, No. 4 (Dec., 1992): pp. 849-880.

Johnson, Paul and Stephen Nicholas, "Male and Female Living Standards in England and Wales, 1812 – 1857: Evidence from Criminal Height Records." *The Economic History Review*, No. 3 (Aug., 1995): pp. 470 – 481.

Komlos, John, "The Secular Trend in the Biological Standard of Living in the United Kingdom, 1730 – 1860." *The Economic History Review*, No. 1 (Feb., 1993): pp. 115-144.

Komlos, John, "Shrinking in a Growing Economy? The Mystery of Physical Stature during the Industrial Revolution." *The Journal of Economic History*, No.3 (Sept., 1998): pp. 779 – 802.

Komlos, John, "Stature and Nutrition in the Habsburg Monarchy: The Standard of Living and Economic Development in the Eighteenth Century," in J. Komlos (Ed.), *The Biological Standard of Living on Three Continents*, San Francisco: Westview Press, 1995: pp. 1149-1161.

Komlos, John and Bjorn Alecke, "The Economics of Slave Heights Reconsidered." *Journal of Interdisciplinary History,* (No. 3, Winter 1996): pp. 437-457.

Lindhert, Peter and Jeffrey Williamson, "English Workers' Living Standards During the Industrial Revolution: A New Look." *The Economic History Review*, No. 1 (Feb., 1983): pp. 1-25.

Mokyr, Joel and Cormac Ó Gráda, "Heights of the British and the Irish c. 1800-1815: Evidence from Recruits to the East India Company's Army," in J. Komlos (Ed.), *Stature, Living Standards and Economic Development*, Chicago: The University of Chicago Press, 1992: pp. 39-59.

Nicholas, Stephen and Richard Steckel, "Heights and Living Standards of English Workers During the Early Years of Industrialization," *The Journal of Economic History*, No. 4 (Dec., 1991): pp. 937-957.

Pomfret, Richard. *The Economic Development of Canada*, Toronto: Methuen, 1981.

Sokoloff, Kenneth. "The Heights of Americans in Three Centuries: Some Economic and Demographic Implications," in J. Komlos (Ed.), *The Biological Standard of Living on Three Continents*, San Francisco: Westview Press, 1995: pp. 133-150.

Steckel, Richard, "Height and Per Capita Income," *NBER Working Paper W880,* April 1982.

Steckel, Richard, "Stature and Living Standards in the United States," in R. Gallman (Ed.), *American Economic Growth and Standards of Living Before the Civil War*, Chicago: The University of Chicago Press, 1992: pp. 265-310.

Steckel, Richard, "Stature and the Standard of Living." *The Journal of Economic Literature*, Vol. 33 (Dec. 1995), pp. 1903-1940.

Steckel, Richard. "Strategic Ideas in the Rise of the New Anthropometric History and Their Implications for Interdisciplinary Research." *The Journal of Economic History,* No. 3 (Sept. 1998): pp. 803-821.

Wachter, Kenneth and James Trussel, "Estimating the Covariates of Historical Heights," *NBER Working Paper W1455,* Sept. 1984.