Stature and living standards in New Zealand: An alternative view and some initial results[1]

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Abstract: For Europeans and their descendents New Zealand was a relatively healthy environment during the 19th century. New Zealanders were relatively tall. Nevertheless stature declined from the 1870s to the early 1880s cohorts, again from the 1880s to the late 1890s, and from the 1910s to the early 1920s. We hypothesize that the 19th century experience reflects the same pattern of adverse pressure on net nutrition documented for this period in other countries. The failure of stature to rise after 1900 is more surprising as height was beginning to rise in other overseas European populations. The sharp decline for the 1920s cohort probably reflects the abrupt deceleration of the New Zealand economy at that time. Stature differed across occupational groups; farmers and men in higher socio-economic status occupations were taller. The differential between shorter and taller groups increased from the late 19th to the early 20th centuries; rising inequality then is one possible explanation for the failure of population mean stature to rise 1900-1920. There was some tendency for those born into a New Zealand city to be shorter as adults. No systematic differences between New Zealanders of European descent and the indigenous Maori are visible before 1900, although among the post-1900 cohorts the Maori were significantly shorter. Crude death rates, infant mortality rates and death through specific infectious diseases confirm a pronounced racial disparity in health. We conclude that there was considerable inequality in the experience of physical well-being even in the relatively healthy New Zealand environment.

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I. Introduction

New Zealand economic history matters to the world. Despite being small and remote, New Zealand was part of the same nineteenth century migration frontier that economic historians of North America study. How European migrants and their descendents fared in a slightly different environment with slightly different institutions has something to say about patterns of economic development. According to the standard indicators New Zealand did quite well. Crafts estimates that New Zealand had the highest Human Development Index (HDI) in the world in 1913, shading Australia and Denmark, and 10 per cent higher than the United States.[2] The standard narrative of New Zealand's twentieth century development is one of relative decline.[3] By 1950 New Zealand and the United States were near equals at the top of Crafts' estimates of the HDI, but by 1999 New Zealand had slipped to merely 16th in the world on the index. Income statistics would tell a picture of even greater relative decline. Historical estimates of income are imperfect, and alternative measures of welfare are useful to check the income and wage figures. Unlike the 15 countries above New Zealand on the HDI, there has not been any effort to use anthropometric measures to measure living standards over the long term.

Thus, this paper arises from our efforts to reconstruct and analyze the evolution of physical well-being in New Zealand, for both Pakeha (European-descendents) and Maori, from the mid-19th century to the late 20th century from anthropometric and related evidence. In this paper we examine in detail the experience of men born in New Zealand between the late 1870s and the

[2] N.F.R. Crafts, "The Human Development Index, 1870-1999: Some Revised Estimates," *European Review of Economic History* 6, no. 3 (2002).

[3] J. D. Gould, *The Rake's Progress?: The New Zealand Economy since 1945* (Auckland: Hodder and Stoughton, 1982), B. H. Easton, *In Stormy Seas : The Post-War New Zealand Economy* (Dunedin, N.Z.: University of Otago Press, 1997). G. R. Hawke, *The Making of New Zealand : An Economic History* (Cambridge: Cambridge University Press, 1985). The pessimism is half a century old: C. G. F. Simkin, *The Instability of a Dependent Economy : Economic Fluctuations in New Zealand, 1840-1914* (London [England]: Oxford University Press, 1951).

early 1920s. A comparison with indigenous skeletal records from the eighteenth century and earlier shows that the average stature of men in New Zealand was remarkably stable until the late nineteenth century. Yet the modern records we bring to bear in this paper suggest that stature in late-nineteenth century New Zealand was subject to the same downward pressures as other countries that industrialized and urbanized in the last quarter of the nineteenth century. Most striking of all the World War II generation—the birth cohorts of 1900-1924—did not appear to grow taller than previous generations. The early 1920s cohorts may even have shrunk, on average, despite other indicators of welfare—income, wages, life expectancy and infant mortality—indicating an improvement in New Zealand living standards.

Men in the birth cohorts of circa 1875-1924 enlisted in large numbers in the two world wars, thus leaving an extensive and detailed archive of records about individual anthropometry. The half-century between the 1870s and 1925 were a transformative period for most societies, because by the earlier decades of the 20th century, and in some countries earlier, physical stature, longevity and other indicators of physical well-being had begun a long march.[4] We are interested to observe how New Zealand, a particularly healthy country in the 19th century fared during this 'modern health transition'.[5] A related question, to the extent health was improving, is whether or not advances were shared through all sectors of society.

[4] *Inter alia* Richard A. Easterlin, *Growth Triumphant: The Twenty-First Century in Historical Perspective* (Ann Arbor: University of Michigan Press, 1998), Phyllis B. Eveleth and J. M. Tanner, *Worldwide Variation in Human Growth*, 2nd ed. (Cambridge: Cambridge University Press, 1990), R.W. Fogel, "New Sources and New Techniques for the Study of Secular Trends in Nutritional Status, Health, Mortality and the Process of Aging," *Historical Methods* 26, no. 1 (1993), Richard H. Steckel, "Heights and Human Welfare: Recent Developments and New Directions," *Explorations in Economic History* 46, no. 1 (2009), ———, "Biological Measures of the Standard of Living," *Journal of Economic Perspectives* 22, no. 1 (2008).

[5] Crafts, "The Human Development Index, 1870-1999: Some Revised Estimates.", Alfred K. Newman, "Is New Zealand a Healthy Country," *Transactions and Proceedings of the Royal Society of New Zealand* 15 (1882).

A large international literature argues that the nature of 19th century economic development could be 'hazardous for your health'.[6] New Zealand, in spite of having a relatively healthy environment, did not escape these pressures.[7] Indeed stature diminished during the 1890s. After 1900, based on the trend in Australia, Europe, and North America, we expect to see increases in stature in New Zealand, as it did in most countries including those most closely comparable to New Zealand such as Australia, Canada and the United States.[8] Unexpectedly, New Zealand shows no evidence of a generalized increase in stature during the first quarter of the 20th century. Sample sizes for this analysis are still small, but these preliminary results nonetheless are striking.

We also identify a degree of inequality in stature by occupation, urbanization and race that may be surprising in a society better known for its egalitarian well-being. The Maori are of particular interest. Disagreement about Maori physical well being figures prominently in early discussions of population decline, assertions of racial inferiority and, importantly, New Zealand social policy.[9] Our evidence suggests that the early twentieth century, while not the

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[6] Michael R. Haines, "Growing Incomes, Shrinking People - Can Economic Development Be Hazardous to Your Health? Historical Evidence for the United States, England, and the Netherlands in the Nineteenth Century," *Social Science History* 28, no. 2 (2004), John Komlos, "Shrinking in a Growing Economy? The Mystery of Physical Stature During the Industrial Revolution," *Journal of Economic History* 58, no. 3 (1998), Richard H. Steckel and Roderick Floud, eds., *Health and Welfare During Industrialization* (Chicago: University of Chicago Press, 1997).

[7] Kris Inwood, Les Oxley, and Evan Roberts, "Physical Stature in Nineteenth Century New Zealand—a Preliminary Interpretation," *Australian Economic History Review* (2010 (forthcoming)).

[8] John Cranfield and Kris Inwood, "The Great Transformation: A Long-Run Perspective on Physical Well-Being in Canada," *Economics and Human Biology* 5, no. 3 (2007), Richard H. Steckel and Donald R. Haurin, "Health and Nutrition in the American Midwest: Evidence from the Height of Ohio National Guardsmen, 1850-1910," in *Stature, Living Standards, and Economic Development*, ed. J. Komlos (Chicago: University of Chicago Press, 1995), Greg Whitwell, Christine de Souza, and Stephen Nicholas, "Height, Health and Economic Growth in Australia, 1860-1940," in *Health and Welfare During Industrialization*, ed. Roderick Floud and Richard H. Steckel (Chicago: University of Chicago Press, 1997), Greg Whitwell and Stephen Nicholas, "Weight and Welfare of Australians, 1890-1940," *Australian Economic History Review* 41, no. 2 (2001).

[9] Derek Dow, *Maori Health and Government Policy* (Wellington: Victoria University Press, 1999). Ian Pool, *Te Iwi Maori : A New Zealand Population Past Present & Projected* (Auckland: Auckland University Press, 1991), Linda Bryder and Derek Dow, "Introduction: Maori Health History, Past, Present and Future," *Health and History* 3, no. 1 (2001).

beginning of challenges to Maori health, was a particularly difficult period in spite of early state efforts to ameliorate it.[10]

II. Source and Method

Our principal sources are the medical examination of New Zealand soldiers who served in the two world wars. Military enlistment during the two wars was widespread in New Zealand. Although not a perfectly representative sample of the male population, the wartime medical exams are the most comprehensive available source before the advent of nationally representative health and fitness surveys first undertaken in the 1970s. We also examine scattered demographic and health detail from the annual reports of various government departments, and the vital statistics published in the annual volumes *Statistics of New Zealand* (annual from 1879) and the *New Zealand Official Yearbook* (annual from 1892).

Systematic differentiation in adult height between large representative samples is the key indicator in most anthropometric analysis.[11] Since most populations share a common potential for adult stature, systematic differences over large enough samples may then be understood as reflection of differences in 'net nutrition' or gross nutrition mediated by disease exposure and work demands during the portions of a life that the body is growing. The military medical exams provide the needed systematic evidence of adult stature, for men at any rate. Relatively large samples are needed because genetic variation within a population makes it uninteresting to examine the height of an individual or a small group. Since adult stature is largely shaped by childhood experience we necessarily think in terms of birth cohorts. Hence the stature of 23 year olds recorded in 1943 may tell us something about the

[10] Raeburn Lange, *May the People Live: A History of Māori Health Development 1900-1918* (Auckland: Auckland University Press, 1999), Dow, *Maori Health and Government Policy*.
[11] Fogel, "New Sources and New Techniques for the Study of Secular Trends in Nutritional Status, Health, Mortality and the Process of Aging." Steckel, "Heights and Human Welfare: Recent Developments and New Directions." Komlos, "Shrinking in a Growing Economy? The Mystery of Physical Stature During the Industrial Revolution."

early-life experience of those born in 1920. The stature of 27 year olds recorded in 1917 speaks to the early-life conditions of those born in 1890. And so on.

The World War I military service records became available to the public in 2005. Since that time we have been slowly accumulating a database that describes select personal characteristics including birthplace and birth date, occupation and stature or height. Practical limitations on record access and the need for a very large sample dictate an unusual sampling strategy. We examine all personnel records that have come into the public domain because they were needed for other research purposes; most of these requests originated with the work of government departments and genealogists. We also sample all files in stretches of the alphabet that are known to include a high proportion of Maori names.[12] This allows us to acquire a larger number of Maori records than would otherwise be possible. We enter all records, both Maori and Pakeha, in the relevant sections of the alphabet.

We gained access to World War II records in early 2008; this work has not yet caught up with the World War I data entry.[13] Sampling for WWII also comprises two elements. The first selection is to enter all files on a random selection of microfilms which are organized alphabetically by surnames. The second sampling principle is to enter data for soldiers whose names appear in Maori-intensive sections of the alphabet. The second principle ensures a minimum number of Maori soldiers and also adds Pakeha observations.

In both world wars height and weight were recorded in the medical examinations that accompanied enlistment for both volunteers and conscripts

[12] We select microfilm reels with names beginning or ending with Ar, Ha, He, Hi, Ho, Hu, Ka, Ko, Ku, Ma, Mo, Nu, Pa, Pe, Pi, Po, Pu, Ra, Re, Ri, Ta, Te, To, Tu, Wa, We and Wh.
[13] The World War II records are available on microfilm at the New Zealand National Archives. Original paper copies remain the property of the New Zealand Defence Force Personnel Archives. Long-term access to the Personnel Archives is not feasible for legal reasons. Unfortunately the quality of the microfilming in the 1960s was poor, and the legibility of the microfilm is poor. As with microfilming of the American censuses, the New Zealand Defence Force records were microfilmed as part of an unemployment works project.

in the New Zealand Expeditionary Forces. Body composition was consistently measured across the military records. The New Zealand military had measured men without shoes since the South African War of 1899-1902 if not before.[14] In both wars heights were measured to the quarter inch. It is less clear how recruits were weighed. Photos from World War I suggest that at least in the 'main centres'—the four largest cities of Auckland, Wellington, Christchurch and Dunedin—that balance weight scales were used.

For World War I we use two samples of New Zealand soldiers, which we refer to as the 'genealogical sample' and the 'casualties sample'. We give a brief description of the sources of the samples and some of the difficulties in constructing a sample for research, before discussing their composition. The genealogical sample has been constructed from the personnel records of New Zealanders serving in World War I, which only became available to the public in 2005. Both the original paper schedules and microfilm copies of 122,357 personnel files have been transferred from the New Zealand Defence Force (NZDF) to Archives New Zealand. These files cover 95 per cent of the men who served in New Zealand forces in World War I. The personnel files of approximately 6000 servicemen (and women) who remained in the NZDF after 1920 have not yet been transferred to Archives New Zealand. Because of the fragile condition of some of the paper files, there is no public access to the original records. Moreover, the microfilm reels contain both publicly available World War I files, and files from World War II. Files from World War II remain restricted, as not all men who served have died. Thus, without special permission the microfilmed files are not available for public research. Instead, Archives New Zealand allows people to request paper copies of World War I records. The records are printed from the microfilm and made available to the person requesting them, and also become available for public research. Genealogists have requested most of the records that have become available although other researchers have been using the World War I files to

[14] Attestation of William Eli Johnston, 1902. AABK/18805/W5515, Box 29, Record 2872. Archives New Zealand, Wellington.

study Pacific Island and Maori men who served in the New Zealand forces. Thus our data contains 368 indigenous Pacific Island-born men who served in New Zealand forces in World War I. The genealogical sample is likely to be biased towards men who survived the war, and produced descendents who are interested in researching their ancestry. With further funding and access to the microfilm we are currently augmenting our data with systematic random sampling procedures.

The 'casualties sample' has been constructed from the Roll of Honour of New Zealand men who died in World War I.[15] This sample may also be biased, if the risk of being killed in action correlated for some reason with stature. Moreover, a large share of the records are not usable for even a basic analysis, missing at least one of height, birth date or birthplace. The casualties sample was transcribed from 93 bound volumes of forms that were filled out when a serviceman was killed in action. Height was meant to be transcribed on the casualty records from the enlistment records.[16] It is understandable that during wartime transcribing information such as height and birthplace, available on other forms, and not obviously related to war service, was a low priority. Thus, of the 16,302 New Zealand servicemen killed in action we have usable information on stature for just 9,575 while only 3744 records specify both height and birthplace.

To date we have collected more than 16,000 records from World War I: 9,575 in the casualties sample and 6,575 in the genealogical sample. The complete dataset includes a substantial number of men born outside New Zealand or the Pacific Islands who are not included in the analysis. For both the casualties and genealogical samples we have information on the following variables: full name, place of birth, date of birth, date of enlistment, occupation at enlistment, military identification number, and height and weight. In the

[15] Active Fatal Casualty Forms World War I, 1915-1919. 93 volumes. AABK 519, Archives New Zealand, Wellington.
[16] A.D. Carbery, *The New Zealand Medical Service in the Great War 1914-18* (Auckland: Whitcombe & Tombs Ltd, 1924).

genealogical sample, we have collected additional information on marital status, educational achievement and religion. Other medical and health information in the World War I files was not uniformly collected. Many of the men were assessed as having 'good' health along various dimensions of health. If any aspect of a man's health was poor, further details from medical tests are sometimes given. Thus, detailed quantitative health information is available selectively for the less fit recruits, making it of limited use for analyzing overall population health. In our multivariate analysis, we only use cases that have complete information about birth date, birthplace, occupation, and body composition. In most of our analyses we exclude men who enlisted before they reached the age of 21 years because many of them were still growing. In itself, this observation that men were still growing in their late teens is an indicator of living standards below current ones. In well-nourished modern populations many men attain adult height before age 20.[17] We also exclude men older than 49 years in order to minimize any complication arising from the diminution of height at advanced ages.

We discard men who were born outside New Zealand or the Pacific Islands, but enlisted in the New Zealand army in World War I. Nearly one-third (32 per cent) of the men who would have been of an eligible age to serve in World War I were born outside New Zealand. Thirty percent of our genealogical sample was foreign born, very close to the proportion in the eligible population.[18] Immigrants may have arrived at a young age, with their attained height reflecting the New Zealand nutritional environment. However, without longitudinal data, we cannot distribute childhood influences into a part reflecting the experience elsewhere and another part reflecting experience in New Zealand and the islands.[19] Approximately 1 in 8 of our sample were born in Great Britain. British migration to New Zealand peaked in the early-

[17] Barry Bogin, *Patterns of Human Growth*, 2nd ed. (Cambridge: Cambridge University Press, 1999).
[18] Government Statistician, *Results of a Census of the Dominion of New Zealand Taken for the Night of 2nd April, 1911,* (Wellington: Registrar General's Office): *xii*, 228-229.
[19] Initial investigations suggest that it would be feasible to trace some of these British migrants back through their migration, and into the British civil and census records.

1860s and mid-1870s.[20] Recruits in World War I—mostly born in the 1880s and 1890s—were more likely to be New Zealand born than men enlisting in the South African war, and men born in the 1870s enlisting in World War I. There are also 261 Australian-born men in the dataset. During the late 1890s and early twentieth century, there was high out-migration from Australia to New Zealand, as New Zealand's real incomes grew faster than in Australia.[21]

After exclusions for missing information, age and foreign birthplace we are left with the 3,501 observations in the genealogical sample and 2,868 in the casualties sample summarized in Tables 1 through 3. The structure of the sample for World War II is summarized in Table 4, where we have over-sample Maori who make up about 20% of the sample. In World War I, about 10 per cent of the genealogical sample comes from the Pacific islands; the remainder were New Zealand-born. Pacific Island and Maori men were less likely to be casualties in World War I because they mostly served in a support unit, the Pioneer Battalion, which was not engaged in frontline service.[22] In other respects the characteristics of the two samples are broadly similar.

The New Zealand-born in World War I divide equally between the North Island and the South Island, reflecting the approximately equal populations of the two main islands in the late nineteenth century. By World War II the population of the North Island has grown relative to the South. There was no appreciable difference in stature between men born in the two islands. There is no unambiguous way to distinguish men who were entirely or largely of European descent (Pakeha) from Maori population indigenous to New Zealand. Thus, we rely on Maori names, principally surnames, to indicate Maori ethnicity. This strategy is conservative, and will exclude Maori with

[20] Jock Phillips and Terry Hearn, *Settlers: New Zealand Immigrants from England, Ireland & Scotland 1800-1945* (Auckland: Auckland University Press, 2008).
[21] W.D. Borrie, *The European Peopling of Australasia : A Demographic History, 1788-1988* (Canberra: Demography Program, Research School of Social Sciences, Australian National University, 1993).
[22] James Cowan, *The Maoris in the Great War* (Wellington: 1926), Christopher Pugsley, *Te Hokowhitu a Tu : The Maori Pioneer Battalion in the First World War* (Auckland: Reed, 1995).

European names. At present our Maori sample is too small to distinguish statistically between different iwi (tribes).

We have identified all men with apparently indigenous names. For convenience we refer to them as indigenous, though there are some caveats to the interpretation of these results. More than a century of interaction meant some in our sample are likely to have both European and Maori ancestry. Moreover, a genetically 'pure' Maori could adapt a European name, and a European might adopt a Maori name. We consider these possibilities relatively uncommon. By identifying Maori with European names as European, our analysis will under-estimate the difference in stature between the two groups.

In defence of our procedure, our analysis comes from a tradition that typically presumes environmental influences (nutrition, disease, workload) are more influential than genetic influences on adult stature.[23] There is little modern evidence on stature differences between Maori and European in New Zealand. Recent health and nutrition surveys have reported a secular trend towards increasing height in cohorts born since the 1940s, but have not distinguished trends amongst ethnic groups.[24] Research on anthropometric differences between New Zealand ethnic groups has been heavily focused on understanding body mass and body fatness differences between New Zealand ethnic groups.[25] This modern research takes ethnicity as a self-ascribed characteristic. By using names as an indicator of ethnicity in our military samples, we approximate self-identified ethnicity as closely as possible given the different data collection methods. Within this framework, the precise genetic composition of a group of an individual matters less than how she or

[23] Karri Silventoinen, "Determinants of Variation in Adult Body Height," *Journal of Biosocial Science* 35 (2003): 272-74.
[24] Ministry of Health, *Tracking the Obesity Epidemic: New Zealand 1977-2003* (Wellington: Ministry of Health, 2004).
[25] E Rush et al., "Body Size, Body Composition, and Fat Distribution: A Comparison of Young New Zealand Men of European, Pacific Island, and Asian Indian Ethnicities," *Journal of the New Zealand Medical Association* 117 (2004).

he lived, especially as a child. The reporting of an indigenous name probably does point to someone who lived within and identified with the indigenous community, growing up in a Maori environment. This social and environmental influence is what we wish to capture.

Men who grew up in an indigenous community and presented for enlistment with European names will be invisible to us. The proportion of such people within the European-descended but New Zealand-born community was probably small in the early twentieth century. Inter-marriage between Maori and Pakeha was accepted and known by both groups, but did not occur at a high rate across the country. The South Island Maori tribe Ngai Tahu inter-married with Europeans at a higher rate than larger tribes in the North Island.[26] The analytical concern is whether Maori who took on European names were systematically different from those who did not. At the moment we have no way to address this concern. For all of these reasons we regard our tabulations and analysis that rely on the indigenous indicator as merely indicative of broad patterns and tendencies.

We employ a maximum likelihood truncated regression model that assesses the contribution of birth cohort, occupation and ethnicity to stature. Analysis is restricted to those born in New Zealand and those aged 21-49 at the time of medical examination. Ages are restricted because some people are still growing in their late adolescent years, and most people begin to lose stature in their 40s (although not noticeably until their 50s). We only look at people born in New Zealand in order to maximize the probability that socio-economic influences on stature formation reflect New Zealand realities.

[26] P Callister, R Didham, and D Potter, "Ethnic Intermarriage in New Zealand," *Official Statistics Research Series* 1 (2005). A Wanhalla, "One White Man I Like Very Much," *Journal of Womenís History* 20, no. 2 (2008).

The estimation ignores men less than 64 inches tall because World War I fitness requirements excluded a disproportionate number of the shorter men. The maximum-likelihood truncated regression model relies on the assumption of a normal distribution of heights in order to 'replace' the under-represented heights at the lower end. World War II stature norms for military enlistment were more flexible, and explicitly permitted enlistment above 62 inches, however for comparability we use the same truncation standard for both estimations.[27] A histogram showing the frequency distribution of heights in both wars is illustrated in Figured 1 and 2. The distribution approximates normality with very little sign of truncation at either end in either war, although a modestly disproportionate decline for WWI is visible at 64 inches.

We examine change over time through a comparison of co-efficients estimated for different birth cohorts. Maori identity is inferred from the use of a Maori first and/or last name. The influence of socio-economic status is examined through occupations organized into five classes: (i) professional, managerial and clerical, (ii) farmers, (iii) farm labourer, (iv) other labourers and servants and (v) all other. The 'other' category is made up of skilled and semi-skilled men working in manufacturing, transport and utilities. The occupational categories are based on major groups in the HISCO occupational classification system. We distinguish between farmers and farm laborers because of the frequency of both occupations, and the important social distinctions between them.[28] The soldier's occupational class is assumed to correlate with his father's occupational class. Admittedly this is an indirect measure of the nutritional circumstances in which the soldier grew up. Occupation is a very rough socio-economic indicator. The presumption of intergenerational persistence further reduces precision. Nevertheless, in the absence of other indicators we rely on these occupational groups to capture socio-economic influences.

[27] The fact that most men classed as unfit were rejected for reasons other than their stature reduces concern about the selection effects of fitness assessment.
[28] Marco H.D. van Leeuwen, Ineke Maas, and Andrew Miles, *Historical International Standard Classification of Occupations* (Leuven: Leuven University Press, 2002).

III. Results

In Table 5 we report coefficients from separate estimations on World War I and World War II data. Results from the casualties' sample were substantively similar to the genealogical sample, however the lack of domestic birthplaces in many of these records made their utility somewhat limited. The World War I estimates describe men born in the final quarter of the 19th century, with the youngest men being born in 1897. The World War II estimates describe the first quarter of the 20th century. Cohorts who were aged 20-30 at some point in the war were more likely to enlist in both wars. Thus, the combined sample is somewhat thin for men born between 1900 and 1910. The omitted categories in the regressions are Pakeha in the 'other' occupational class born 1885-1889 (World War I) and 1910-1914 (World War II).

The pattern of cohort coefficients provides no indication that stature was increasing over time as in Australia, Canada and the United States through most of this period.[29] Indeed, the World War I data for New Zealand show a significant decline in stature from the early 1880s to the later 1890s; those born in the early 1920s were also significantly shorter than other cohorts. We use five-year cohorts in an attempt to identify these effects as specifically as possible. The disadvantage of short cohorts is that the number of observation in each cohort is small. We do not yet have enough data to know if the apparent fluctuations in stature should be understood as purely cyclical in nature.[30] The Australian data also show a reversal in the 1890s although not in the 1920s.[31]

The coefficients estimated on occupational group suggest the presence of significant socio-economic inequality. In both periods men in the rural

[29] Cranfield and Inwood, "The Great Transformation: A Long-Run Perspective on Physical Well-Being in Canada."
[30] Ulrich Woitek, "Height Cycles in the Late 18th and 19th Centuries," *Economics and Human Biology* 1 (2003).
[31] Whitwell and Nicholas, "Weight and Welfare of Australians, 1890-1940."

occupations were taller. Men in the professional and clerical occupations were taller – as expected from the higher class standing and family circumstances permitting greater spending on food and healthy housing. Men in the labouring and manufacturing (omitted) occupations, especially those in urban areas and lacking in specific skills, probably grew up with lower family income in less healthy environments, and consequently are shorter. There are some signs of increasing inequality inasmuch as the differential between shorter and taller groups increased from the late nineteenth to the early twentieth century. The differentials between occupational classes are similar in size to those reported by Steckel and Haurin in their study of the Ohio National Guard.[32] Caution is necessary in comparing absolute levels of height across samples. Nevertheless, we can put the New Zealand troops in context by noting they were three-quarters of an inch shorter than the Ohio National Guard troops of a similar era. Costa and Steckel show the Ohio National Guard troops were taller than the average native-born white American.[33] Thus, the average New Zealand male born in the late nineteenth century and early twentieth century was probably slightly taller than the average American. The similarity in the occupational differences between New Zealand and the United States is unsurprising. It is more significant for New Zealand historiography where we lack census and survey data that might offer alternative insights into inequality at the turn of the century. Similar to the United States, the myth of a classless society in New Zealand was strong.[34]

[32] Steckel and Haurin, "Health and Nutrition in the American Midwest: Evidence from the Height of Ohio National Guardsmen, 1850-1910."
[33] Dora Costa and R.H. Steckel, "Long Term Trends in Health, Welfare and Econoic Growth in the United States," in *Health and Welfare During Industrialization*, ed. R.H. Steckel and R. Floud (Chicago: University of Chicago Press, 1997).
[34] The comparisons are well brought out in Peter J. Coleman, *Progressivism and the World of Reform : New Zealand and the Origins of the American Welfare State* (Lawrence, KS: University Press of Kansas, 1987). A good recent summary of the literature is Melanie Nolan, "Constantly on the Move, but Going Nowhere? Work, Community and Social Mobility," in *The New Oxford History of New Zealand* ed. Giselle Byrnes (Auckland: Oxford University Press, 2009).

A useful variation on the basic model reported in Table 4 is to recognize that New Zealand cities were less healthy environments in which to grow up.[35] The model reported in Table 6 is intended to isolates a distinct urban effect for each of the four major cities. We lose a substantial number of observations, and therefore precision, because birthplace inside New Zealand is not always available. This is especially serious for WWII as is clear from Table 4. The estimates for 19th century cohorts from World War I data suggest a small negative but statistically insignificant effect of being born in three of the four cities. The 20th century cohorts from World War II data also show a small negative but statistically insignificant urban effect, with the exception of Christchurch which now appears to be relatively healthy. The introduction of urban effects does not alter in a qualitative way the pattern of other co-efficient estimates, although standard errors have increased because of smaller numbers in each cell.

The most dramatic change between the two estimations reported in Tables 5 and 6 is in the effect of being Maori. The World War I data suggest that men with indigenous names were not systematically shorter, controlling for other influences, during the late 19th century. The estimation on World War II soldiers, however, shows that the early 20th century Maori cohorts were nearly three-quarters of an inch shorter. This differential cannot be the result of Maori soldiers being younger on average or shifting into lower-status jobs since the estimation independently controls for these influences (admittedly in a somewhat rigid manner). The size of the Maori stature penalty for World War II cohorts—four-fifths of an inch—is striking.

Thus far we have examined information for the adults who have stopped growing. However, substantial numbers of men also enlisted at ages 18-20 years. We attempt to make use of this evidence through a simple comparison of men of the same age and ethnicity who enlisted in the two wars. The

[35] Pamela Wood, *Dirt: Filth and Decay in a New World Arcadia* (Auckland: Auckland University Press, 2005).

unconditional means and differentials are reported in Table 7. A difference of means test on the hypothesis that the young adults in the two wars were the same height cannot be rejected for any age, Pakeha or Maori. However, the same test allows us to reject the hypothesis of common Maori-Pakeha stature for 19- and 20-yr olds in World War I and, much more strongly, 18- and 19-year olds in World War II. We would not want to make too much of these results because samples are small for some pair-wise comparisons and the use of unconditional means does not take account of any potentially confounding factors. Nevertheless, this evidence is consistent with the evidence of Tables 1 and 2 that stature was not changing over time except for Maori, who were becoming absolutely shorter.

IV. Discussion

As a rule of thumb, it is useful to have at least 200 observations in order identify most effects in the presence of genetic variation and other sources of variability in anthropometric data. The identification of small or complex effects may require even larger samples. The detail reported in Tables 5 and 6 make clear that our samples are small relative to the questions we wish to ask of them. Accordingly, it would be unwise to interpret a failure to identify an effect as reliable evidence that it in fact does not exist or to assume that the coefficients will not change as samples expand. Nevertheless we may summarize some preliminary conclusions and compare with other kinds of information in order to identify consistency and valued added by the anthropometric data.

(a) Change over time

We see no evidence of a secular increase in stature in either the WWI or WWII data. In fact Table 5 reports evidence of decreasing stature 1870s to the early 1880s, 1880s to the late 1890s, and 1910s to the early 1920s. The first of these transitions relies on a very small 1870s sample and might best be

set aside for the moment. The decline in stature of 0.8 inches from the early 1880s to the late 1890s is more secure.

The dip in height during the 1890s is striking in part because economic growth in this period was substantial (Figure 2). The anthropometric evidence, therefore, invites us to consider other aspects of the pattern of economic growth that may have offset the pull of rising incomes. Possible candidates are (i) a rising relative price of protein-intensive food in New Zealand as export transport costs fell, (ii) the epidemiological consequences of population growth, urbanization and migration not yet moderated by substantial public health investments, (iii) compensating differentials in the form of increasing workload and (iv) adverse distributional shifts. Currently we are investigating evidence for each of these effects.

It is more surprising that stature did not increase after 1900 and in fact declined during the 1920s. By the early 20th century an understanding of the germ theory of disease and a widespread commitment to public well-being reduced the health risks of urbanization and contributed to increasing stature almost everywhere that evidence is available. In this context our preliminary finding for the early 20th century is surprising. Admittedly, the samples remain small especially for men born in the 1920s (Table 5). Nonetheless, the severity of decline in stature for the 1920s cohort is consistent with broader economic data insofar as the early 1920s was a difficult moment in the country's economic history, as is clear from Figure 3 and recent studies of the period (Greasley and Oxley).

(b) Socio-economic and rural-urban differentials

The pattern of differences in height across occupational groups suggests that men working at higher socio-economic status occupations were taller. Farm labourers were taller than average as well, although farmers were even taller. Undoubtedly these effects reflect the advantages for physical well-being of a

superior access to resources and living in a rural environment. A lower relative price of food and limited exposure to infectious disease contribute in unknown proportions to the rural effect, although arguably both were important. Farmers are especially tall because they benefit from all of these effects including, for many although not all farmers, substantial wealth.[36]

The complexity of these effects suggests that a strategy to identify distinct causal pathways will be useful. There are some signs of increasing inequality inasmuch as the differential between shorter and taller groups appears to have increased from the late 19th to the early 20th centuries. This is especially interesting insofar as increasing inequality is one possible explanation for the failure of mean stature to rise 1900-1920. Equally striking is the size of the occupational effects. Professional and clerical workers were more than half an inch taller than labourers and the manufacturing class in WWI; farmers were almost a full inch taller in WWII. These are powerful differences. It is clear that the distribution of physical well-being in late 19th and early 20th century New Zealand was highly unequal. Yet as noted earlier the differences were the same size as those found by Steckel and Haurin in the American Midwest, and lower than in Europe.[37]

By and large the effect of being born into a New Zealand city is associated with shorter stature, although many of these effects are not statistically significant. Clearly, we need to wait for larger samples before the urban effects are known with acceptable precision. Even at this point, however, the effects largely conform to expectation. It would be surprising if there were not some negative effect of urban environments that were known to be relatively unhealthy (Wood 2005). The one noteworthy change from World War I to World War II cohorts is that Christchurch appears to have become a much healthier place. This finding corroborates Geoffrey Rice's assessment

[36] Margaret Nell Galt, "Wealth and Income in New Zealand C. 1870 to C. 1939" (PhD, Victoria University, 1985).
[37] Steckel and Haurin, "Health and Nutrition in the American Midwest: Evidence from the Height of Ohio National Guardsmen, 1850-1910."

of the period and points to the efficacy of the city's commitment to land drainage, sewerage and public health staff (Rice 1991).[38]

(c) Maori health status

The 19th century decline of Maori population and the early 20th century beginnings of a policy commitment to Maori health direct attention at the physical well-being of the Maori.[39] Using as a marker the apparent indigeneity of the solder's name we are able to examine whether the Maori were shorter or taller than Pakeha after controlling for the influence of occupation, cohort and urbanization. The WWI medical data reveal no systematic ethnic or racial difference in stature – again recognizing the limitation of having only 140 Maori observations (Tables 1 and 3). It is easier to interpret the large (0.8 inches) and significantly negative co-efficient on the WWII marker. We infer that some combination of nutrition, disease vulnerability and the demands of work during childhood undermined the health of Maori born during the early 20th century. If we believe the results for WWI, the physical well-being of the Maori deteriorated relative to Pakeha and to earlier generations of Maori.

In an effort to assess the credibility of this pattern we examine other health indicators that would reflect the experience of the same WWII cohorts. In Table 8 we summarize mortality information as it is appears in the annual reports of the Department of Public Health 1925-1940. The 5-year infant mortality and crude death rates of the Maori were 2 to 4 times that of Pakeha. The differential does not tend to diminish, indeed the last five year window 1935-1939 appears to have been particularly difficult for the Maori.

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[38] Geoffrey Rice, "Public Health in Christchurch, 1875--1910: Mortality and Sanitation," in *A Healthy Country: Essays on the Social History of Medicine in New Zealand* ed. Linda Bryder (Wellington: Bridget Williams Books, 1991). There may also have been a redrawing of boundaries to incorporate into the city suburbs that had superior health.

[39] Bryder and Dow, "Introduction: Maori Health History, Past, Present and Future.", Dow, *Maori Health and Government Policy*. Lange, *May the People Live: A History of Māori Health Development 1900-1918*.

There is no easy way 90 years later to assess the relative importance of disease versus nutrition for Maori mortality, stature or any other indicator of physical well-being. Most observers have explained high Maori infant mortality during the 1920s and 1930s as the result of child pneumonia, diarrhoea and enteritis, which themselves were understood to be a consequence of poor living conditions and an increasing reluctance to breast-feed.[40] The 1935 report of the Department of Public Health also points to the importance of disease rather than nutrition:

> The two main conditions in which the Maori child compares unfavourably with the European child are tuberculosis and skin diseases … The percentage of Maori with subnormal nutrition, however, is lower than that of the European children.[41]

The losses of life attributed to various diseases, reported in Table 7, reinforce this perspective. The Maori were 5 times more likely to die of influenza, 10 times more likely to die of pulmonary tuberculosis, 20 times more likely to die of measles and nearly 40 times more likely to die of typhoid.

These differentials arose from some combination of differences in disease exposure, differences in acquisition of the disease upon exposure and variability of the impact of disease after it has taken hold. For tuberculosis, which was studied more than other diseases at the time, disease acquisition clearly mattered a lot. The 1940 report of the same department notes that TB was found in 0.2% of all Pakeha children and an astonishing 40% of Maori children examined the previous year (Table 9).[42]

The mortality and morbidity data confirm that disease of various kinds severely compromised Maori health during the 1920s and 1930s. A substantial

[40] Linda Bryder, "New Zealand Infant Welfare Services and Maori," *Health and History* 3, no. 1 (2001).
[41] New Zealand, *Appendices to the Journals of the House of Representatives*, H-31, Report of the Department of Public Health, 1935, p. 8.
[42] New Zealand, *Appendices to the Journals of the House of Representatives*, H-31, Report of the Department of Public Health, 1940, p. 3.

Pakeha-Maori difference in physical stature among WWII soldiers is hardly surprising in this context. It is harder to understand why we do not encounter a comparable difference in stature among WWI soldiers. The lack of comparable mortality data for the late 19th century complicates the picture, but continuing population decline until the end of the 19th century makes it unlikely that other health indicators would show Maori in a more favourable light than during the 1920s and 1930s. Unfortunately the limitations of available evidence make it impossible to advance further on this question at the present time. Maori fertility rose in the 1920s and 1930s, giving rise to the possibility that resources within Maori families were constrained with extra mouths to feed.[43]

(d) Comparison with other measures of living standards

The stagnation of height in New Zealand for European descendents, and the regression of Maori stature from a long-term average of 68 inches to 67 inches is striking. One concern with the results is the dip in height for the youngest cohort in the World War II sample. If men were exaggerating their age to get into the military then we are measuring men (boys!) who were still growing, giving the impression of regression in height. Such an effect is perhaps unavoidable with military records, since the more representative military intakes during the wars brought in a group of men largely between the ages of 20 and 35. Disentangling age and cohort effects is difficult. Thus we are currently in the process of collecting a large sample of prison and court records to give us a sample that is more evenly spread over cohorts.

Income

Were our results to stand in larger and different samples they would complicate a story of improving living standards. Income per-capita compared

[43] Ian Pool, Arunachalam Dharmalingam, and Janet Sceats, *The New Zealand Family from 1840: A Demographic History* (Auckland: Auckland University Press, 2007). Lifetime fertility rates from 6 to 7.

favourably with other developed countries. By 1938 New Zealand's GDP per capita, adjusted for purchasing power parity, was the highest in the world, but New Zealand's development was accompanied by long swings in economic growth.[44] Average incomes per capita in New Zealand around 1870 were high compared to the rest of the world, but falling and the prospects for economic development appeared uncertain.[45] By the end of the 1880s New Zealand experienced net emigration, urban unemployment, discontent surrounding sweated conditions in the clothing trades, and an unrequited hunger for land among the settlers. Real GDP per capita fell in the years to 1890, when wool dominated staple exports. Thereafter, in the forty years 1890-1938 New Zealand's real GDP per capita growth averaged around 1.26 per cent per annum, but there were marked swings around the mean growth rate.[46] In particular, New Zealand experienced a thirty-year boom from around 1890, a long depression centred on the 1920s, and a remarkably fast recovery during the 1930s. Accordingly, New Zealand's GDP per capita, corrected for purchasing power differences, was 97.2 per cent of the US level in 1913, but this relativity fell to 76.3 per cent in 1929 and rose to 105.5 per cent in 1938.[47] Modern research suggests that economic shocks have a pro-cyclical effect on child health in less-developed countries—recessions are bad for children's health. In modern middle-income countries, the effects are theoretically ambiguous.[48] Possibly the failure of New Zealand stature to increase reflects shocks to childhood health from the cyclical swings of an export dependent economy.

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[44] David Greasley and Les Oxley, "Growing Apart? Australia and New Zealand Growth Experiences, 1870-1913," *New Zealand Economic Papers* 33, no. 2 (1999).
[45] JA Dowie, "A Century Old Estimate of the National Income of New Zealand," *Business archives and history* 6 (1966). D Greasley, "Outside the Club: New Zealand's Economic Growth, 1870-1993," *International Review of Applied Economics* 14, no. 2 (2000).
[46] David Greasley and Les Oxley, "The Pastoral Boom, the Rural Land Market, and Long Swings in New Zealand Economic Growth, 1873–1939," *Economic History Review* 62, no. 2 (2009).
[47] Angus Maddison, *The World Economy : A Millennial Perspective* (Paris: OECD, 2001).
[48] Francisco H. G. Ferreira and Norbert Schady, "Aggregate Economic Shocks, Child Schooling, and Child Health," *World Bank Research Observer* 24, no. 2 (2009).

Childhood growth

The stagnation of adult stature in the World War II cohorts also runs counter to contemporary evidence on the height of New Zealand school children. The School Medical Service in New Zealand surveyed school children nearly every decade from 1913 (except for the 1940s). The early twentieth century cohorts appear to be growing rapidly (Figure 4), with gains of an inch or more in height at each age over two decades.[49] Some of the gains are probably due to an expansion of coverage by the successive surveys, which began in urban schools and drew increasingly larger samples. Thus, some of the gains in height may be an artefact of the more selective sample in 1913. The 1925 and 1934 surveys appear similar in methodology and composition, but much of the original documentation and schedules were lost in a 1956 fire at the New Zealand National Archives. The early twentieth century saw New Zealand welfare policy make determined efforts to improve child health, through such interventions as the School Medical Service itself, and the introduction of child allowances to families in 1927.[50] How would it be possible that there were sustained improvements in the health and statue of school children at the same time as stature stagnated? One possibility is a change in the growth curve. Many children in New Zealand left school at 14 or 15, and were in the workforce for most of their teenage years with several inches of potential growth ahead of them. The 1920s and 1930s saw the relatively labour intensive dairying industry expand. There was contemporary concern that children and other helpers on dairy farms worked long and physically demanding hours.[51] Reconciling the evidence on the apparent rapid growth of school children with our results for adults is a priority for our future research.

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[49] New Zealand Division of Public Health Family Health Branch, *Physical Development of New Zealand School Children 1969* (Wellington: Department of Health, 1971).

[50] Margaret Tennant and New Zealand. Dept. of Internal Affairs. Historical Branch., *Children's Health, the Nation's Wealth : A History of Children's Health Camps* (Wellington, N.Z.: Bridget Williams Books and Historical Branch Dept. of Internal Affairs, 1994), Bronwyn Labrum, "The Changing Meanings and Practice of Welfare, 1840s-1990s," in *The New Oxford History of New Zealand* ed. Giselle Byrnes (Auckland: Oxford University Press, 2009), 404-05, Melanie Nolan, *Breadwinning: New Zealand Women and the State* (Christchurch: Canterbury University Press, 2000).

[51] W. T. Doig, *A Survey of Standards of Life of New Zealand Dairy-Farmers*, Bulletin / Dept. Of Scientific and Industrial Research ; No. 75 (Wellington,: Govt. Print., 1940).

Infant mortality and life expectancy

For the European-descended Pakeha population an 'economic' explanation for stagnating stature is the most plausible, since other indicators of disease and demography suggest the country was becoming healthier. The civil registration system for births and deaths in New Zealand was well organized from the late 1850s, and a reliable nationwide series for infant mortality is readily derived from the official statistics. These are subject to the usual concerns about under-reporting of neo-natal deaths.[52] Accurate figures for Maori are not available until the 1920s. For the Pakeha population, infant mortality decline was early and sustained (Figure 5), and apparently world-leading.[53] The decline was attributed at the time to the work of the Plunket Society, an infant welfare organization.[54] Similarly, life expectancy at birth increased for both Pakeha and Maori over the first half of the twentieth century (Figure 6).[55] The improvement in life expectancy and declines in infant mortality seem robust. While there is debate about the precise magnitude and timing of some of the changes, the trend is agreed.

V. Conclusion

Contrary to the experience of similar countries—Australia, Canada, and the United States—in the same time period New Zealand men experienced stagnation and regression in stature over fifty years extending from the 1870s to the 1920s. While the late nineteenth century stagnation is similar to the experience abroad, the distinctiveness of the New Zealand experience is the

[52] Statistics New Zealand, *A History of Survival in New Zealand: Cohort Life Tables 1876–2004* (Wellington: Statistics New Zealand, 2006), 9.
[53] Søren Edvinsson, Ólöf Garðarsdóttir, and Gunnar Thorvaldsen, "Infant Mortality in the Nordic Countries, 1780-1930," *Continuity and Change* 23, no. 03 (2008).
[54] Robert Morse Woodbury, *Infant Mortality and Its Causes* (Baltimore: Williams & Wilkins, 1926). See also *New Zealand Official Yearbook,* (Wellington: Government Printer, 1923): 139. Philippa Mein Smith, *Mothers and King Baby* (London: Macmillan, 1997), Erik Olssen, "Truby King and the Plunket Society: An Analysis of a Prescriptive Ideology," *New Zealand Journal of History* 15, no. 1 (1981).
[55] Statistics New Zealand, *A History of Survival in New Zealand: Cohort Life Tables 1876–2004*, Pool, *Te Iwi Maori : A New Zealand Population Past Present & Projected*.

failure for men's stature to rise in the first quarter of the twentieth century. The stagnation in stature is contrary to an otherwise impressive decline in infant mortality, rising life expectancy, and gains in wages and income over the same time period. Though our results should be taken cautiously because of small sample sizes at present, long recessions in New Zealand in the 1880s, 1920s and early 1930s, and the possibility of rising relative prices for protein in an open economy, make stagnation in stature quite plausible.

Table 1: World War I New Zealand Expeditionary Force Data, Genealogical Sample, Summary Statistics

Sample	N		Age (years)	Height (inches)	Weight (pounds)	Birth year
New Zealand born	3189	Median	26	68	150	1889
		Mean	27	68	151	1888
		Coefficient of variation	0.21	0.04	0.12	0.003
Pacific Island born	312	Median	24	68	159	1892
		Mean	25	68	160	1892
		Coefficient of variation	0.16	0.03	0.12	0.002
Indigenous name	373	Median	24	68	160	1893
		Mean	25	68	162	1891
		Coefficient of variation	0.16	0.03	0.11	0.002

Note: Men with an indigenous name are included within the New Zealand and Pacific Island categories, in addition to being reported separately in the bottom line.

Table 2: World War I New Zealand Expeditionary Force Casualties Data, Summary Statistics

Sample	N		Age (years)	Height (inches)	Weight (pounds)	Birth year
New Zealand born	2853	Median	27	67.9	150	1890
		Mean	28	68.0	148	1888
		Coefficient of variation	0.21	0.04	0.12	0.003
Pacific Island born	15	Median	23	67.8	160	1892
		Mean	25	67.4	159	1891
		Coefficient of variation	0.15	0.02	0.10	0.002
Indigenous name	144	Median	22	68.0	160	1893
		Mean	24	68.0	159	1891
		Coefficient of variation	0.18	0.03	0.11	0.002

Note: Men with an indigenous name are included within the New Zealand and Pacific Island categories, in addition to being reported separately in the bottom line.

Table 3: World War I Sample exclusion due to missing fields

		Casualties	Genealogical
All records	Complete height records	9501	6137
	Known to be New Zealand born[†]	3403	4299
	Aged 21-49 and ≥ 64 inches	2731	3051
Why excluded[‡]	Outside 21-49 age window	567	1107
	< 64 inches tall	133	139
Maori	Complete height records	190	572
	Known to be New Zealand born	190	572
	Aged 21-49 and ≥ 64 inches	142	334
Why excluded[‡]	Outside 21-49 age window	46	216
	< 64 inches tall	2	22
Pacific Island born	Complete height records	20	510
	Aged 21-49 and ≥ 64 inches	15	298
Why excluded[‡]	Outside 21-49 age window	5	210
	< 64 inches tall	0	21

Notes
[†] Birthplace information is missing for many men in the casualties sample.
[‡] Men may be excluded from the sample for both reasons, as the restrictions are not mutually exclusive.

Table 4: Structure of WWII Sample

	All useable records	With intra-NZ birthplace
All records, 21=<age=<49, hgt>=64	2279	1250
Farmer	192	109
Farm labourer	218	60
Profesional-clerical	306	191
Labour	476	251
Manufacturing-transport (omitted)	1087	637
Aboriginal name	547	297
Born 1890-1899	130	79
Born 1900-1904	186	100
Born 1905-1909	362	202
Born 1910-1914 (omitted)	610	343
Born 1915-1919	822	435
Born 1920-1924	169	91
Auckland		106
Wellington		88
Christchurch		105
Dunedin		52

Table 5: Maximum Likelihood Truncated (64") Estimation of Stature, NZ-born Soldiers 21-49 years

World War One (n=3051)			World War Two (n=2279)		
	Coef.	P>|z|		Coef.	P>|z|
Born 1860-1874	+.59	.06	Born 1890-1899	+.26	.36
Born 1875-1879	-.17	.39	Born 1900-1904	-.14	.57
Born 1880-1884	+.31	.06	Born 1905-1909	-.13	.52
Born 1890-1894	-.08	.57	Born 1915-1919	+.06	.71
Born 1895-1899	-.52	.02	Born 1920-1924	-.51	.07
Farmer	+.77	.00		+.95	.00
Labourer, farm	+.22	.23		+.21	.36
Professional-Clerical	+.51	.00		+.38	.05
Labourer, other	+.06	.71		+.01	.95
Indigenous Name	-.07	.77		-.78	.00
Constant	67.5	.00		67.6	.00

Table 6: The Urban Effect within a Maximum Likelihood Truncated (64") Estimation of Stature, NZ-born Soldiers 21-49 years

World War One (n=2664)			World War Two (n=1250)		
	Coef.	P>|z|		Coef.	P>|z|
Born 1860-1874	+.73	.03	Born 1890-1899	+.08	.84
Born 1875-1879	-.19	.36	Born 1900-1904	-.22	.53
Born 1880-1884	+.42	.07	Born 1905-1909	+.11	.67
Born 1890-1894	-.02	.92	Born 1915-1919	+.05	.81
Born 1895-1899	-.44	.08	Born 1920-1924	-.64	.10
Farmer	+.69	.00		+.99	.00
Labourer, farm	+.34	.08		+.04	.90
Professional-Clerical	+.63	.00		+.43	.09
Labourer, other	+.11	.52		-.10	.72
Indigenous Name	-.15	.58		-.69	.01
Born Auckland	+.06	.80		-.43	.18
Born Dunedin	-.32	.15		-.07	.88
Born Christchurch	-.33	.13		+.70	.02
Born Wellington	-.22	.33		-.01	.99
Constant	67.6	.00		67.6	.00

Table 7: Unconditional Mean Stature for 18-20 Year olds

	Mean Stature (in)		t-statistic for difference
	WWI	WWII	WWI-WWII
Pakeha 18 yrs	na	68.0	na
Pakeha 19 yrs	67.7	68.0	-1.1
Pakeha 20 yrs	67.7	67.6	+0.6
Maori 18 yrs	66.7	66.7	+0.8
Maori 19 yrs	66.8	66.6	+0.5
Maori 20 yrs	67.3	67.1	+0.6
t-statistic for Pakeha-Maori difference			
18 yrs	na	6.1	
19 yrs	2.4	5.3	
20 yrs	2.7	1.3	

Table 8: Demographic Indicators of Maori and Pakeha Health

	Maori	Pakeha	M/P
deaths/10,000 people			
1920-1924	16.0	9.0	1.77
1925-1929	15.6	8.5	1.83
1930-1934	15.9	8.3	1.92
1935-1939	20.2	9.0	2.25
infant mortality/1,000 live births			
1925-1929	115.8	37.7	3.07
1930-1934	93.2	32.3	2.88
1935-1939	114.7	32.1	3.58

Source: New Zealand, Appendices to the Journals of the House of Assembly, H-31, Report of the Department of Public Health, 1925-1940

Table 9: Disease Impact, Maori and Pakeha, 1937-1940

Deaths/10,000 people

	Maori	Pakeha	M/P
Pulmonary Tuberculosis	31.68	3.28	9.7
Other Tuberculosis	9.13	0.65	14.0
Influenza	4.10	0.75	5.5
Thyphoid	1.83	0.05	36.5
Measles	24.30	1.10	22.1

Source: New Zealand, Appendices to the Journals of the House of Assembly, H-31, Report of the Department of Public Health, 1925-1940

Figure 1: Frequency Distribution of Stature, Adult NZ-born Soldiers, WWI

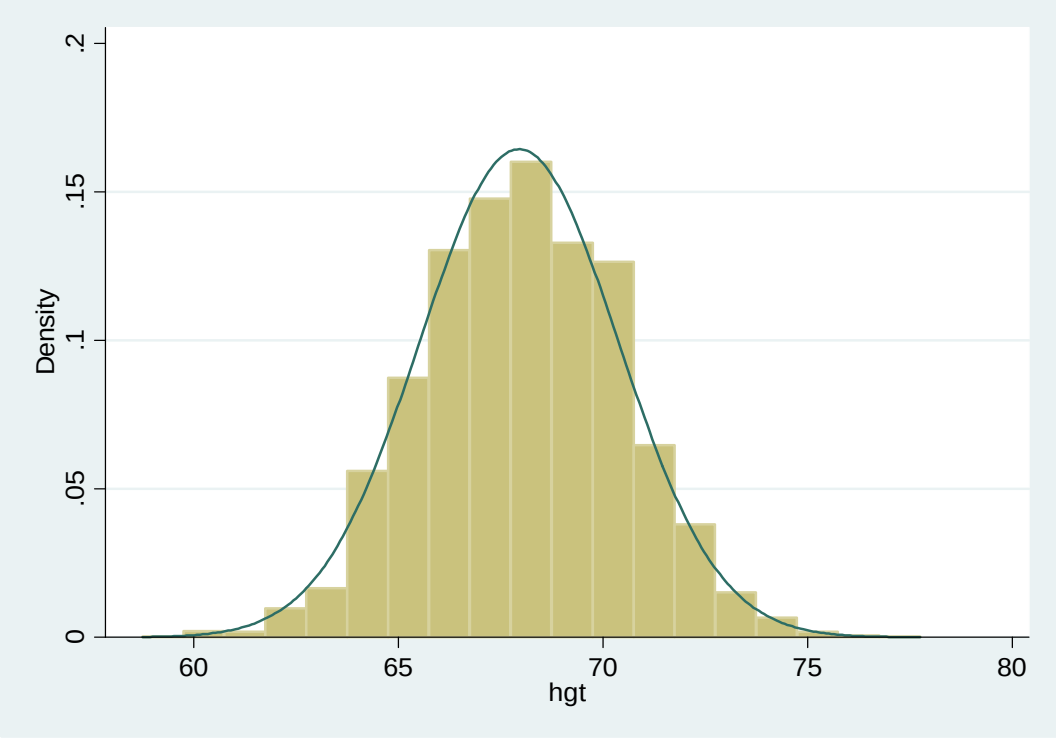
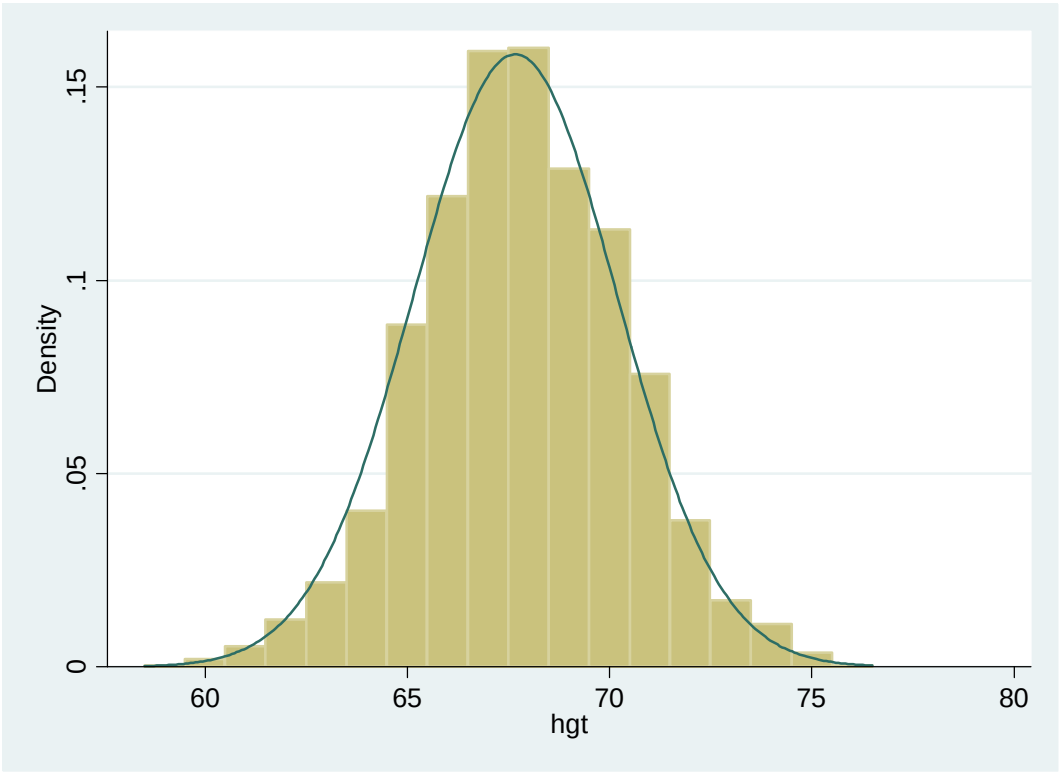


Figure 2: Frequency Distribution of Stature, Adult NZ-born Soldiers, WWII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0
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.15
60
65
70
75
80
hgt

Figure 3: Long-term Pattern of Real GDP and Commodity Output

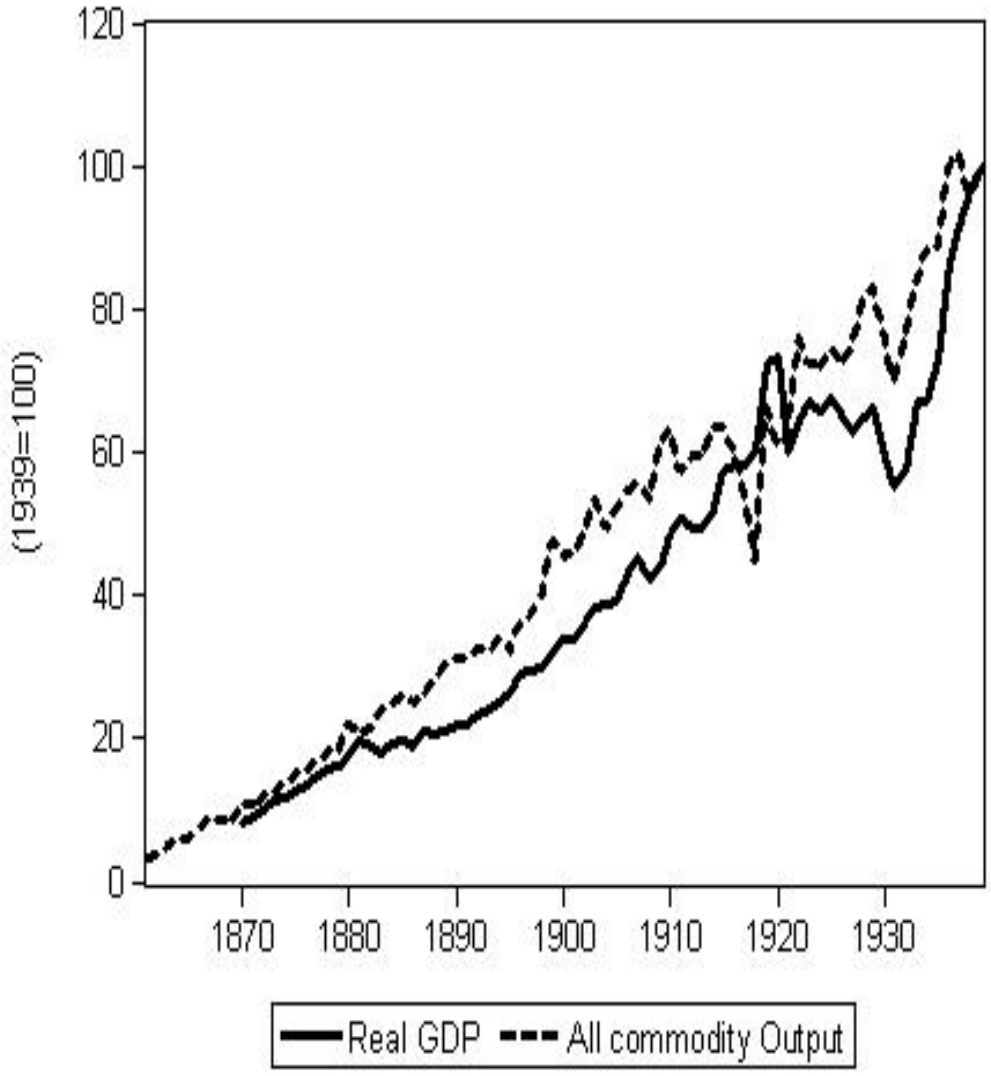


Figure 4. Average height of New Zealand boys, 1913-1934

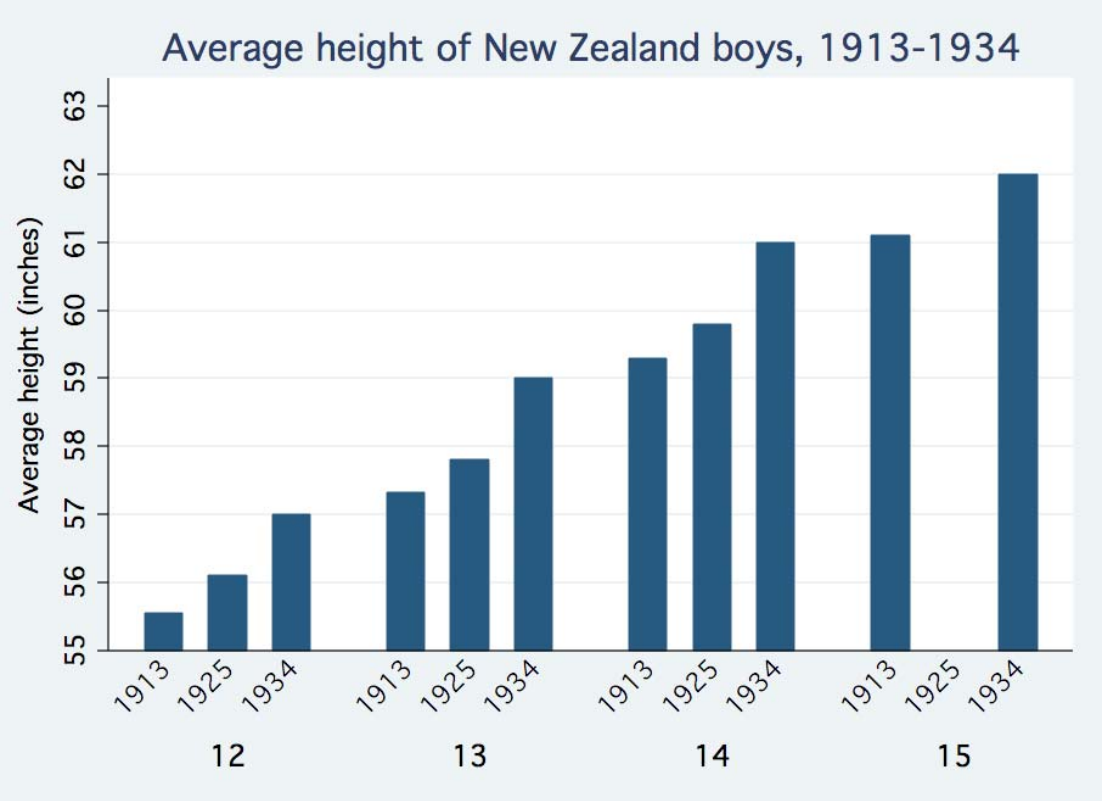


Figure 5. Infant mortality in New Zealand, 1861-1938

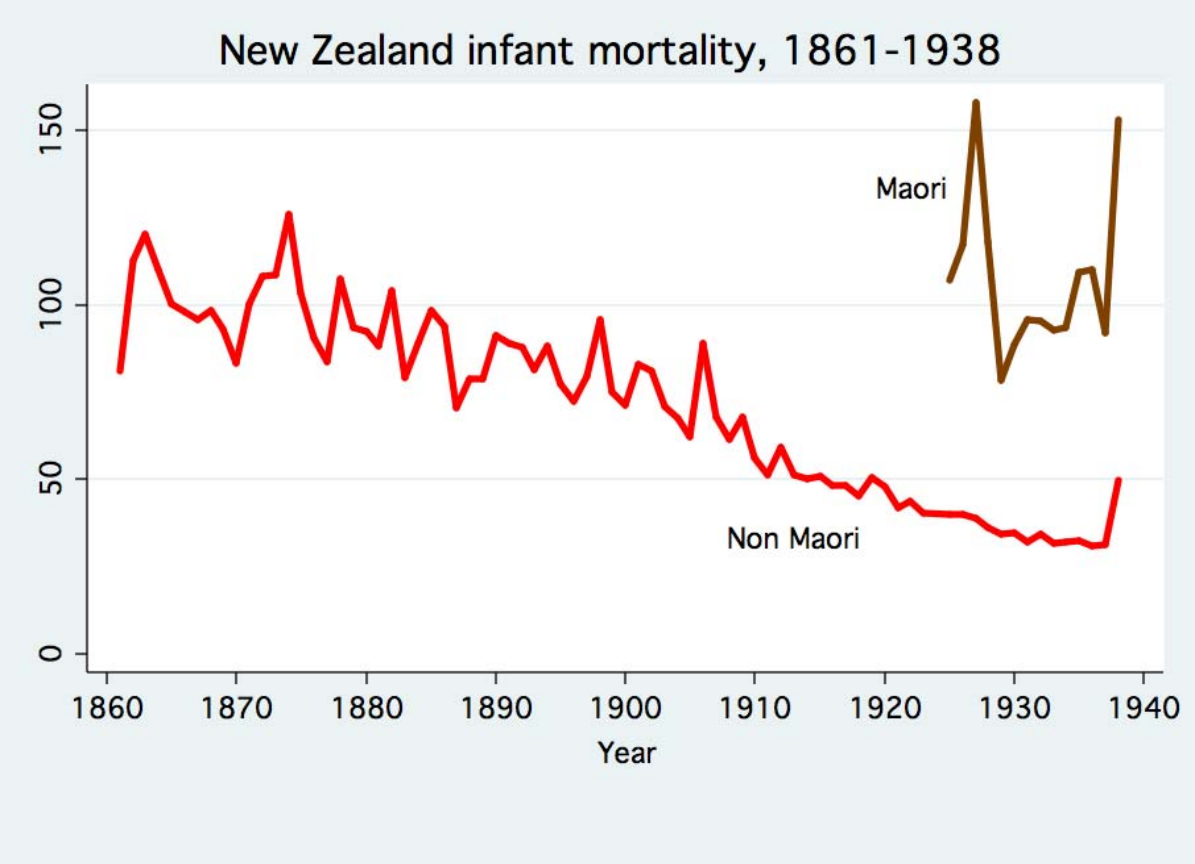
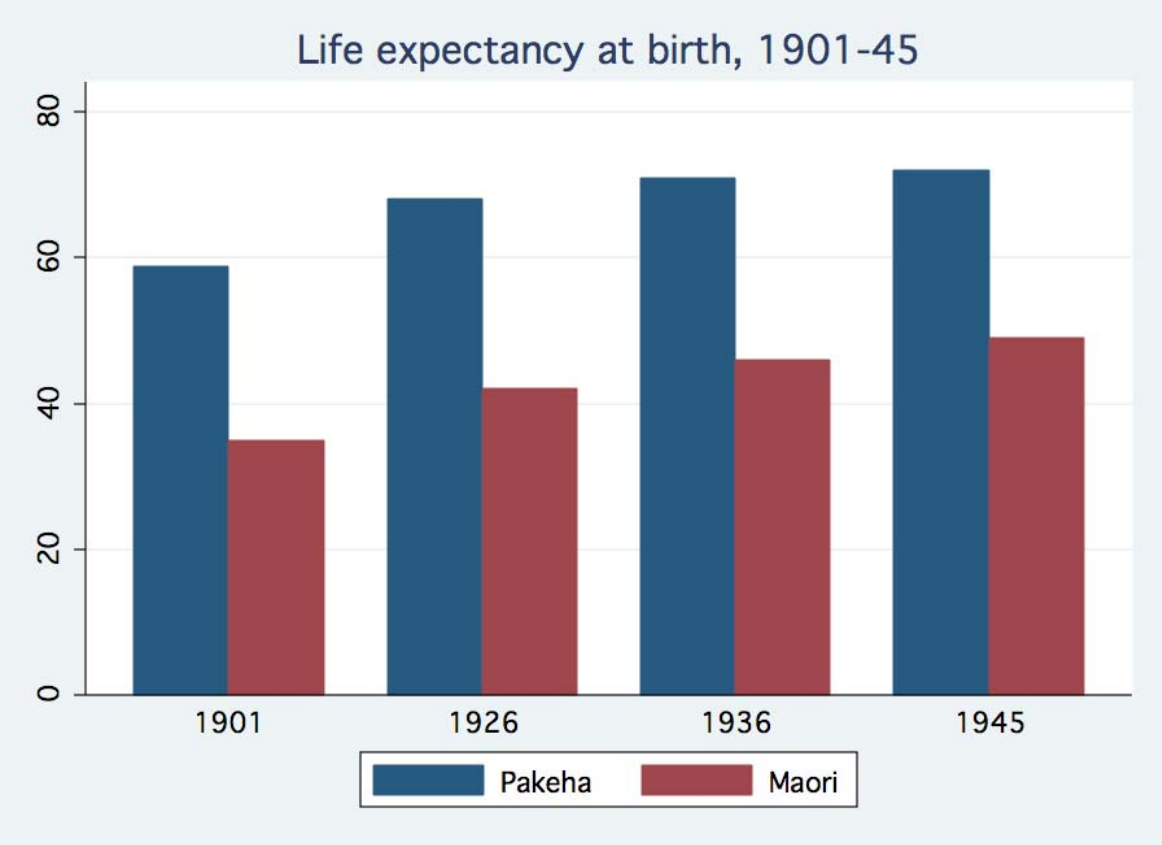


Figure 6. Life expectancy at birth, 1901-1945



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