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Tall, Active, and Well Made?
Maori Stature and Health in New Zealand

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"Tall, active, and well made" [1]? Māori stature and health in New Zealand

Abstract: We examine physical well-being among New Zealand Māori from the 1700s to the mid-twentieth century. After colonization Māori stature declined slowly. Late nineteenth century Māori and Pākehā (European settlers) stood equally tall, but Māori stature lagged between 1900 and World War II. Stature increased after the 1920s for Pākehā and 1950s for Māori. Convergence has re-established comparable stature. Fertility decline, improvements in socio-economic status, and health policy may explain convergence of stature and infant mortality. We hypothesize that the early twentieth century divergence reflects cumulative land loss, disease incidence, rural-urban migration and labour market segregation. [95 words / maximum 99]

JEL codes: I14; J15; N30; O57

I. Introduction

Between the sixteenth and nineteenth centuries Europeans colonized many previously independent societies in the Americas, Asia, Africa and Australasia. While African and Asian indigenous populations were stable or increased slightly during the era of European colonization (Manning, 2013), there was significant indigenous population decline in settler colonies in the Americas and Australasia that had been isolated from Eurasian diseases, and where European migrants and their descendents quickly outnumbered the indigenous

[1] Richard Cruise, *Journal of a Ten Months Residence in New Zealand* (London: Longman, Hurst, Rees, Orme, Brown and Green, 1824), 263.

population (Crosby, 1986, Kunitz, 1996).[2] However, the exact size of pre-European populations and the magnitude of decline remain unclear and debated by scholars to the present day (Gray, 1985, Livi-Bacci, 2006, Livi-Bacci, 2007, Pool, 1991, Thornton, 1997).The physical health of indigenous peoples clearly suffered, and yet some populations remained tall in spite of population loss through military conflict, epidemic disease and lost access to means of subsistence. The best-known example is the experience of Indians in the Mississippi River valley and on the western plains of North America who experienced little or no decline in physical stature even as the advancing tide of European settlement undermined health and well-being in ways that caused a sharp decline in population (Carlson and Komlos, 2013, Prince, 1995, Prince and Steckel, 2003, Steckel and Prince, 2001).

New Zealand provides another setting to examine the physical well-being of an indigenous population following European colonization and settlement. In this paper we examine the evolution of physical well-being among the indigenous Māori population as reflected in their stature, assembling a continuous series of stature measures from microdata covering cohorts born between 1830 and 1990. Māori population expanded considerably in the several centuries between their arrival in New Zealand and the arrival of Europeans late in the eighteenth century, with formal British colonization occuring in 1840 (Orange, 1987).

As in the Americas the range of estimates of pre-European population size have varied widely. Currently there is a scholarly consensus that the Māori population was around 125,000 in 1769.

[2] There is a large literature on settler colonies. Among important recent comparative works are (Belich, 2009, Denoon, 1983, Lloyd, 1998, Lloyd et al., 2013)

The introduction of European diseases and firearms precipitated population decline before colonization. Yet in comparison to the Americas the impact of European disease appears to have been smaller. A significantly longer voyage to New Zealand is likely to have reduced the incidence of diseases arriving in the country. Moreover, population density in New Zealand was low reducing the chances for diseases to spread. The introduction of firearms through trade with Europeans led to higher mortality, more through inter-tribal conflict known as the "Musket Wars," than through conflict with Europeans (Ballara, 2003). By 1840 when the Treaty of Waitangi gave Britain sovereignty over New Zealand the Māori population was around 80,000 (Pool, 1991).[3] Large-scale European—largely British—migration and settlement began around 1830 and continued through the late nineteenth century. Migration combined with high Pākehā fertility rates led to rapid European population growth until the 1890s, before a fertility decline in the early twentieth century that was similar in timing and size to American and Australian fertility declines (Jones, 1971, Pool et al., 2007).

While the colonial authorities espoused concern for protecting Māori, the actual practice of nineteenth century colonial settlement led to continuing population decline (Figure 1).

[3] While Europeans signed numerous treaties with indigenous peoples in other contexts the Treaty of Waitangi is distinctive for being a national treaty between Britain and most Māori tribes. The extent to which Māori ceded sovereignty has been the subject of significant political and historical discussion in New Zealand since the 1970s as part of a process of reconciling claims of breaches of the Treaty of Waitangi. Among a large literature see (Byrnes, 2004, Hill, 2009, Orange, 1987). For a comparative perspective see *inter alia* (Armitage, 1995, McHugh, 2009, McHugh, 2011)

Conflicts with Pākehā settlers and the colonial government were episodic from the 1840s through early twentieth century, and most intense in the 1860s (Belich, 1987). Through these conflicts, judicially sanctioned confiscation, and coerced purchases, Māori were deprived of ownership of the most productive agricultural land (Boast, 2008). Fertility is likely to have been disrupted by the dislocation induced by conflict and land loss. Infectious diseases also continued contribute to Māori population decline (Pool, 1991). Māori population reached a nadir of 42,000—approximately half its 1840—level in 1896.

In the twentieth century, in spite of rising population, Māori health was demonstrably inferior to that of Pākehā. Once it was clear, after 1900, that the Māori population was growing, health disparities between Māori and Pākehā (Europeans and their descendents in New Zealand) have been a recurring policy concern (Blakely et al., 2005, Craig et al., 2012, Durie, 1998, Rose, 1960, Rose, 1972). While Māori (male) life expectancy was 14 years lower than for Pākehā in 1951, the gap was 6 years in 1976, and then widened again to 10 years by 1991 (Tobias et al., 2009). Early in the twentieth century Pākehā infant mortality was extremely low by world standards (39/1000 in 1925), and while Māori rates were also low by world standards they were high in comparison to Pākehā rates.

Although the demographic outline is clear at least in broad terms, the exact origin of ethnic health disparities in New Zealand has been unclear, primarily because reliable evidence for Māori health only became available in the 1920s with the requirement, for the first time, to register all Māori births, marriages and deaths and with the emergence of a government commitment to monitor and support health in general and Māori health in particular (Dow,

1999, Lange, 1999, Pool, 1977). For earlier generations systematic evidence about individual health and demographic experience is unavailable. Aggregate-level information from historical census tabulations is useful in a broad way, but there is considerable uncertainty about the basis for Māori coverage and no way to investigate in the absence of microdata (Pool, 1991).

We expand the information available for analysis of the welfare of Māori taking an anthropometric approach using a "net nutrition" methodology, which interprets adult stature as a reflection of the physical well-being of children (Floud et al., 2011, Steckel, 2008, Steckel, 2009, Steckel, 2013). Assembling a time series of Māori stature necessarily takes us into multiple sources, not all of which are consistent with each other. Yet by assessing the merits of each we can move beyond differences in stature observed between the samples. Their biases go in different directions; how much military, anthropological and correctional samples should differ from each other is not clear. Nevertheless, where multiple sources point to a similar pattern we are able to remark more confidently on the trends and differences in Māori stature.

The logic of anthropometric history is that trends in mean stature can identify changes in economic and environmental conditions. Yet because population trends in stature may reflect simultaneous changes in disease incidence, caloric availability, and the physical demands of work and daily living, the time trend in stature does not in itself identify *why* stature changed. In other countries—especially the United States—it has been common to use variation in birthplace and early-life residence to measure different economic and environmental conditions experienced by people within the same cohort to explain why stature changed in a particular time period. In a representative example, Haines, Craig and Weiss (2003) are able to use

information on the county of Union Army enlistment and state of birth to measure local agricultural production population density, disease levels, and wealth during the growth period of the individuals for whom they have stature information.[4]

Unfortunately these well-used approaches to measuring individual circumstances in early life are not possible in New Zealand, making it considerably more difficult to infer *why* mean stature changed at different points for Māori and Pākehā. Like other scholars in the anthropometric tradition we rely on juridical and military sources for individual-level measures of adult stature. But in New Zealand we cannot match these adult sources to individual early-life census records as scholars in Britain, Canada and the United States have done, because the New Zealand authorities destroyed the manuscript census forms after publication of census results.[5]

Similarly, we are unable to use birthplaces *within* the same country as a proxy for early-life conditions. When birthplace—at a state, province or county level—is recorded with adult stature, scholars have been able to match aggregate measures about birthplaces to individual records. Variation over time in the economic and environmental conditions experienced in different states, provinces or counties of birth then allows scholars to examine why stature changed. This approach relies first on individuals born within the country of interest providing

[4] Other examples are numerous. For example, see Zehetmayer (2011) using post-Civil War Army data, or Carson (2008) using prison data.

[5] Nineteenth and twentieth century Australian census manuscripts were destroyed in a similar manner. Thus in both countries the earliest census microdata available dates from the 1970s.

a sub-national place of birth—a state, province, county or municipality; and secondly on statistical authorities publishing consistent series of sub-national data that identify the same states, provinces, counties or municipalities. These conditions are only infrequently observed in New Zealand. The country was divided into six provinces in 1852, that had split into nine, when the provinces were abolished in 1876 (Morrell, 1964). Provincial boundaries persisted into some late nineteenth and early twentieth century statistical series, but many series at the provincial level ceased publication in the 1920s. They were replaced either by disaggregated series for a selection of towns and cities that did not cover the entire country, or in a series of statistics for rural counties for which the boundaries are not always clear. Accordingly, series of state and county data consistent over many decades that are familiar to North American and British scholars have no analog in New Zealand. Moreover, the abolition of the provinces and the small size of the country means that in most of our data sources people born in New Zealand provided no information beyond "New Zealand" with which to place them in a sub-national economic and environmental context in their early life. Thus, we must rely on nationwide variation over time to establish plausible reasons for changes in Māori stature.

II. Māori stature during the 18th and 19th centuries

The physical condition of Māori impressed Europeans when they first met. Abel Janzoon Tasman, the Dutch explorer who discovered New Zealand for Europeans, wrote that Māori were giants, though it seems he mostly met chiefs. Despite his pioneering voyage Tasman did not place New Zealand firmly on the European map, though the Dutch connection survives in the country's name. More than a century passed before the celebrated repeat voyages of James Cook to New Zealand beginning in 1769. Cook, who was reported to stand six feet tall himself,

wrote in his journal that

> The Natives of this Country are a strong raw boned well made Active people rather above than under the common size especialy the men …. They seem to injoy a good state of hilth and many of them live to a good old age (Cook, 1893).

Archaeological evidence is consistent with Cook's observation. A study of 98 skeletons from museum collections around New Zealand led Houghton to estimate pre-contact stature at 68 inches, which was well above European standards of the day (Houghton et al., 1975). Māori mental capacity and social organization as well as their physique impressed Europeans from the early contact period. Māori were seen by many Europeans—within New Zealand and outside—as amongst the highest, if not the highest, class of non-Europeans. Māori were seen as nearly uniquely suited for adapting successfully to European 'civilization'. The impressions of European explorers and early settlers quickly reached the European and American public. In 1799 the Religious Tract Society told its readers in a pamphlet

> Generally speaking the South Sea islanders are above the middle stature, and in habits of body are rather corpulent than the contrary. The females in most of the islands are taller and stouter than those of Europe. The New Zealander is the most gigantic in stature and muscular in frame, and may be justly regarded as the most robust and hardy of the oceanic race." (Religious Tract Society, 1799)

Massachusetts school children learned similarly in an 1825 reader that Māori were "generally

equal to the tallest Europeans in stature, … stout and well made, but by the manner of sitting in their canoes, their legs are distorted" (Rowe, 1825). John George Wood's 1871 magnum opus on the *Uncivilized Races of Men* described Māori as

> a singularly fine race of people—tall, powerful, and well made," though also noting that "There seems to be two castes of men among the New Zealanders. The upper caste is distinguished by the above characteristics; but the lower is shorter in stature (Wood, 1871).

In 1884 the writer Anthony Trollope attempted a more precise description: an "active people—the men averaging 5 feet 6 inches in height—and are almost equal in strength and weight to Englishmen" (Trollope, 1884). A presenter at the 1890 American Association for the Advancement of Physical Education took it as common knowledge that Māori were amongst the tallest in the world, ascribing this to "climatic conditions" that make "the Laplander average in stature but 4 feet 11 inches, and the New Zealander 5 feet 9 inches" (Test, 1890). A belief in great Māori stature even persisted into a Charles Atlas-like advertisement in *Popular Mechanics* for a book called *Selling Human Stature*. The book promised to reveal to readers the answer to the question "What made the average New Zealander FIVE AND A HALF INCHES TALLER than the Indian."[6]

Systematic measurements began to appear in the middle decades of the 19th century. In April 1849 A.S. Thomson, a Regimental Surgeon with the British army, measured Māori men who

[6] "The Taller Person Has the Advantages in Life," *Popular Mechanics*, January 1946, p.75A.

presented for vaccination at the military hospital in Auckland (Thomson, 1854a, Thomson, 1854b, Thomson, 1854c).[7] Our reworking of Thompson's data places the mean for this group at 67.2 inches, and even this understates adult stature insofar as the age of nearly one-third of those measured was 16-20 years. Thompson's data suggest that men born early in the period of European settlement and living through the disruptions to Māori society and economy of the 1820s and 1830s had shrunk little if at all from the stature of their pre-historic ancestors. Admittedly, Thomson noted that they were "Waikato natives or men employed on the government works, both of which classes are usually better fed than the natives generally."

Additional evidence of Māori and Pākehā stature is available for those who participated in police and military forces of the period. The Armed Constabulary enlisted both ethnicities in the 'New Zealand Wars' of the 1860s and 1870s.[8] Records survive as well for militia units 1885-1910[9] and troops serving in the South African conflict 1899-1902 and World War One.[10]

[7] Thompson later wrote the first general history of New Zealand: *The Story of New Zealand: Past and Present, Savage and Civilized* (London: Murray, 1859).

[8] Archives of New Zealand, *Armed Constabulary Description Book* [P 8 1*1; MICRO 6429]; Peter Cooke and John Crawford, *The Territorials: the history of the territorial and volunteer forces of New Zealand* (Auckland: Random House, 2011). Some records are not useable because information was missing, individuals had not reached the age of 21 years or were born outside New Zealand.

[9] Archives of New Zealand, *Capitation Rolls of Volunteer Corps* 1860-1911, ARM 41 and *Volunteer Corps* 1863-1872 AD23. Annual capitation rolls for the militia units report name and occupation but not birthplace. Accordingly we can identify the Māori but, unfortunately, we cannot distinguish NZ-born from foreign-born Pākehā. Rolls from across New Zealand for the period 1885-1908 record 2671 entries with a Māori name. 1204 unique names with useable detail are available, although not all had reached 21 years. 90% of militia with Maori names report one of 7 occupations: farming trades (49%), labourer (15%), settler (12%), flax cutter/miller (5%),

A simple summary of these records in Table 1 provides an overview of the nineteenth century experience by birth cohort. We exclude men who enlisted before the age of 21 years because some of them were still growing and men older than 49 years in order to minimize the effect of height diminution at advanced ages.

Here we distinguish Māori from Pākehā on the basis of surname. Intermarriage is a complicating factor of unknown prevalence within our sources. Some scholars suspect there was a great deal more mixing of the races than is identified by published sources (Buck, 1925, Harre, 1968, Pool, 1991).[11] In the face of these complications we identify as Māori anyone who enlisted using a Māori name. Self-identification through the choice of name is a clear signal that someone has chosen to live visibly as Māori. We recognize that a genetically 'pure' Māori could adapt a European name, and a European might adopt a Māori name. Moreover identification via surnames does not identify as Māori men whose Māori descent was through their maternal line. For our purposes, though, the precise genetic composition of an individual matters less than how she or he lived. The reporting of an indigenous name points to someone

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sheep and stock trades (4%), bushmen (4%) and fishermen (1%). Nevertheless, the remaining occupations are diverse; they include trades such as coach-builder, butcher, bookbinder, blacksmith, carpenter, baker, billiard-maker and painter as well as service sector roles such as teacher, shop-assistant, clerk, clergy, lawyer, chemist, cook, store-keeper, manager, lawyer, journalist and letter-carrier.

[10] The South Africa War personnel records are part of the World War One collection described below. Many (although not all) South African war soldiers reported birthplace; they were entirely Pākehā.

[11] The South Island tribe Ngai Tahu may have intermarried more than the more populous North Island iwi. See P. Callister, R. Didham, and D Potter, *Ethnic Intermarriage in New Zealand*, Official Statistics Research Series 1 (2005). Angela Wanhalla, "One White Man I Like Very Much," *Journal of Women's History* 20, no. 2 (2008).

who lived within and identified with the indigenous community and, most importantly, grew up in a Māori environment. This social and environmental influence is what we wish to capture. Name-based identification is also broadly consistent with the modern self-identification criterion for ethnicity (Kukutai, 2011). In any case, in the military sources ethnicity was not explicitly recorded by the military authorities until after World War II, reflecting a more widespread practice by the New Zealand government which did not always collect data on the ethnicity of individuals.

Lest readers mistake this for official impartiality or blindness to questions of color or race, it should be noted that the government did distinguish Māori and Pākehā in the census (Kukutai, 2011). Separate "native" schools and a special court for Māori land issues also demonstrate that the New Zealand state was not racially blind (Barrington, 2008). Yet the native schools also educated significant numbers of Pākehā children in rural areas, and the ostensibly Māori unit in World War I, the Pioneer Battalion, included significant numbers of Pākehā (Pugsley, 1995). In World War II the famed 28th Māori Battalion was a unit raised and led by Māori political leaders to contribute to the war effort, but the majority of Māori who served in World War II served in normal, integrated units of the New Zealand forces. Assimilation of Māori into Pākehā society and ways of life was a consistent goal of New Zealand's political leaders until the late twentieth century. Moreover, European immigrants to New Zealand were diverse mostly in the sense that they came from different parts of Britain or Ireland (Phillips and Hearn, 2008). Thus the politics of racial statistics in New Zealand were quite different than in the United States, for example, where distinctions between white and black and between different nations of white people, were of huge political importance.

The Armed Constabulary, militia and South African War soldiers were somewhat unrepresentative of the broader population. These men likely were taller than the average for their societies. Nonetheless, the data in Table 1 are broadly consistent in two important respects. (i) Māori who undertook military service in the nineteenth century were roughly as tall as their Pākehā counterparts; indeed Māori were taller in most pair-wise comparisons. (ii) Stature appears to have declined slightly over time within each of the sources, for both groups.[12] This is the first suggestion that the net nutrition of Māori children, while very good by the standards of the day, may have declined slowly through the nineteenth century. Admittedly, many of the decadal and ethnic difference lack statistically significance on a difference of means test (unsurprisingly given the size of samples).

It must also be recognized that the Armed Constabulary sample is *not* regionally representative of the entire Maori population. Taranaki, Bay of Islands and Hawkes Bay clearly were under-

[12] A tendency for Pākehā decline born at the end of the century is reported elsewhere; see G. Whitwell, C. de Souza, C. and S. Nicholas, "Height, Health and Economic Growth in Australia, 1860--1940", in R.H. Steckel and R. Floud (eds) *Health and Welfare during Industrialization* (Chicago: University of Chicago Press, 1997), pp. 379--422; G. Whitwell and S. Nicholas, "Weight and Welfare of Australians 1890--1940". *Australian Economic History Review*, 41: 159--175; Ralph Shlomowitz, "Did the mean height of Australian--born men decline in the late nineteenth century? A comment". *Economics and Human Biology*, 5: 484--8; K. Inwood, L. Oxley and E. Roberts, "Physical stature in nineteenth century New Zealand: a preliminary interpretation". *Australian Economic History Review*, vol. 50 (2010): 262-83; John Cranfield and Kris Inwood, A tale of two armies: the stature of Australian and Canadian soldiers in World War One". *Australian Economic History Review* 50 (2015): 212-233 .

represented (Table 2). The Armed Constabulary as a fighting force was raised to counter Māori guerilla campaigns in the Waikato, Taranaki and Hawkes Bay. The Bay of Islands also had a long tradition of resisting colonial authority. The Waiapu (east coast) and Bay of Plenty (north coast) regions, on the other hand contributed a large majority of the Māori troops; they were substantially over-represented in the Armed Constabulary. A recognition that the samples are small and describe only a subset of the Māori conditions our use of the mid nineteenth century data.[13]

The militia and especially the World War One (WWI) data are more numerous and more representative (Crawford and McGibbon, 2007). Very large numbers of young and middle-age New Zealanders sought to enlist. Middle-class patriotic fervour was sufficiently strong to ensure that those with limited labour market opportunities did *not* dominate this enlisment, as is the case with so many military enlistments.[14] Our sample consists of ~15000 records selected from those made public by Archives New Zealand before 2009 and an oversample of 1800

[13] One reason to be cautious about the representativeness of the Māori in the Armed Constabulary is that some of those resisting the government appear to have been shorter. The stature of prisoners reportedly captured c1870 in the Hawkes Bay area averaged 66.8 inches. See Archives New Zealand, *Descriptions of and comments on Maori prisoners of war*, ACFK 8169 AGG-HB7 1/2b. We make this calculation for 198 men aged 21-50 years. Of course the representativeness of these prisoners is no more clear than that of the Armed Constabulary.

[14] Unfortunately, in the absence of census microdata there is no easy way to assess under- or over-representation of specific social groups.

Māori and 800 Pacific Islanders obtained with special permission from the files of men whose names fall in sections of the alphabet with significant indigenous representation.[15]

For these men we have information on name, place and date of birth, enlistment date, occupation at enlistment, marital status, educational achievement and religion, military identification number, and height and weight. Heights were measured to the quarter inch. The New Zealand military had measured men without shoes since at least the South African War of 1899-1902.[16] Many of the men were assessed as having 'good' health along various dimensions. If any aspect of a man's health was poor, further details from medical tests are sometimes given. Thus, while more detailed quantitative health information is available selectively for the less fit recruits, it is not easily used in the analysis of overall population health (Callon, 1980).

We set aside the records of women who served as nurses because their numbers are not sufficient to support analysis. We also discard men born outside New Zealand. This is 30% of

[15] Archives New Zealand took custody of 122,000 WWI and South African War records in 2005; they were released in response to individual requests from family historians. We had access to these records. Very recently Archives New Zealand announced that it has digitized and will make available all WWI and South African War records. About 5% of WWI records were not transferred from the New Zealand Defence Force to Archives in 2005 because the individuals went on to serve post-WWI; these service files were not publicly available when we collected data for this sample. The oversample was obtained from 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. We also acquire some Pākehā in this process.

[16] South African War attestation of William Eli Johnston, 1902. AABK/18805/W5515, Box 29, Record 2872. Archives New Zealand, Wellington.

our sample - roughly the same as the foreign-born share of men at appropriate ages in the 1911 census (32%).[17] The New Zealand-born personnel 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.

In Table 3 we compare the regional origins of WWI Māori with their proportions in the 1881 and 1901 censuses. Māori in most regions enlisted roughly in proportion to their share of the young male population. The under-representation of Waikato, Taranki and Northland (Bay of Islands in Table 2) continued, although the bias was much diminished from the experience of the Armed Constabulary fifty years earlier. Māori enlistment in WWI was more nearly representative of the entire population than sources we have examined previously.

Despite their very different character the WWI data describe a pattern familiar from earlier sources. Māori were as tall as Pākehā, and neither group appears to have become significantly taller or shorter across the cohorts. The Māori population was greatly reduced during the nineteenth century, in contrast to the fast growth of Pākehā, but throughout this process the stature of neither group changed markedly although there are signs of a modest tendency for both to become shorter.

[17] 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. Roughly 1 in 8 of our men were born in Great Britain. British migration to New Zealand peaked in the early-1860s and mid-1870s; see J. Phillips, and T. Hearn, *Settlers: New Zealand Immigrants from England, Ireland & Scotland 1800-1945* (Auckland: Auckland University Press, 2008).

III. Maori stature during the 20th century

The experience of early twentieth century cohorts may be seen from WWII personnel records, which are similar to those of WWI. We obtained permission to examine personnel files directly at the military personnel archive because they are not yet publicly available.[18] The core of our sample comes from a random selection of the microfilmed records; most Pākehā and a few Māori records are obtained in this way. As with WWI, we expand the Māori sample in sections of the alphabet with significant indigenous representation and with all records from the Māori 28th Battallion.[19]

The WWI and WWII personnel files have sufficient detail for a multivariate estimation that identifies change over time taking account of confounding influences. We employ a maximum likelihood truncated regression model that assesses the contribution of birth cohort, occupation and urban birth. Analysis is restricted to those born in New Zealand and those aged 21-49 at the time of medical examination (Table 4). 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.

[18] WWI records were made publicly available on the death of the last WWI returned soldier (veteran). We expect a similar release of WWII records sometime in the 2020s.

[19] See http://www.28maoribattalion.org.nz for the Maori Battalion.

The estimation ignores men less than 64 inches tall because a disproportionate number may have been excluded by WWI fitness requirements.[20] 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. WWII stature norms for military enlistment specified 62 inches; for comparability we use the same truncation standard for both wars. In practice few if any men were rejected on the basis of their stature. Not surprisingly, the distribution of stature for both wars approximates normality with very little sign of truncation.

We estimate separately on WWI and WWII data in recognition that enlistment processes may have differed slightly. The former describe men born in the final quarter of the 19th century while the latter describe the first quarter of the 20th century. The omitted categories are Pākehā in the 'other' occupational class (manufacturing and transport workers) born 1885-1889 and 1910-1914 outside of the major cities.

Estimated co-efficients, which are reported in Table 4, show little change over time. There was some tendency for the 1890s-born WWI soldiers to be shorter, as is seen in previous estimations for New Zealand and other countries (Cranfield and Inwood, 2007, Inwood et al., 2010). Overall, however, Pākehā stature appears to have changed very little between 1870 and 1900 and between 1900 and 1925. WWI troops born in the South Island cities of Dunedin and

[20] Few men in either war were rejected for military service on the basis of their stature; see Callon, *'Fighting Fit'* and Archives New Zealand, *General Instructions for medical Examination of Army Recruits*, AD 1 box 1252 271/18/2 part3 May 20 1943.

Christchurch experienced a modest stature penalty. For WWII cohorts, however, none of the cities had a significant urban penalty.

The coefficients estimated for broadly defined occupational groups suggest the presence of significant socio-economic inequality. The soldier's occupation acts as a proxy for father's occupation on the assumption of intergenerational persistence at the level of broad occupational classess. The assumption is reasonable for the period but, admittedly, it introduces imprecision to the extent that some men may not enter the occupational class of their fathers. Moreover, any selection by stature into occupations will bias the interpretation of estimates for the purpose of assigning causal significance.

It is not possible to assess fully the risk of imprecision and bias with New Zealand soldiers.[21] Fortunately, for WWI soldiers in Canada, it has been shown that the assumption of intergenerational persistence has no substantive effect in the sense that a similar estimation is robust to the use of the soldier's own occupation as opposed to the father's occupation (Cranfield and Inwood, 2015a). Although it is difficult to be more precise for New Zealand, it remains useful to adjust for changing occupational composition even if causal interpretation of occupational effect is uncertain.

With this caveat, we observe that in both periods men in the rural occupations were relatively

[21] A dearth of plausible instruments precludes any correction for endogenous selection. The obstacle to a more direct assessment of intergenerational persistence is destruction of all historical census manuscripts in New Zealand. We are working to develop a small sample of father-son occupations from vital events registration.

tall. Men in the professional and clerical occupations were also tall – as expected from the higher class standing and family circumstances permitting greater spending on food and healthy housing. Men in the laboring and manufacturing (the omitted group) occupations, especially those in urban areas and lacking in specific skills, probably grew up with lower family income in less healthy environments, and consequently were shorter.

A comparison of the two estimations indicates that farmers in the WWII cohorts increased their stature advantage over urban manufacturing and transport workers from the experience of WWI cohorts. Other occupations diminished in size relative to the omitted group; general laborers experienced the biggest loss. Inequality increased to the extent that the differential between shorter and taller groups increased from WWI to WWII cohorts.

The most striking difference between the two estimations, however, is the effect of being Māori. We estimate both ethnicities jointly with a dummy variable for Māori ethnicity and then separately for each ethnicity. The former method suggests that WWI Māori were one-fifth of an inch shorter than Pākehā after controlling for other influences. In the WWII cohorts, however, Māori were about two-thirds of an inch shorter. The increased differential cannot be the result of Māori 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 large size of the Māori stature penalty for WWII cohorts is striking. It suggest that the net nutritional experience of children born during the first quarter of the twentieth century was very different for Māori and Pākehā – a difference that had not been visible in WWI or in the ninetheenth century sources.

We investigate more closely with separate estimations that remove the constaint of forcing socio-economic, cohort and birthplace controls to be the same for each ethnicity. For WWI the occupational and cohort controls follow qualitatively similar patterns for Māori and Pākehā. The biggest difference is that a farm occupation does not yield a stature advantage for Māori; there are not enough urban-born Māori to consider that effect. The intercept co-efficient in the two regressions suggests that Māori were slightly taller than Pākehā (rather than slightly shorter as in joint estimation with dummy variable).

Individual ethnic estimation for the WWII cohorts tells a very different story. The intercept co-efficient indicate that Māori were about half an inch shorter than Pākehā (with or without the urban effects). There is no consistent trend over time for either group. Occupational patterns differ a little; the most importance difference (again) was that being a farmer (or farm labourer) was associated with greater stature for Pākehā and the opposite for Māori.

Separate ethnic estimations allow us to perform a simple Blinder-Oaxaca decomposition on the WWII data, reported in Table 5.[22] The decomposition suggests that about one-third of the Māori-Pākehā differential is associated with being born into particular cohorts or occupations associated with short stature. Roughly two-thirds of the differential arose from ethnic differences in the stature consequences of personal characteristics (for example farmer, being strongly positive for Pākehā stature but negative for Māori). The implication is that the early

[22] For the decomposition we use co-efficients from an OLS estimation, which are very close to those of the maximum likelihood truncated estimation.

twentieth-century differential reflects why Māori had a different set of characteristics (e.g. fewer professionals and more laborers) and also as yet unexplained differences in the effect of being born at a particular time or into a particular occupation.

The most striking feature of our examination of military stature is the divergence between Pākehā and Māori that opened up during the early twentieth century. The visual representation of Figure 2 ignores any selection differences between WWI and WWII, however it has the advantage of pointing directly at this divergence. We next consider if patterns visible among soldiers might also be visible across other parts of the population. The WWI and WWII enlistments crossed class boundaries and represent a very large share of younger and middle-aged men, however the military filter for basic fitness and good behavior makes it is useful to consider other sources.

Prison records describe a different subset of the population. Prisoners came from less affluent social backgrounds, on average, than did the soldiers. There is no requirement for basic physical fitness or mental competence. Another difference, and an advantage, is that prison records record heights continuously each year rather than in a small number of years (eg 1914-1918 and 1939-1945).

We have collected data on all New Zealand-born individuals in prison registers held by Archives New Zealand. These include four large sets of records for prisons in New Plymouth, Witako and Wanganui and smaller record sets from 34 other prisons; some are national

institutions of a specialized nature and others local gaols.[23] Three-fifths of the records come from prisons in New Plymouth and Napier which, fortuitously, are located near areas with substantial Māori populations in the provinces of Taranaki and Hawkes Bay respectively. In total there are more than 28,000 records male prisoners although not all have reached adulthood and some men were incarcerated more than once. The admissions stretch from the 1860s to the 1970s. After exclusions for missing information and age we are left with nearly 24,000 records for New Zealand-born men between 21 and 49 years (Inwood et al., 2015).

We distinguish Māori by the descriptions of nativity made in the prison registers themselves, unlike in the military records where we haved to rely on surname. The nativity descriptions appear to have had a crude "blood quantum" concept behind it with some men described as being between ¼ and ¾ Māori. Others were merely described as Māori; many of these men likely were "full-blooded" although we do not know this with certainty. We examine all men indentified as Māori regardless of the blood quantum. Our interpretation is a social one, as with the military records, that being noted as Māori of whatever proportion reflects something about the origins of that person. The reporting of someone as Māori points to someone who lived within and identified with the indigenous community, and probably grew up in a Māori environment.

A rolling average of stature by year of birth is shown for both ethnicities in Figure 3. The pattern closely follows that of the military records. Māori born before 1890 who entered prison tended

[23] Registers for the largest prisons in the four main centres – Auckland, Christchurch, Dunedin and Wellington- have not been transferred to Archives New Zealand.

to be slightly taller than Pākehā, but the difference is neither consistent nor statistically significant. The differential reversed for men born after 1890, and the gap grew in size after 1900.

A more formal test of the timing of divergence is available from a multivariate regression similar to that undertaken with soldiers in which stature is regressed on occupation group, decadal cohort and ethnicity. This evidence confirms that cohort-specific Māori co-efficients are either small or statistically insignificant until the 1920s, at which point the differential becomes significant and then grows to a substantial size for the 1930s and 1940s birth cohorts.[24] Māori fell behind decisively during the war and interwar period, and then closed the gap slightly after WWII.

Thus, the prison records identify an early twentieth-century divergence between Māori and Pākehā stature that is consistent with the evidence of military personnel records. The different selection process, the continuous nature of prison admissions and an alternate method of ethnic identification make the coincidence of military and prison evidence data all the more persuasive.[25] Within the framework of net nutrition it is clear that Māori childhood was disadvantaged relative to Pākehā in the early twentieth century in a way that had not been true for earlier generations. Indeed, the prison data suggest that many Māori children born in the

[24]Inwood, Oxley and Roberts "Physical growth and ethnic inequality", table 3.

[25] Evidence suggests that the early 20th century was also damaging for Australian aborigines, in spite of having very different living conditions than for the Māori. See S.R. Nicholas, R. Gregory and S. Kimberley, "The Welfare of Indigenous and White Australians 1890-1955", in J. Komlos and J. Baten, eds., *The Biological standard of living in comparative perspective* (Stuttgart: Franz Steiner Verlag, 1998), pp.35-54.

1940s would grow up shorter than their grandparents born in the nineteenth century. Other sources confirm the experience. Surveys undertaken during 1962-1963 in the Lake Taupo region, for example, indicate that 40-49 year-olds and 50-59 year-olds were taller than or similar in stature to 20-29 year-olds in the same communities.[26]

The prison data to which we have access identify adult stature for people born until the early 1950s (Figure 3). The only available source that describes people later is the series of health surveys undertaken by the New Zealand government. We examine microdata from health and/or nutrition surveys in 1989, 1997, 2002, 2007, 2008 and 2011-2013. Each sampled with a similar random stratified design allowing for some oversampling of Māori and Pacific Islanders. The details vary but the selection was in all cases random and representative for each ethnicity.[27]

Microdata from the modern surveys are represented in Figure 4. The pattern is clear. The divergence in stature beginning c 1900 began to reverse itself among men born in the 1950s

[26] Prior, "Health", Tables II and IV. This study also points to disease rather than insufficient nutrition as a distinguishing characteristic of Māori health.

[27] Each survey randomly selected adults (and in some cases children) within households, households within 'small area units' and units within socio-economically defined 'strata' or District Health Boards. Self-identified Māori households were oversampled by increasing sample density in regions with concentrations of Māori population (based on the census and the electoral roll). This method may have increased slightly the selection of Pākehā who lived close to concentrations of Māori but in other respect all surveys were random and representative for each ethnicity. The surveys examined private households. Some non-private accommodation was included in 2011-2013 although prisons, hospitals and aged-care institutions with medical care continued to be excluded. The surveys tended to rely on self-identification of ethnicity.

and 1960s. Convergence was dramatic among those born after 1970; Māori and Pākehā born in the 1980s and 1990s would grow up to be roughly the same stature.

Other indicators that first became available during the 1920s and 1930s largely confirm Māori experience in the mid-twentieth century. In Figure 5 and Table 6 we summarize infant mortality and crude death rates as they were reported in the Historical Statistics of the United States, National Vital Statistics Reports, New Zealand Official Yearbooks and the Annual Reports of the Registrar General (various). The 5-year infant mortality and crude death rates of the Māori were 2 to 4 times that of Pākehā. The late 1930s were particularly difficult for the Māori.

Not surprisingly, during the 1930s concern grew in government and professional circles for the 'Māori health problem'. Information collected by the Department of Public Health pointed to to the importance of disease rather than nutrition:

> "The two main condition in which the Māori child compares unfavourably with the European child are tuberculosis and skin diseases … The percentage of Māori children with subnormal nutrition, however, is lower than that of the European children."[28]

The losses of life attributed to various diseases, reported in Table 7 reinforce this perspective. Māori were 5 times more likely to die of influenza, 10 times more likely to die of pulmonary

[28] New Zealand, Appendices to the Journals of the House of Assembly, H-31, *Report of the Department of Public Health*, 1935, p. 8.

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. Exposure clearly mattered a lot for tuberculosis. A 1940 report of the same department notes that tuberculosis was found in 0.2% of all Pākehā children and an astonishing 40% of Māori children.[29]

The mortality and morbidity data confirm that diseases of various kinds severely compromised Māori child health during the 1930s. Sharpe usefully reminds us that in the historical context respiratory disease such as tuberculosis as well as the more widely-recognized gastrointestinal and diarrheal diseases (including typhoid) could damage a child's ability to realize growth potential (Sharpe, 2012). In these circumstances a substantial Pākehā-Māori difference in physical stature for those born in the 1930s is unsurprising.

Public attention to Māori health increased in the 1960s just as various measures were beginning to reveal significant improvements (Prior, 1968, Rose, 1960, Rose, 1972). The most recent estimates suggest that life expectancy increased especially rapidly from the early 1950s to the later 1960s (Tobias et al., 2009). Infant mortality provides a longer-run perspective in Figure 5. No sustained improvement in Māori infant mortality was visible until the end of WWII but, as with stature, dramatic change followed soon after. Infant mortality, among Māori was cut in half from 1945 to 1960. Pākehā infant mortality remained much lower, but with a slower rate

[29] New Zealand, Appendices to the Journals of the House of Assembly, H-31, *Report of the Department of Public Health*, 1940, p.

of decline in the gap between ethnicities was closing. The tendency to converge until the difference between ethnicities, while still noticeable and a concern for public policy, was small relative to earlier in the century.

V. Reflections and Conjectures

Our goal in this paper has been to establish the long-term trajectory of Māori health and ethnic health disparities in New Zealand. Our portrayal of the experience for men born since WWII is familiar: the convergence of stature largely mimics other summary indicators such as infant mortality and cohort-specific life expectancy at birth. Improvements among the Māori, absolutely and relative to Pākehā have been considerable, even if the surviving ethnic divide remains a significant policy challenge. We have no reason to question the standard New Zealand view of this convergence, for example as expressed by Pool and Cheung (2003).[30] Since World War II Māori incomes increased, fertility diminished and the government's social policy commitment ensured that the benefits of public health and medical knowledge improvements reached Māori as well as Pākehā.

Our evidence for the trajectory of adult stature before World War Two is more novel. The long-run data demonstrate that ethnic differentials in physical well-being did not begin in the 1960s, or even in the 1930s. And yet, unexpectedly, there is no evidence that Māori stature

[30] Pool and Cheung do not consider the possible impact of the Māori cultural renaissance of the 1960s, which may have contributed to a collective self-confidence and with it more effective economic action. Equally, greater self-confidence may have diminished any tendency for 'ethnic migration' whereby the more successful ceased to self-identify as Māori and instead represented themselves as Pākehā.

was compromised to any significant extent during the experience of colonization in the late eighteenth and nineteenth centuries. Thus, we can be relatively confident in saying that the origins of stature differentiation along ethnic lines are situated in the early decades of the twentieth century. Admittedly, the nineteenth century sources are fragmentary and must be interpreted with caution. Nevertheless, our dominant impression is that Māori stature remained roughly comparable to that of Pākehā throughout the nineteenth century. And yet Māori population was declining. The Māori experience therefore parallels that of North American Indians of the Great Plains and Mississippi River valley who appear to have maintained their stature in the same period despite enduring a comparable process of demographic decline (Carlson and Komlos, 2013, Prince and Steckel, 2003, Steckel and Prince, 2001).

There are a number of ways to reconcile the divergent experience of stature and demographic trends. Some sources of elevated mortality risk such as military conflict may have had relatively weak adverse consequences for the survivors. Population loss would have mitigated the impact of a widespread dispossession of Māori land. A theme originally developed to understand the Irish in a European context may be helpful in both North America and New Zealand (Nicholas and Steckel, 1997). A rural population with access to food resources and sufficiently isolated from infectious disease circulation had the potential, at least, for health that compared well with higher-income but more urban societies.

Whatever the explanation for the seemingly paradoxical nineteenth-century experience, the early twentieth-century brings a different interpretative challenge. As we have seen, during the early decades of the century Māori experienced a marked relative deterioration and a small

absolute deterioration in physical well-being. This is especially telling because precisely in these years many other populations entered the 'modern health transition' to substantial improvements in stature and health (Easterlin, 2009, Floud et al., 2011).

We view the early twentieth century in the context of a century-long colonial expansion by Europeans in New Zealand. By the 1890s an accelerating process of industrialization and urbanization was challenging the health of both Māori and Pākehā. The loss of political sovereignty, social and economic disruption over several generations and diminishing access to land undoubtedly enhanced Māori vulnerability to the ill effects of industrialization without providing the same protections as enjoyed by Pākehā. For a largely rural population the cumulative impact of land loss, portrayed in Figure 6, must have been significant, and especially so after the Māori population had ceased to decline and begun to increase. Thus we interpret declining stature and elevated mortality and morbidity during the first half of the twentieth century as long-run consequences for the Māori of a process of invasion and colonization that began in the later decades of the eighteenth century.

Table 1: Mean Stature of NZ-born males, 21-49 yrs, various sources

	Māori			Pākehā		
	# obs	height mean	s.d.	# obs	height mean	s.d.
Armed Constabulary, 1866-1881						
born 1820s & 1830s	64	70.0	1.64	11	68.7	2.43
born 1840s	114	69.2	1.63	103	69.2	1.89
born 1850s & 1860s	44	68.0	2.01	153	69.7	2.08
Militia (Māori), South African War (Pākehā)						
born 1860s	162	69.1	2.01	39	68.8	2.18
born 1870s	384	69.0	2.06	479	68.6	1.82
born 1880s	216	68.7	2.00	122	68.5	1.47
World War One						
Born 1875-1879	44	67.9	2.29	730	67.9	2.38
Born 1880-1884	81	67.7	2.55	1393	67.8	2.53
Born 1885-1889	186	68.0	2.20	2381	67.9	2.34
Born 1890-1894	555	67.9	2.16	4046	67.9	2.36
Born 1895-1898	248	67.6	2.30	1035	67.7	2.49

Table 2: Spatial Distribution of Māori in the Armed Constabulary Sample and Māori Population in the 1874 (first) Census

Census district	Proportion of Armed Constabulary	Proportion of Māori Men >15 years 1874 Census
Auckland	1.6	1.0
Bay of Islands	6.6	12.4
Hawkes Bay	1.9	22.4
Maketu	35.8	12.1
Opitiki	23.0	8.7
Otago	0.4	2.2
Raglan	0.8	8.9
Taupo	1.9	3.4
Taranaki	1.2	14.9
Waiapu	26.1	10.0
Otaki	0.4	3.1
Wellington	0.4	0.9

Table 3: Spatial Distribution of the WWI Māori Sample and Māori Population in the 1881 and 1901 Censuses

		Proportion of Māori	
	WWI	1881 Census	1901 Census
North Island			
Auckland	2.8	3.7	3.5
Bay of Plenty	23.4	25.4	12.4
Chatham Islands		0.4	0.3
Coromandel	0.9		1.5
Gisborne	10.4		10.2
Hawkes Bay	13.0	9.3	12.1
Manawatu-Wanganui	6.8	8.1	8.6
Northland	16.3	16.8	20.3
Taranaki	2.0	6.4	5.8
Waikato	15.6	21.9	18.2
Wellington	3.7	3.4	2.4
South Island			
Canterbury	3.1	1.6	1.8
Marlborough	0.3		0.7
Otago	1.4	1.6	0.9
Southland	0.7		0.5
Tasman	0.3	1.6	0.4
West Coast	1.3		0.2

Table 4: Maximum Likelihood Truncated (64") Estimation of Stature, NZ-born Soldiers 21-49 years, WWI and WWII

World War One

	all	all	Pakeha	Pakeha	Maori
Māori	**-0.18**	**-0.21**			
Farmer	**0.73**	**0.70**	**0.79**	**0.76**	0.05
Farm labourer	**0.45**	**0.42**	**0.40**	**0.37**	0.55
Professional/clerical	**0.73**	**0.74**	**0.74**	**0.75**	1.24
Labourer	**0.25**	**0.23**	**0.25**	**0.23**	0.00
Born 1865-1874	0.20	0.20	0.23	0.24	-0.62
1875-1879	-0.22	-0.20	-0.20	-0.18	-0.72
1880-1884	-0.11	-0.10	-0.08	-0.06	-0.94
1890-1894	-0.04	-0.05	-0.05	-0.05	-0.06
1895-1899	**-0.27**	**-0.28**	**-0.31**	**-0.32**	-0.14
Dunedin		**-0.37**		**-0.37**	
Christchurch		**-0.34**		**-0.34**	
Wellington		-0.09		-0.09	
Auckland		-0.02		-0.02	
Constant	**67.47**	**67.53**	**67.44**	**67.50**	**67.77**
Observations	8815	8815	7979	7979	836

World War Two

	All	All	Pakeha	Pakeha	Māori	Māori
Māori	**-0.68**	**-0.65**				
Farmer	**0.66**	**0.69**	**0.88**	**0.93**	-0.49	-0.49
Farm labourer	**-0.23**	-0.20	-0.01	0.02	**-0.74**	**-0.73**
Professional/clerical	**0.57**	**0.57**	**0.62**	**0.62**	0.21	0.15
Labourer	**-0.32**	**-0.29**	**-0.39**	**-0.36**	**-0.48**	**-0.47**
Born 1890-1895	0.08	0.10	0.03	0.05	0.72	0.73
1900-1904	0.09	0.09	0.07	0.08	0.03	0.02
1905-1909	0.11	0.11	0.03	0.03	**0.46**	**0.46**
1915-1919	**0.20**	**0.21**	0.17	0.19	0.28	0.28
1920-1924	-0.01	-0.01	0.11	0.12	0.00	0.00
Auckland		0.02		0.00		0.50
Wellington		0.10		0.09		1.61
Christchurch		**0.78**		**0.82**		-0.26
Dunedin		0.08		0.11		0.16
Constant	**67.54**	**67.48**	**67.52**	**67.45**	**67.06**	**67.04**
Observations	9080	9080	6114	6114	2966	2966

Coefficients estimated with significance at 5% confidence level are **bolded**
Coefficients estimated with significance at 10% confidence level are underscored

Table 5: Blinder-Oaxaca decomposition of the WWII sample

Blinder-Oaxaca decomposition: WW2 sample

Height	coeff	p value	nobs
Pakeha	68.09		6114
Maori	67.42		2966
difference	0.670	0.00	
endowments	0.205	0.00	
coefficients	0.465	0.00	
interactions	0.0004	0.99	

Table 6: Demographic Indicators of Māori and Pākehā Health

Deaths/10,000 people	Māori	Pākehā	M/P ratio
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	Māori	Pākehā	M/P ratio
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

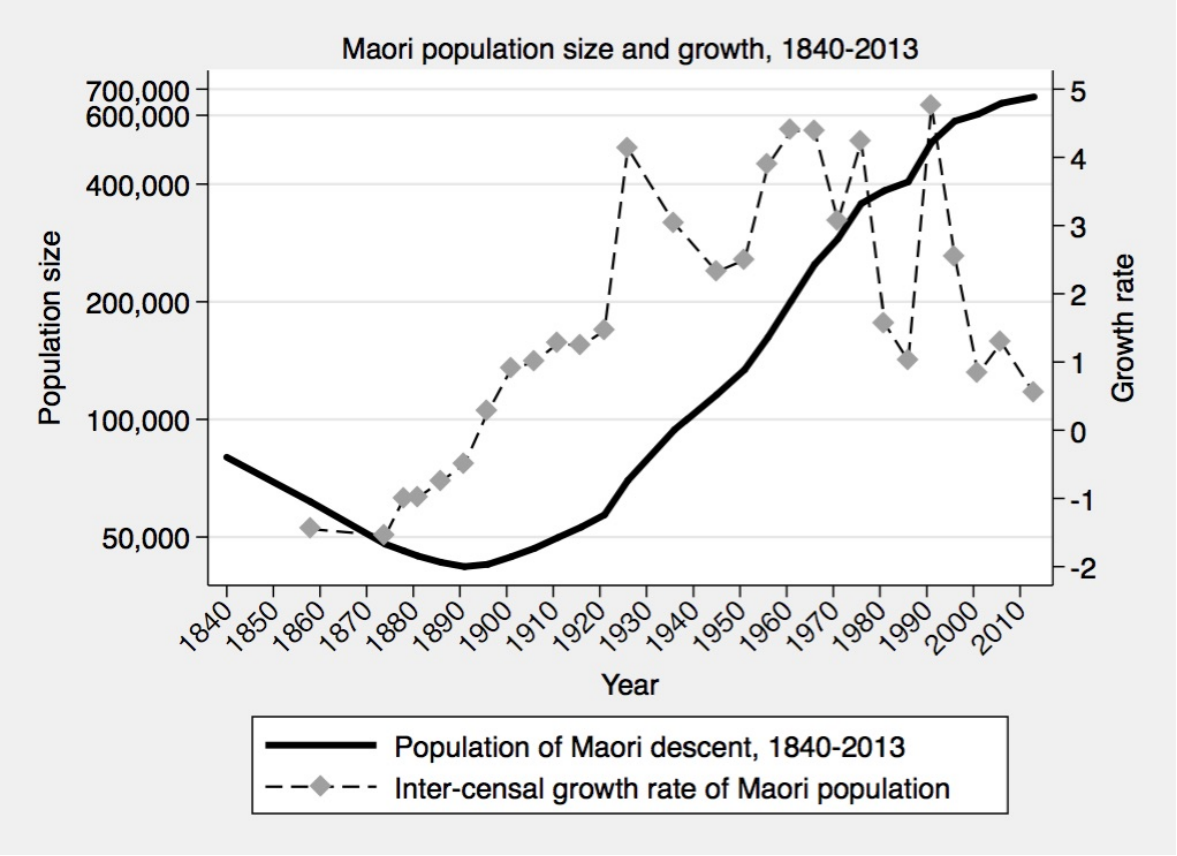
Table 7: Disease Impact, Māori and Pākehā, 1937-1940

Deaths/10,000 people

	Māori	Pākehā	M/P ratio
Pulmonary	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: Maori population size and growth, 1840-2013



Source: Long Term Data Series on Statistics NZ.

Figure 2: Rolling Average of Mean Stature, Māori and Pākehā Soldiers (combining WWI and WWII), by Birth Cohort 1870-1925

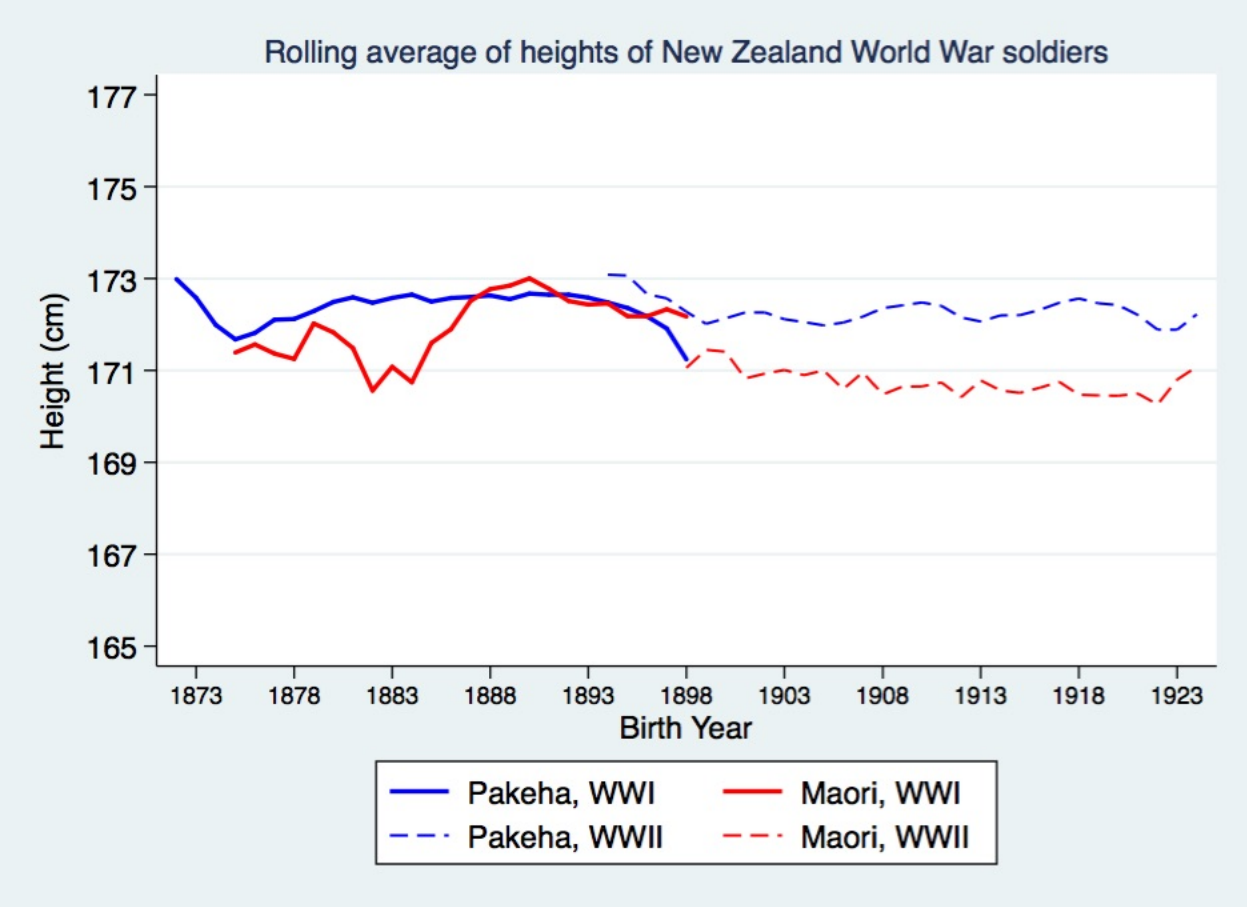
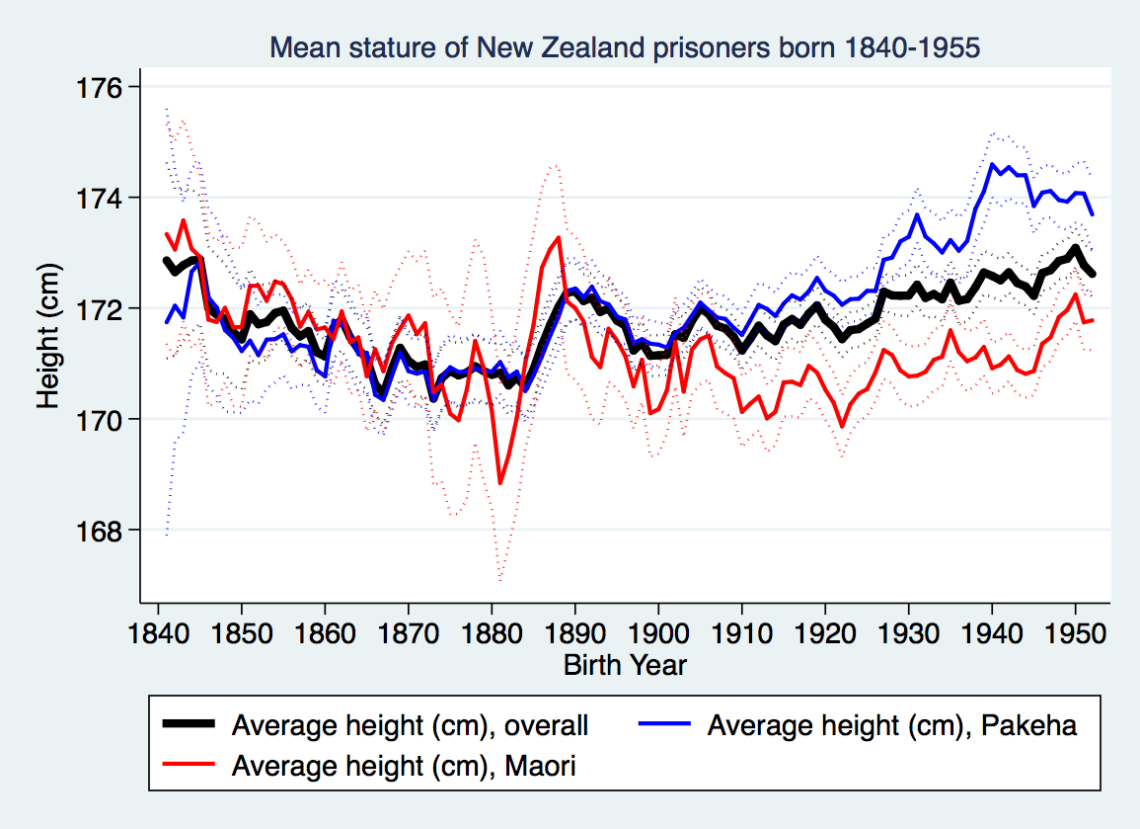
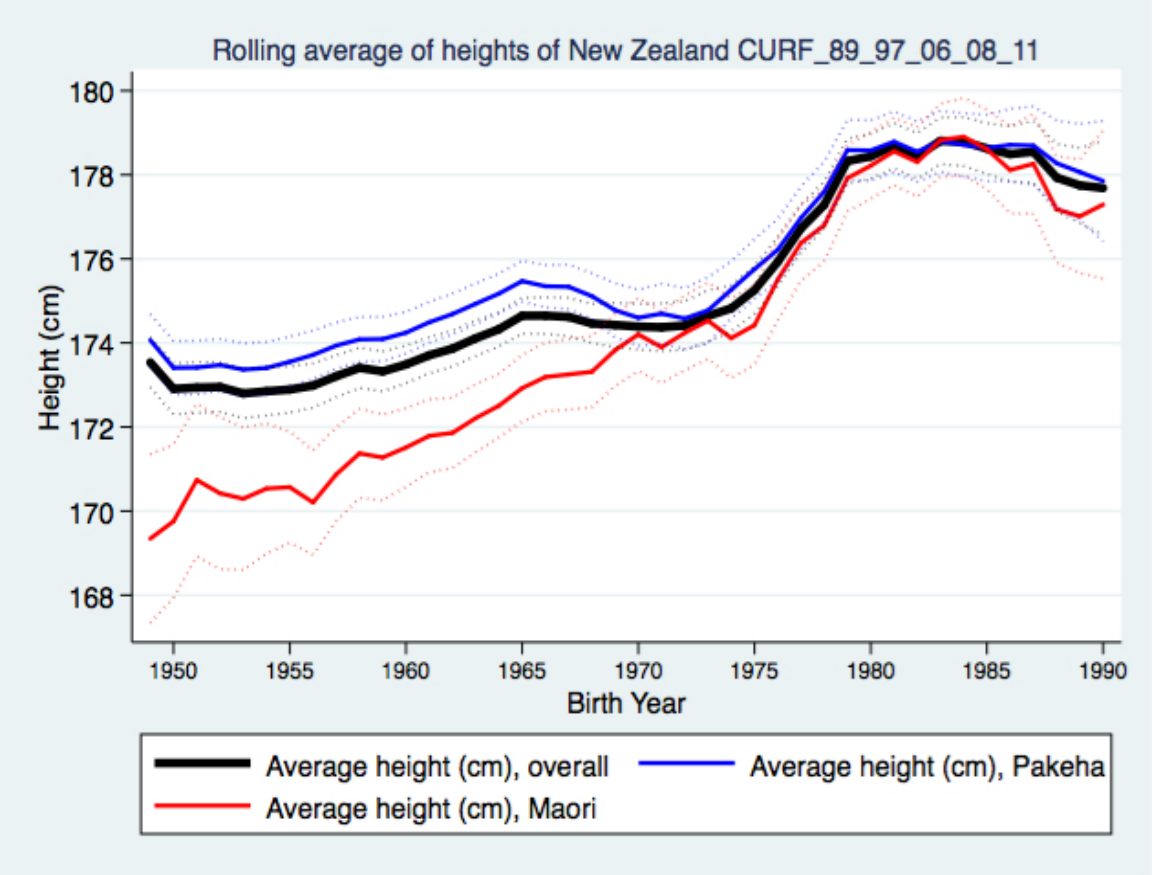


Figure 3: Rolling Average of Mean Stature, Māori and Pākehā Prisoners, by Birth Cohort 1840-1955



Source: Archives New Zealand, *Prison Admission Records* (see text)

Figure 4: Rolling Average of Mean Stature, Health and Nutrition Surveys



Source: New Zealand Health and Nutrition Surveys 1989-2011

Figure 5: Infant Mortality per 1000 live births 1862-2013

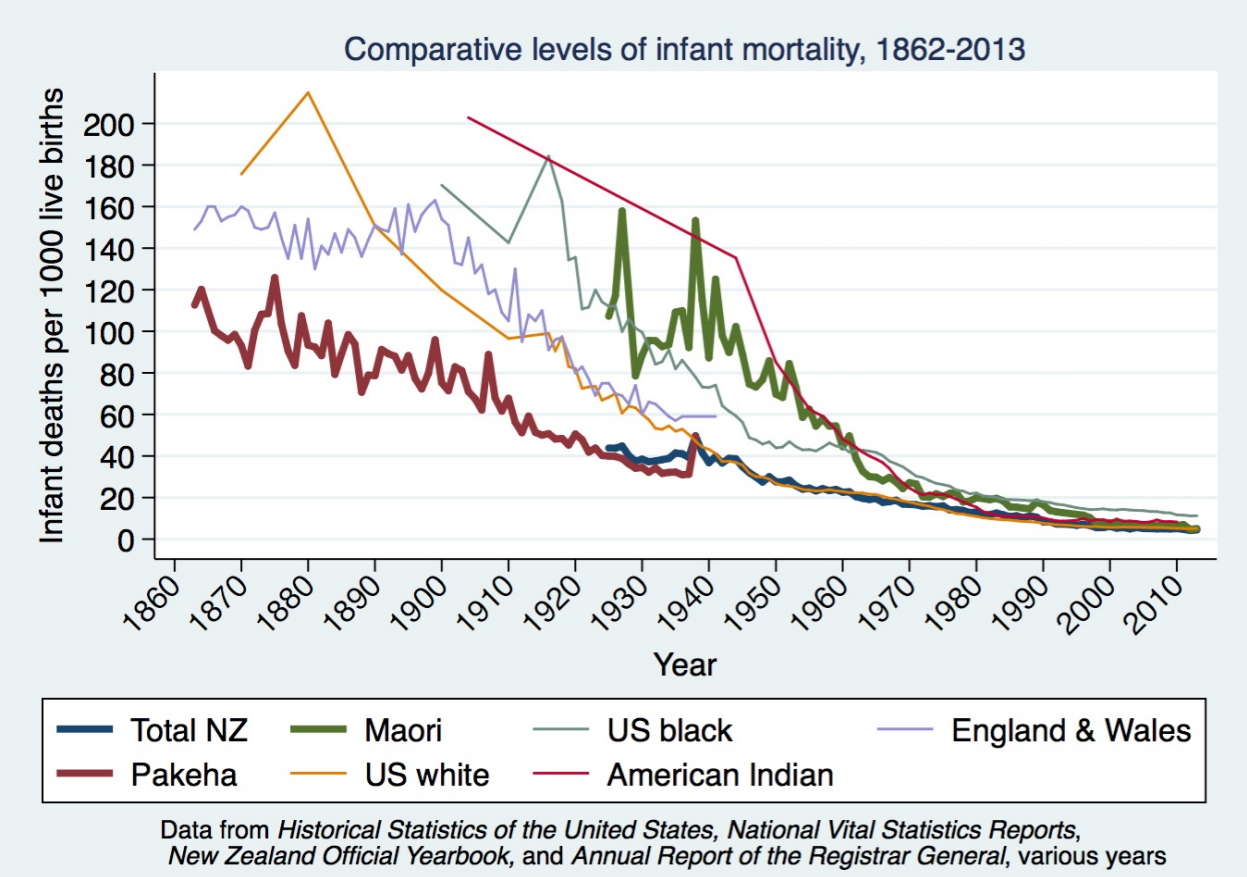
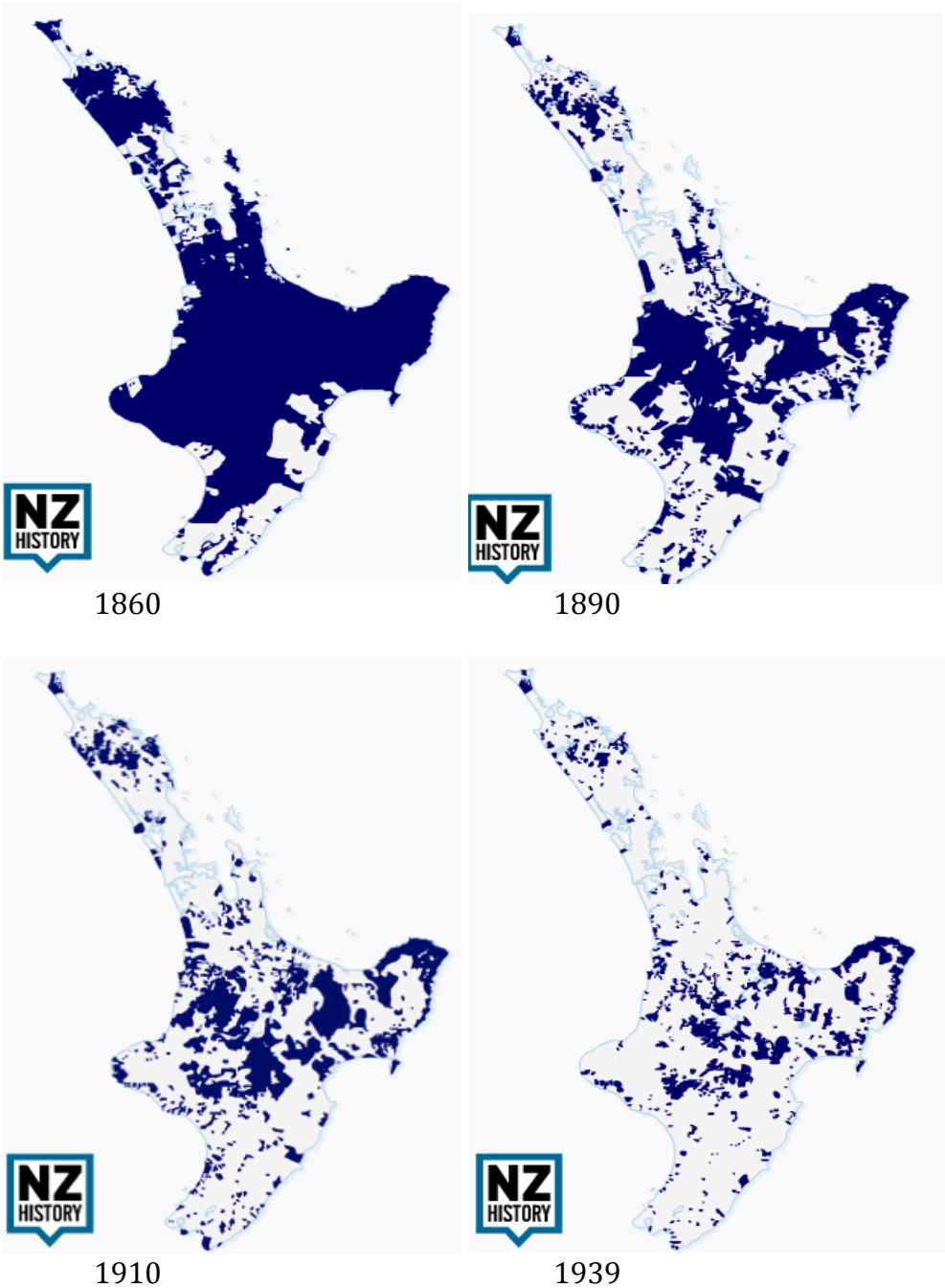


Figure 6: Extent of Māori Land 1860-1939



1860 1890

1910 1939

Source: http://www.nzhistory.net.nz/media/interactive/maori-land-1860-2000. Data from Alan Ward, *National Overview*, Volume II, Wellington: Waitangi Tribunal, 1997.

The Waitangi Tribunal is an official agency set up in 1974 to hear Māori claims over breaches of the Treaty of Waitangi.

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