Physical Well-Being and Ethnic Inequality in New Zealand Prisons, 1840-1975

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Abstract

The British colonization of New Zealand after 1840 was marked by an unusual concern for incorporating the indigenous Māori population into the new society. But despite a continuing political rhetoric of protection and sovereignty Māori have historically had lower living standards and, since the 1920s, higher rates of incarceration than European-descended New Zealanders (Pākehā). In this paper we examine differences between Māori and Pākehā over 130 years using prison records. Aggregate data from the Ministry of Justice show long-term change and differences in incarceration rates. Using a dataset of all extant registers of men entering New Zealand prisons we show change over time in convictions, height, weight, and body mass index. The adult statures of Māori and Pākehā were similar for men born before 1900 but marked differences emerged among cohorts born during the twentieth century. We are able to trace the divergence among adults to different patterns of adolescent growth. By World War II the gap in adult stature widened to around 3 cm, before narrowing for men born after World War II. Periods of divergence in stature are paralleled by divergence in fertility and indicators of family size, suggesting the economic situation of Māori families was stressed by increasing fertility. By contrast, the average body mass index of Māori men admitted to prisons has been consistently higher than for Pākehā. The prison data suggest a gradual increase in obesity and overweight for both ethnic groups beginning around 1970. Viewed together the information from prisons suggests that inequalities in nutrition between Māori and Pākehā are long-standing but not unchanging, indeed they increased for cohorts born into the early 20th century.

Keywords

Height; Obesity; BMI; New Zealand; Māori; Anthropometric history; Biological standard of living

1. Introduction

Long-term change in the health of a population is a key indicator of changing living standards. Unfortunately few measures of health and living standards are consistent over several decades. A large literature has established that a good measure of changing health and living standards is average stature (Steckel, 2008). A second anthropometric indicator, body mass index (BMI)—a measure of weight adjusted for height—is useful in a different way because very low levels may signal deprivation and high levels of BMI increase the risk of premature death. Stature, weight and mortality have been measured in similar ways in large populations over long periods of time facilitating comparison over time and space. Yet in New Zealand, only mortality statistics have been published annually in official series allowing researchers to document changing patterns of health for Māori and Pākehā. Since the 1970s modern health surveys in New Zealand have documented recent changes and variation in height and weight, but until recently there has been little accessible historical evidence.[1] As in other countries, the available sources in New Zealand for studying height and weight in the past come largely from military records, prisons, and schools.

New Zealand military records have been used to show that, as in other countries settled by migrants from Europe, adult stature declined or was stagnant for cohorts born during the middle and late nineteenth century (Cranfield & Inwood, 2007; Komlos, 1998; Steckel & Haurin, 1995; Whitwell, de Souza, & Nicholas, 1997). And yet military records have some weaknesses for our purpose. They draw disproportionately from the tallest and fittest and from young men. The military did not enlist large numbers of the indigenous Māori population. Prison records are a very useful complement because

annual admissions over a long time permit a continuity of both birth and measurement cohorts. Moreover, particularly in the twentieth century prison records include significant numbers of Māori allowing an identification of ethnic differentials in height and weight over more than a century.

Prison records have an additional advantage of describing significant numbers of adolescents and young adults. The pattern of child growth in late adolescence and into early adulthood, which is largely undocumented in other sources, offers further insights into changes in living standards. The timing and magnitude of stature growth in adolescence and young adulthood can vary significantly in different economic and social conditions. Historically, the growth of younger children (ages 0-12) has often been compromised by repeated bouts of infectious disease or inadequate food intake. Young men's adolescent growth has more often been restrained by diets inadequate to sustain both growth in stature and the high levels of physical activity that were historically required in agriculture and industry. Thus, the stature of men entering prison in their late teens and early twenties—when they are potentially still growing—can illustrate the living standards of young men and patterns of well-being for different groups in society.

In the 1890s New Zealand was hit by an economic depression at the same time as the urban population grew rapidly. These economic changes left a permanent imprint on the bodies of men growing up in that era, both Māori (indigenous) and Pākehā (European settlers). While Pākehā stature slowly recovered from the early twentieth century, the Māori experience was quite different. As the Māori population grew rapidly the stature of Māori and Pākehā men diverged around 1900 and grew to a point where Māori men stood nearly an inch shorter than Pākehā. These gaps did not start to close until around

World War II. While trends in Māori and Pākehā stature were quite different, weight tells a different story. The ethnic gap in weight has been fairly constant, and both ethnic groups have become increasingly heavy over the course of the twentieth century.

2. Stature and weight as measures of health

Stature is a summary measure of the effect of nutrition, environmental conditions, disease, and physical workload on the body during childhood- and early adulthood-growth (Bogin, 1999; Eveleth & Tanner, 1990). Sustained nutritional deficits while a person is growing result in individual stature falling short of maximum potential height. The human body puts calories to the immediate task of replenishing energy and fighting disease, before it can grow taller. If a growing person is persistently sick or expending more calories than they take in, growth will slow. When these nutritional deficits are widespread across the population, average stature will fall (Jelenkovic, et al., 2011; (Silventoinen, 2003). There are three main causes of nutritional deficits, which while analytically separate are not mutually exclusive: (1) limitation in the availability of calories, (2) persistent bouts of infectious disease while energy intake is constant, (3) elevated energy expenditure while energy intake and disease exposure are constant.

As a summary measure subject to several influences changes in the average stature of a population do not identify the causes of change. Rather, changes in average stature show when different cohorts, which are presumed to have the same genetic potential for achieving a particular height, have grown at different rates. Once these periods of changing stature are identified, the contemporaneous influences on net nutrition must be investigated to identify the potential causes of changing stature. Since

the 1970s stature has been widely and increasingly used to measure the biological standard of living in an historical and comparative context (Floud, Wachter, & Gregory, 1990; Komlos, 1998; Steckel, 2013).

The historical trajectory of weight has attracted less research attention. Weight directs our attention at different points in the life cycle. Since people differ in height, the appropriate way to measure changes in weight is to normalize for height. The conventional measure is the Body Mass Index (BMI): Weight in kilograms divided by height in meters squared (Keys, Fidanza, Karvonen, Kimura, & Taylor, 1972). While modern health studies sometimes track how weight changes over individual lifetimes, in historical records we typically only know how heavy a person was at one point in time.

Historical sources impose further constraints. Again the most common sources for adult weights are military and juridical sources. Before the nineteenth century technology lacked the capacity to record accurately human weights. Balance scales—such as steelyards—have been used since ancient times, but are of little value for measuring live weight (which moves). Fairbanks scales were perfected and mass produced in the United States by the middle of the 19th century, and were more stable and suitable for weighing people and animals. By the mid-1870s Fairbanks scales and similar designs manufactured elsewhere were used in anthropometric studies (Bowditch, 1877; Roberts, 1879). Ironically it was the weight of platform scales themselves, which were too bulky and expensive to have been used in the field and at muster stations, which means we have little historical data on weight before the late nineteenth century.

Prisons, being more fixed in place than military enlistment locations, were earlier than the military to begin weighing their subjects regularly. The United States Army

Academy at West Point weighed cadets from the 1870s onwards, and weight measurements were taken for a sample of Civil War soldiers in the 1860s. Yet these measurements were collected in a limited number of places (Costa, 2004; Komlos, 1987). But in Britain, the Wandsworth prison in London first weighed prisoners in 1858 (Horrell, Meredith, & Oxley, 2009). Many state prisons in the United States were recording the weight of prisoners from the early 1870s (Carson, 2011). By the end of the century many prisons were weighing the majority of prisoners on admission (Whittin, 1913).

One motivation for prisons to take measurements of height and weight, was to identify prisoners in a somewhat standardized way before fingerprinting was widely used (Anonymous, 1897; Guthrie & Jenkins, 2005). The descriptive motivation can be seen in the archival sources where descriptions such as "stocky" or "stout" were used in place of actual weights if a prisoner was not weighed on admission. Weights were also recorded to demonstrate that prison rations were appropriate (Home Office, 1899) and to provide data for research. In Britain and the United States, although not New Zealand, prisoners were also used in biological and medical research (Carpenter, 2006; Dunlop, 1899; Hall, et al., 2012; Parssinen, 1974; Rector, 1929).

With weight as with stature, we make inferences about the population not about individuals. We infer from an increase in average BMI that (1) people have been recently taking in more calories, and/or (2) exerting less energy in work and other physical activities, (3) and/or have become less susceptible to gastrointestinal diseases and other conditions inhibiting absorption of nutrients. As with stature, these influences are not mutually exclusive; significant changes may offset each other. Simply observing a trend

in average weight, in itself, does not tell us which of the possible forces are at work. Both stature and weight identify periods in which net nutrition has changed, and point the researcher to discover what changes in food intake, physical activity and disease actually occurred. It turns out that in developed countries in the twentieth century these influences on net nutrition have largely—but certainly not always—operated in the same direction: calories have become cheaper (Logan, 2009), work has become less intense (Brownson, Boehmer, & Luke, 2005), and disease load has declined (Cain & Paterson, 2012). Yet the twentieth century experience is significantly different than nineteenth century trends when changes in the components of net nutrition went in opposite directions.

3. Historiographical Context

One of the most significant findings by anthropometric historians has been that the stature of men in North America and most of Western Europe fell in the late nineteenth century, and only recovered in the twentieth century (Haines, 2004). Industrial and urban growth meant that despite rising incomes, health-related infrastructure often could not keep pace with population growth. Moreover nutrient-dense food became less affordable; protein deficient diets—especially deficient in milk protein — may have contributed to declines in stature (Baten & Murray, 2000; Koepke & Baten, 2005). In Australia men were taller than European-descended men in North America and Europe. Yet Australian men born in the long economic depression of the 1880s and 1890s may have been shorter than their Australian peers born in the 1870s or early 20th century (de Souza, 1994; Nicholas, Gregory, & Kimberley, 1998; Shlomowitz, 2007; Whitwell & Nicholas, 2001).

Was New Zealand different? At first glance, late nineteenth century New Zealand was a healthy country with non-monetary measures suggesting a high standard of living. The New Zealand Official Yearbook for 1912, for example, claims the lowest infant mortality rates anywhere in the world, detailing how infant mortality started declining in the 1890s (Dominion of New Zealand, 1912; Mein Smith, 1991). Population density in New Zealand cities was low compared to population density elsewhere (Ferguson, 1994). Income per-capita also compared favourably with other developed countries. By 1938 New Zealand's GDP per capita, adjusted for purchasing power parity, was the highest in the world (Greasley & Oxley, 1999, 2009).

Society-wide averages, of course, cannot speak to distributional questions. In a settler economy such as New Zealand, a particularly important question is how colonial settlement affected the health and physique of the indigenous Māori population. International comparisons of indigenous and European-descended stature are limited. North American evidence suggests indigenous populations continued to have adequate protein in their diets because they were more rural (Komlos, 2003; Prince & Steckel, 2003; Steckel & Prince, 2001). Australian indigenous men born between the 1890s and 1920s experienced no improvement in average height, while white stature rose from the early twentieth century after decline during the late nineteenth century (Nicholas, et al., 1998).

There is limited evidence about Māori health prior to and during colonisation. Government reports from the 1880s and 1890s suggest Māori health was quite poor. Tuberculosis, for example, was quite common among Māori living in damp conditions and close proximity to their neighbours (Dow, 1999). During the same period Māori

population declined significantly, reaching a nadir of 42,000 people in 1896, a halving of the population in 60 years according to the best estimates (Pool, 1991). This decline is consistent with the hypothesis of deteriorating health under the impact of colonization. The Māori population recovered rapidly in the twentieth century, with delayed declines in fertility, compared to the Pākehā population.

While the Māori population recovered rapidly after 1900, the New Zealand government and Māori leaders were concerned about continuing poor health in the early twentieth century (Lange, 1999). Yet the nature of the concern had shifted from population decline (a "dying race") to morbidity among the living High rates of tuberculosis among Māori were a particular concern before World War II (MacIntyre, 1938; Myers, 1937). Most Māori lived in rural areas until a spurt of rapid urbanization in the 1950s and 1960s (Pool, 1991). Rural residence is likely to have benefited Māori by isolating the population from infectious diseases. Yet when medicine became more effective in the early twentieth century, rural Māori likely suffered by comparison through poorer access to medical care. In response to these issues the New Zealand government appointed doctors to serve Māori communities in the inter-war era. They documented outbreaks of infectious disease that hit remote Māori communities, and contributed to significantly higher mortality rates in Māori in the 1920s and 1930s (Department of Health, 1939).

Māori migration to New Zealand cities in the 1950s and 1960s was well-timed to improve Māori health. Urban epidemics of infectious disease were now rare, and cities provided greater access to modern medical care. Yet since the 1950s researchers have documented significant disparities in Māori and European health, measured by both

morbidity and mortality (Durie, 1998; Rose, 1960, 1972; Tobias, Blakely, Matheson, Rasanathan, & Atkinson, 2009). While health inequality appears to have been persistent the form of those inequalities has changed. The gap in Māori and Pākehā health today reflects that both groups have been through an epidemiological transition. Chronic diseases, such as cancer and cardiovascular conditions, are the major causes of death for both Māori and Pākehā. However, the burden is significantly higher for Māori. Age-specific mortality rates for cardiovascular conditions are around twice as high in Māori as Pākehā (Robson & Harris, 2008).

Mortality from cardiovascular causes—such as heart attack, stroke, diabetes, or hypertension—can be related to both height and weight. A significant amount of research has shown that nutritional conditions in the growth period (from 0-20 years of age) that lead to short stature are also implicated in later cardiovascular mortality (Lawlor, Ben-Shlomo, & Leon, 2004). Nutrition and physical activity in adulthood is also indicative of later cardiovascular mortality. Obesity and low levels of physical activity are significant adult causes of early mortality from circulatory conditions (Gillman, 2004). Since Māori mortality from cardiovascular conditions has been high, it is important to understand how stature and weight have changed.

4. New Zealand prisons and their data

The development of penal institutions in New Zealand was heavily influenced by the British and Australian experience (Pratt, 1993). A humanitarian impulse in the colonization of New Zealand, and the negative example of Australian penal settlement meant that New Zealand penal policy was sometimes formed in reaction to perceived

excesses of British and Australian prisons. After the establishment of British authority in 1840, the unitary colonial government was technically in charge of prisons. In practice, local authority reigned. A shortage of actual structures to hold prisoners saw approximately 100 people transported to Tasmania between 1840 and 1854. The formation of the New Zealand provincial governments in 1853 saw those governments take over responsibility for penal policy; major prisons were established in the "four main centres": Auckland, Wellington, Christchurch, and Dunedin. The provincial governments put a low priority on prison building. A royal commission in 1868 found over-crowding and poor administration, concluding with a call for a re-centralized prison administration.

Prison administration was re-centralized in 1876 after the abolition of the provincial governments. Captain Arthur Hume, recruited from England, became the first national inspector-general of prisons in 1880; he introduced a strict system of "efficiency, economy and uniformity" in prisons which were meant to be a "reformative deterrent." Hume's tenure witnessed a major expansion of the physical capital of the New Zealand prison system, with new prisons built at Mount Cook in Wellington, and Mount Eden in Auckland (despite the names, both prisons are within 75m of sea level) in the 1880s. A new Dunedin prison was completed in 1897. Hume was served throughout the New Zealand prison system by a significant number of men with experience in colonial conflicts with Māori during the 1860s and 1870s (Belich, 1987; Egarr, 2012).

Hume set a pattern of long tenure among New Zealand prison commissioners when he retired in 1909. The two commissioners that followed Hume, Charles Matthews (1912-1924) and Bert Dallard (1925-49) oversaw a turn towards a more rehabilitative system. Matthews appointed school teachers to prisons, and started prison farms which

Dallard expanded as an economy measure during the Great Depression and World War II. Sam Barnett followed Dallard from 1949-1970. Under Barnett's stewardship penal policy developed more systematic and professional rehabilitation. In the 1950s Barnett introduced rehabilitative reforms largely under his own initiative. In the 1960s a liberal National Party Justice Minister, Ralph Hanan, took a personal interest in improving conditions in prisons. Hanan and Barnett's aim to improve prison conditions were frustrated by a rapid rise in prison admissions in the 1960s, which was attributed by many contemporary observers to Māori urban migration (M. Jackson, 1988).

Extant registers from New Zealand prisons are our principal source of information on height and weight. We have collected data on all the New Zealand-born individuals in prison registers that have been transferred to Archives New Zealand. As can be seen from Figure 1, these records constitute a minority of all prison records. In each year our data encompass no more than 1/8 of the total number of distinct people admitted to prison. We rely heavily on the records of the New Plymouth and Napier prisons (Table 1). They were at no time the major prisons in the country but they have the considerable advantage of being located in close physical proximity to areas with substantial Māori populations. Registers for the largest prisons in the four main centres, by and large, have not been transferred to Archives New Zealand.[2] We also include some data from the *Police Gazettes*, which reprinted identifying details, including stature but not weight, from the admission register in a monthly bulletin sent to all police stations. The purpose of the *Gazette* was to alert police to potential recidivists in their midst.

Release and potential recidivism come last in the sequence of events that may lead a person to be incarcerated. Patterns of criminal convictions and incarceration

changed significantly in New Zealand over a century (Figure 2). We use convictions in the Magistrates Court as an indicator of changing patterns of crime and punishment. Magistrates Courts handled the vast majority of criminal cases in New Zealand. In 1871 the Magistrates Courts handled 15,606 cases, increasing to 31,983 in 1906 and 57,579 in 1957. By comparison the Supreme Court handled fewer than 400 cases a year before the 1920s. Extensive statistics on the courts' annual workload and decisions were presented annually in the official publications *Statistics of New Zealand* in the nineteenth century, from 1907 to 1920 *Statistics of the Dominion of New Zealand,* and from 1920 to 1951 *Report on the Justice Statistics of the Dominion of New Zealand.* After 1951 the series is not always consistent with the earlier statistics, and thus we terminate the series at 1951, although our dataset of admissions extends into the mid-1970s.

We report the number of cases heard in the Courts about male defendants—separated into Māori and Pākehā—for years in which a census was taken (quinquennially after 1881, excepting 1931 and 1941). In the same manner, we also report the number of Māori and Pākehā prisoners received into prison. It should be noted that individuals could be, and were, received multiple times in a year, however statistics on "distinct prisoners" were less consistently recorded. Although some boys did commit crimes and were tried in the Magistrates Court, the numbers were small. We define the population at risk of offending and being incarcerated as males 15 and older.

There are distinct differences in the historical trajectory of convictions and imprisonment for Māori and Pākehā (Figure 2). Pākehā conviction and incarceration rates were initially much higher than Māori rates, with many Pākehā men imprisoned in the 1870s and 1880s for crimes such as assault. In a frontier society many disputes were

settled violently (though compared to the United States fatalities were rare). Yet as Pākehā society urbanized in the late nineteenth century conviction rates dropped sharply, before rising again between after 1892. Public sentiment against alcohol in this period led to more prosecutions and convictions for offences related to drunkenness (Fairburn, 1989). Māori conviction and incarceration rates were much lower than Pākehā until the turn of the twentieth century, when many Māori men were also convicted of offences relating to drunkenness. Increasing Māori conviction rates also reflected a gradual loss of Māori sovereignty and its replacement by Pākehā authority. Arrests and convictions were a very important manifestation of governmental authority (Bull, 2004; Hill, 1995). From around 1911 Māori conviction rates in the Magistrates Courts were similar to Pākehā rates. Māori incarceration rates, however, only rose significantly after 1916, and thereafter remained significantly higher than for Pākehā. Thus, for the same level of convictions Māori had a higher chance of going to prison.

Thus, we begin our analysis with 28,292 male prison records. We include the records of those older than 13 years in order to be able to identify the age at which adult or maximum stature was reached. In well-nourished modern populations most men attain adult height before age 20 (Bogin, 1999). Thus evidence of men still growing in their late teens is, in itself, an indicator of living standards below current ones. We exclude men older than 50 years from our analysis of height in order to minimize any complication arising from the diminution of height at advanced ages. We restrict our sample to those born in New Zealand so that we can attribute height and weight entirely to nutritional conditions in New Zealand. While immigrants may have spent much of their life in New Zealand, their exact dates of immigration are unknown.

After exclusions for missing information and age we are left with the 26,611 records for males between 13 and 50 years of age with information on age, birth date, birth place, occupation and height, and 22,354 with information on weight. Generally, height is reported if weight is available allowing us to calculate BMI for 22,298 men. We are careful to distinguish between men and their records because some men appeared more than once because of multiple incarcerations.

We distinguish men who were entirely or largely of European descent (Pākehā) from the indigenous Māori population indigenous by descriptions of nativity made in the prison registers themselves. The nativity descriptions reflect a crude "blood quantum" concept with some men described as being between ¼ and ¾ Māori. Others were merely described as Māori, and we have no way of knowing whether these men were in fact "part Māori" as well. In the nineteenth century it seems likely that some of the Māori not noted as being part-Māori were "full-blooded." But there has been significant inter-racial marriage in New Zealand since British arrival, and it is uncertain many men showing up after World War II are "full-blooded" (Callister, Didham, & Potter, 2005; Wanhalla, 2008). Our analyses take all men indicated as Māori, no matter the blood quantum noted, as Māori. This interpretation is a social one, 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, growing up in a Māori environment. This social and environmental influence is what we wish to capture.

Family context is important in understanding stature, since children are initially totally dependent on the resources provided to them by their family, in order to grow. In

adolescence, when humans go through the second major growth spurt of their lives, family resources and needs are again crucial in determining how close people will come to reaching their potential height. Adolescent children whose parents can provide them with adequate nutrition for daily living *and* physical growth are able to both eat sufficient food, and expend less energy by remaining in school and out of the workforce longer. Adolescents who enter the labour force to contribute to family income are often living in a family environment where incomes—and thus expenditure on food—are variable, and enter the labour force without completing their schooling. Particularly in the early twentieth century the paid employment that was available to adolescents with limited schooling was often physically demanding, working as an agricultural or industrial labourer. In early twentieth century New Zealand, Māori boys were less likely to attend secondary school, and tended to work in less-skilled occupations when they entered the labor force (Barrington, 2008; Sutherland, 1935).

The near-normality of height and weight distribution for those born in New Zealand and over the age of 21 is clear from Figures 3 and 4. There are two principal exceptions to an otherwise normal-looking pattern. The proportion of people reporting the height of 71 inches (180cm) is smaller than expected. It is likely that this is a function of heights being rounded up to 6 feet (72 inches), and reflects instances of imprecise measurement. The second exception for height is a small but noticeable under-representation of those at around 170cm or 5 foot 9. BMI deviates more from normality than stature, with the distribution massing in the upper end of the normal weight range between a BMI of 22 and 25.

5. Ethnic differences in the patterns of physical growth: stature

Our goal in the analysis is to assess the extent of social and ethnic differentials, their change over time and the evolution of stature and body mass index through adolescence and into adulthood. An overview of the experience of stature is provided in Figure 5 by the rolling average of physical stature for men 21 years or older. Here the data are organized by date of birth. Those noted as indigenous—Māori—were significantly shorter than the European-descended Pākehā in the twentieth century. But the average stature of the two ethnic groups overlaps until the early twentieth century, after which there is a growing divergence. After 1900 Pākehā stature began to grow (albeit slowly at first) but Māori stature did not begin to increase until those born in the 1920s, and even then the increase in stature from one Māori cohort to another continued to fall behind Pākehā. This pattern largely replicates findings from an analysis of the same cohorts measured in World War I and World War II records (Inwood, Oxley, & Roberts, 2014).

Hypothesis-testing in a multiple regression framework provides further insight. We capture change over time by identifying decade-long birth cohorts. These reflect the trends visible in Figure 5 and preserve sufficient sample size at each age for an identification of physical growth from early identification into adulthood.

We examine the influence of socio-economic status via occupations organized into seven classes: professional and managerial (1 per cent of the sample), farmer (2 per cent), farm labourer (12 per cent), other labourers and servants (49 per cent), clerical and sales (9 per cent) and skilled workers in manufacturing, transport and utilities (29 per cent). Records denoting unemployed, disability, student and other conditions not

associated with work are assigned to a small miscellaneous category. Our occupational categories are derived from the HISCO coding scheme (van Leeuwen, Maas, & Miles, 2002). The large share of labourers likely reflects both an imprecision and lack of curiosity in recording, and also the low socioeconomic status of prisoners. Labourers are the omitted category in the estimation.

The prisoners' occupational class is assumed to correlate with his father's occupational class, giving an indirect measurement of the nutritional circumstances in which the prisoner 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 examine the hypothesis that these occupation-based socio-economic groupings capture the net effect of various influences on adult height.

We hypothesize that rural occupations indicate access as children to a lower relative price of food and limited exposure to infectious disease. The professional and clerical occupations suggest a higher class standing and family circumstances permitting greater spending on food and healthy housing. We anticipate that both groups will have above-average stature. Prisoners born to fathers with labouring 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 as adults. Occupation correlates partially with the indigenous identity indicator discussed above. Nevertheless, to the extent that men with indigenous names report a variety of occupations, inclusion of the indigenous identity variable identifies picks up a 'pure' effect of being indigenous over and above any effects of ethnic clustering in particular

occupations. More than two thirds of the Māori men in our sample were labourers or farm labourers.

The OLS regression estimates reported in Table 3 follow the pattern of rolling averages in Figure 5. The cohort-specific Māori co-efficients at the end of the table 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. The prison regressions with occupational controls indicate that Pākehā labourers born before 1914 averaged 67.4 inches against 67.2 for Māori, but then Pākehā increased to 68.0 and 68.5 inches in the next two periods in contrast to 67.4 and 68.1 inches for Māori. Hence, Māori fell behind decisively during the war and interwar period, and then closed the gap slightly after WWII. There is no sign of immiserization; Māori did not become shorter. However, the prolonged delay in the realization of stature gains compared to Pākehā set them back considerably in a relative sense during the early 20th century. Whereas Pākehā born at mid-century were 2cm taller than their peers born c1900, average stature for Māori had barely changed. During the first half of the twentieth century the New Zealand economy and environment provided rising living standards for Pākehā, but Māori did not share in these gains.

The occupational effects reflect considerably inequality in standard of living. Farmers and men in the professional-managerial class were taller among both Māori and Pākehā. Manufacturing and transport workers and service sector tradesmen were taller than general labourers among Pākehā but not among Māori. Admittedly, the occupational differentials reflect any endogenous sorting into occupations, for example that taller men becaming farmers because they were taller, as well as birth into farm families.

The patterns of adult height are a cumulative product of growth in each year of life. The disease and nutritional environment very early in life matters most but growth can accelerate or falter at any age depending on circumstances. There is no systematic evidence of Māori child stature before the 1960s, but the prison records contain reports of stature for children as young as 11 years. Sample size allows us to estimate average height by age beginning at 13 years through a series of age-specific dummy variables; height from 30 to 50 years is the omitted category.

The patterns documented in Table 3 and Figure 6 point to another ethnic difference. Pākehā 19 years and older were as tall as their older siblings and cousins. To the extent we can infer life-course experience from cross-sectional data, physical growth ceased on average at the age of 19. The equivalent point for Māori was 22 years. Māori needed three more years than Pākehā to reach their adult height. This is consistent with an experience of deprivation earlier in life from which some recovery is made by extending the period of physical growth into adulthood. We have no direct knowledge of the ages of relative deprivation for Māori, but we can observe that there was not consistent ethnic difference among 13-15 year olds. Beginning at age 16, however, a small difference opens up, and thereafter Māori stature never catches up. Interpretation of this puzzling pattern will require further research but already we can see that growth faltering in mid-adolescence is consistent with the onset of very different life experiences for Māori, such as earlier entry into the labour market and into more taxing jobs.

The timing of stature divergence in the early twentieth century is coincident with a period when Māori and Pākehā family forms diverged most dramatically. Both Pākehā and Māori fertility, as best we can tell, was high in the late nineteenth century. Notably,

fertility decline among Pākehā occurred slightly later than in North America or Britain (Sardon, 2006). In the late twentieth century fertility rates have again converged for Māori and Pākehā, though they remain somewhat higher for Māori, with recent total fertility rates for Māori women around 2.8, compared to 1.9 for Pākehā women (N. Jackson, Pool, & Cheung, 1994; Statistics New Zealand, 2011). In the first half of the twentieth century, the differences were more extreme as declining infant mortality led to the average Māori family having 7 children in the 1920s and 1930s, compared to 3 or fewer for Pākehā women in the same decades (Pool, Dharmalingam, & Sceats, 2007).

The correlation of fertility and family differences with stature differences can be seen in Figure 7. We measure fertility differences as the excess of Māori over Pākehā total fertility rates (Pool, et al., 2007). Family structure is more complicated to measure with the New Zealand census. Individual census returns were destroyed, and the census reported information on household and family inconsistently over time. Thus, we use the ratio of children (aged 0-14) to adult women (15-60) as a rough indicator of average family size in the Māori and Pākehā population. This index can be constructed for every census year after 1886, except 1906 when the census did not record Māori ages precisely. By and large the fertility and child:women series run parallel to each other. When total fertility rates are high variation in family size is low. Thus, between 1900 and World War II when Māori total fertility rates ranged between 6.5 and 7, Māori men had a high chance of growing up in a large household.

Divergence in stature coincident with these trends suggests that larger Māori families were under some economic pressure, and unable to provide fully for large numbers of children. The period of stature convergence after World War II also

corresponds with a period of declining family size, and convergence (but not equality) in Māori and Pākehā earnings (Brosnan, 1984; Brosnan, Rea, & Wilson, 1995; Sorrenson, 1990).

6. Ethnic differences in the patterns of physical growth: BMI

Weights recorded on admission to prison allow us to examine BMI, the standard adjustment of weight for height. Again, a rolling average graph gives a continuous long-term overview and then a more finely-directed multivariate regression analysis is used to identify the influence of occupation and different periods, and the pattern of BMI change over the life-course from age 13 to age 30 (Figure 8). Our periodization is no longer defined with reference to birth year; rather we use the year in which height and weight are measured. This is because very recent activity and consumption determine the fluctuation of weight, in contrast to height, which is influenced by early life conditions.

Interpreting the influence of occupation on weight necessarily differs from stature. Formerly, in the analysis of stature, we relied on occupation as a proxy for childhood conditions through an assumption of intergenerational persistence. In considering weight, occupation becomes a rough indicator of energy expenditure during work activity and of income with which consumption may be financed. Professional, managerial, clerical and sales occupations are relatively sedentary, whereas agricultural occupations typically involve higher levels of physical activity. Work in transportation and manufacturing lies somewhere in between these extremes, and has changed significantly during the twentieth century with the growing use of non-human energy to power manufacturing work. We recognize that influences associated with occupation are

not well identified because of reporting imprecision and the high level of aggregation into occupational classes. Nevertheless, the information provides at least some minimal protection against being misled by a confounding influence.

Body mass index (BMI) gives a slightly different perspective on the welfare of New Zealand men, and one broadly similar in its outlines to the story suggested by stature. Whereas stature reflects net nutrition during the growth period, BMI reflects net nutrition over the more recent past. Thus, BMI directs our attention at resources at a different point in individual and family life-cycles. Marital status was not consistently recorded in New Zealand prison registers. For those for whom it was available, 58% were single, 32% married or otherwise partnered, and the remaining 10% divorced, separated, or widowed. The prison population, in other words, was young and composed of men less likely to be married than men of the same age in the general population.

BMI among both Māori and Pākehā BMI increased over the twentieth century (when our estimates are more precise owing to larger sample sizes). This indicates rising living standards at least as measured by net nutrition. Higher BMI among farmers of both ethnicities and Pākehā professionals supports the interpretation that higher weight reflects a combination of lower energy expenditure and higher incomes.

As with stature, the ethnic differences are quantitatively large and change somewhat over time. Māori in New Zealand prisons were consistently heavier than Pākehā, even after adjusting for occupational and age differences. This finding informs contemporary debates about Māori body composition and obesity. Modern epidemiological surveys point to significantly higher rates of overweight and obesity among Māori. Other Polynesian populations are also observed to have high rates of

obesity. These facts have contribute to a continuing debate if Polynesian peoples—including Māori—are genetically predisposed to be heavier than European populations (Birkbeck, 1981; Finucane, et al., 2011; Ministry of Health, 2008; Rush, Freitas, & Plank, 2009; Taylor, et al., 2010). While our data cannot reveal genetic bases for the differences between Māori and Pākehā, they confirm at least that the gap is long-standing.

The differences between Māori and Pākehā BMI change both over time, and across the life-course. For the relatively small numbers of prisoners under 16, we cannot detect a significant difference in BMI between Māori and Pākehā. After the age of 16, Māori BMI is consistently heavier than Pākeha, and increases both over time and across the life course. In particular, the gap between Māori and Pākehā BMI widens gradually and significantly after World War II. Before World War II the gap in Māori and Pākehā BMI was around 2.5, but widened significantly in the 1960s and 1970s. Pākehā were getting heavier too, but at a somewhat slower rate than Māori.

The timing of Māori stature decline and weight gain suggests a life-course explanation for a Māori cardiovascular disease epidemic in the last quarter of the twentieth century (Blakely, Ajwani, Robson, Tobias, & Bonné, 2004; Curtis, Harwood, & Riddell, 2008; Tobias, et al., 2009). Longitudinal studies of European populations have shown that cardiovascular disease and mortality risk is elevated in populations deprived in childhood who then experience more abundant nutritional conditions as adults (Lawlor, et al., 2004). Māori men growing up in the first half of the twentieth century had stagnant average stature, suggesting relatively deprived nutritional conditions. In the second half of the century, calorie availability increased for these men who had become

used to sparser conditions and were thus more susceptible to increasing weight and its corresponding cardiovascular disease risks.

7. Conclusion

The experience of stature for men born in late nineteenth-century New Zealand was very different than that of men born a century later. Socio-economic variations in height were pronounced for those born in the 1880s and 1890s. One hundred years later the differentials were reduced (although not eliminated) by the long-term diminution of economic inequality and reduced marginal significance of income for height at high income levels. Another point of contrast is that during the late twentieth century each generation was significantly taller than the one preceding. This was not true for nineteenth-century cohorts. As in similar jurisdictions in Europe and North America New Zealanders born during the 1890s grew up shorter than those born earlier. This may reflect a cyclical pattern. It remains clear, though, that any cohort differences were small compared with the occupational and ethnic effects. This is entirely the opposite of the late twentieth century.

We began the paper recognising the importance of historical origins for Māori-Pākehā health differentials. Our evidence suggests that Māori stature in the early 1900s began to differ from Pākehā stature even after controlling for generational and occupational effects. There is no evidence in this sample of an earlier Māori advantage in physique that would accord with popular qualitative observations from the time. Pākehā stature began to grow for cohorts born in the 1920s, but a significant increase in Māori stature was not evident until cohorts born around the end of World War II. The timing of

this divergence is intriguing, coming nearly a century after European colonization, and coincident with divergence in family and household structures. It suggests that inequalities in resources were sharpest not on the frontier, but in an era of urbanization and welfare state development. Stature adds another dimension to this picture of ethnic inequality since colonization, and points to a need to examine Māori and Pākehā well-being from other perspectives in the modern era. Viewed together the evidence from New Zealand's prisons suggests that inequalities in nutrition between Māori and Pākehā are long-standing, but not unchanging.

Table 1: Prisons included in the sample

Prison	Number of admissions
Napier	11,484
New Plymouth	7,371
Witako	3,307
Wanganui	3,207
Prison unknown, data from photographs of prisoners	1,184
Auckland	774
Tolaga Bay	348
Onehunga	341
Wellington	301
Whangaroa	234
Lyttleton	205
Dunedin	203
Lincoln	135
Addington	97
Gisborne	91
Nelson	50
Timaru	47
Invercargill	44
Hokitika	42
Oamaru	35
Picton	23
Shortland	20
Tauranga	17
Westport	15
Mount Cook	15
Opotiki	10
Wairoa	9
Awanui	8
Lawrence	7
Rotorua	7
Clyde	5
Greymouth	3
Naseby	3
Reefton	3
Woodville	2
Arrowtown	2
Ashburton	2
Hampden	1
Newcastle	1
Total	29,653

Table 2: New Zealand Prisons, Summary Statistics

	Mean Height (cm)	Mean Weight (kg)	Mean BMI
Māori or Pākehā			
Pākehā	172.1	70.3	23.7
Māori	171.1	77.5	26.5
Occupation			
Professional or managerial	173.5	74.4	24.6
Clerical	172.8	70.6	23.6
Sales	172.9	71.2	23.8
Service	171.4	71.3	24.2
Manufacturing, utilities, transport	172.2	72.8	24.5
Labourer (not farm)	171.4	71.9	24.5
Farmer or farm manager	173.6	74.9	24.9
Farm labourer	171.9	75.2	25.4
Unknown or not in labor force	169.7	70.8	24.4
Total	171.8	72.6	24.6

Table 3: Maximum Likelihood Analysis of Stature, New Zealand Prisoners 21-49 years at Admission
Dependent variable: Stature in cm

	Model 1 b/se/t	Model 2 b/se/t	Model 3 b/se/t	Model 4 b/se/t
Māori	-0.99	-0.86	-1.36	-0.93
	0.10	0.10	0.11	0.42
	-10.08	-8.48	-12.63	-2.19
Professional		1.29	1.52	1.48
		0.40	0.40	0.39
		3.26	3.86	3.77
Clerical sales service		0.39	0.58	0.54
		0.20	0.20	0.20
		1.96	2.88	2.70
Laborer		-0.58	-0.18	-0.30
		0.11	0.11	0.11
		-5.35	-1.65	-2.68
Farmer		1.60	2.18	1.96
		0.29	0.30	0.30
		5.43	7.30	6.57
Farm laborer		-0.03	-0.20	-0.09
		0.17	0.17	0.17
		-0.17	-1.18	-0.53
Unknown		-2.21	-2.05	-2.26
		0.32	0.32	0.32
		-6.85	-6.33	-6.99
Born 1830s			-0.32	-2.54
			0.96	2.63
			-0.33	-0.97
Born 1840s			1.02	0.23
			0.39	0.54
			2.60	0.42
Born 1850s			0.48	-0.55
			0.27	0.34
			1.78	-1.59
Born 1860s			-0.19	-0.69
			0.25	0.29
			-0.77	-2.39
Born 1870s			-0.76	-0.88
			0.26	0.28
			-2.89	-3.15
Born 1880s			-0.52	-0.61
			0.24	0.26
			-2.16	-2.38

	Model 1 b/se/t	Model 2 b/se/t	Model 3 b/se/t	Model 4 b/se/t
Born 1900s			-0.00	-0.10
			0.21	0.22
			-0.01	-0.46
Born 1910s			0.24	0.32
			0.20	0.22
			1.21	1.42
Born 1920s			0.52	0.65
			0.21	0.23
			2.53	2.80
Born 1930s			1.07	1.49
			0.21	0.26
			5.01	5.82
Born 1940s			1.71	2.62
			0.21	0.25
			8.14	10.32
Born 1950s			1.58	1.77
			0.28	0.37
			5.72	4.77
Māori born 1830s				2.26
				2.85
				0.80
Māori born 1840s				1.24
				0.83
				1.50
Māori born 1850s				1.96
				0.61
				3.23
Māori born 1860s				1.55
				0.60
				2.57
Māori born 1870s				1.58
				0.82
				1.92
Māori born 1880s				1.00
				0.71
				1.41
Māori born 1900s				0.56
				0.55
				1.02
Māori born 1910s				-0.48
				0.51
				-0.94
Māori born 1920s				-0.72
				0.51
				-1.42

	Model 1 b/se/t	Model 2 b/se/t	Model 3 b/se/t	Model 4 b/se/t
Māori born 1930s				-1.27
				0.50
				-2.52
Māori born 1940s				-2.08
				0.49
				-4.23
Māori born 1950s				-0.75
				0.61
				-1.24
Constant	172.14	172.33	171.81	171.81
	0.06	0.09	0.18	0.19
	3067.33	2007.37	970.48	908.25

Table 4: Maximum Likelihood Analysis of BMI, New Zealand Prisoners 18-75 years at Admission

Dependent variable: Body Mass Index			
	Model 1 b/se/t	Model 2 b/se/t	Model 3 b/se/t
Māori	2.63	2.65	2.54
	0.05	0.05	0.05
	57.20	56.08	50.85
Professional		0.88	0.95
		0.20	0.20
		4.50	4.86
Clerical sales service		-0.08	-0.03
		0.09	0.09
		-0.83	-0.28
Laborer		-0.24	-0.09
		0.05	0.05
		-4.78	-1.77
Farmer		0.56	0.82
		0.14	0.15
		3.90	5.62
Farm laborer		0.05	0.02
		0.08	0.08
		0.68	0.21
Unknown		-0.27	-0.20
		0.14	0.14
		-1.95	-1.44
Admitted in 1870s			-0.02
			0.42
			-0.04
Admitted in 1880s			-0.34
			0.21
			-1.59
Admitted in 1900s			0.06
			0.18
			0.33
Admitted in 1910s			0.19
			0.20
			0.98
Admitted in 1920s			0.39
			0.16
			2.49
Admitted in 1930s			0.35
			0.15
			2.34
Admitted in 1940s			0.44

	Model 1 b/se/t	Model 2 b/se/t	Model 3 b/se/t
			0.15
			2.97
Admitted in 1950s			0.82
			0.15
			5.44
Admitted in 1960s			0.52
			0.15
			3.57
Admitted in 1970s			0.92
			0.15
			6.30
Constant	23.54	23.62	23.05
	0.03	0.04	0.14
	890.60	584.22	161.90

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References

Anonymous. (1897). The Bertillon System of Identification by Measurement. In *Scientific American* (Vol. 76, pp. 214-215).

Barrington, J.M. (2008). *Separate but Equal?: Maori Schools and the Crown 1867-1969*. Wellington: Victoria University Press.

Baten, J., & Murray, J. (2000). Heights of Men and Women in Nineteenth-Century Bavaria: Economic, Nutritional, and Disease Influences. *Explorations in Economic History, 37*, 351-361.

Belich, J. (1987). *The New Zealand Wars and the Victorian Interpretation of Racial Conflict*. Auckland: Penguin.

Birkbeck, J.A. (1981). Obesity, socioeconomic variables and eating habits in New Zealand. *Journal of Biosocial Science, 13*, 299-307.

Blakely, T., Ajwani, S., Robson, B., Tobias, M., & Bonné, M. (2004). Decades of disparity: widening ethnic mortality gaps from 1980 to 1999. *New Zealand Medical Journal, 117*.

Bogin, B. (1999). *Patterns of human growth* (2nd ed.). Cambridge: Cambridge University Press.

Bowditch, H.P. (1877). *The growth of children*. Boston: Massachusetts State Board of Health.

Brosnan, P. (1984). Age, education and Maori‐Pakeha income differences*. *New Zealand Economic Papers, 18*, 49-61.

Brosnan, P., Rea, D., & Wilson, M. (1995). Labour market segmentation and the state: the New Zealand experience. *Cambridge Journal of Economics, 19*, 667-696.

Brownson, R.C., Boehmer, T.K., & Luke, D.A. (2005). Declining Rates of Physical Activity in the United States: What Are the Contributors? *Annual Review of Public Health, 26*, 421-443.

Bull, S. (2004). 'The Land of Murder, Cannibalism, and All Kinds of Atrocious Crimes?': Maori and Crime in New Zealand, 1853–1919. *British Journal of Criminology, 44*, 496-519.

Cain, L.P., & Paterson, D.G. (2012). *The Children of Eve: Population and Well-being in History*. New York: Wiley.

Callister, P., Didham, R., & Potter, D. (2005). Ethnic Intermarriage in New Zealand. *Official Statistics Research Series, 1*, 1-73.

Carpenter, K.J. (2006). Nutritional studies in Victorian prisons. *The Journal of nutrition, 136*, 1-8.

Carson, S.A. (2011). The Body Mass Index of Blacks and Whites in the United States during the Nineteenth Century. *Journal of Interdisciplinary History, 42*, 371-391.

Costa, D. (2004). The measure of man and older age mortality: Evidence from the Gould Sample. *The Journal of Economic History, 64*, 1-23.

Cranfield, J., & Inwood, K. (2007). The great transformation: A long-run perspective on physical well-being in Canada. *Economics and Human Biology, 5*, 204-228.

Curtis, E., Harwood, M., & Riddell, T. (2008). Cardiovascular disease. In B Robson & R Harris (Eds.), *Hauora: Màori Standards of Health IV. A study of the years 2000–2005* (pp. 141-159). Wellington: Te Rōpū Rangahau Hauora a Eru Pōmare.

de Souza, C. (1994). *Height, Health and Living Standards of Australian Men, 1861-1902*. Unpublished M.Com, University of Melbourne, Melbourne.

Department of Health. (1939). Annual Report of the Director General of Health. In *Appendices to the Journal of the House of Representatives* (Vol. H-31). Wellington: New Zealand Parliament,.

Dominion of New Zealand. (1912). New Zealand Official Yearbook. In Government Statistician (Ed.). Wellington: Government Printer.

Dow, D. (1999). *Maori Health and Government Policy*. Wellington: Victoria University Press.

Dunlop, J.C. (1899). *Report on Prison Dietaries*. London: Eyre & Spottiswoode.

Durie, M. (1998). *Whaiora: Maori health development*. Auckland: Oxford University Press.

Egarr, T. (2012). *Discipline and Defence: The Military Influence on Policing and Imprisonment, c.1870-1913*. Victoria University of Wellington, Wellington.

Eveleth, P.B., & Tanner, J.M. (1990). *Worldwide variation in human growth* (2nd ed.). Cambridge: Cambridge University Press.

Fairburn, M. (1989). *The ideal society and its enemies : the foundations of modern New Zealand society, 1850-1900*. Auckland, N.Z.: Auckland University Press.

Ferguson, G. (1994). *Building the New Zealand Dream*. Palmerston North: Dunmore Press.

Finucane, M.M., Stevens, G.A., Cowan, M.J., Danaei, G., Lin, J.K., Paciorek, C.J., Singh, G.M., Gutierrez, H.R., Lu, Y., Bahalim, A.N., Farzadfar, F., Riley, L.M., & Ezzati, M. (2011). National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9·1 million participants. *The Lancet, 377*, 557-567.

Floud, R., Wachter, K., & Gregory, A. (1990). *Height, Health and History: Nutritional Status in the United Kingdom, 1750-1980*. Cambridge: Cambridge University Press.

Gillman, M.W. (2004). A life course approach to obesity. In Diana Kuh & Yoav Ben-Shlomo (Eds.), *A life course approach to chronic disease epidemiology* (pp. 189-217). Oxford: Oxford University Press.

Greasley, D., & Oxley, L. (1999). Growing apart? Australia and New Zealand growth experiences, 1870-1913. *New Zealand Economic Papers, 33*, 1-14.

Greasley, D., & Oxley, L. (2009). The pastoral boom, the rural land market, and long swings in New Zealand economic growth, 1873–1939. *Economic History Review, 62*, 324-349.

Guthrie, G., & Jenkins, S. (2005). Bertillon Files: An untapped source of nineteenth-century human height data. *Journal of Anthropological Research, 61*, 201-215.

Haines, M.R. (2004). 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*, 249-270.

Hall, K.D., Heymsfield, S.B., Kemnitz, J.W., Klein, S., Schoeller, D.A., & Speakman, J.R. (2012). Energy balance and its components: implications for body weight regulation. *The American Journal of Clinical Nutrition, 95*, 989-994.

Hill, R. (1995). *The Iron Hand in the Velvet Glove: The Modernisation of Policing in New Zealand 1886-1917*. Wellington: Dunmore Press.

Home Office. (1899). Report of the Commissioners of Prisons and the Directors of Convict Prisons. In. London.

Horrell, S., Meredith, D., & Oxley, D. (2009). Measuring misery: Body mass, ageing and gender inequality in Victorian London. *Explorations in Economic History, 46*, 93-119.

Inwood, K., Oxley, L., & Roberts, E. (2014). 'Tall, active and well made': New insights into Māori health, c.1700 - 1990. In *Economic History Association*. Columbus.

Jackson, M. (1988). The Maori and the Criminal Justice System. In. Wellington: Department of Justice.

Jackson, N., Pool, I., & Cheung, M.C. (1994). Maori and non-Maori fertility. Convergence divergence or parallel trends? *New Zealand Population Review, 20*, 31-57.

Keys, A., Fidanza, F., Karvonen, M., Kimura, N., & Taylor, H. (1972). Indices of relative weight and obesity. *Journal of chronic diseases, 25*, 329.

Koepke, N., & Baten, J. (2005). The Biological Standard Of Living In Europe During The Last Two Millennia. *European Review of Economic History, 9*, 61-95.

Komlos, J. (1987). The height and weight of West Point cadets: dietary change in antebellum America. *Journal Of Economic History, 47*, 897-927.

Komlos, J. (1998). Shrinking in a Growing Economy? The Mystery of Physical Stature during the Industrial Revolution. *Journal Of Economic History, 58*, 779-802.

Komlos, J. (2003). Access to Food and the Biological Standard of Living: Perspectives on the Nutritional Status of Native Americans. *American Economic Review, 93*, 252-255.

Lange, R. (1999). *May the People Live: A History of Māori Health Development 1900-1918*. Auckland: Auckland University Press.

Lawlor, D.A., Ben-Shlomo, Y., & Leon, D.A. (2004). Pre-adult influences on cardiovascular disease. In Diana Kuh & Yoav Ben-Shlomo (Eds.), *A life course approach to chronic disease epidemiology* (pp. 41-76). Oxford: Oxford University Press.

Logan, T.D. (2009). The transformation of hunger: The demand for calories past and present. *The Journal of Economic History, 69*, 388-408.

Mein Smith, P. (1991). Infant welfare services and infant mortality: a historian's view. *The Australian Economic Review, 24*, 22-34.

Ministry of Health. (2008). *A Portrait of Health: Key results of the 2006/07 New Zealand Health Survey*. Wellington: Ministry of Health.

Nicholas, S., Gregory, R., & Kimberley, S. (1998). *The welfare of Indigenous and White Australians 1890-1955*. Stuttgart: Franz Steiner Verlag

Parssinen, T.M. (1974). Popular science and society: the phrenology movement in early Victorian Britain. *Journal of Social History, 8*, 1-20.

Pool, I. (1991). *Te Iwi Maori : a New Zealand population past present & projected*. Auckland: Auckland University Press.

Pool, I., Dharmalingam, A., & Sceats, J. (2007). *The New Zealand Family From 1840: A Demographic History*. Auckland: Auckland University Press.

Pratt, J. (1993). *Punishment in a Perfect Society*. Wellington: Victoria University Press.

Prince, J.M., & Steckel, R.H. (2003). Nutritional Success On The Great Plains: Nineteenth-century Equestrian Nomads. *Journal of Interdisciplinary History, 33*, 353-384.

Rector, F.L. (1929). *Health and medical service in American prisons and reformatories*. New York: The National Society of Penal Information, Inc.

Roberts, C. (1879). *A Manual of Anthropometry*. London: J. & A. Churchill.

Robson, B., & Harris, R. (2008). Hauora: Màori Standards of Health IV. A study of the years 2000–2005. In. Wellington: Te Rōpū Rangahau Hauora a Eru Pōmare.

Rose, R.J. (1960). *Maori-European Standard of Health*. Wellington: Medical Statistics Branch, Department of Health.

Rose, R.J. (1972). *Maori-European comparisons in mortality*. Wellington,: National Health Statistics Centre, Dept. of Health.

Rush, E.C., Freitas, I., & Plank, L.D. (2009). Body size, body composition and fat distribution: comparative analysis of European, Maori, Pacific Island and Asian Indian adults. *British Journal of Nutrition, 102*, 632-641.

Sardon, J.-P. (2006). Fertility in the Developed English-speaking Countries Outside Europe: Canada, United States, Australia and New Zealand. *Population (english edition), 61*, 267-291.

Shlomowitz, R. (2007). Did the mean height of Australian-born men decline in the late nineteenth century? A comment. *Economics and Human Biology, 5*, 484-488.

Silventoinen, K. (2003). Determinants of variation in adult body height. *Journal of Biosocial Science, 35*, 263-285.

Sorrenson, M.P.K. (1990). Modern Māori: The Young Māori Party to Mana Motuhake. In Keith Sinclair (Ed.), *The Oxford Illustrated History of New Zealand*. Auckland: Oxford University Press.

Statistics New Zealand. (2011). *Demographic Trends: 2011*. Wellington: Statistics New Zealand.

Steckel, R.H. (2008). Biological Measures of the Standard of Living. *Journal of Economic Perspectives, 22*, 129–152.

Steckel, R.H. (2013). Biological Measures of Economic History. *Annual Review of Economics, 5*, 401-423.

Steckel, R.H., & Haurin, D.R. (1995). Health and Nutrition in the American Midwest: Evidence from the Height of Ohio National Guardsmen, 1850-1910. In J. Komlos (Ed.), *Stature, Living Standards, and Economic Development* (pp. 117-128). Chicago: University of Chicago Press.

Steckel, R.H., & Prince, J.M. (2001). Tallest in the World: Native Americans of the Great Plains in the Nineteenth Century. *American Economic Review, 91*, 287-294.

Sutherland, I.L.G. (1935). *The Maori Situation*. Wellington: Harry H. Tombs.

Taylor, R.W., Brooking, L., Williams, S.M., Manning, P.J., Sutherland, W.H., Coppell, K.J., Tipene-Leach, D., Dale, K.S., McAuley, K.A., & Mann, J.I. (2010). Body mass index and waist circumference cutoffs to define obesity in indigenous New Zealanders. *The American Journal of Clinical Nutrition, 92*, 390-397.

Tobias, M., Blakely, T., Matheson, D., Rasanathan, K., & Atkinson, J. (2009). Changing trends in indigenous inequalities in mortality: lessons from New Zealand. *International Journal of Epidemiology, 38*, 1711-1722.

van Leeuwen, M.H.D., Maas, I., & Miles, A. (2002). *Historical International Standard Classification of Occupations*. Leuven: Leuven University Press.

Wanhalla, A. (2008). One White Man I Like Very Much. *Journal of Women's History, 20*, 34-56.

Whittin, E.S. (1913). *The Caged Man*. New York: Columbia University.

Whitwell, G., de Souza, C., & Nicholas, S. (1997). Height, Health and Economic Growth in Australia, 1860-1940. In Roderick Floud & Richard H. Steckel (Eds.), *Health and Welfare during Industrialization* (pp. 379-422). Chicago: University of Chicago Press.

Whitwell, G., & Nicholas, S. (2001). Weight and Welfare of Australians, 1890-1940. *Australian Economic History Review, 41*, 159-175.

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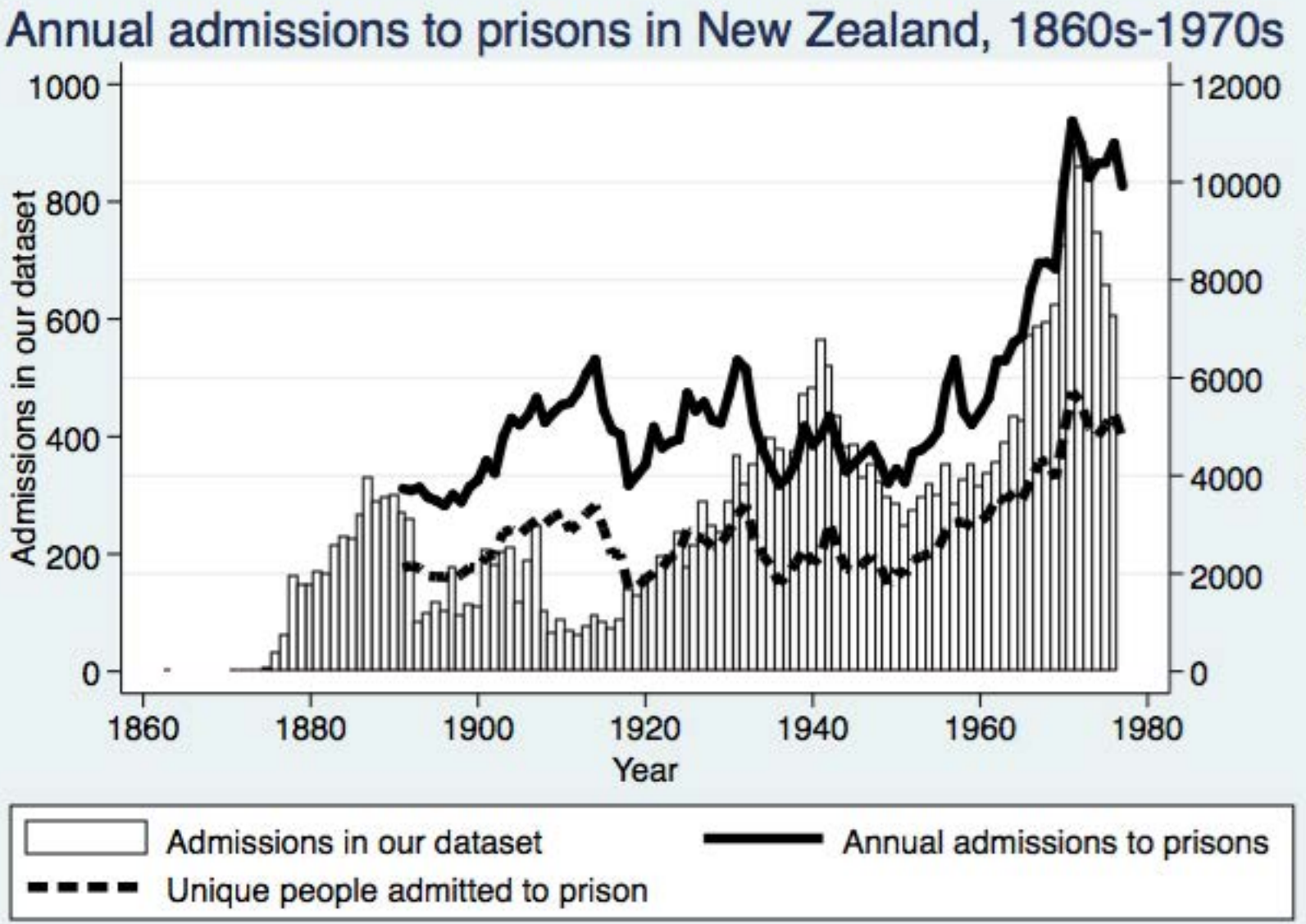
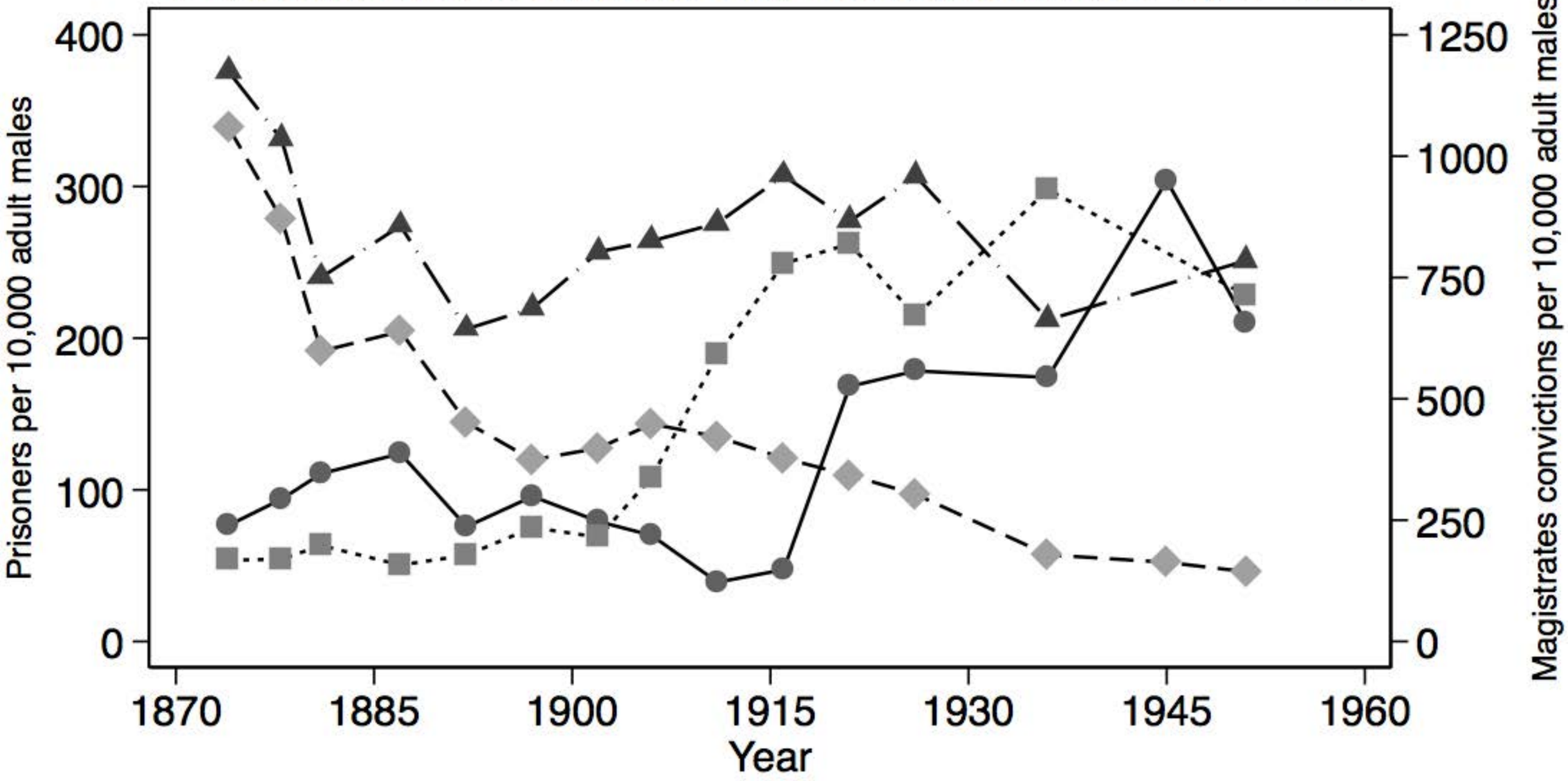
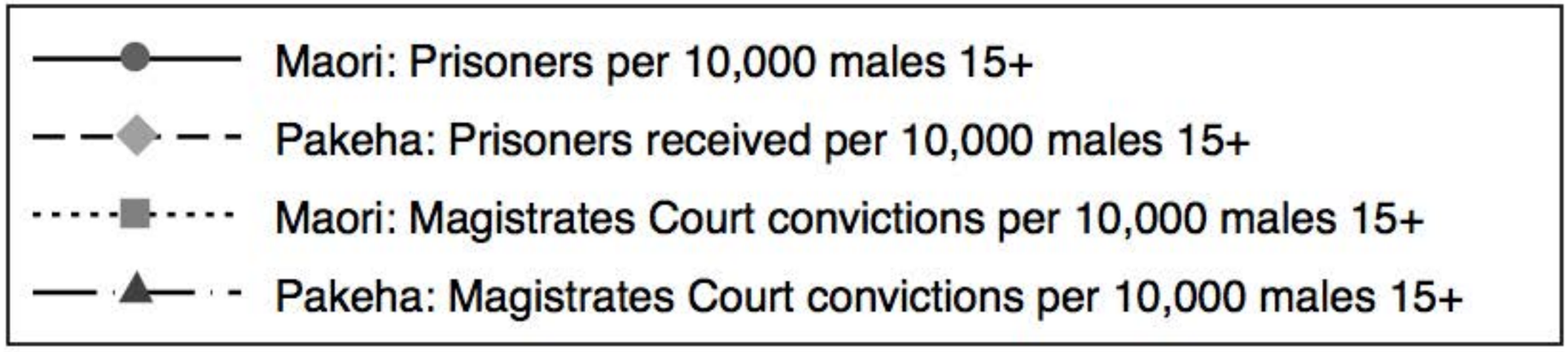
[1] Government reports since the early 1900s have documented the changing stature of children. Adult data was not published until the 1970s.

[2] Inquiries with archivists suggest that in the case of the Mount Eden (Auckland) prison a major prison riot in 1965 contributed to a reluctance on the part of prison officials to transfer records to Archives New Zealand.

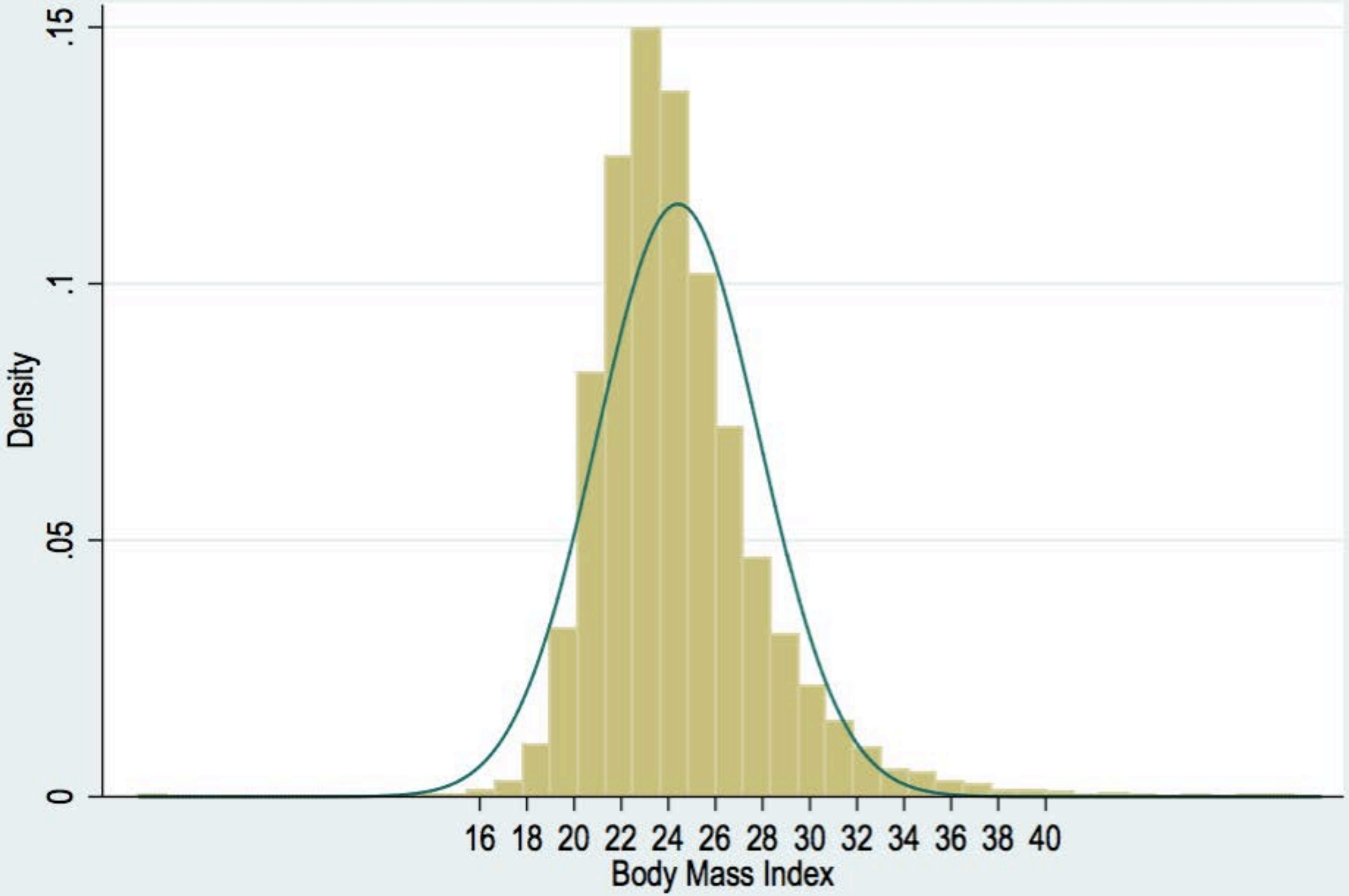

Annual admissions to prisons in New Zealand, 1860s-1970s
Admissions in our dataset
Admissions in total
1000
800
600
400
200
0
12000
10000
8000
6000
4000
2000
0
1860
1880
1900
1920
1940
1960
1980
Year
Admissions in our dataset
Annual admissions to prisons
Unique people admitted to prison

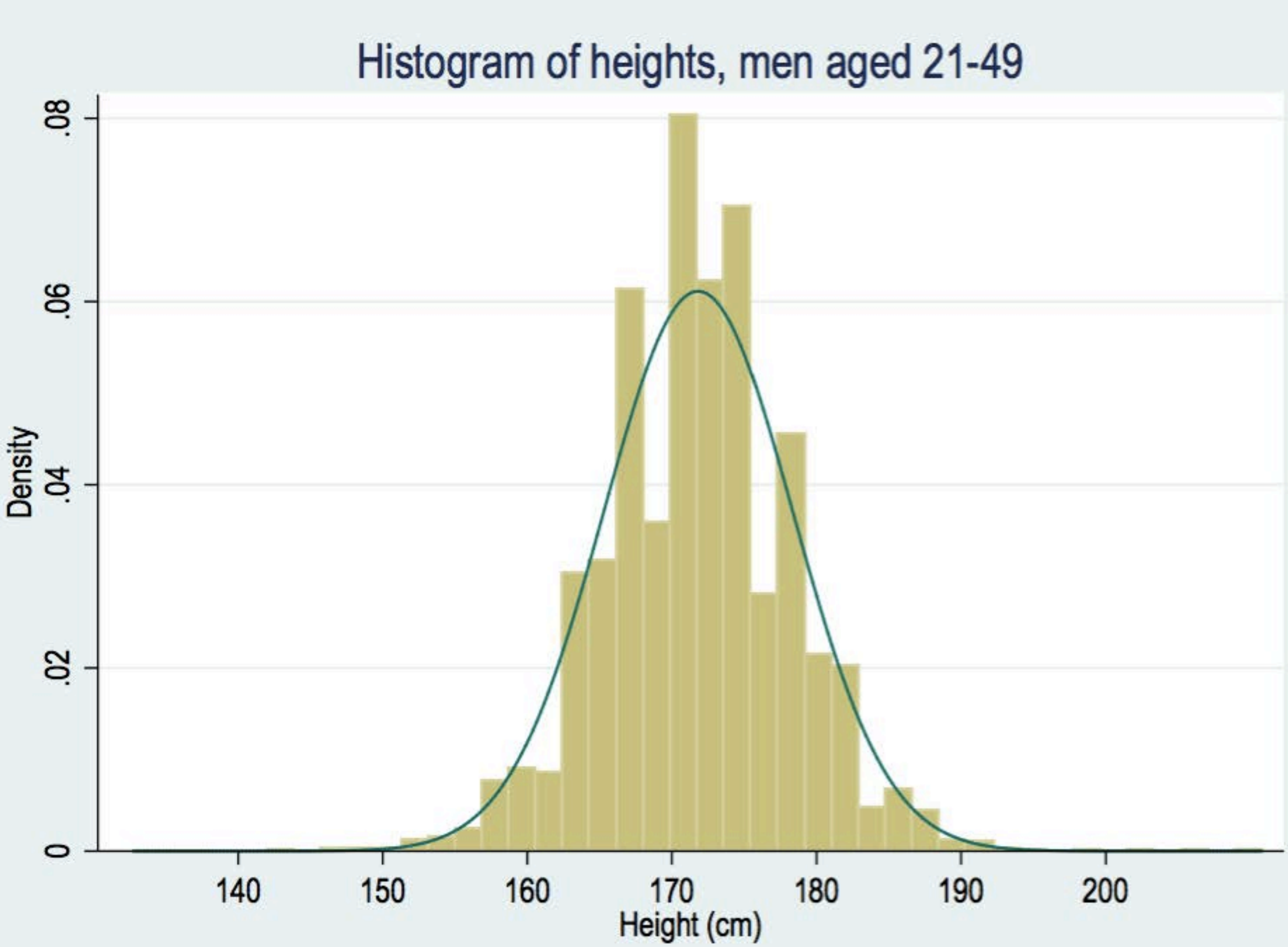
Maori and Pakeha conviction and incarceration rates, 1874-1951





Distribution of BMI, men aged 18-75




Histogram of heights, men aged 21-49
Density
0
.02
.04
.06
.08
140
150
160
170
180
190
200
Height (cm)

Mean stature of New Zealand prisoners born 1840-1955

Height (cm)

176
174
172
170
168

1840 1850 1860 1870 1880 1890 1900 1910 1920 1930 1940 1950

Birth Year

Average height (cm), overall
Average height (cm), Pakeha
Average height (cm), Maori

Height by age for Maori and Pakeha prisoners, pre-1914 and post-1945

Height (cm)

175
170
165
160
155

15 16 17 18 19 20 21 22 23

Age

Pakeha, pre-1914
Pakeha, post-1945
Maori, pre-1914
Maori, post-1945

Change in fertility rates, child:adult woman ratios, and prisoners' average stature, 1874-1961

Stature (cm) / TFR (children)

5
4
3
2
1
0
-1
-2

Difference in child:adult female ratio

1.5
1
.5
0
-.5

1870 1880 1890 1900 1910 1920 1930 1940 1950 1960

Year of birth

Difference in average stature (cm) (Pakeha - Maori)

Difference in total fertility rates (Maori - Pakeha)

Difference in child:adult female ratio (Maori - Pakeha)

Rolling average of BMI of New Zealand prisoners admitted to prison, 1880-1977

BMI

30
29
28
27
26
25
24
23
22

1880
1900
1920
1940
1960
1980

Prison Admission Year

Average BMI, overall
Average BMI, Pakeha
Average BMI, Maori