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RESEARCH ARTICLE

The biological standard of living of Korean men under Confucianism, colonialism, capitalism, and communism

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Abstract

This study focuses on analysing the heights of 10,953 Korean men aged 20 to 40 years who were measured during the Joseon dynasty, the Japanese colonialisation period, and the contemporary period, the latter including both North and South Korea. This study thus provides rare long-term statistical evidence on how biological living standards have developed over several centuries, encompassing Confucianism, colonialism, capitalism, and communism. Using error bar analysis of heights for each historical sample period, this study confirms that heights rose as economic performance improved. For instance, economically poorer North Koreans were expectedly shorter, by about 6 cm, than their peers living in the developed South. Similarly, premodern inhabitants of present-day South Korea, who produced a gross domestic product (GDP) per capita below the world average, were about 4 cm shorter than contemporary South Koreans, who have a mean income above the world average. Along similar lines, North Koreans, who have a GDP per capita akin to that of the premodern Joseon dynasty, have not improved much in height. On the contrary, mean heights of North Koreans were even slightly below (by about 2.4 cm) heights of Joseon dynasty Koreans. All in all, the heights follow a U-shaped pattern across time, wherein heights were lowest during the colonial era. Heights bounced back to Joseon dynasty levels during the interwar period, a time period where South Korea benefitted from international aid, only to rise again and surpass even premodern levels under South Korea's flourishing market economy.

Keywords: anthropometry; colonialism; height; historical trends; interwar period; Joseon dynasty; living standards; North Korea; socio-economic differences; South Korea

Introduction

Perhaps second to none, the Korean peninsula provides scholars a great opportunity to study the biosocial well-being of humans brought up under four major world ideologies: Confucianism, colonialism, capitalism, and communism.

Indeed, Confucianism was adopted as the state ideology in Korea following the foundation of the Joseon dynasty (1392–1910) in the late 14th century, replacing the preceding Goryeo dynasty (918–1392) that was primarily based on Buddhism. The adoption of Confucianism in early Korea in turn resulted in major improvements in daily living conditions, ranging from dietary improvements from the abolition of Buddhist vegetarianism to scientific innovations under King Sejong (1397–1450), who reinforced Confucian 'education zeal' by creating the Korean alphabet for the common people. Facing foreign threats by industrialised powers in the Age of Imperialism, Japan first occupied and later annexed Korea as a colony (1910–1945). Under harsh and

exploitative imperial rule, the Japanese imposed early industrialisation on Korea. This resulted in noticeable socio-economic advancements stemming from the introduction of modern farming and manufacturing methods, which occurred despite the exportation of most foods to the Japanese mainland (Song, 1990). As Japan sided with the Axis powers during World War II, it lost all colonies, including Korea, when it surrendered to the Allies in 1945. During the Soviet Union's march into Korea from the north to drive out the retreating Japanese, the Americans, fearing that the Red Army might overrun and seize the entire peninsula, spontaneously suggested dividing Korea into zones roughly of equal size along the 38th parallel north: a Soviet-controlled zone north of the parallel and an American occupational zone south of it. The outbreak of the Cold War in the aftermath of World War II led to the formal declaration of two Koreas in 1948, namely the Democratic People's Republic of Korea (DPRK), widely known as 'North Korea', as well as the Republic of Korea (ROK), commonly known as 'South Korea'.

The Cold War escalated into an open war when North Korea attacked South Korea in 1950, triggering the Korean War (1950–1953). The Korean War ended in a stalemate that by and large cemented the inter-Korean border near the original 38th parallel. That border has existed to the present day. The division into two Koreas was not only a geographic 'divorce'; it is also meant that diametrically opposed systems were installed in each country thereafter. While the Americans backed the South, this way facilitating the adoption of a capitalist and market-oriented system, the Soviet bloc supported the North, where it implemented a typical state planning system. The North went through a great famine in the 1990s as a result of inefficient central planning during the Cold War era, while living standards slowly improved in the South due to steady upgrading of its industrial base. In fact, South Korea became one of the world's most capitalist nations as well as the fastest growing economy by the late 20th century (Maddison, 2001). Meanwhile, its 'twin' in the North remains perhaps the last communist bulwark in the post-Cold War era, largely characterised by economic backwardness.

With this history, a central question remains on how the living conditions of the Korean people evolved under each of these four major systems. To put this question to the test, scholars frequently resort to the human welfare indicator of gross domestic product (GDP) per capita (Maddison, 1995). GDP per capita, commonly known as mean income, measures the total value of goods and services produced per head within a given economy in a year, providing an easy measure of overall economic performance. It has become the most widely applied indicator of living standards for past and present populations (Van Zanden *et al.*, 2014).

Figure 1 suggests that the GDP per capita in the north and south regions of the Korean peninsula did not differ much in the 19th century (namely 1820 and 1870) and were slightly below the world average at that time. GDP per capita did not differ much between the two Koreas at the beginning of the Japanese colonisation in 1913, although overall Korea started to fall behind the world average during that period. In 1940, towards the end of the colonial period, Korea's gap with the world not only further widened, but South Korea also pulled ahead of North Korea as the Japanese boosted agricultural production in the 'flat' southern region – the traditional 'breadbasket' region as opposed to the northern region, which consists mostly of mountains. Interestingly, both Koreas fared economically equally well from 1950 to 1970 (Figure 1). This is likely because the North benefitted initially from major socialist reforms such as a nationwide medical system, full employment rates, and a food rationing system, all of which contributed to a healthy and productive workforce after the Korean War. However, South Korea surpassed the North by 1980, and the gap even began to widen dramatically by the year 2000. By 2010, South Korea's GDP per capita became on par with the average of Western Europe or Japan (Bolt and Van Zanden, 2013), making the nation one of the richest countries in the world. In stark contrast, North Korea's GDP per capita has hovered around 2,000 international dollars since the 1990s, thus only one-third of the amount of its capitalist neighbour to the south. Also noteworthy is that South Korea surpassed the average per capita GDP of the world by 1990, whereas North Korea has

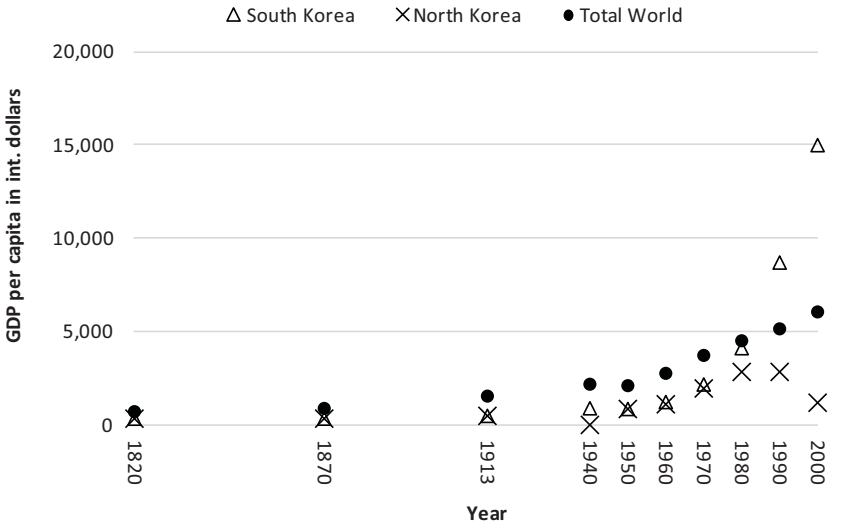

Figure 1. Gross domestic product (GDP) per capita in the two Koreas and the world, 1820–2000.

never caught up. On the contrary, North Korea's GDP per capita even started to fall remarkably behind the rest of the world during the 1990s, when the great famine hit the country.

Beyond the common economic indicator GDP, scholars centred around the Nobel Prize-winning economic historian cum population economist, Robert Fogel, suggested a complementary measure for standard of living: human height (Steckel, 1995; Ulijaszek and Komlos, 2010; Komlos and Baten, 1998). While GDP per capita does not account for the distributional effects of income, human height better captures socio-economic differences across people because important input factors of human well-being, such as medical and nutritional provisions, have a large bearing on anthropometric outcomes (Steckel, 1995). Moreover, human height measurements are much more straightforward than economic indicators, leaving less room for political manipulation or measurement errors while also being widely available for nearly all populations in recent centuries (Baten and Blum, 2014). Not surprisingly, major organisations such as the European Community (Garcia and Quintana-Domeque, 2005), OECD (Van Zanden *et al.*, 2014), and United Nations (Waterlow *et al.*, 1977) have adopted human height as an indicator of underlying socio-economic living conditions for people. Therefore, some followers and students of Fogel suggested the term 'biological standard of living' (Komlos and Baten, 1998; Komlos and Kriwy, 2003; Koepke and Baten, 2005) as an alternative concept to measure the common people's standard of living.

The purpose of this study is the investigate the biological standard of living of Koreans raised on under Confucianism, colonialism, communism, and capitalism. Similar biosocial studies have so far focused on the effects of Japanese colonialism on height in Taiwan (Morgan and Liu, 2007) or Korea (Kim and Park, 2011) as well as on how heights differed in the two Germanies (Hermanussen, 1997; Komlos and Kriwy, 2003) or the two Koreas (Pak, 2004; Schwekendiek, 2009) in comparative communist-capitalist perspective. While the effects of Japanese imperialism on the height of the colonised people remain inconclusive, communism has a negative effect on the height of the people compared to their co-ethnic peers brought up in a free market economy. Notwithstanding that a sizeable number of economic-historical studies on height in Southeast Asia (Bassino *et al.*, 2018; Baten *et al.*, 2013) and Northeast Asia (Shay, 1994; Morgan, 2004; Baten and Hira, 2008) already exists, this study fills a gap in the anthropometric literature by analysing human height measurements of a people in the long run.

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Methods

For data availability reasons, we focus on men. For instance, typical historical sources containing anthropometric measurements include military and militia records (Haines, 1998; Schuster, 2005) or prison registers (Nicholas and Oxley, 1993; Carson, 2011).

Moreover, this study limits itself to men who were physically measured. There are several studies on Koreans that draw upon self-reported anthropometric measurements (Ulijaszek and Schwekendiek, 2013; Schwekendiek and Baten, 2019), but these have been discarded herein in order to minimise measuring errors that oftentimes exist in such samples. In a similar vein, this study does not consider the heights of Koreans that were indirectly re-estimated based on femur measurements. In fact, height estimations based on osteometric data vary largely (Pak, 2011; Shin *et al.*, 2012) as there is no scholarly consensus on the conversion method of Asian, let alone Korean, heights.

Furthermore, this study limits itself to individuals who were 20 to 40 years of age at the time of measurement. On the one hand, individuals below 20 years of age were removed due to the fact that they still might experience growth (Sinclair and Dangerfield, 1998). On the other hand, males over 40 years of age start to shrink noticeably, that is, about 0.6 cm compared to their peak height (Chandler and Bock, 1991). Through these exclusions, we can by and large focus on 'final' heights of individuals. We also controlled for age and age-squared in a regression analysis to capture any remaining shrinking or catch-up growth effects.

It should also be noted that the international age system was used. Confusingly enough, Korean age differs from international age by up to 2 years for cultural reasons (Pratt *et al.*, 1999). Traditionally, 1 year is added due to the inclusion of pregnancy and a second year is added due to the cultural norm that Koreans advance in age on the first day of the Lunar New Year instead of their individual birthdays. International age was calculated by subtracting measurement year from birth year throughout all samples used in the present study.

The Korean peninsula consists of provinces (first-level administrative regions) that fortunately have not changed since the Joseon dynasty (Lautensach *et al.*, 1988). All individuals included in this study did have information on their provincial whereabouts, as individuals with missing province information were removed from the analysis. However, after the end of the Korean War, the province Gangwon was split into a North Korean Gangwon province and a South Korean Gangwon province. As one objective of this study is to compare premodern Koreans to modern Koreans, all residents from the pre-divided Gangwon province were removed. Furthermore, all individuals from pre-divided Korea who resided in a province of modern-day North Korea were removed due to low sample sizes that make statistical comparison meaningless. Instead, this study will focus on height comparisons of pre-divided South Korea and modern South Korea as well as height comparisons of modern South Korea and modern North Korea.

We show information on the heights of Koreans we did use for this study in Table 1. In the following, we will discuss the retrieved samples in chronological order, starting with Joseon dynasty records and ending with the samples representing the two divided Koreas.

Data sources

We take data for militia recruits from Jun *et al.* (2017). Their heights were originally measured for combat reasons. The sample includes militia recruits of the Joseon dynasty who were listed on haphazard records that happened to survive over the centuries. Unlike the standing army, no minimum heights were imposed on militia recruits. Commoners and unfree people (*nobi*, which is sometimes translated as 'slave'), thus the vast majority of the population, were included on the militia rosters. Only the noble class (*yangban*), which was believed to have been about 5% of the population (Palais, 1995), was exempted from the militia draft. The valid sample size is 2,184 men 20 to 40 years of age who were measured from 1621 to 1728 in provinces of present day's South Korea during the Joseon dynasty.

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Table 1. Overview of Korean periods and height samples of Korean men

	Joseon Korea	Colonial Korea	Interwar Korea	South Korea	North Korea
Background					
Historical period	1392–1910	1910–1945	1945–1950	1948–present	1948–present
Ideological priorities	Confucianism	Colonialism	De-colonisation	Capitalism	Communism
Political influence	China	Japan	USA and USSR	USA	USSR
Samples					
Measurement period	1621–1728	1914–1944	1936–1956	1998–2010	1998–2007
Birth period	1586–1708	1890–1915	1907–1933	1958–1990	1959–1990
Target group	Militia	Political prisoners	Bank employees	Random sample (KNHANES)	Refugees
Observations	2,184	75	72	7,182	1,406

The total sample size of this study is 10,953 observations due to the inclusion of 34 individuals without exact measurement year but valid entries on age and survey year information.

Heights of Koreans measured during the colonial period were retrieved from Choi and Schwekendiek (2009). The Japanese colonisers measured Korean men incarcerated in the Seodaemun Prison from 1914 to 1944 for biometric identification reasons. The Seodaemun Prison was the largest and main political prison in Korea during colonial rule (Park and Kim, 2010). It was located downtown in the capital Seoul. The Seodaemun prisoners were primarily incarcerated for protesting against colonial rule. As such, people from all walks of life, ranging from farmers to intellectuals, were incarcerated. Note that only 75 valid entries could be retrieved due to a large number of missing values regarding the residential provinces of inmates (Choi and Schwekendiek, 2009).

Seventy-two southern Korean men aged 20 to 40 years represent the interwar period, lasting from the end of World War II in 1945 to the beginning of the Korean War in 1950. These men were employed at a large local bank. Although the exact reason for the recording of their physical measurements is not known, their height might have been measured for biometric reidentification reasons. The data are discussed in Schwekendiek and Park (2020). The bank measured these individuals during and after the Japanese colonisation, from 1936 to 1956, thus inclusive of the post-Korean War period. This sample likely represents the mid-upper stratum of society as reading abilities were evidently required in the banking industry. In comparison, only 54% of Korean men aged 25 to 39 were literate in 1930 (Kimura, 1993). We will discuss possible selection issue below.

Moving to the modern post-war period, we analyse heights of South Korean men born from 1958 to 1990. The South Korean government collected these data (Kweon *et al.*, 2014). Similar to the National Health and Nutrition Examination Surveys (NHANES) conducted by the US government (Komlos, 2010), the Korean government started to carry out such large nutritional surveys (called 'Korean NHANES' or simply KNHANES) since the late 1990s for the purpose of monitoring the well-being status of the population. The surveyors selected the individuals randomly, and height measurements were included as a general indicator of health and nutrition. This dataset was originally analysed in Schwekendiek (2020). The KNHANES sample size is 7,182 men.

Last, we added data for North Koreans. Pak *et al.* (2011) extensively discuss this sample. The data are comprised of North Korean refugees who were measured upon their arrival in South Korea by the government as a part of a medical checkup. The valid sample size is 1,406 men aged

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20 to 40 of years. Similar to the militia and Seodaemun prison data, the sample includes both poorer economic refugees, such as farmers and labourers, and affluent political dissidents, such as professors and pilots.

Analysis

How have biological living conditions developed on the Korean peninsula under Confucianism, colonialism, capitalism, and communism? We show mean final height of men who were, as discussed above, 20 to 40 years of age at measurement, as shown in Table 1.

Mean height during the Joseon dynasty was about 168 cm. In comparison, if one applies the Trotter–Gleser conversion methodology for 'Mongoloid' populations, final height based on femur conversions of Joseon dynasty men ranges from 164 cm based on 85 skeleton remains (Pak, 2011) to 165 cm based on 67 skeleton remains (Shin *et al.*, 2012). Note that at about 168 cm, Koreans were as tall as Frenchmen, who stood at around 168 cm in the mid-18th century (Komlos *et al.*, 2003). If so, this means that Koreans enjoyed similar biological living conditions to Europeans in premodern times.

Heights fell to 164 cm during Japanese colonisation, tentatively suggesting that colonial exploitation was detrimental to the biological living standard of Koreans. In particular, although domestic rice production improved 1.4-fold from 1912 to 1936 thanks to modern farming techniques and equipment, rice exports from Korea to Japan rose 1.8-fold during the same period (Song, 1990). This means that the average Korean had fewer staple crops to eat day by day during colonisation, which could explain the decline in mean height.

During the interwar period, biological living conditions apparently improved slightly as Koreans became taller by 3–4 cm on average. However, one should keep in mind that individuals measured during the interwar period tend to represent the mid-upper class as all of them were bank employees. Possible further selection biases will be discussed below.

The mean height of South Korean men is 172 cm. South Korea's GDP per capita is nowadays on par with Western Europe (Bolt and Van Zanden, 2013), and Korean men are likewise nowadays as tall as some Europeans such as Italians (Schwekendiek and Jun, 2010), corroborating that industrialisation and capitalism have driven height in South Korea.

Lastly, the mean height of Korean men raised under communism is about 166 cm. At that height, North Koreans are as tall as or even slightly shorter than southern Koreans of the Joseon dynasty (Table 2). This suggests that North Koreans have even worse biological living conditions than that of their premodern ancestors. Unlike Joseon dynasty Koreans, who had access to staple crops such as rice from the far southern provinces of the Korean peninsula, North Koreans have effectively been cut off from fertile land since the artificial division of the peninsula along the 38th parallel in 1948. As communism and import-substitution left the nation without any strong comparative advantage in trade, North Korea has been facing food deficits and a lack of medical supplies since the Cold War.

To further test statistical differences across the samples and respective historical periods, we conducted error bars analysis (Figure 2–4) along with multivariate regressions. The purpose of the error bar analysis is to plot the overall height trend across time as well as to check for statistical differences of mean heights in each period. To quantify the size of the height difference for each period, we performed a regression analysis using height as the dependent variable and the historical periods as a set of dummies. Age and age-squared were added to control for any remaining shrinking or catch-up issues regarding final height.

Our first error bar analysis focuses on men residing in pre-divided southern Korea and contemporary South Korea by plotting mean heights and corresponding 95% confidence intervals (Figure 2). As all samples are from provinces located in present day's South Korea, this allows for a sound comparison of anthropometric changes over time. Figure 2 suggests that heights statistically significantly declined in the colonial period, only to improve statistically significantly in the

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Table 2. Mean final height of Korean men by major periods

Major phase	Historical period	Target group	Height in cm
Joseon Korea	1392–1910	Militia	168.31
Colonial Korea	1910–1945	Political prisoners	164.00
Interwar Korea	1945–1950	Bank employees	167.35
South Korea	1948–present	Random	172.43
North Korea	1948–present	Refugees	166.00
Total			

The total sample size is 10,953 observations.

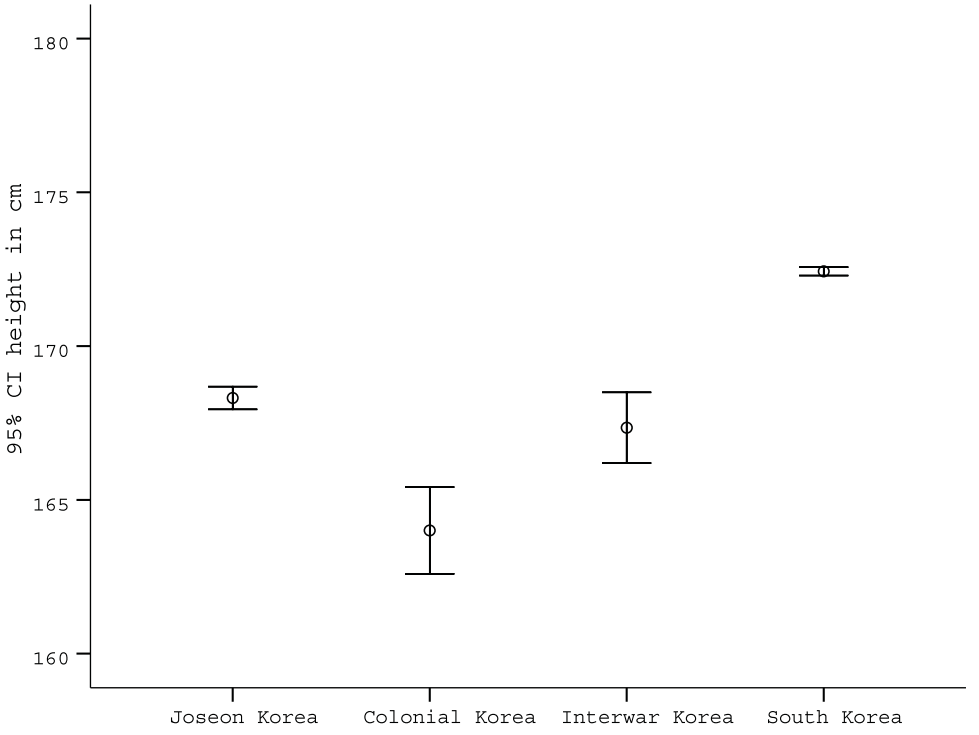

Figure 2. Error bar analysis of final height of old pre-division southern Korean men and contemporary South Korean men.

interwar period as well as the post-division period, forming a U-shape across time. Only the interwar period and Joseon period do not statistically differ.

For the second error bar analysis, we assumed that the height of pre-division southern Koreans is by and large also representative of pre-division northern Koreans' height (Figure 3). In doing so, we can compare heights in present-day North Korea to heights in the North before the split, even though the real heights of pre-division northern Koreans are absent from the present study. Figure 3 suggests that contemporary North Korea is not statistically different from the colonial period or interwar period as confidence intervals overlap. However, while contemporary North Koreans are significantly taller than colonial Koreans, they are statistically shorter compared to Koreans of the premodern period.

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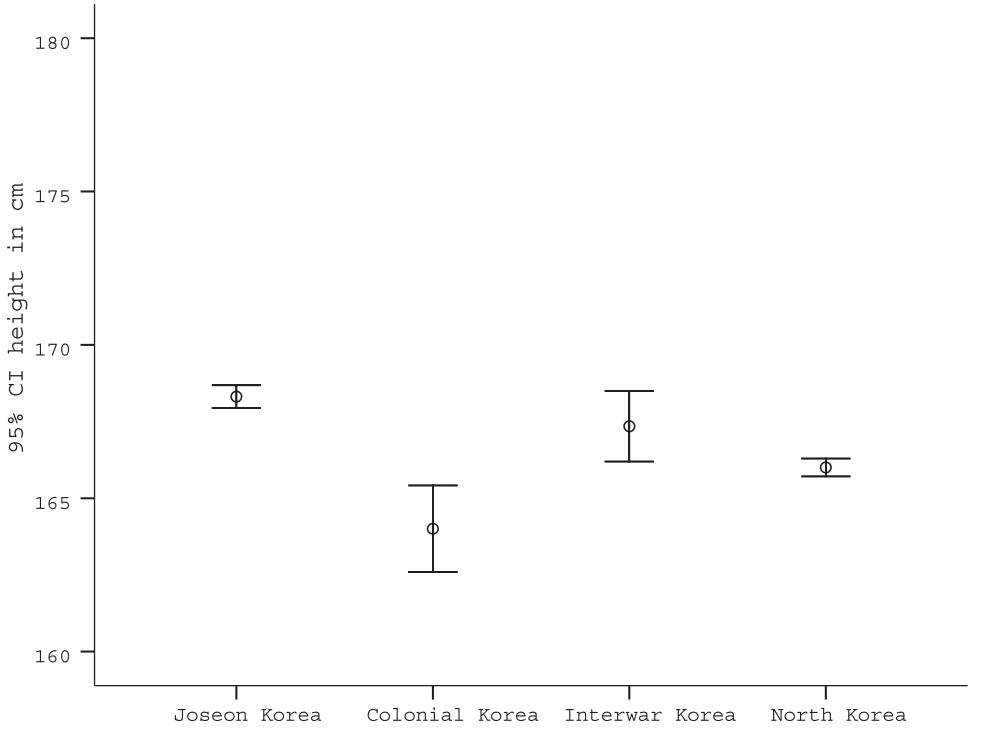

Figure 3. Error bar analysis of final height of pre-division southern Korean men and contemporary North Korean men.

The last error bar analysis pays attention to the contemporary period by plotting the height of men in contemporary South Korea against their peers' height in contemporary North Korea (Figure 4). The analysis reveals that there is a large difference in biological living standards between South Koreans and North Koreans. Those raised under communism are statistically significantly shorter than those living in the capitalist South.

Regression analysis suggests that southern Koreans living in the Joseon dynasty were taller than southern Koreans measured during Japanese colonisation by a significant 4 cm (Table 3, Linear regression 1). Though interwar southern Koreans do not statistically differ from southern Koreans of the Joseon dynasty, contemporary South Koreans are significantly taller than the latter by about 4 cm. Controlling for age, we do find some remaining shrinking and catch-up growth effects as both coefficients come out statistically significant in the regression (Table 3, Linear regression 2). However, the size effect is rather low (-0.01 to 0.5 cm) while not particularly having a noticeable impact on the period dummies.

Sampling issues

Table 4 sheds light on selection biases using higher educational status as a socio-economic stratification variable (see the notes in Table 4 for definitions used). Unfortunately, we cannot address differences in height by education regarding the militia samples, as primarily the elites (*yangban*) were highly educated, yet exempted from the draft. We focus on the 1950s to 1960s birth periods in the case of North Korea and South Korea for a broad comparison with the interwar period.

Overall, higher educated individuals tend to be taller than their non-educated peers (Table 4). The only exception is higher educated Koreans born in the colonial period, who were shorter than

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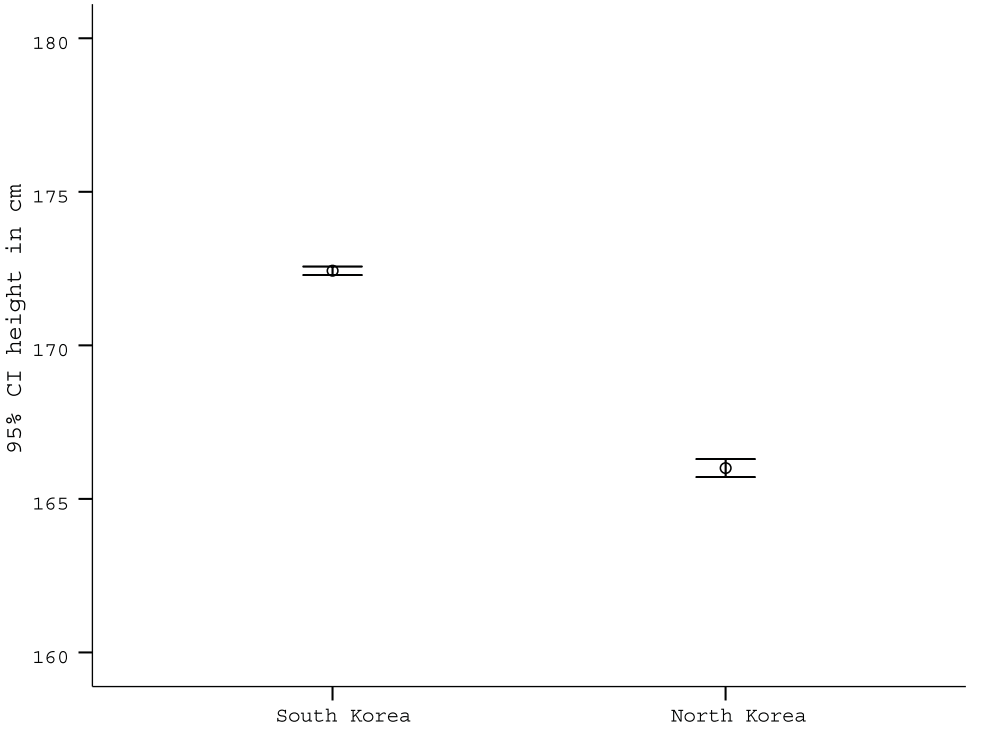

Figure 4. Error bar analysis of final height of contemporary South Korean men and contemporary North Korean men.

Table 3. Linear regression of final height of Korean men

	Linear regression (1)		Linear regression (2)	
	Coefficients	*P*-values	Coefficients	*P*-values
(Constant)	168.313	0.000	162.347	0.000
Measurement period by historical phases				
Joseon Korea (1392–1910), reference				
Colonial Korea (1910–1945)	−4.308	0.000	−4.441	0.000
Interwar Korea (1945–1950)	−0.966	0.232	−1.197	0.138
South Korea (1945–present)	4.116	0.000	4.292	0.000
Measurement age in years				
Age			0.495	0.000
Age (squared)			−0.010	0.000
Adjusted R-squared	0.072		0.079	
Number of observations	9,547		9,547	

Coefficients significant on the 1% level are flagged. The sample size (9,547 observations) reported here is lower than the total pooled sample size reported in Table 1 and Table 2 (10,953 observations) because the North Korean sample (1,406 observations) were not included here in order to compare height trends in South Korea with pre-divided Southern Korea.

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Table 4. Mean final height of Korean men by educational status

Sample	Birth period	Status	Height in cm
Colonial Korea	1890s–1910s	Political prisoners (higher education)	163.8
		Political prisoners (lower education)	164.6
Interwar Korea	1910s–1940s	Bank employees	167.4
South Korea	1950s–1960s	KNHANES (higher education)	171.8
		KNHANES (lower education)	170.2
North Korea	1950s–1960s	Refugees (higher education)	168.9
		Refugees (lower education)	167.3

Higher education refers to BA or MA degree in the case of South Korea, 4-year college or vocational college in the case of North Korea, as well as student or journalist or teacher job status in the case of colonial Korea.

their non-educated peers. However, one should bear in mind that educational status was derived from their job status at incarceration (see notes in Table 4). Many political prisoners in the 'unemployed' category were possibly higher educated but lost their job as the Japanese colonisers imposed high capital asset requirements on them to drive them out of business. Also, many highly qualified Koreans were probably put out of work due to a land reform the Japanese utilised to seize land from Koreans. Therefore, it is perhaps better to simply use the mean height of the entire sample from Colonial Korea, which is 164.0 cm (Table 2).

If so, bank employees (167.4 cm, Table 4) measured in the interwar period were taller by 3.4 cm compared to political prisoners (164.0 cm, Table 2). However, the political prisoners were measured at the first half of the colonial era, whereas the bank employees in the latter half (Table 1), which could indicate that Japanese reforms might have caused the gap. However, a more likely explanation could indeed be selection bias. Beyond managers and tellers, also many guards probably worked at the bank. These were likely selected due to their physical stature, meaning that both non-educated and educated employees at the bank were on the taller side, all of which could possibly explain the 3.4 cm gap in mean height.

Comparing the bank employees from the interwar period with randomly selected South Koreans born in the 1950s to 1960s, we find that the bank employees (167.4 cm, Table 4) are closer to the mean of the lower-educated KNHANES cohorts (170.2 cm, Table 4) than to the highly educated ones (171.8 cm, Table 4). Though a bit puzzling, one should bear in mind that the South Korean cohorts benefitted from massive US food aid as well as antibiotics introduced during and after the Korean War in the 1950s, whereas the North had to even feed the Red Army since the end of Japanese colonisation. It is therefore perhaps safer to compare the interwar bank employees to the cohorts born in North Korea in the 1950s to 1960s. Interwar Koreans were about 1.5 cm shorter than highly educated North Koreans and about 0.1 cm taller than lower educated North Koreans (Table 4).

To sum up, we conclude that the bank employees were about 1.5 cm taller compared to North Koreans born from the 1950s to 1960s and about 3.5 cm taller than Koreans raised in the earlier period of Japanese colonisation. Whether or not this is due to selection bias or underlying socio-economic reasons remains unclear.

Conclusion

Offering rare long-term statistical evidence on how biological living standards have developed over several centuries, this study focuses on the final heights of Korean men measured from the

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Joseon dynasty, the Japanese colonisation period, and the contemporary Koreas, thus investigating socio-economic living conditions under Confucianism, colonialism, capitalism, and communism. Such a time-encompassing study, especially one based on actually measured anthropometric data, is quite rare in applied research as most anthropometric studies limit themselves to only a few years or decades or have to rely on controversial osteometric estimations. Overall, this study confirms that heights improved as economic performance and GDP per capita rose (Table 2 and Figure 1). For instance, economically poorer North Koreans were expectedly shorter, by about 6 cm, than their peers living in the developed South (Table 1). In a similar vein, premodern southern Koreans, having a GDP per capita below the world average, were about 4 cm shorter than contemporary South Koreans, who have a mean income above the world average (Table 2 and Figure 1). Similarly, North Koreans, possessing a GDP per capita akin to that of premodern Joseon dynasty Korea, have not improved much in height. On the contrary, the mean heights of North Koreans were even found to be slightly below (by about 2.4 cm) that of southern Joseon dynasty Koreans (Table 2 and Figure 1).

All in all, the heights of pre-division southern Koreans and post-division South Koreans follow a U-shaped pattern across time (Figure 2). Heights were lowest during the colonial era, which might have been due to the exploitation of the main staple crop, rice, by the Japanese. However, as we only observe the early 17th century, a simple further explanation could be that mean heights declined during the preceding 18th and 19th centuries, prior to colonisation. Indeed, previous studies found that other socio-economic indicator such as real wages have remarkably fallen in the late Joseon dynasty (Park and Yang, 2007; Jun *et al.*, 2008), indicating that living conditions and presumably height were low before Japanese annexation of the peninsula. Furthermore, we find that heights bounced back to premodern levels during the interwar period, a time period where South Korea benefitted from international aid, only to rise once more and surpass premodern levels.

Future studies will have to focus on the long-term development of Korean women's heights, which might have experienced a completely different biological standard of living. Given especially the role of Confucianism, which discriminates against females in the intra-household distribution of resources such as food (Gill, 1998), one can expect larger height improvements for women when compared to their male peers due to rising gender equality throughout the centuries. Also needed are studies linking anthropometric trends in Korea to specific socio-economic indicators on both the micro- and macro-levels.

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