Economic Development and Changing Socioeconomic Differences in Health: Evidence from South Korea, 1946–1977

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This study examines how socioeconomic differences in health change with improvements in economic and environmental conditions in South Korea. Using a newly collected 0.5% random sample of military records for all males born from 1946 to 1957, I found that socioeconomic disparity in health increased across birth cohorts. A possible hypothesis is that health shocks (such as exposure to war-caused disruptions, natural disasters, and infectious diseases) could weaken the effects of different parental investments. Such shocks were more prevalent prior the end of the Korean War. In support of the hypothesis, I found that socioeconomic disparity in adult height among the cohorts born before 1952 was less pronounced among conscripts from the central region, which was more severely affected by the Korean War, than those from the south region.

Keywords: Economic development, Height, Disparity in health, The Korean War, Military records

JEL Classification: I14, N35, O15

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I. Introduction

A large number of studies across various disciplines have established considerable variations in health across populations of different socioeconomic backgrounds (Kitagawa and Hauser 1973; Notkota *et al.* 1985; Lehmann *et al.* 1990; Diderichen 1990; Lawson and Black 1993; Deaton and Paxson 1999; Lleras-Muney 2005; Cutler *et al.* 2012). Estimating the magnitudes and determining the causes of socioeconomic disparities in health have major research themes of social sciences (Currie *et al.* 2010; Cutler *et al.* 2012; Aizer and Currie 2014). Growing evidence suggests that the magnitude of the socioeconomic gradient in health differs across nations and over time (Pappas *et al.* 1993; Marmot 2004; Cutler *et al.* 2011). Despite the contributions of recent studies, the factors explaining the changing relationship between socioeconomic status and health across times and places remain not fully understood (Glied and Lleras-Muney 2008; Cutler *et al.* 2010).

The purpose of this study is to examine how socioeconomic differences in health change with improvements in economic and environmental conditions based on the historical experiences of South Korea. Individuals born immediately after the Second World War spent their childhood and adolescence during periods of upheavals, including chaotic political and social circumstances that followed the liberation from the Japanese occupation, the devastation of the Korean War, and the long and slow recovery from the destruction caused by the two wars. By contrast, those born toward the end of the 1950s were the first generation to experience childhood during periods of prolonged peace and rapid economic growth in the 1960s and 1970s. Comparing the health disparities of these birth cohorts offers a unique opportunity to study how socioeconomic conditions shape health outcomes over time .

Recently collected data on Korean military records for a sample of male birth cohorts born from 1946 to 1957 enable me to utilize the semi-experimental circumstances of South Korea in the mid-twentieth century. The data contain information on conscripts, such as place of current residence, place of original residence, education, occupation, and results of physical examinations. These records provide a rare opportunity to connect a person's adult health outcomes to parental characteristics. Unlike most micro household data today, the military records contain information on parents regardless of living arrangement. Using these records, I investigate how the relationship between parental SES (indicated by the quality of father's occupation) and adult health outcomes (such as height at age 20) changed across birth cohorts.[1]

The results obtained from the military records show that conscripts whose fathers were employed in more prestigious occupations were significantly taller at conscription than the children of lower-class fathers. More importantly, socioeconomic disparity in health *increased* across birth cohorts. I found no advantages of having high-class fathers for the cohorts born prior to the Korean War. The differences in height according to father's occupation emerged for the conscripts who were conceived or born during the Korean War, and the disparity became larger in the post-war birth cohorts.

A possible explanation is that socioeconomic differences in parental investments in children reduced over time. However, unlike the results from height regressions, the differences in schooling according to father's occupation remained relatively stable across birth cohorts, which tends to reject the hypothesis. Another possible hypothesis is that health shocks (such as exposure to war-caused disruptions, natural disasters, and infectious diseases) could weaken the effects of different parental investments. Such shocks were more prevalent prior the end of the Korean War. In support of the hypothesis, I found that the socioeconomic disparity in adult height among the cohorts born before 1952 was less pronounced among conscripts from the central region, which was more severely affected by the Korean War, than those from the south region.

II. Backgrounds

A. Socioeconomic Differences in Health

Differences in various measures of health across populations of different socioeconomic backgrounds have been found in every society

[1] The effect of socioeconomic status measured by father's occupation on children's height could partly capture the effect of genetic transmission across generations (McEvoy and Visscher 2009). This study cannot distinguish between the effects of socioeconomic and genetic factors by employing twin- or sibling-fixed effect model because of data limitations.

throughout history. Inequality in health is an important social problem even in wealthy nations today (Kitagawa and Hauser 1973; Notkota *et al.* 1985; Lehmann *et al.* 1990; Diderichen 1990; Lawson and Black 1993; Deaton and Paxson 1999; Lleras-Muney 2005; Cutler *et al.* 2012). Growing evidence suggests that socioeconomic differences in health perhaps originate from early stage of life. Parental characteristics, such as education, occupation, and income, are strongly related to children's health outcomes from birth to late childhood (Case, Lubotsky, and Paxon 2002; Currie and Stabile 2003; Currie *et al.* 2010; Lindahl 2016). That early-life health persistently affects human capital development, socioeconomic outcomes, and adult health is now widely accepted (Almond and Currie 2010; Almond, Currie, and Duque 2017).

Previous research suggests that health differentials by socioeconomic status cannot be fully explained by differences in health behaviors or access to medical care (Cutler *et al.* 2012). Several hypotheses have been suggested to explain how social and economic environments alter human biological functioning. Frequently cited mediating factors between wealth and health include work-related stress, family background, and other social support networks. A growing number of studies demonstrate that health at middle and older ages reflects earlier health and may be correlated across and within generations (Barker *et al.* 1989; Barker 1997; Ravelli *et al.* 1998; Wadsworth and Kuh 1997; Aizer and Currie 2014). Some studies see the principal effects of socioeconomic status on health as stemming not from brief episodes but instead from the accumulation of repeated stress over the lifespan (Seeman *et al.* 1997). Another line of research focuses on the role of income inequality, maintaining that inequality in relative socioeconomic status raises the level of psycho-social stress, which negatively affects endocrine and immunological processes (Sapolsky 1993; Wilkinson 1996; Marmot 2004).

Although socioeconomic disparity in health is universally observed, the magnitude of the gradient differs across nations and over time. The mortality differentials by the quality of occupation are larger in England and Wales than in Sweden (Marmot 2004). Evidence suggests that the social health gradient has not diminished despite rising income during the second half of the twentieth century (Preston *et al.* 1981; Marmot *et al.* 1991; Marmot 1999). Health differentials by education actually increased in recent years. Pappas *et al.* (1993) estimated that U.S. mortality differentials according to education increased by 20% between

1960 and 1986. The life expectancy of U.S. college graduates increased by 1.6 years from 1990 to the early 2000s, whereas those with lower educational attainment had no gains during the same period (Cutler *et al.* 2011).

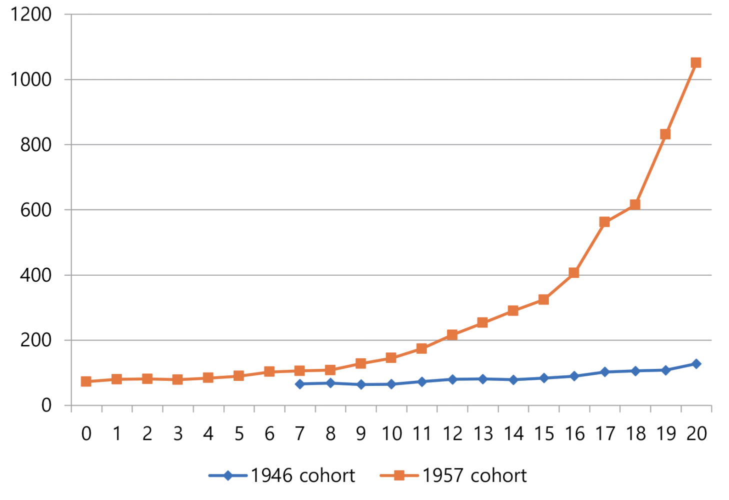
Possible explanations for the recent rise in health inequality are advances in medical technology and growing importance of health management. With better ability to utilize the newly available means to improve health, people of high SES may benefit more from technological changes than low-class individuals (Glied and Lleras-Muney 2008; Cutler *et al.* 2010). However, the factors explaining the changing relationship between socioeconomic status and health across periods and places remain not fully understood.

B. Case of Korea

South Korea has achieved rapid economic growth since its liberation from the Japanese occupation in 1945. Within only four decades after the Korean War (1950–1953), South Korea has emerged as one of the richest newly industrialized countries. Previous estimates of incomes suggest that the real GDP per capita stagnated in the early 1960s and began to increase rapidly in the following years (Pyo 2001; Kim 2012; Cha 2014). World Bank Statistics indicated that the annual growth rate for per capita GNP in South Korea was 6.6 percent in 1965–1999, the highest among all countries (Song 2003).

As a consequence of the rapid economic development and dramatic social changes associated with it, early-life experiences of the cohorts born shortly after 1945 substantially differed according to the year of birth. For instance, the subjects of the cohorts born just after the end of the Second World War went through the chaotic years following the liberation from Japan, severe disruptions caused by the Korean War, and the period of slow recovery from the aftermath of the devastating war. By contrast, the cohorts born toward the end of the 1950s spent their childhood and adolescence in a prolonged period of peace when South Korea began to achieve an economic miracle.

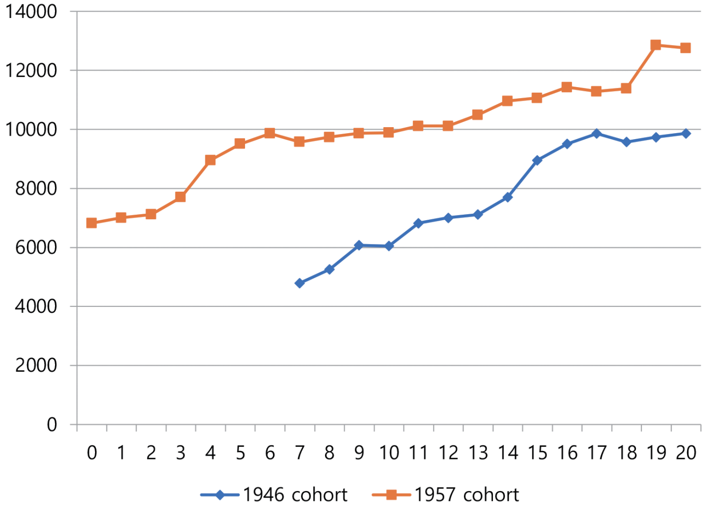
Figures 1 to 6 compare the early-life experiences of the 1946 and 1957 birth cohorts based on several indicators of standards of living. The results show that the two birth cohorts spent their formative years in very different conditions, although they were born just 11 years apart. For instance, the per capita income of South Korea (in fixed US



Source: ECOS of the Bank of Korea

Figure 1

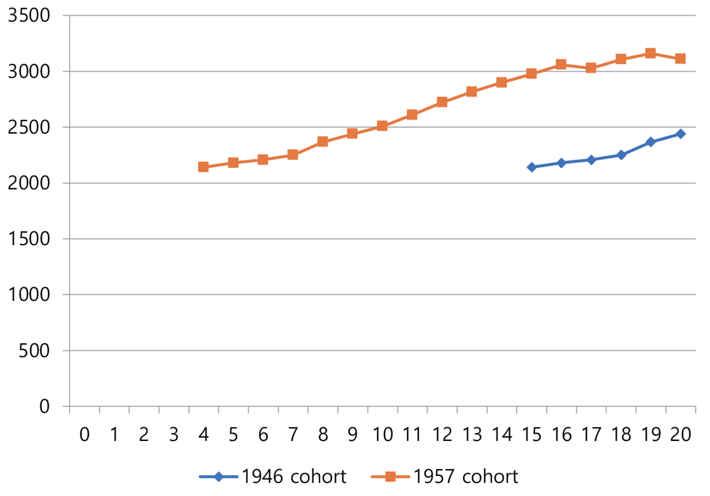
GDP per Capita by Age for the 1946 and 1957 Birth Cohorts (US Dollars in 2010 Constant Price)



Source: Korea Statistical Yearbook

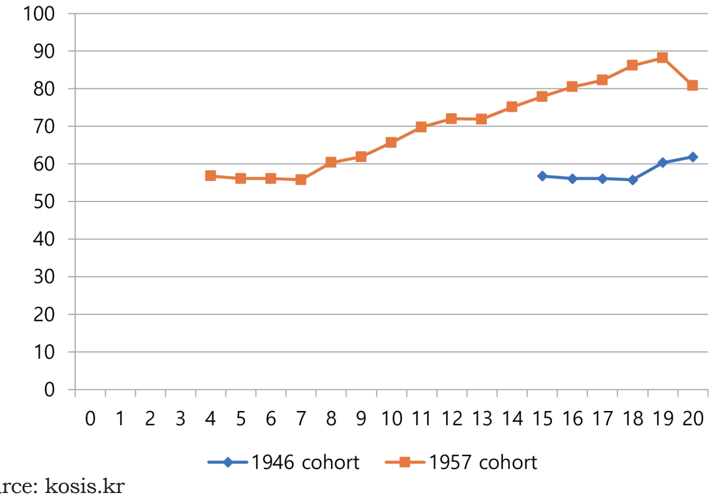
Figure 2

Number of Medical Facilities by Age for the 1946 and 1957 Birth Cohorts



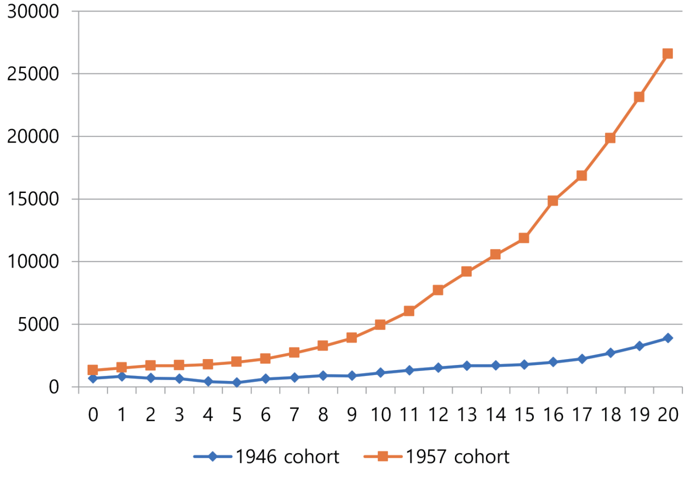
Source: kosis.kr

Figure 3
Daily Calorie Supply per Capita by Age for the 1946 and 1957 Birth Cohorts



Source: kosis.kr

Figure 4
Daily Protein Supply per Capita by Age for the 1946 and 1957 Birth Cohorts



Source: Korea Statistical Yearbook

Figure 5

Electric Power Supply by Age for the 1946 and 1957 Birth Cohorts

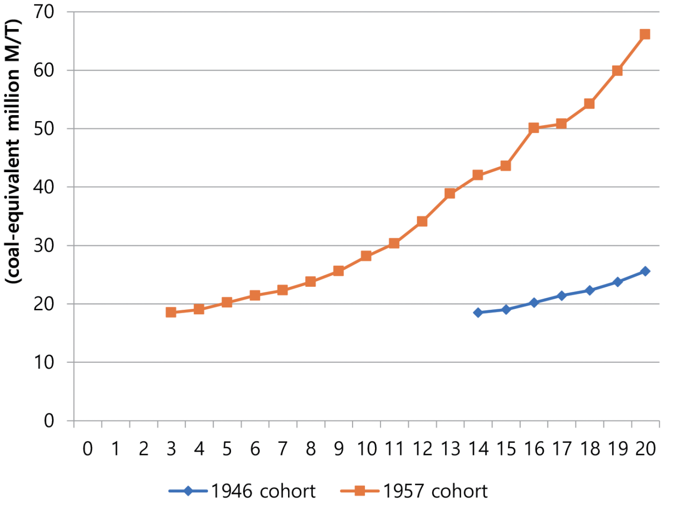


Figure 6

Energy Consumption by Age for the 1946 and 1957 Birth Cohorts dollars) stagnated under 130 dollars until the 1946 birth cohort reached age 20, whereas it rapidly increased from 106 dollars to 1,051 dollars during the years when the 1957 birth cohort were aged 7 to 20 (Figure 1). When the individuals born in 1957 were aged 16, average Koreans were four times wealthier than when those born in 1946 were at the same age.

Figure 2 shows that the 1957 birth cohort had much improved access to medical service in early childhood and adolescence compared with the 1946 birth cohort. For instance, around age 7, the late birth cohort had twice the number of medical facilities that the early birth cohort had at the same age. As presented in Figures 3 and 4, birth cohorts born in the late 1950s were likely better nourished in late childhood than those born in the late 1940s. At age 15, average daily provisions of total calories and of protein were considerably larger for the late birth cohorts than for those born earlier. Likewise, the 1957 birth cohort spent their late childhood when electricity and energy in general were more abundantly supplied compared with the 1946 birth cohort (Figures 5 and 6).

Given the rapid improvements in living conditions during the childhood and adolescence between individuals born shortly after 1945 and those born in the late 1950s, expecting that various socioeconomic and health outcomes improved across birth cohorts is reasonable. The average height at age 20 increased by approximately 2 cm between the 1946 and 1957 birth cohorts (Lee 2019). Although vital statistics prior to 1970 are highly unreliable, life expectancy has substantially increased between 1960 and 1970 (National Statistical Office 1998). Age at menarche, often used as an index of the biological standard of living, has declined, particularly after 1946 (Hong *et al.* 1993; Hwang *et al.* 2003; Sohn 2017). However, how the rapid economic growth changed socioeconomic differences in health over time is unknown.

III. Data

For the purpose of the study, I used a 0.5% random sample of military records for all males (including those exempted from service) born from 1946 to 1957. After a large-scale recruitment was attempted on a compulsory basis following the outbreak of the Korean War, military service became a mandatory duty for all males in South Korea. All males must take physical examinations for military conscription at

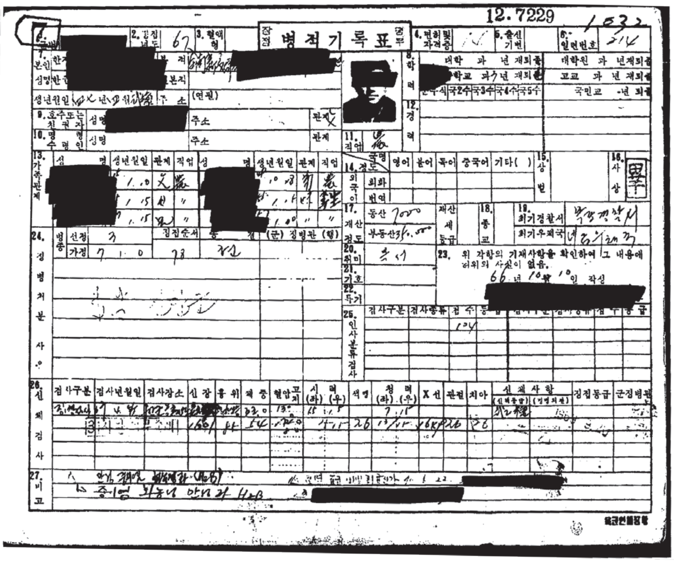


Figure 7
Sample of Carded Military Record

age 20. Military record cards are produced for all males including those exempt from service. On the front page of the card, the information on personal and family characteristics and the results of physical examinations is recorded. For veterans, military service records are provided on the back page of the card.

The carded military records (CMR, hereafter) are kept in the central office of the Military Manpower Administration (MMA, hereafter). A sample of the card is provided in Figure 7. From 2002 (for the birth cohorts born in 1982 or later), CMRs are available in machine-readable forms. Either image files or micro films of military records can be obtained for earlier birth cohorts. Judging from the total number of records, CMRs seem available for the entire male population at least from the mid-1960s.

By obtaining permission from the MMA, we collected a 0.5% sample of CMRs for the birth cohorts born from 1946 to 1957. The CMRs for the individuals born from 1948 and 1957 are contained in the forms of image files that can be sorted according to the National Registration Number, of which first six digits provides the birth dates. We selected men who were born in the 20th day of each month and whose ID ends with 4 or 6, which gave one in 150 sample. Further selections of records that are complete and readable provided us with a roughly 0.5% sample. For the birth cohorts born from 1946 to 1948, the CMRs are available in the forms of micro films. We selected the first 15 films from each roll composed of 3,000 films for these cohorts. If the selected film is incomplete or difficult to read, we replaced it by the next film.

To protect the privacy of the individuals included in the sample, we deleted the following information from the selected CMRs: 1) the names of the conscript and family members, 2) military ID, 3) last seven digit numbers of National Registration Number, and 4) address below the level of county or district. The front and back pages of CMRs with the sensitive personal information deleted were scanned at the MMA, and we obtained the resulting image files. After duplicate records were detected and excluded, we inputted the information drawn from the image files into database.

We identified nine different types of CMRs in terms of format and content. Four major types, denoted as Forms 1 to 4, account for the majority of the sample. The variables pertaining to the information on conscripts available from all types of CMR include birth dates, place of current residence, place of original residence, education, occupation, specialty, results of physical examinations and aptitude tests, and conscription decision. The data also provide information on the age, occupation, and relationship to the conscript of parents (or guardian) and other family members. The variables on physical examinations include height, weight, chest measurement, blood pressure, eyesight, and particular health problems.

Table 1 presents the number of samples by birth year. The total number of CMRs collected and scanned at the MMA is 18,359. Of these CMRs, we found 21 records with a missing page, and 233 duplicated records. After excluding these defected records, 18,115 CMRs were inputted into machine readable forms. The sample size for each birth cohort ranges from 1,031 (the 1947 birth cohort) to 2,211 (the 1957 birth cohort). Of these 18,115, we selected men whose height and other characteristics required for the study are available in the records.

Korean military records provide a rare opportunity to connect a person's adult health outcomes to parental characteristics. In most micro household data, parental characteristics are available only if a person cohabits with parents. CMRs contain information on parents regardless of living arrangement. Henceforth, the data allow me to

Table 1
Number of Military Records by Year of Birth

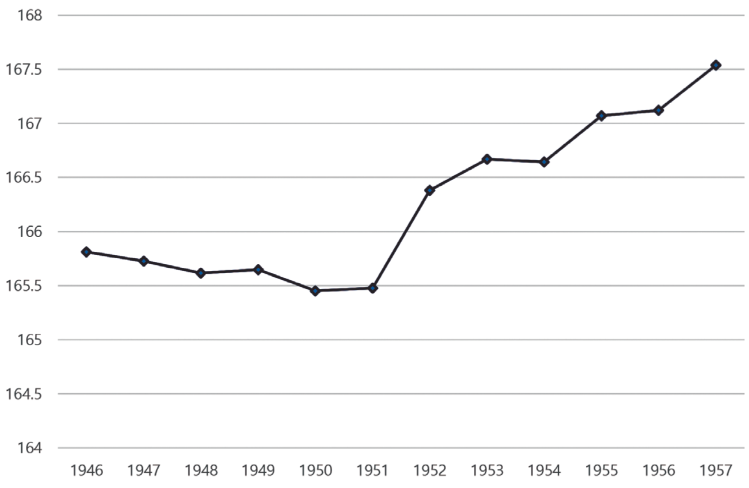
Year of Birth	(A) Number of Records Collected	(B) Number of Incomplete Records	(C) Number of Duplicated Records	(D) Number of Records Inputted
1946	1,162	0	4	1,158
1947	1,036	0	5	1,031
1948	1,443	1	1	1,441
1949	1,143	0	23	1,120
1950	1,310	1	5	1,304
1951	1,303	0	43	1,260
1952	1,577	0	2	1,575
1953	1,404	11	35	1,358
1954	1,706	4	6	1,696
1955	1,875	0	52	1,823
1956	2,157	1	18	2,138
1957	2,243	3	29	2,211
Total	18,359	21	223	18,115

Source: Sample of Korean Military Records.

investigate how the relationship between parental SES (indicated by the quality of father's occupation) and adult health outcomes (such as height at age 20) changed across birth cohorts.

IV. Methods

Figure 8 shows how the average height of military conscripts changed from the subjects of the 1946 birth cohort to those born in 1957. A stark contrast is observed between the years 1946 to 1951 and the period from 1951 to 1957. The mean height slightly declined from 165.8 cm for the 1946 cohort to 165.5 cm for the 1950 and 1951 birth cohorts. Afterwards, Korean men became taller at a considerably rapid pace. The mean height increased by more than 2 cm in just 6 years. That the average height jumped by 0.9 cm between 1951 and 1952 is particularly remarkable. The results suggest that the Korean War likely affected significantly the anthropometric measures of the birth cohorts



Source: Sample of Korean Military Records.

Figure 8
Average Height by Year of Birth

who experienced the war in utero or in early childhood.

Previous studies find that prenatal exposure to the Korea War, especially during the first 10 months (June 1950 to April 1951) in which war-caused damages to civilians were concentrated, negatively affected health and socioeconomic outcomes at older ages (Lee 2014; Lee 2017). A possible mechanism by which early-life exposure to the war affects adult outcomes is the effects of wartime hunger that could adversely affect fetal growth. Maternal stress caused by war-related disruptions such as exposure to combat activities and bombing could negatively affect fetal health, too. Consistent with the prediction of the "Fetal Origins Hypothesis," we observe much lighter weights of the cohorts born in 1950 or 1951, who spent at least a part of their prenatal period during the worst 10 months of the war, compared with the neighboring birth cohorts. Similarly, the heights of the men born in 1950 or 1951 are below a smooth long-term trend in height across cohorts.

Considering the potential effects of early-life exposure to the Korean War and socioeconomic and environmental differences between the pre- and post-war periods, I classified the men in the sample military records into three birth cohorts: (1) 1946–1949; (2) 1950–1954, and (3) 1955–1957. The 1946–1949 cohorts were born in the chaotic years following the liberation in 1945 and went through the Korean War in early childhood. The 1950–1954 birth cohorts spent at least part of their prenatal period during the Korean War and were exposed to war-related disruptions as newly born children. Finally, the individuals born from 1955 to 1957 were the first birth cohorts who spent their entire lives in peace and prosperity.

Among potential determinants of adult heights, the key variable of interest in this study is parental socioeconomic status. I included the father's occupation as an index of socioeconomic conditions during childhood and adolescence. Given that our data sources were created when the individuals in our sample were approximately aged 20, many of their fathers were presumably dead or retired by the time the former was conscripted. Thus, a considerable proportion of conscripts did not provide information on their fathers. Given the importance of the household head in South Korea at the time, majority of them had lost their fathers. The father's occupation was not reported for approximately one-third of the individuals in our sample, although other paternal characteristics (*e.g.*, relationship or age) were provided. No information was provided whether these fathers were out of the labor force or if their jobs were not reported. In our analyses, the father's occupation was classified into the following categories: professional, clerical, service, farming, manual, no job reported, and father absent.

The information on conscripts and their family members kept in military records enables the inclusion of characteristics that affected their early life. First, family size was considered a potential determinant of within-family allocation of nutrients. Previous studies suggest that numerous family members, particularly siblings, tend to reduce parental investments in children (Conley and Glauber 2006; Lee 2008). The format of the Korean Military Records hinders the determination of the precise family size or members or siblings. The table concerning family information has only six lines, thereby allowing up to six other family members to be reported. In selecting family members to be included, the parents and grandparents are prioritized (if alive) followed by the siblings. Thus, a few siblings likely failed to be reported for conscripts from large families. For these reasons, the following categorical variables on family size were included in our analysis: one to three, four to six, and seven or above.

Second, dummy variables indicating the season of birth were constructed based on each conscript's date of birth. Previous studies establish that the season of birth is significantly related to later outcomes, including adult height, perhaps because of seasonal variations in in-utero conditions, such as nutrition and maternal exposure to disease. In general, individuals born in the winter/spring in the Northern Hemisphere are significantly taller than the average of their birth cohort, whereas those born in the final three months of the year are significantly shorter (McGrath *et al.* 2006; Tanaka *et al.* 2007). Our analyses classified seasons of birth into four quarters: January to March, April to June, July to September, and October to December.

That environmental factors, such as prevalence of diseases and sanitary conditions, are important determinants of adult height is well documented. Previous historical studies suggest that population and urbanization are closely related to considerably short stature and high mortality in the US, the UK, and other advanced countries until the early twentieth century (Fogel 1991; Wilson and Pope 2003; Haines *et al.* 2003; Cain and Hong 2009). For example, in the mid-nineteenth century US, residents in rural areas stood 3.3 cm taller than city dwellers. The advantages of living in the countryside in the past were generally attributed to considerable isolation from other people, thereby reducing the chances of exposure to infectious diseases and improved access to high-quality foods. Moreover, increased pollution caused by industrialization and inflow of city-bound migrants and policy failures in providing proper public health measures and additional housing in the early stage of urbanization are blamed for the highly unhealthy living conditions in urban areas in the past.

Father's occupation could be related to the environmental factors that may influence adult heights. For instance, conscripts whose fathers were engaged in farming would be overrepresented among men from rural areas, whereas those with white-collar fathers were more likely from urban areas. The effects of environmental factors on heights could differ between the US or UK in the nineteenth century and South Korea in the 1950s and 1960s. Given the potential positive aspects of urbanization, such as high wages and improved access to markets and medical services, how urbanization and industrialization were associated with the heights of South Koreans born in the mid-twentieth century is an empirical question. To take into account the effects of environmental differences at least partially, I included province fixed effect in the regression analyses. In addition, I included cohort fixed effect in the regressions conducted with the sample of the entire birth

TABLE 2
SAMPLE MEAN AND STANDARD DEVIATION OF VARIABLE

Variable	(1) Full Sample	(2) 1946–1949	(3) 1950–1954	(4) 1955–1957
Height	166.4437	165.6998	166.1751	167.2495
	(5.2629)	(5.2921)	(5.2095)	(5.1993)
Father's occupation				
Professional	0.0070	0.0067	0.0063	0.0080
	(0.0832)	(0.0814)	(0.0789)	(0.0889)
Clerical	0.02398	0.0227	0.0185	0.0310
	(0.1530)	(0.14891)	(0.1348)	(0.1735)
Service	0.0052	0.0035	0.0045	0.0071
	(0.0719)	(0.0587)	(0.0671)	(0.0842)
Farming	0.3889	0.4418	0.3529	0.3946
	(0.4875)	(0.4966)	(0.4779)	(0.4888)
Manual	0.0232	0.0180	0.0179	0.0329
	(0.1508)	(0.1331)	(0.1327)	(0.1783)
No job	0.3435	0.2692	0.3871	0.3436
	(0.4749)	(0.4436)	(0.4871)	(0.4750)
Father absent	0.2037	0.2336	0.2092	0.1775
	(0.4028)	(0.4232)	(0.4068)	(0.3821)
Family size				
1 to 3	0.0921	0.1251	0.1059	0.0543
	(0.2892)	(0.3309)	(0.3078)	(0.2266)
4 to 6	0.6109	0.5676	0.6049	0.6469
	(0.4876)	(0.4955)	(0.4889)	(0.4780)
7 or more	0.2969	0.3073	0.2892	0.2988
	(0.4569)	(0.4614)	(0.4534)	(0.4578)
Season of Birth				
First quarter	0.2845	0.2850	0.2789	0.2905
	(0.4511)	(0.4514)	(0.4485)	(0.4540)
Second quarter	0.2309	0.2230	0.2392	0.2268
	(0.4214)	(0.4163)	(0.4266)	(0.4188)
Third quarter	0.2425	0.2428	0.2486	0.2354
	(0.4286)	(0.4288)	(0.4322)	(0.4243)
Fourth quarter	0.2421	0.2493	0.2333	0.2474
	(0.4284)	(0.4326)	(0.4230)	(0.4315)
N	16,933	4,045	6,864	6,024

cohorts.[2] I also conducted robustness checks with smaller samples for whom additional variables pertaining to local environmental characteristics such as population density (100s of persons per 1 km^2) and percentage of non-farm population in the county.

Table 2 reports the sample mean and standard deviation of the variables used in the regression analyses. As presented in Figure 2, the mean height increases across birth cohorts. About one out of five conscripts did not report their fathers presumably because they were dead by the time of conscription. About one third of men did not report father's occupation but provided other information on father. Among the fathers with known occupation, farmers accounted for the majority. Although the occupational composition of fathers differed across the three birth cohorts, no clear long-term tendency emerged, except that the percentage of conscripts with no father reported decreased across cohorts. This result may reflect the secular decline in premature mortality in Korea. As for the family size, more than 60% of the conscripts in the sample reported 4 to 6 family members in the CMRs. Less than 10% reported three or fewer family members. The high percentage of men from families with a modest size could be explained by the fact that they were aged 20. Many of their grandparents or even parents should be dead by then; some of older siblings (especially females who get married and left home) could be unreported.

V. Father's Occupation and Heights: Regression Results

Our baseline regressions are based on a sample of 16,837 men for whom all variables included in the analysis are known. I use this sample to estimate the following equation:

$$H_{i,j,c} = \beta_0 + \beta_1 z_{i,j,c} + \beta_2 x_{i,j,c} + \theta_j + \delta_c + \varepsilon_{i,j,c} \quad (1)$$

where $H_{i,j,c}$ is the height of the ith person from the jth province and who belongs to the cth birth cohort, $Z_{i,j,c}$ is the vector of the variables on father's occupation, $X_{i,j,c}$ are the variables on family and personal

[2] More detailed information on local environment factors such as contraction rates of infectious disease and industrial structure can be obtained from the 1960s. However, it cannot be used for comparing the adult heights of the birth cohorts born in the 1940s and early 1950s.

characteristics, θ_j represents the province fixed effect, δ_c denotes the cohort fixed effect, and $\varepsilon_{i,j,c}$ is the error term. Four different specifications were used. In the first model, only the variables on father's occupation were included (column 1). In the second model, family size and season of birth were included (column 2). Province fixed effect was added in the third model (column 3), and finally the full model was estimated (column 4). Table 3 provides the results.

The results regarding the difference in height by father's occupation are remarkably similar across different specifications. In general, the sons of individuals employed in more prestigious occupations were significantly taller at conscription than the children of lower-class fathers. For example, conscripts whose fathers were employed in a professional job are approximately 2 cm taller than manual laborers' sons (control group). Similarly, having a father engaged in a clerical job increases height by approximately 1.2 cm compared with children of manual laborers. Men who belong to other categories (service, farming, no job, and father absent) were not statistically different from the sons of manual laborers in terms of height at conscription.

The estimated effect of family size is an anticipated one (positive for smaller family and negative for larger family), but only the coefficient for smaller family is significant where the full model is estimated. Men from families with three or fewer family members are approximately 0.32 cm taller than those with four to six family members. The estimated birth season effect is expected, too (positive for the second quarter and negative for the fourth quarter). Compared with the conscripts born in the first quarter (control group), men born in the second quarter were approximately 0.28 cm taller, and those born in the fourth quarter were approximately 0.28 cm shorter.

How did the socioeconomic differences in heights changed across birth cohorts? Figure 9 compares the relationship between father's occupation and mean height at conscription across the three birth cohorts. The figure depicts that the socioeconomic gradient of height became steeper over time. Among the cohorts born from 1946 to 1949, for instance, the sons of professionals were approximately 1.3 cm taller than the conscripts whose fathers were manual laborers. The difference increased to 1.9 cm for the 1950–1954 birth cohorts and to 2.2 cm for the post-war birth cohorts. The advantage of having a clerical father over having a father engaged in manual labor or farming also substantially increased over time.

TABLE 3
FATHER'S OCCUPATION AND HEIGHT AT CONSCRIPTION: REGRESSION RESULTS WITH THE FULL SAMPLE

Variable	(1)	(2)	(3)	(4)
Intercept	166.6638***	166.7046***	167.0052***	166.1230***
	(0.2426)	(0.2533)	(0.2679)	(0.3150)
Father's occupation				
Professional	2.0371***	2.0253***	2.0316***	2.1146***
	(0.5411)	(0.5410)	(0.5408)	(0.5364)
Clerical	1.1779***	1.1906***	1.2215***	1.2630***
	(0.3561)	(0.3566)	(0.3564)	(0.3534)
Service	-0.6183	-0.5817	-0.5593	-0.5253
	(0.6103)	(0.6104)	(0.6099)	(0.6048)
Farming	-0.4080	-0.4150*	-0.3275	-0.1509
	(0.2511)	(0.2511)	(0.2529)	(0.2510)
Manual	NI	NI	NI	NI
No job	-0.0944	-0.1098	-0.1101	0.0366
	(0.2522)	(0.2524)	(0.2525)	(0.2507)
Father absent	-0.3343	-0.3630	-0.3247	-0.1138
	(0.2586)	(0.2621)	(0.2625)	(0.2605)
Family size				
1 to 3		0.0746	0.0791	0.3173**
		(0.1510)	(0.1510)	(0.1504)
4 to 6		NI	NI	NI
7 or more		-0.0659	-0.0582	-0.0119
		(0.0916)	(0.0919)	(0.0913)
Season of Birth				
First quarter		NI	NI	NI
Second quarter		0.2751**	0.2814**	0.2962***
		(0.1134)	(0.1134)	(0.1125)
Third quarter		-0.0284	-0.0255	-0.0159
		(0.1119)	(0.1119)	(0.1110)
Fourth quarter		-0.2859**	-0.2841**	-0.2758**
		(0.1120)	(0.1119)	(0.1110)
Province fixed effect	No	No	Yes	Yes
Cohort fixed effect	No	No	No	Yes
R-square	0.0038	0.0052	0.0080	0.0259
F-value	10.87***	8.04***	5.23***	12.05***
N	16,932	16,837	16,837	16,837

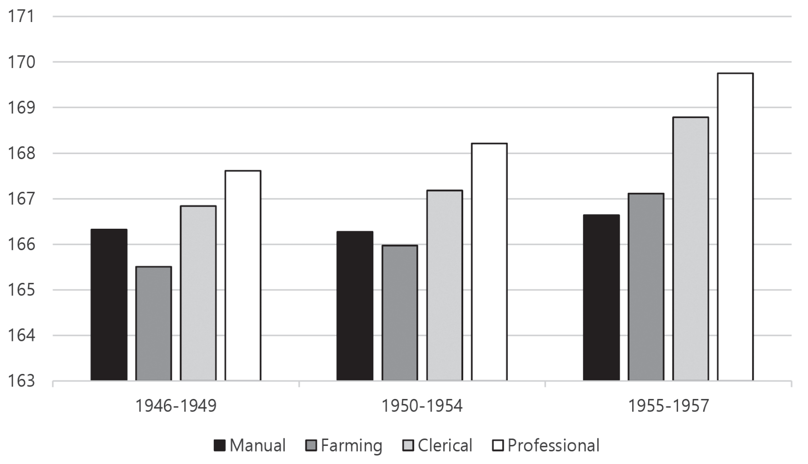


Figure 9

Average Height by Father's Occupation: Comparison across Birth Cohorts

The full baseline model was estimated separately for the three birth cohorts. The results confirm the increase of socioeconomic difference in height over time, as Figure 3 shows. For the 1946–1949 birth cohorts, the conscripts whose fathers had a professional or clerical job were not significantly taller than the sons of manual laborers if other variables were controlled. The advantage of professionals' sons first emerged for the 1950–1954 birth cohorts, they were 1.8 cm taller than the control group. For the latest birth cohorts, the gap increased to 2.8 cm, and the men with clerical fathers were significantly taller than the control group by 1.9 cm.

Several other notable differences across cohorts were observed. For the 1946–1949 birth cohorts, the sons of service workers, farmers and those with no reported occupation were significantly shorter than the sons of manual laborers. Having no father also significantly reduced heights only for the pre-war birth cohorts. Such differences became all statistically insignificant for later birth cohorts. The positive effect of having smaller family was statistically significant only for the 1955–1957 birth cohorts. The effects of season of birth differed across birth cohorts, and they became insignificant for the post-war birth cohorts.

Table 4

Father's Occupation and Height at Conscription: Comparison across Birth Cohorts

Variable	(1) 1946–1949	(2) 1950–1954	(3) 1955–1957
Intercept	167.0613***	166.6956***	166.9414***
	(0.6001)	(0.4682)	(0.3862)
Father's occupation			
Professional	0.7035	1.8216**	2.8185***
	(1.1597)	(0.9010)	(0.8239)
Clerical	0.2220	0.9610	1.8856***
	(0.7840)	(0.6304)	(0.5113)
Service	-2.7117*	-0.6419	0.2515
	(1.5205)	(1.0275)	(0.8628)
Farming	-1.1395**	-0.2910	0.2880
	(0.5736)	(0.4415)	(0.3631)
Manual	NI	NI	NI
No job	-0.9619*	-0.0687	0.4531
	(0.5784)	(0.4396)	(0.3616)
Father absent	-1.0075*	-0.1789	0.0920
	(0.5896)	(0.4547)	(0.3829)
Family size			
1 to 3	0.2737	0.0658	0.6412**
	(0.2744)	(0.2252)	(0.3102)
4 to 6	NI	NI	NI
7 or more	-0.1674	-0.1264	0.1996
	(0.1892)	(0.1444)	(0.1511)
Season of Birth			
First quarter	NI	NI	NI
Second quarter	0.4922**	0.2810	0.1729
	(0.2364)	(0.1756)	(0.1878)
Third quarter	0.1118	-0.3141*	0.2540
	(0.2307)	(0.1736)	(0.1860)
Fourth quarter	-0.3552	-0.6678***	0.1967
	(0.2292)	(0.1768)	(0.1933)
Province fixed effect	Yes	Yes	Yes
R-square	0.0136	0.0109	0.0109
F-value	2.12***	2.87***	2.54***
N	4,003	6,822	6,010

VI. Changing Socioeconomic Differences in Height: Possible Mechanisms

Why did socioeconomic disparities in adult height among the Korean conscripts increased over time? One hypothesis is that socioeconomic differences in parental investments in children increased over time.[3] Two possible scenarios that might result in the change can be suggested. First, occupational disparities in economic status might have widened. Second, parents' behaviors regarding investments in children changed that increased the differences in outcomes according to parents' SES. These explanations are not necessarily mutually exclusive.

As an indirect test of the hypothesis, I investigated whether socioeconomic differences in other human capital outcomes similarly increased over time for the birth cohorts under study. If the above hypothesis is true, we expect to observe similar changes in socioeconomic differences in various types of adult outcomes that are influenced by parental investments in early life. Accordingly, I conducted similar regression analysis where the years of schooling at age 20 was included in place of adult height as the dependent variable.

Table 5 presents the regression results obtained from the full sample. As in the regressions for heights, four different specifications were used. For all specifications, father's occupation emerged as a strong determinant of years of schooling. Conscripts whose fathers had professional or clerical jobs were educated more than manual laborers' sons by approximately 2.5 years. By contrast, the men whose fathers had a service job or no job were taller than the control group, whereas farmers' sons and fatherless conscripts were shorter. The advantage associated with living in a smaller family was more pronounced for education than adult height. Conscripts born in early months of the year were more highly educated than those born in late months. This seasonality likely resulted from the fact that the cut-off date in determining school entry age was the first of March for the birth cohorts under study.

Table 6 presents the results of education regressions separately

[3] The overall size of parental investments in children likely increased over time, as indicated by the growth of the average height during the period under study. The hypothesis implies that the variance of parental investments rose over time.

TABLE 5
FATHER'S OCCUPATION AND YEARS OF SCHOOLING AT CONSCRIPTION: REGRESSION RESULTS WITH THE FULL SAMPLE

Variable	(1)	(2)	(3)	(4)
Intercept	9.9146***	10.0625***	10.8755***	10.4865***
	(0.1242)	(0.1296)	(0.1351)	(0.1573)
Father's occupation				
Professional	2.5094***	2.5093***	2.5318***	2.4973***
	(0.2760)	(0.2758)	(0.2717)	(0.2711)
Clerical	2.5231***	2.5123***	2.5766***	2.5739***
	(0.1815)	(0.1815)	(0.1789)	(0.1784)
Service	0.8726***	0.9039***	0.8854***	0.9006***
	(0.3102)	(0.3100)	(0.3053)	(0.3045)
Farming	-0.6473***	-0.6531***	-0.3328***	-0.3042**
	(0.1285)	(0.1284)	(0.1275)	(0.1273)
Manual	NI	NI	NI	NI
No job	0.4736***	0.4552***	0.4985***	0.5075***
	(0.1292)	(0.1292)	(0.1273)	(0.1272)
Father absent	-0.4310***	-0.5167***	-0.3451***	-0.3169**
	(0.1324)	(0.1341)	(0.1323)	(0.1321)
Family size				
1 to 3		0.1617**	0.1214	0.1483**
		(0.0763)	(0.0753)	(0.0754)
4 to 6		NI	NI	NI
7 or more		-0.1660***	-0.1374***	-0.1244***
		(0.0468)	(0.0463)	(0.0462)
Season of Birth				
First quarter		NI	NI	NI
Second quarter		-0.1123*	-0.0947*	-0.0892
		(0.0579)	(0.0753)	(0.0569)
Third quarter		-0.1024*	-0.1137**	-0.1016*
		(0.0571)	(0.0563)	(0.0562)
Fourth quarter		-0.1598***	-0.1368**	-0.1282**
		(0.0571)	(0.0562)	(0.0561)
Province fixed effect	No	No	Yes	Yes
Cohort fixed effect	No	No	No	Yes
R-square	0.0585	0.0603	0.0892	0.0952
F-value	185.03***	103.49***	66.81***	50.38***
N	17,869	17,755	17,755	17,755

TABLE 6
FATHER'S OCCUPATION AND YEARS OF SCHOOLING AT CONSCRIPTION: COMPARISON ACROSS BIRTH COHORTS

Variable	(1) 1946–1949	(2) 1950–1954	(3) 1955–1957
Intercept	10.6799*** (0.2894)	11.0778*** (0.2429)	10.7740*** (0.1948)
Father's occupation			
Professional	2.2710*** (0.5738)	2.7166*** (0.4578)	2.4094*** (0.4143)
Clerical	3.1462*** (0.3799)	2.3028*** (0.3231)	2.2445*** (0.2566)
Service	-0.2641 (0.7264)	1.1993** (0.5159)	1.0443** (0.4377)
Farming	-0.3411 (0.2747)	-0.3580 (0.2295)	-0.3072* (0.1833)
Manual	NI	NI	NI
No job	0.5774** (0.2776)	0.3029 (0.2280)	0.6703*** (0.1824)
Father absent	-0.0769 (0.2832)	-0.4714** (0.2362)	-0.4741** (0.1932)
Family size			
1 to 3	-0.3014** (0.1344)	0.5177*** (0.1149)	-0.0200 (0.1556)
4 to 6	NI	NI	NI
7 or more	-0.0274 (0.0930)	-0.1753** (0.0742)	-0.1709** (0.0763)
Season of Birth			
First quarter	NI	NI	NI
Second quarter	-0.1773 (0.1162)	-0.1206 (0.0901)	0.0068 (0.0947)
Third quarter	-0.0470 (0.1135)	-0.2804*** (0.0889)	0.0469 (0.0939)
Fourth quarter	-0.2035* (0.1122)	-0.2991*** (0.0905)	0.0944 (0.0926)
Province fixed effect	Yes	Yes	Yes
R-square	0.0898	0.0862	0.1161
F-value	17.38***	25.56***	30.54***
N	4,609	7,071	6,073

conducted for the three birth cohorts. The full model was used for the comparison across cohorts. Unlike the results from height regressions, the differences in schooling according to father's occupation did not change much across birth cohorts. The height difference between the sons of professionals and of manual laborers remained little changed for the three cohorts. The advantage of sons of clerical fathers over the control group diminished between the 1946–1949 birth cohorts and those born after 1949. These results tend to reject the hypothesis that socioeconomic differences in parental investments increased over time.

Another possible hypothesis is that health shocks (such as exposure to war-caused disruptions, natural disasters, and infectious diseases) could weaken the effects of different parental investments. Such shocks were more prevalent prior the end of the Korean War. Population selection is a possible mechanism by which severe environment dilutes the positive influences of superior socioeconomic status. Robust individuals tend to survive harsh conditions, and such positive population selections would be stronger among disadvantaged people compared with the rich. Previous studies also find that individuals who survive infectious disease may acquire partial or complete immunity and therefore may have lower mortality rates (Lee 1997, 2003).

The nineteenth-century US provides an example. One of the puzzling phenomenon in the U.S. demographic history is a weak association between wealth and mortality in the past. Steckel (1988) found that wealth had no systematic effect on the survival of women or children in households matched in the 1850 and 1860 censuses. Circa 1900, economic status was a much less important determinant of child mortality than place of residence (Preston and Haines 1991, pp. 150–158). This finding led to discussions of egalitarian patterns of death and of relatively small differences in health by social class perhaps because the poor were better fed in the US than in Europe. Actually, a positive effect of wealth on health was noted at least for some diseases on which nutritional influence is great (Lee 1997). However, the association between wealth and mortality from all causes was weak because the influence of infectious diseases was so strong that it dominated the effect of economic status.

The Korean War (1950–1953) offers an opportunity to examine the hypothesis. Although the war lasted for more than three years, the major war damage sustained by civilians was concentrated in the first 10 months following the sudden invasion of North Korea (late June 1950

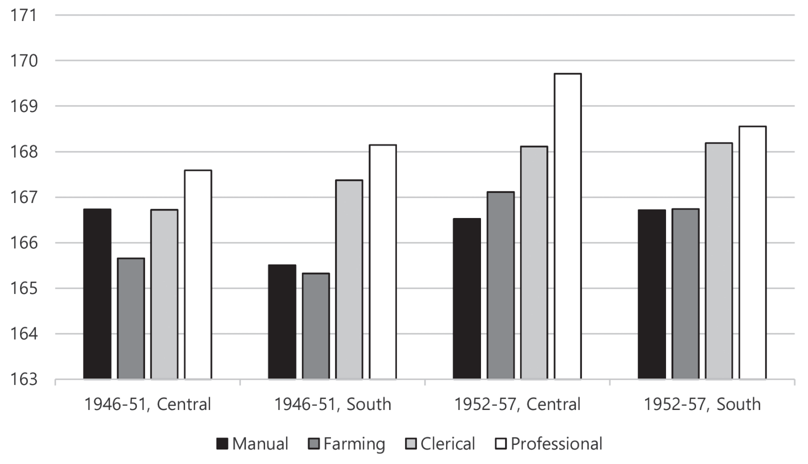


Figure 10

Early-Life Exposure to the Korean War and Height by Father's Occupation

to late March 1951). At that time, the frontline rapidly and unexpectedly moved back and forth across South Korea (Halberstam 2007; Chung 2010; Yang 2010). Roughly half of the birth cohorts in the sample (born from 1946 to 1951) were exposed to war-related disruptions such as arduous refugee experiences, suffering under the North Korean occupation, hunger, and direct exposure to combat in early childhood. Later birth cohorts were not directly affected. Furthermore, the severity of wartime experience considerably differs depending on the place of residence. For example, central region residents were hit particularly hard because they lived closer to North Korea and their area was invaded twice by enemy forces. Previous studies find that prenatal exposure to the worst months of the war in utero negatively affected later health and socioeconomic outcomes and that the negative cohort effect was more strongly revealed for the individuals born in the central region (Lee 2014, 2017).

These specific circumstances help identify the effects of wartime disruptions on the socioeconomic gradient of health through a comparison across birth cohorts and places of birth. I conducted a sort of triple-difference analysis, comparing heights of conscripts between elite and non-elite occupations of fathers, between the 1946–1951 and 1952–1957 birth cohorts (indicating early exposure to the Korean War) and between the central and south regions (indicating different wartime experiences).

In support of the hypothesis, Figure 10 shows that the socioeconomic disparity in adult height among the cohorts born prior to 1952 was less pronounced for conscripts from the central region, which was more severely affected by the Korean War, than those from the south region. For the cohorts born after 1951 who were unaffected by the disruptions caused by the war, clear differences in heights according to the quality of father's occupation are observed for the residents of the central and south regions.

Table 7 reports the results of height regressions separately conducted

Table 7

Early-Life Exposure to the Korean War and the Effect of Father's Occupation on Height

Variable	(1) 1946–1951 Central	(2) 1946–1951 South	(3) 1952–1957 Central	(4) 1952–1957 South
Intercept	167.3546*** (0.7656)	165.6118*** (0.6030)	166.4456*** (0.4820)	167.0204*** (0.3771)
Father's occupation				
Professional	0.3699 (1.6145)	2.5041** (1.1832)	3.1803*** (0.9778)	1.5343* (0.8696)
Clerical	-0.3655 (1.0810)	1.7967** (0.8199)	1.5589** (0.6811)	1.1662** (0.5353)
Service	-3.9063* (2.2409)	-1.8089 (1.3382)	0.9390 (1.0857)	-0.3602 (0.9467)
Farming	-1.5690** (0.7700)	-0.2880 (0.5945)	0.5785 (0.4791)	-0.2837 (0.3742)
Manual	NI	NI	NI	NI
No job	-1.4620* (0.7702)	0.0570 (0.6011)	0.3894 (0.4754)	0.0211 (0.3759)
Father absent	-0.9215 (0.7993)	-0.1652 (0.6096)	0.3101 (0.5070)	-0.3105 (0.3933)
Other controls	Yes	Yes	Yes	Yes
R-square	0.0106	0.0078	0.0069	0.0039
F-value	1.62*	3.39***	2.17**	2.48***
N	1,679	4,734	3,433	6,988

for the four categories according to the year and place of birth. All the controls used in the baseline regressions were included in the analyses but omitted from the table. The results confirm the conclusions drawn from Figure 4. Only for the 1946–1949 birth cohorts born in the central region, sons of professionals and clerical workers were statistically no different from the sons of manual laborers in terms of stature. For the rest of the conscripts, conscripts whose fathers had elite occupations were significantly taller than low-class men.

VII. Conclusion

This study has explored how socioeconomic differences in health changed with improvements in economic and environmental conditions in South Korea, using a newly collected 0.5% random sample of military records for all males born from 1946 to 1957. The conscripts whose fathers were employed in more prestigious occupations were significantly taller at conscription than the children of lower-class fathers. For example, conscripts whose fathers were employed in a professional job were approximately 2 cm taller than manual laborers' sons. More importantly, socioeconomic disparity in health increased across birth cohorts. No advantages of having high-class fathers were observed for the cohorts born prior to the Korean War. The differences in height according to father's occupation emerged for the conscripts who were conceived or born during the Korean War, and the disparity became larger for the post-war birth cohorts.

A possible explanation for the result is that socioeconomic differences in parental investments in children reduced over time. As a test, I conducted similar regression analysis where the years of schooling at age 20 was included in place of adult height as the dependent variable. The results show that father's occupation was a strong determinant of years of schooling. Conscripts whose fathers had professional or clerical jobs were educated more than manual laborers' sons by approximately 2.5 years. Unlike the results from height regressions, however, the differences in schooling according to father's occupation remained slightly changed across birth cohorts, thereby rejecting the hypothesis of narrowed gap in parental investments.

Another possible hypothesis is that health shocks (such as exposure to war-caused disruptions, natural disasters, and infectious diseases) could weaken the effects of different parental investments. Such shocks were more prevalent prior the end of the Korean War. I conducted a sort of triple-difference analysis, comparing heights of conscripts between elite and non-elite occupations of fathers, the 1946–1951 and 1952–1957 birth cohorts (indicating early exposure to the Korean War) and the central and south regions (indicating different wartime experiences). In support of the hypothesis, I found that the socioeconomic disparity in adult height among the cohorts born prior to 1952 was less pronounced for conscripts from the central region, which was more severely affected by the Korean War, than those from the south region. For the cohorts born after 1951 who were unaffected by the disruptions caused by the war, clear differences in heights according to the quality of father's occupation are observed for the residents of the central and south regions.

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