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Abstract

When someone is born dictates the environment, society, and historic events that they will experience and share with other members of their birth cohort as they age. The age at which an individual experiences an adverse event, combined with their early and later-life characteristics, are important determinants of their health and mortality at older ages. South Korea has undergone several major shocks and changes in the last century, including Japanese annexation, North/South division, catastrophic war, and rapid industrialization. The short time in which these developments occurred, combined with South Korea's rapid aging and low fertility, provides a unique setting to investigate differences in health by birth cohort. This study aims to examine how the rate of disease accumulation differs across cohorts born during the Japanese annexation (1932-1944), Korean liberation (1945-1949), Korean War (1950-1953), and Post-war (1954-1961) periods. Data are from eight waves of the Korean Longitudinal Study of Aging (2006-2020) and our sample includes 8,266 participants aged 50-74 years. Using Poisson regression models with standard errors clustered at the individual level, we find that the disease accumulation rate increases with younger cohorts. The two younger cohorts have the highest annual rate of disease accumulation (9%), followed by the two older cohorts (5%). We also compute predicted disease counts and find that while the oldest Japanese annexation (1932-1944) cohort has the most disease at younger ages, from age 63, the younger cohorts, especially the Post-war (1954-1961) cohort, quickly surpass them. These trends demonstrate that despite improvements in living standards, socioeconomic factors, and healthcare over time, younger cohorts are developing more disease at a faster rate than their older counterparts. This indicates a need to better understand the factors that might be driving this development so that measures to mitigate the speed of accumulation can be implemented accordingly.

1. Introduction

Population aging is a dynamic process influenced by a variety of macro and micro-level factors. At the country level, factors like economic development, health systems, and the balance between births, migration, and deaths push and pull at the age structure. These macro-level structures are driving but are also driven by individual-level components, such as socioeconomic status, health behaviors, and family dynamics. Above all, time is the most significant but uncontrollable force that drives aging and development (Ferraro, 2014). When, where, and in what circumstances an individual is born sets the foundation for the rest of their life. For this reason, it is important to understand the role of birth cohorts on health and aging.

Over the last century, health and mortality have generally improved due to significant improvements in living standards, economic conditions, and health and social care. However, both period and cohort studies have shown that disability, chronic diseases, and mortality seem to be increasing, likely due to population aging, changing lifestyle and environmental factors, and improved diagnosis and treatment (Case & Deaton, 2015; Oostrom et al., 2016; Ribe et al., 2023; Zheng et al., 2023). While a period perspective is useful for understanding changes over a particular time period, e.g., between 2000-2020, or in response to specific events, e.g., the COVID-19 pandemic, a cohort comparison perspective is better suited for identifying the long-term impacts of historical events and shifts in social and cultural norms across generations.

South Korea provides a unique opportunity to study cohort patterns in health because major historical events which impact health have occured in a relatively narrow period of time. This allows each cohort to experience the same substantial social and cultural changes at different stages of their life course. Additionally, South Korea's rapid population aging, low fertility, and low migration rates makes it a relevant case study to understand how health patterns are changing with successive generations in light of individuals' characteristics. Thus, this study aims to understand how disease accumulation differs across birth cohorts in South Korea.

2. Background

2.1. Cohort changes in health

Existing studies have found that the burden of multimorbidity is increasing and the age at first incidence is occurring earlier in more recent cohorts (Bishop et al., 2022; Canizares et al., 2018; Zheng et al., 2023). There are also worsening trends in mental health, cognitive function, and disabilities in younger cohorts (Zheng, 2021; Zheng & Echave, 2021; Fors et al., 2022). The declining health trends are likely attributed to lifestyle changes, differing early-life exposures, and increasing income inequality across cohorts, but could also be indicators of improvements in disease-specific mortality, disease screening, and an increase in the reporting of multimorbidity (Bishop et al., 2022; Canizares et al., 2018; Zheng et al., 2022). These studies have focused on cohort trends in the US, Canada, or Europe, so we do not know whether the same can be seen in other countries.

2.2. South Korean historical context

From 1910-1945, the Korean peninsula was under Japanese rule, meaning Koreans were heavily oppressed and forced to adopt Japanese customs, language, and policies in lieu of their own (Cumings, 2021). In 1945, Korea gained its independence from Japan, but would soon be divided along the 38th parallel to become North and South Korea. The Korean War

followed from 1950-1953 and had detrimental effects on South Korea's population, infrastructure, and economy. At the end of the war, most existing infrastructure in South Korea was destroyed, half the population lived in extreme poverty, and South Korea was one of the poorest countries in the world (C.K. Kim, 2019).

South Korea struggled to rebuild until 1961 when a new government came into power with the ambitious goal to rapidly develop the economy (C.K. Kim, 2019). There was also an increased emphasis on vocational training to develop technical skills, which would play a large role in the country's economic growth (Isozaki, 2019). During this period, rural to urban migration and educational attainment increased, and birth rates and infant mortality declined (Seth, 2017). South Korea transitioned to a middle-income country by the mid-1980s and to a high-income country in 1996.

2.3. The health transition in South Korea

Alongside South Korea's economic transition came its demographic transition. While this process took over a century for most European countries, it was much faster for countries which transitioned more recently (Vallin, 2002). In 1970, life expectancy at birth in South Korea was 62.3 years and total fertility rate was 4.53 (Statistics Korea, 2021, 2023c). In 2022, life expectancy increased to 82.7 years while total fertility rate dropped to 0.78 (Statistics Korea, 2023b, 2023a). The country is expected to become a super-aged society by 2025, meaning that 20% of their population will be over age 65; by 2050 this proportion is estimated to be 44% (The Lancet Regional Health-WesternPacific, 2023). Increasing life expectancy, coupled with below-replacement fertility, are major contributors to the shifting age structure we observe in South Korea and many other high-income countries.

Changes in the distribution of population age structures reflect progression through stages of Vallin & Meslé's (2004) theory of health transition. The first stage of this framework consists of Omran's (1971) epidemiologic transition theory, whereby infectious diseases are replaced by non-communicable diseases. The second stage is the cardiovascular revolution, which describes how improvements in cardiovascular disease treatment contribute to life expectancy increases. The last stage is the "fight against aging", where life expectancy gains are occurring most among the oldest ages. In South Korea, the cardiovascular revolution seems mostly completed. Over half of the increases in life expectancy between 1983-2005 were attributable to reductions in cardiovascular disease (S. Yang et al., 2010).

In 1990, the top five causes of death were stroke, ischemic heart disease, cirrhosis, stomach cancer, and road injuries, the latter three being replaced by lung cancer, Alzheimer's disease, and lower respiratory infections in 2019, respectively (Park et al., 2023). In 2040, the forecasted leading causes of years of life lost include liver cancer, lung cancer, stroke, and Alzheimer's Disease, for which liver cancer is the leading cause for males and Alzheimer's Disease is the leading cause for females (Park et al., 2023). Additionally, multimorbidity is increasing over time among older persons; the cumulative incidence was 32% between 2008 and 2018 (T.W. Lee et al., 2022).

2.4. Birth cohorts

Each birth cohort includes a distinct composition of people with varying innate and acquired characteristics, but this heterogeneity is unique to each cohort over its lifetime (Ryder, 1985). Drawing on life course epidemiology, we know that social and biological exposures during early life and adulthood can have long-term effects on later life health (Ben-Shlomo et al., 2016). Therefore, studying how disease accumulates across birth cohorts can give us a better understanding of how social, economic, historical, and cultural changes may be associated with health and how this may evolve with time (Ferraro, 2014; Ryder, 1985).

In this paper, we define cohorts based on four distinct periods of South Korean history: Japanese annexation (1932-1944), Korean liberation (1945-1949), Korean War (1950-1953) and Post-war (1954-1961). Each cohort has unique experiences based on how old they were when different events occurred, but they generally experienced similar social, economic, and environmental conditions over their life course. For example, members of the Japanese Annexation (1932-1944) cohort could have fought in the Korean War and thus have a very different experience compared to someone from the Korean Liberation (1945-1949) cohort.

2.5. Early-life exposures

Older South Koreans grew up during a period inundated with major events and changes. Their lived experiences likely play a role in shaping their later life characteristics, including their health and socioeconomic status. Theories such as the critical period model and the fetal origins hypothesis suggest adverse events that occur during key developmental stages will likely lead to negative outcomes later in life (Barker, 1990; Kuh et al., 2003). For example, a parent dying during childhood is associated with various adverse later life outcomes, including poor mental and physical health, mortality, and lower socioeconomic status (Hiyoshi et al., 2021; Serratos-Sotelo & Eibich, 2021). The timing of the adverse event also seems to determine the type and severity of the outcome. For example, in-utero exposure to famine or war can lead to more severe later life cardiometabolic conditions, musculoskeletal problems, and functional limitations compared to exposure during later stages of childhood or adolescence (Haas & Ramirez, 2022; C. Lee, 2014, 2017; Ramirez & Haas, 2022). For this study, this would entail that the late Korean liberation (1945-1949) cohort and the Korean War (1950-1953) cohort would be most affected by later life health problems since they were born just before or during the war period, while the Japanese annexation (1932-1944) cohort would be healthier but more affected by socioeconomic problems since they were older when the war occurred.

2.6. Education

Educational attainment is one of the major structural improvements in South Korea that can be easily mapped across time. In 1945, only 65% of children were enrolled in primary school, but by 1980, over 60% of men and almost 40% of women had at least a secondary school education and in 2010, these values increased to about 95% and 90%, respectively (S. Kim & Lee, 2010). Alongside these increases in education came decreases in mortality, however these were largely concentrated in the highly educated population while the lowest educated group showed little change between 1970 and 2010 (Bahk et al., 2017). Individuals with lower education also tend to have more diseases than those with higher education, and the largest differences were seen for individuals with multimorbidity (Ki et al., 2017; J. Kim et al., 2020). While an individual's own education has substantial influence throughout their life course, parental education can also play a key role in determining their children's educational attainment and occupation (Crosnoe & Elder, 2004) and is also a significant predictor for later life self-rated health and functional limitations (S.H. Lee et al., 2020).

2.7. Environmental conditions

Prior to the expansion of education to rural areas, there was a strong urban/rural education gradient. Just after the Korean War, about 70% of the South Korean population lived in rural areas, but with rapid urbanization, this percentage declined to 20% in 2000, then subsequently stagnated (Ma et al., 2018). From 2010, there was an increase in urban to rural migration, driven mainly by those from the Post-war (1954-1961) cohort seeking better

quality of life and economic conditions (Ma et al., 2018). Similar to other high-income countries, the rural population has higher prevalence of diabetes, lung disease, heart disease, arthritis, and multimorbidity, which may be attributed to limited healthcare services and preventive measures in rural areas (Jang et al., 2016; Yi et al., 2019). In contrast, urban areas are more prone to the effects of air pollution, which is associated with all-cause and cardiovascular mortality, but to different extents based on sex, socioeconomic status, and health behaviors (H. Kim et al., 2021).

2.8. Lifestyle factors

In South Korea, rapid uptake of cigarette smoking began in the 1970s and peaked in the early 1990s (Choi et al., 2007), specifically for men born in the Post-war period between 1959-1963 (S. Kim et al., 2022). However, between 1992 and 2016, smoking prevalence in males and females decreased from 71.7% to 39.7% and 6.5% to 3.3%, respectively (Chang et al., 2019). Patterns of lung cancer mortality seem related to trends in cigarette sales 20-30 years earlier, which likely explains recent increases in lung cancer incidence (Choi et al., 2007).

In contrast to declines in smoking, prevalence of overweight and obesity increased from 29.7%-36.3% between 2009-2019, likely due to dietary and lifestyle behavior changes (Y. S. Yang et al., 2022). This is mainly seen for individuals in their 20s and 80s, which includes individuals from our Japanese annexation cohort (1932-1944). The relative risk of diabetes, myocardial infarction, and ischemic stroke is greater for individuals with obesity and abdominal obesity compared to those without (Y. S. Yang et al., 2022). The relationship between BMI and body fat percentage differs between people of Asian and European descent. For the same age, sex, and BMI, Asians tend to have a higher body fat percentage and more central obesity than Europeans, which puts them at greater risk for cardiometabolic diseases at younger ages (Yoon et al., 2006).

2.9. Summary

Over the last century, Korea has gone from being under Japanese rule, to being split into two countries which waged war against each other, to transforming into a highly developed wealthy nation that now faces a new challenge with population aging. The conditions and events that occurred during the early life of older South Koreans, in addition to environmental and individual characteristics accumulated throughout their life course, likely play important roles in shaping later life health and mortality outcomes. However, the timing of when in life these events occur is important. Thus, this study investigates whether the rate of disease accumulation differs across birth cohorts in South Korea.

3. Methods

3.1. Data

This study uses data from the Korean Longitudinal Study of Aging (KLoSA) (Korea Employment Information Service, 2015). The KLoSA collects information on various socioeconomic, demographic, and health factors for participants aged 45 and older across South Korea, excluding Jeju Island (Korea Employment Information Service, 2023). From wave 1 (2006), 10,254 participants were interviewed and followed up biannually to wave 8 (2020). We excluded anyone missing information on own education (n=8), diseases (n=45), parental education (n=82), height (n=39), and weight (n=5). We additionally excluded the observations of anyone while they were under age 50 and over age 74 (n=1809) to have an age range that was more evenly distributed across the different birth cohorts. Figure 1 uses a

lexis diagram to depict the entry and follow-up time for a sample of participants. Our final sample consisted of 8,266 participants who were present in at least one wave.

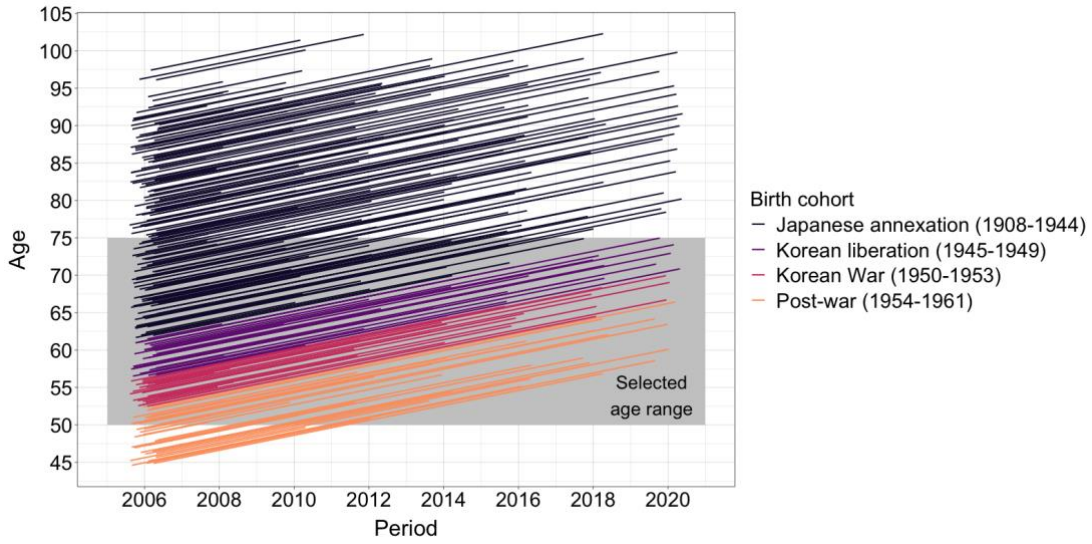

Figure 1. Lexis diagram depicting entry and follow-up times for a sample (n=250) of participants from the original study population, prior to any exclusions. The grey area represents the age range selected for our final analytic sample.

3.2. Outcome

The outcome for this study is disease accumulation, defined as counts of the following self-reported diseases: arthritis, cancer, chronic lung disease, diabetes, heart disease, hypertension, liver disease, psychiatric disorders, and stroke. These diseases were chosen because first, they were asked about in all study waves and second, because they cover the major causes of death and disability in South Korea (Vos et al., 2020). Additionally, they cover many of the core conditions which should be included in measures of multimorbidity (Ho et al., 2021). Participants were asked whether they had ever been diagnosed with one of these diseases. If the participant answered "yes", they were not asked again in subsequent waves because that value was carried forward, indicating the chronic nature of these diseases.

3.3. Predictors

We use four distinct cohorts in our analysis derived from self-reported year of birth: Japanese annexation (1932-1944), Korean liberation (1945-1949), Korean War (1950-1953) and Post-war (1954-1961). The following measures were also self-reported. Age in years is used as a continuous variable. Sex is categorized as male or female. Parental death during childhood is defined as whether or not at least one parent died while the participant was under 15 years old. Parental education is defined as the highest level of education obtained by either mother or father and categorized as "no formal education", "elementary school", or "middle school or more". Own education is the participant's highest level of reported education, categorized as "middle school or less", "high school", and "university". Geography is time-varying and dichotomized as urban and rural residence at the time of the survey. Smoking is time-varying and is defined as whether the participant was an ever/current or never smoker. Obesity is also time-varying and defined using the WHO's recommend body mass index (BMI) cut-off of $\geq 25 kg/m^2$ for Asia-Pacific populations (World Health Organization. Regional Office for the Western Pacific, 2000). The KLoSA imputed BMI values were used where available, but for missing observations, BMI was computed using the participant's reported weight and height. For observations in which participants were missing weight, the average between the

previous and subsequent waves was taken. For individuals with inconsistent reports of height, the average value across waves was used.

3.4. Statistical analysis

We computed descriptive statistics for the total study sample by sex and birth cohort. We also computed age-specific prevalence of accumulated disease and the proportion of each disease distributed across sex and birth cohorts. Statistical analysis was conducted using Poisson regression models, accounting for the panel structure of the data by including categorical study wave and computing clustered standard errors at the individual level. Models were built in a stepwise manner, beginning with a model containing the outcome, birth cohort, sex, and age. Subsequently, an interaction term was added between cohort and age. Based on this interaction model, we built three additional models with different predictors: the early-life exposure model, the later-life characteristics model, and the combined model including all predictors. The early-life exposure model includes parental death during childhood and parental education. The later-life characteristics model includes own education, urban/rural geography, smoking status, and obesity status. We subsequently stratified all models by sex and by parental education. All models were also weighted using longitudinal weights provided by KLoSA which account for panel attrition.

3.5. Sensitivity analysis

Several sensitivity analyses were conducted. There is debate as to whether hypertension is only a risk factor for subsequent disease, or if it should be considered as a disease itself. Most studies on multiple diseases and multimorbidity include hypertension as a disease, which is why it was included in our main analysis (Ho et al., 2021). Arthritis is not often strongly associated with mortality, especially when compared to other diseases such as cancer or stroke, and also tends to be more common amongst women. Thus, we wanted to evaluate whether our results would differ substantially if hypertension and/or arthritis were excluded. Due to the uneven distribution of participants at the youngest and oldest ages leading to excess extrapolation, we wanted to see how different age ranges might change the results. We used various age ranges that still included participants from each cohort: 50-70 years, 55-70 years, and 55-75 years. We could not include dementia in our outcome because it was only asked in the last two study waves. Therefore, we included scores from the Mini-Mental State Examination (MMSE) as a proxy to test whether the exclusion of neurodegenerative issues might be driving down the disease prevalence of the Japanese annexation (1932-1944) cohort.

Statistical analyses were conducted in R Studio (R version 4.2.0) (RStudio Team, 2023).

4. Results

4.1. Descriptive statistics

Table 1 provides descriptive characteristics by cohort at entry wave. Disease count is lower in the younger cohorts, with 72% of the Post-war (1954-1961) cohort having no disease at entry compared to 38% of the Japanese annexation (1932-1944) cohort. Females make up over half the sample in each cohort. The average age is 67.6, 58.9, 54.5, and 50.8 in the Japanese annexation (1932-1944), Korean liberation (1945-1949), Korean War (1950-1953), and Post-war (1954-1961) cohort, respectively. A greater proportion of individuals from the Japanese annexation (1932-1944) and Korean liberation (1945-1949) cohorts lost a parent during childhood compared to the more recent cohorts (13% vs. 9%). The older cohorts had a greater

proportion of low parental and own education, but this improved substantially with younger cohorts. There is also an increasing trend in urban residence across cohorts, reflecting the general trends of urbanization over time. For smoking and obesity status, the two middle cohorts have the highest percentages of ever smoking and being obese, which are likely functions of aging and changing behavioral patterns.

4.2. Age-specific prevalence

For all cohorts, the prevalence of no disease decreases with age, the prevalence of one disease increases until the early 60s, then flattens in the older ages, and the prevalence of multimorbidity increases with age (Figure 2). The Post-war (1954-1961) cohort generally has the highest prevalence of no disease relative to the older cohorts, starting at 75% at age 50 and decreasing to 35% at age 65. The Japanese annexation (1932-1941) and Korean liberation (1945-1949) cohorts have the highest prevalence of one disease at older ages. The Korean liberation (1945-1949) and Korean War (1950-1953) cohorts have the highest prevalence of multimorbidity. At age 74, there is a six percentage-point difference in prevalence of multimorbidity between the Japanese annexation (1932-1944) and Korean liberation (1945-1949) cohorts. The prevalence of multimorbidity in the Post-war (1954-1961) cohort appears to be increasing at a faster rate than the Japanese annexation (1932-1944) cohort and is approaching the prevalence of the Korean liberation (1945-1949) and Korean War (1950-1953) cohorts.

4.3. Distribution of disease across birth cohorts

Figure 3 presents the distribution of diseases by sex and birth cohort for ages 62-66 reflecting the ages in which all cohort groups are represented. Females generally have higher proportions of hypertension, arthritis, cancer, and psychiatric disorders than males. Males from the Japanese annexation cohort (born 1932-1944) have the highest proportion of most diseases (except arthritis and liver disease) compared to males from the other cohorts. In contrast, the pattern is more mixed for females. Females from the Japanese annexation (1932-1944) cohort have the highest proportion of diabetes, liver disease, and lung disease, females from the Korean liberation (1945-1949) cohort have the highest proportion of hypertension, arthritis, heart disease, and stroke, females from the Korean War (1950-1953) cohort have the highest proportion of psychiatric disorders, and females from the Post-war (1954-1961) cohort have the highest proportion of cancer.

4.4. Disease accumulation across birth cohorts

Table 2 presents results from five models. Model 0 is the null model estimating the association between disease accumulation and birth cohort, age, sex, and study wave. Model 1 adds an interaction between birth cohort and age. We find that females have a 20% (IRR 1.20, 95% CI 1.12-1.28) higher rate of annual disease accumulation compared to males. For each additional year of age from the average age of the sample (62.9 years), the rate of disease accumulation increases by 9% (IRR 1.09, 95% CI 1.07-1.11), and this is also the rate for the Post-war (1954-1961) cohort. The Korean War (1950-1953) cohort also has an IRR of 1.09, computed as its main effect multiplied by the age main effect multiplied by its interaction effect (1.09∗1.02*0.98). Similarly calculated, the Korean liberation (1945-1949) cohort and Japanese annexation (1932-1944) cohort IRRs are both 1.05. The Post-war (1954-1961) and Korean War (1950-1953) cohorts thus have the highest IRRs.

Table 1. Characteristics of study sample at entry wave, by cohort

	Japanese annexation (1932-1944) (n=3,428)	Korean liberation (1945-1949) (n=1,384)	Korean War (1950-1953) (n=1,113)	Post-war (1954-1961) (n=2,341)
Disease count				
0	1299 (37.9%)	738 (53.3%)	699 (62.8%)	1683 (71.9%)
1	1222 (35.6%)	412 (29.8%)	285 (25.6%)	511 (21.8%)
2	612 (17.9%)	166 (12.0%)	101 (9.1%)	124 (5.3%)
3	226 (6.6%)	51 (3.7%)	26 (2.3%)	20 (0.9%)
4	63 (1.8%)	13 (0.9%)	1 (0.1%)	3 (0.1%)
5	4 (0.1%)	3 (0.2%)	0 (0%)	0 (0%)
6	2 (0.1%)	1 (0.1%)	0 (0%)	0 (0%)
7	0 (0%)	0 (0%)	1 (0.1%)	0 (0%)
Sex				
Male	1532 (44.7%)	663 (47.9%)	506 (45.5%)	1012 (43.2%)
Female	1896 (55.3%)	721 (52.1%)	607 (54.5%)	1329 (56.8%)
Age (years)				
Mean (SD)	67.6 (3.52)	58.9 (1.40)	54.5 (1.12)	50.8 (0.98)
Parental death during childhood				
No	2974 (86.8%)	1203 (86.9%)	1008 (90.6%)	2125 (90.8%)
Yes	454 (13.2%)	181 (13.1%)	105 (9.4%)	216 (9.2%)
Parental education				
No formal education	2423 (70.7%)	826 (59.7%)	599 (53.8%)	907 (38.7%)
Elementary school	742 (21.6%)	394 (28.5%)	369 (33.2%)	887 (37.9%)
Middle school or more	263 (7.7%)	164 (11.8%)	145 (13.0%)	547 (23.4%)
Own education				
Middle school or less	2665 (77.7%)	901 (65.1%)	613 (55.1%)	779 (33.3%)
High school	538 (15.7%)	357 (25.8%)	377 (33.9%)	1142 (48.8%)
College/university	225 (6.6%)	126 (9.1%)	123 (11.1%)	420 (17.9%)
Urban/rural				
Urban	2486 (72.5%)	1058 (76.4%)	913 (82.0%)	1960 (83.7%)
Rural	942 (27.5%)	326 (23.6%)	200 (18.0%)	381 (16.3%)
Smoking status				
Never smoker	2459 (71.7%)	940 (67.9%)	763 (68.6%)	1661 (71.0%)
Ever smoker	969 (28.3%)	444 (32.1%)	350 (31.4%)	680 (29.0%)
Obesity status				
Not obese	2583 (75.4%)	996 (72.0%)	783 (70.4%)	1777 (75.9%)
Obese	845 (24.7%)	388 (28.0%)	330 (29.6%)	564 (24.1%)

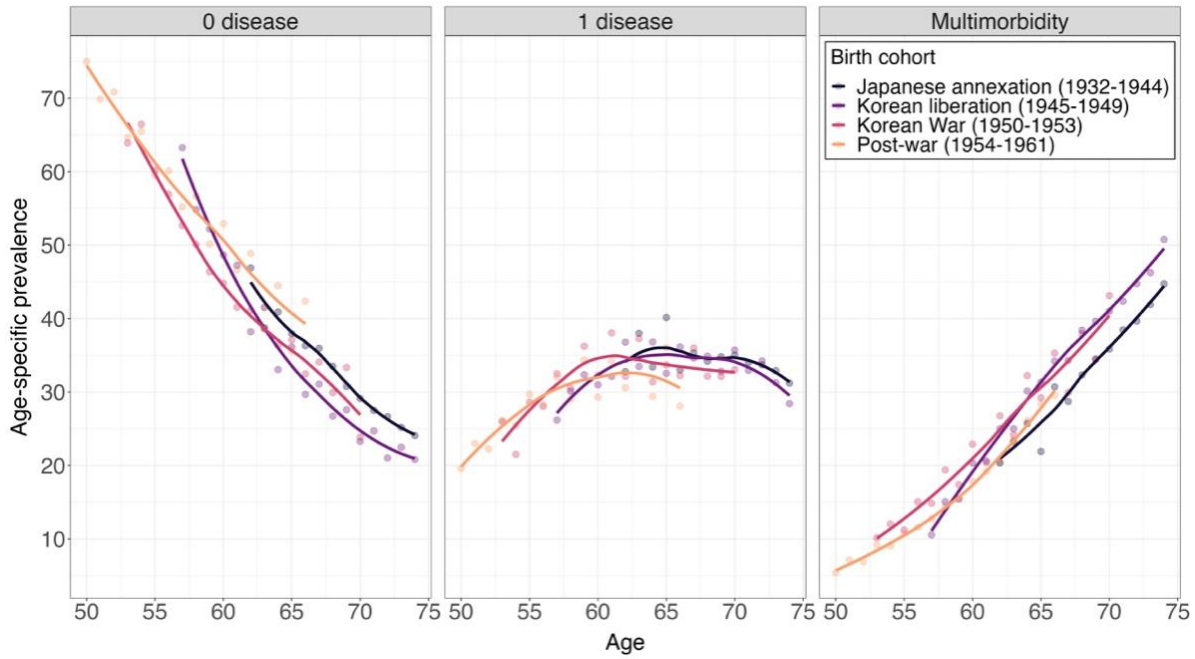

Figure 2. Age-specific prevalence of zero disease, one disease, and multimorbidity for each birth cohort. Lines are smoothed across points using the LOESS method.

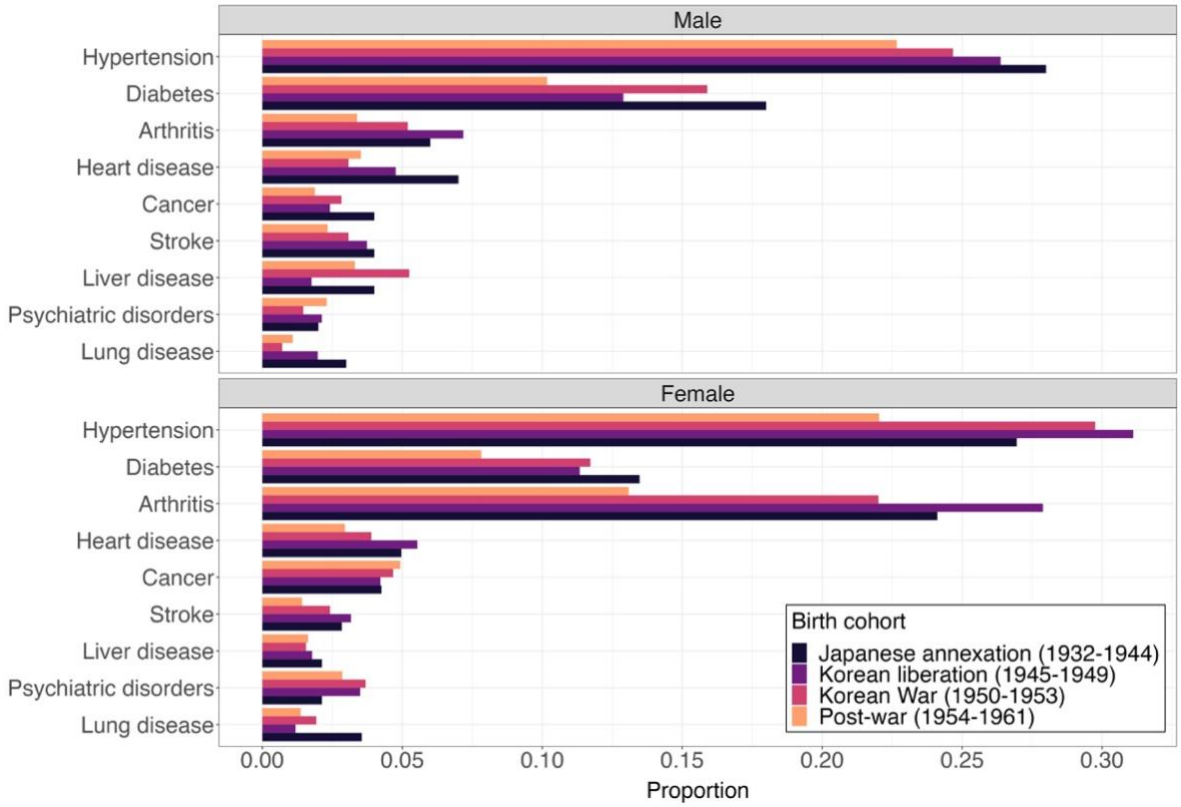

Figure 3. Distribution of disease proportion across sex and birth cohorts. Only participants aged 62-66 are included in this plot, reflecting the ages in which all cohorts are represented.

Table 2. Incidence rate ratios with 95% confidence intervals for disease accumulation across four birth cohorts, adjusted for age, sex, early-life exposures, and later-life characteristics.

		Model 0	Model 1	Model 2	Model 3	Model 4
Intercept		0.73 (0.60-0.90)	0.77 (0.62-0.96)	0.80 (0.65-0.99)	0.74 (0.59-0.92)	0.74 (0.59-0.92)
Birth cohort	Post-war (1954-1961)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)	0.88 (0.67-1.16)	1.01 (0.78-1.29)	0.99 (0.77-1.27)	0.99 (0.78-1.26)	0.99 (0.77-1.26)
	Korean liberation (1945-1949)	1.06 (0.88-1.27)	0.98 (0.80-1.19)	0.97 (0.80-1.17)	0.97 (0.81-1.18)	0.97 (0.80-1.17)
	Korean War (1950-1953)	1.12 (0.98-1.28)	1.02 (0.88-1.18)	1.00 (0.87-1.16)	1.00 (0.87-1.15)	1.00 (0.86-1.15)
Age[a]		1.06 (1.05-1.08)	1.09 (1.07-1.11)	1.08 (1.06-1.10)	1.08 (1.06-1.10)	1.08 (1.06-1.10)
Sex	Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Female	1.20 (1.12-1.28)	1.20 (1.13-1.28)	1.20 (1.13-1.28)	1.19 (1.09-1.29)	1.19 (1.09-1.30)
Wave	1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	2	1.10 (1.07-1.13)	1.14 (1.11-1.17)	1.14 (1.11-1.17)	1.15 (1.12-1.18)	1.15 (1.12-1.18)
	3	1.13 (1.08-1.19)	1.20 (1.15-1.25)	1.21 (1.15-1.26)	1.22 (1.16-1.27)	1.22 (1.16-1.27)
	4	1.14 (1.06-1.22)	1.21 (1.13-1.30)	1.22 (1.14-1.31)	1.24 (1.16-1.33)	1.24 (1.16-1.33)
	5	1.15 (1.04-1.27)	1.22 (1.11-1.34)	1.24 (1.13-1.36)	1.27 (1.15-1.39)	1.27 (1.15-1.39)
	6	1.14 (1.01-1.30)	1.21 (1.06-1.37)	1.23 (1.08-1.39)	1.27 (1.12-1.44)	1.27 (1.12-1.44)
	7	1.09 (0.93-1.28)	1.13 (0.96-1.33)	1.15 (0.98-1.35)	1.20 (1.03-1.41)	1.20 (1.03-1.41)
	8	1.03 (0.85-1.25)	1.04 (0.86-1.27)	1.07 (0.88-1.30)	1.13 (0.94-1.37)	1.14 (0.94-1.38)
Parental death during childhood	No			*Ref*		*Ref*
	Yes			1.07 (0.98-1.17)		1.04 (0.96-1.14)
Parental education	No formal education			*Ref*		*Ref*
	Elementary school			0.93 (0.87-1.00)		0.99 (0.92-1.06)
	Middle school or more			0.83 (0.75-0.93)		0.95 (0.85-1.07)
Own education	Middle school or less				*Ref*	*Ref*
	High school				0.80 (0.74-0.86)	0.81 (0.75-0.88)
	College/university				0.69 (0.61-0.77)	0.70 (0.62-0.80)
Geography	Urban				*Ref*	*Ref*
	Rural				0.90 (0.84-0.96)	0.90 (0.84-0.96)
Smoking status	Never smoker				*Ref*	*Ref*
	Ever smoker				1.15 (1.05-1.26)	1.15 (1.05-1.26)
Obesity status	Not obese				*Ref*	*Ref*
	Obese				1.43 (1.35-1.51)	1.43 (1.35-1.51)
Birth cohort∗Age interaction	Post-war (1954-1961)∗Age		*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)∗Age		0.95 (0.94-0.97)	0.95 (0.94-0.97)	0.96 (0.95-0.97)	0.96 (0.95-0.97)
	Korean liberation (1945-1949)∗Age		0.98 (0.97-0.99)	0.98 (0.97-0.99)	0.98 (0.97-0.99)	0.98 (0.97-0.99)
	Korean War (1950-1953)∗Age		0.98 (0.97-0.99)	0.98 (0.97-0.99)	0.98 (0.97-0.99)	0.98 (0.97-0.99)
Log-likelihood (df)		-93,193,391 (13)	-93,077,310 (16)	-92,929,996 (19)	-91,438,411 (21)	-91,424,202 (24)

Note: Results were computed using Poisson regression models with clustered standard errors

[a] Age is centered at the mean of the sample: 62.9 years

Models 2 and 3 build upon model 1 by adjusting for early-life exposure variables later-life characteristics, respectively. Results for both models are very similar to model 1 (Table 2). Model 4 is the fully adjusted model and results are generally consistent with the previous models, indicating the robustness of the estimates.

Figure 4 shows the predicted disease count for models 0, 1, and 4. Model 0 demonstrates that before adding the interaction between cohort and age, the Korean War (1950-1953) and Korean liberation (1945-1949) cohorts have the highest predicted rates of disease accumulation over age, and the Japanese annexation (1932-1944) has the lowest. However, once the interaction is added in model 1, there is a clear shift in the pattern of disease accumulation across cohorts. The Japanese annexation (1932-1944) cohort has the highest predicted disease count from age 50, but from about age 63, they have the lowest count. By contrast, the Post-war (1954-1961) cohort has the lowest predicted disease count in younger ages, but the highest in older ages. The Korean liberation (1945-1949) and Korean War (1950-1953) cohorts follow this same pattern, but to a lesser degree. Overall, we find that even after adjustment for early-life and later-life characteristics, more recently born cohorts have a steeper gradient of disease accumulation than earlier cohorts.

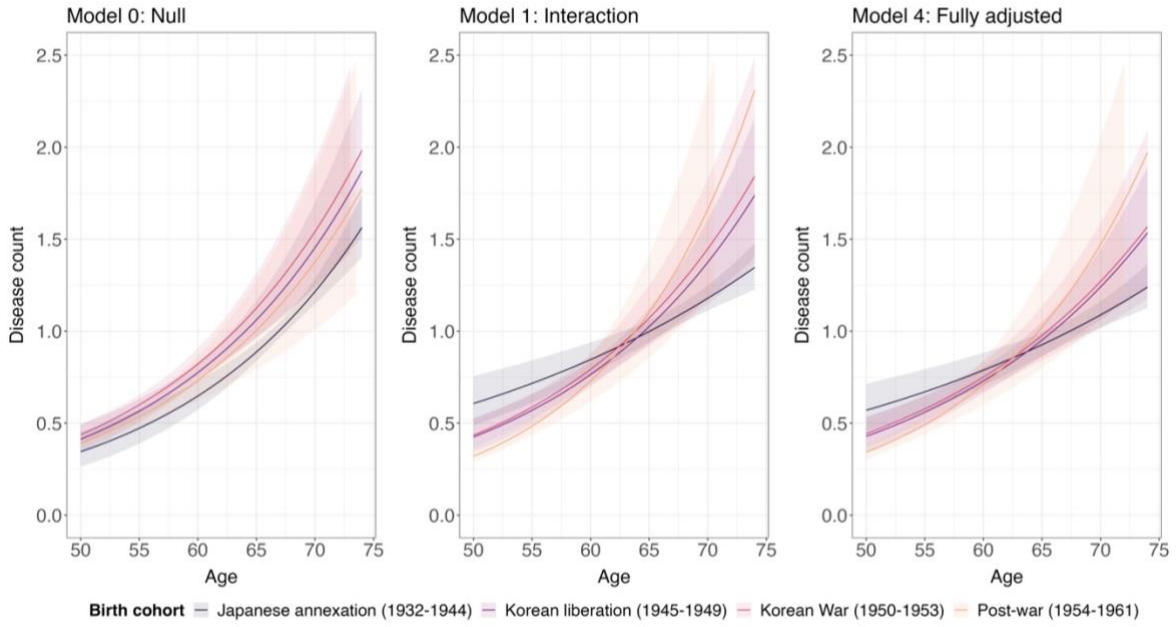

Figure 4. Predicted disease counts for each cohort based on models 0, 1, and 4.

4.5. Stratification by sex and parental education

Females have consistently higher rates of disease accumulation than males, but the difference decreases once we adjust for later-life characteristics (Supplementary material, Appendix I). After stratifying by parental education, we observe the greatest difference in the Japanese annexation (1932-1944) and Post-war (1954-1961) cohorts, with almost a two percentage-point difference between the highest and lowest levels of parental education (Supplementary material, Appendix II). The Korean War (1950-1953) cohort only has a slight increase with more parental education (0.3pp). In contrast, the Korean liberation (1945-1949) cohort has a negative relationship between disease accumulation and parental education, with there being a 0.8 percentage-point higher rate of disease accumulation in the lowest parental education group compared to highest.

4.6. Sensitivity analysis

After removing hypertension and/or arthritis from the counts of diseases and running the same models, we find that the results are consistent with the main analysis (Supplementary material, Appendix III, Tables 1-3). Sensitivity analysis for the different age groups (Supplementary material, Appendix III, Tables 4-6) and for including the MMSE score (Supplementary material, Appendix III, Table 7) also resulted in patterns consistent with our main analysis.

5. Discussion

In this paper, we investigated whether there are cohort differences in disease accumulation across birth cohorts in South Korea. We identified a gradient of disease accumulation, whereby the Post-war (1954-1961) and Korean War (1950-1953) cohorts had the highest rates (9%), and the Korean liberation (1945-1949) and Japanese annexation (1932-1944) cohorts had the lowest (5%). This pattern remains similar after adjusting for early-life and later-life characteristics. These findings are also reflected in our predicted disease counts, where we observe that although the Post-war (1954-1961) cohort, and to a lesser extent the Korean War (1950-1953) and Korean liberation (1944-1949) cohorts, have the lowest disease count at younger ages, the rate at which they accumulate disease increases rapidly with age.

The Japanese annexation (1932-1944) cohort having the lowest rate of disease accumulation and accordingly, the lowest predicted disease count at older ages, may be due to their resilience and selective survival. Since this cohort was older when they experienced the Korean War and its aftermath, they may have built up more resilience towards physical health problems than the younger cohorts (Ramirez & Haas, 2021, 2022), which could explain why when we control for MMSE score in the sensitivity analysis, results are comparable to the main analysis. Additionally, there may be some selective survival, particularly of males who had to fight (and survive) the war, and early-life mortality of weaker individuals, leading to the individuals in this oldest cohort being healthier.

The more recent cohorts having faster rates of disease accumulation could suggest an expansion of morbidity is occurring over time. This could be due to improvements in living standards and healthcare treatments allowing people to live longer while improved disease screening allows for diagnoses at younger ages, thus increasing the years lived with disease (Permanyer et al., 2023; S. Yang et al., 2010). However, it is difficult to disentangle whether the more recent cohorts have a higher rate of disease accumulation because they are being diagnosed at younger ages or if they actually have more disease. Additionally, the fact that the two younger cohorts had the highest prevalence of multimorbidity corroborates previous studies which found that early-life and in-utero exposure to war leads to increased risk for later-life disease and poor health outcomes (Haas & Ramirez, 2022, 2024; C. Lee, 2014, 2017; Ramirez & Haas, 2021). However, since we did not examine changes in life expectancy and time spent with functional limitations across these cohorts, we cannot confirm whether morbidity is expanding and if there are specific effects of the war experience on life expectancy and later life disability. Future research should investigate this further.

The trend of health worsening in more recent cohorts has also been seen in other countries. In the US and Canada, recent cohorts have more chronic diseases and multimorbidity (Bishop et al., 2022; Canizares et al., 2018; Zheng et al., 2023), which can largely be attributed to childhood illness and increases in obesity. Across several European countries, younger cohorts experience more chronic disease accumulation (Ribe et al., 2023), poorer functional health trajectories (Haas et al., 2017), and more disability (Fors et al., 2022) compared to older cohorts, potentially because of increasing unhealthy life expectancy. There

seems to be limited research on cohort differences in health from Asia and they tend to focus on specific diseases, but the trends are the same. Younger cohorts from Japan, China, and Singapore have increased risks for colorectal cancer (Chung et al., 2019) and gastric cancer (Li et al., 2023), again likely due to increases in obesity and changes in diet and lifestyle.

This study has several limitations. Firstly, there is survival bias, in that participants had to have survived through myriad adverse events to be able to take part in the survey and therefore might be characteristically different from people who did not survive to this point. Second, all information was self-reported, which makes the data susceptible to recall bias, particularly in terms of the early-life exposure variables. Third, we did not have information on many relevant early-life variables, such as place of birth and migration history, place of residence during the war, or childhood socioeconomic conditions. Lastly, due to the sparse/unevenly distributed data at the youngest and oldest ages across cohorts, we could not account for those ages without excess extrapolation. However, the central age range chosen for the analysis is representative of when chronic diseases are most likely to develop (Zhu et al., 2018).

5.1. Conclusion

Viewing disease accumulation using a life course framework, by jointly considering birth cohort context and early-and later-life exposures, allows for the broader consideration of factors affecting successful aging. We identified different disease prevalence patterns and rates of accumulation across cohorts. This may indicate that the long-term effects of adverse events and improved living conditions vary depending on the timing of occurrence throughout the life course. The increasing rate of disease accumulation among recent cohorts should be further investigated to better understand what might be driving the trend and how it can be mitigated. If this trend continues as younger cohorts age, South Korea will be facing a substantial increase in chronic disease prevalence in a rapidly expanding older population. Appropriate preventive measures, healthcare, and social care infrastructure must be put in place to manage the future increase of older persons with multimorbidity.

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Supplementary Material

Appendix I. Models stratified by sex

Table 1. Incidence rate ratios with 95% confidence intervals for disease accumulation across four birth cohorts for **males**, adjusted for age, early-life exposures, and later-life characteristics, using data from the Korean Longitudinal Study of Aging (2006-2020)

		Model 0	Model 1	Model 2	Model 3	Model 4
Intercept		0.72 (0.52-1.01)	0.74 (0.53-1.04)	0.76 (0.54-1.07)	0.70 (0.50-0.97)	0.69 (0.49-0.97)
Birth cohort	Post-war (1954-1961)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)	0.83 (0.53-1.30)	1.00 (0.67-1.49)	0.98 (0.66-1.47)	1.00 (0.68-1.48)	0.99 (0.67-1.46)
	Korean liberation (1945-1949)	0.99 (0.73-1.32)	0.93 (0.68-1.26)	0.92 (0.67-1.25)	0.93 (0.69-1.25)	0.92 (0.68-1.24)
	Korean War (1950-1953)	1.05 (0.84-1.30)	0.97 (0.77-1.21)	0.96 (0.76-1.20)	0.97 (0.77-1.21)	0.96 (0.77-1.20)
Age[a]		1.06 (1.03-1.09)	1.08 (1.05-1.11)	1.08 (1.05-1.11)	1.07 (1.04-1.10)	1.07 (1.04-1.10)
Wave	1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	2	1.12 (1.07-1.17)	1.17 (1.12-1.22)	1.17 (1.12-1.22)	1.18 (1.12-1.23)	1.18 (1.12-1.23)
	3	1.16 (1.07-1.25)	1.23 (1.14-1.33)	1.24 (1.15-1.33)	1.25 (1.16-1.35)	1.24 (1.15-1.34)
	4	1.19 (1.06-1.34)	1.29 (1.15-1.44)	1.29 (1.15-1.45)	1.30 (1.16-1.46)	1.30 (1.16-1.45)
	5	1.21 (1.03-1.42)	1.30 (1.11-1.52)	1.30 (1.12-1.52)	1.33 (1.14-1.55)	1.32 (1.13-1.54)
	6	1.24 (1.01-1.53)	1.32 (1.08-1.63)	1.34 (1.09-1.64)	1.36 (1.11-1.67)	1.36 (1.11-1.66)
	7	1.20 (0.92-1.56)	1.25 (0.96-1.63)	1.27 (0.98-1.64)	1.30 (1.01-1.68)	1.30 (1.00-1.67)
	8	1.14 (0.84-1.56)	1.17 (0.86-1.61)	1.19 (0.87-1.63)	1.23 (0.91-1.67)	1.23 (0.90-1.66)
Parental death during childhood	No			*Ref*		*Ref*
	Yes			1.13 (0.99-1.29)		1.09 (0.96-1.25)
Parental education	No formal education			*Ref*		*Ref*
	Elementary school			0.95 (0.85-1.06)		1.00 (0.89-1.12)
	Middle school or more			0.91 (0.76-1.08)		1.03 (0.86-1.23)
Own education	Middle school or less				*Ref*	*Ref*
	High school				0.87 (0.78-0.97)	0.87 (0.78-0.98)
	College/university				0.74 (0.64-0.86)	0.74 (0.63-0.87)
Geography	Urban				*Ref*	*Ref*
	Rural				0.89 (0.80-1.00)	0.90 (0.80-1.00)
Smoking status	Never smoker				*Ref*	*Ref*
	Ever smoker				1.13 (1.03-1.25)	1.13 (1.02-1.25)
Obesity status	Not obese				*Ref*	*Ref*
	Obese				1.38 (1.26-1.51)	1.38 (1.26-1.52)
Birth cohort∗Age interaction	Post-war (1954-1961)∗Age		*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)∗Age		0.95 (0.93-0.97)	0.95 (0.93-0.97)	0.96 (0.93-0.98)	0.96 (0.93-0.98)
	Korean liberation (1945-1949)∗Age		0.98 (0.96-0.99)	0.98 (0.96-0.99)	0.98 (0.97-1.00)	0.98 (0.97-1.00)
	Korean War (1950-1953)∗Age		0.98 (0.96-1.00)	0.98 (0.96-1.00)	0.98 (0.96-1.00)	0.98 (0.96-1.00)
Log-likelihood (df)		-44,049,195 (12)	-43,998,704 (15)	-43,952,280 (18)	-43,427,890 (20)	-43,412,693 (23)

Note: Results were computed using Poisson regression models with clustered standard errors.

[a] Age is centered at the mean of the sample: 62.9 years

Table 2. Incidence rate ratios with 95% confidence intervals for disease accumulation across four birth cohorts for **females**, adjusted for age, early-life exposures, and later-life characteristics, and stratified by *sex*, using data from the Korean Longitudinal Study of Aging (2006-2020)

		Model 0	Model 1	Model 2	Model 3	Model 4
Intercept		0.88 (0.68-1.14)	0.94 (0.72-1.23)	1.00 (0.76-1.30)	0.89 (0.68-1.16)	0.90 (0.69-1.18)
Birth cohort	Post-war (1954-1961)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)	0.92 (0.65-1.30)	1.01 (0.74-1.39)	0.99 (0.73-1.35)	0.99 (0.73-1.35)	0.99 (0.72-1.34)
	Korean liberation (1945-1949)	1.13 (0.90-1.42)	1.03 (0.80-1.33)	1.02 (0.79-1.31)	1.03 (0.81-1.32)	1.03 (0.80-1.31)
	Korean War (1950-1953)	1.19 (1.00-1.42)	1.07 (0.89-1.29)	1.05 (0.87-1.27)	1.03 (0.86-1.24)	1.03 (0.85-1.23)
Age[a]		1.07 (1.05-1.09)	1.09 (1.07-1.12)	1.09 (1.06-1.12)	1.08 (1.05-1.10)	1.08 (1.05-1.10)
Wave	1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	2	1.08 (1.05-1.12)	1.12 (1.08-1.16)	1.12 (1.08-1.16)	1.13 (1.09-1.17)	1.13 (1.09-1.17)
	3	1.12 (1.06-1.19)	1.18 (1.11-1.24)	1.18 (1.12-1.25)	1.20 (1.14-1.27)	1.20 (1.14-1.27)
	4	1.10 (1.01-1.20)	1.16 (1.07-1.26)	1.17 (1.08-1.28)	1.21 (1.11-1.31)	1.21 (1.11-1.31)
	5	1.11 (0.98-1.25)	1.17 (1.04-1.32)	1.19 (1.06-1.34)	1.23 (1.10-1.38)	1.23 (1.10-1.38)
	6	1.08 (0.92-1.26)	1.13 (0.96-1.32)	1.15 (0.98-1.34)	1.21 (1.04-1.41)	1.21 (1.04-1.41)
	7	1.01 (0.83-1.24)	1.04 (0.84-1.28)	1.06 (0.86-1.30)	1.15 (0.94-1.40)	1.14 (0.94-1.40)
	8	0.96 (0.75-1.22)	0.95 (0.74-1.23)	0.98 (0.76-1.26)	1.09 (0.85-1.39)	1.08 (0.85-1.38)
Parental death during childhood	No			*Ref*		*Ref*
	Yes			1.03 (0.92-1.15)		1.01 (0.90-1.12)
Parental education	No formal education			*Ref*		*Ref*
	Elementary school			0.92 (0.84-1.01)		0.99 (0.90-1.09)
	Middle school or more			0.78 (0.68-0.89)		0.91 (0.79-1.05)
Own education	Middle school or less				*Ref*	*Ref*
	High school				0.75 (0.67-0.84)	0.77 (0.68-0.86)
	College/university				0.58 (0.47-0.73)	0.62 (0.48-0.78)
Geography	Urban				*Ref*	*Ref*
	Rural				0.91 (0.84-0.98)	0.90 (0.83-0.98)
Smoking status	Never smoker				*Ref*	*Ref*
	Ever smoker				1.26 (1.03-1.55)	1.26 (1.03-1.55)
Obesity status	Not obese				*Ref*	*Ref*
	Obese				1.44 (1.35-1.54)	1.44 (1.35-1.54)
Birth cohort∗Age interaction	Post-war (1954-1961)∗Age		*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)∗Age		0.95 (0.94-0.97)	0.95 (0.94-0.97)	0.96 (0.95-0.98)	0.96 (0.95-0.98)
	Korean liberation (1945-1949)∗Age		0.97 (0.96-0.99)	0.98 (0.96-0.99)	0.98 (0.97-0.99)	0.98 (0.97-0.99)
	Korean War (1950-1953)∗Age		0.98 (0.96-0.99)	0.98 (0.96-0.99)	0.98 (0.97-0.99)	0.98 (0.97-0.99)
Log-likelihood (df)		-49,033,486 (12)	-48,967,090 (15)	-48,842,553 (18)	-47,882,882 (20)	-47,868,421 (23)

Note: Results were computed using Poisson regression models with clustered standard errors.

[a] Age is centered at the mean of the sample: 62.9 years

Appendix II. Models stratified by parental education

Table 1. Incidence rate ratios with 95% confidence intervals for disease accumulation across four birth cohorts if **both parents had no formal education**, adjusted for age, early-life exposures, and later-life characteristics, using data from the Korean Longitudinal Study of Aging (2006-2020)

		Model 0	Model 1	Model 2	Model 3	Model 4
Intercept		0.72 (0.55-0.94)	0.77 (0.58-1.03)	0.77 (0.58-1.03)	0.70 (0.52-0.94)	0.70 (0.52-0.94)
Birth cohort	Post-war (1954-1961)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)	0.92 (0.65-1.30)	1.01 (0.73-1.39)	1.01 (0.73-1.39)	0.97 (0.70-1.33)	0.97 (0.70-1.33)
	Korean liberation (1945-1949)	1.07 (0.85-1.36)	0.96 (0.74-1.25)	0.96 (0.74-1.25)	0.95 (0.73-1.23)	0.95 (0.73-1.23)
	Korean War (1950-1953)	1.05 (0.88-1.26)	0.95 (0.78-1.16)	0.95 (0.78-1.16)	0.93 (0.77-1.14)	0.93 (0.77-1.14)
Age[a]		1.05 (1.03-1.07)	1.07 (1.05-1.10)	1.07 (1.05-1.10)	1.07 (1.04-1.10)	1.07 (1.04-1.10)
Sex	Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Female	1.26 (1.16-1.37)	1.26 (1.17-1.37)	1.26 (1.17-1.37)	1.37 (1.22-1.54)	1.37 (1.22-1.54)
Wave	1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	2	1.10 (1.07-1.14)	1.13 (1.10-1.17)	1.13 (1.10-1.17)	1.13 (1.10-1.17)	1.13 (1.10-1.17)
	3	1.16 (1.09-1.23)	1.21 (1.15-1.28)	1.21 (1.15-1.28)	1.20 (1.14-1.27)	1.20 (1.14-1.27)
	4	1.20 (1.10-1.31)	1.26 (1.16-1.37)	1.26 (1.16-1.37)	1.25 (1.15-1.36)	1.25 (1.15-1.36)
	5	1.23 (1.09-1.39)	1.29 (1.14-1.44)	1.29 (1.14-1.44)	1.27 (1.14-1.43)	1.27 (1.14-1.43)
	6	1.24 (1.06-1.45)	1.27 (1.09-1.49)	1.27 (1.09-1.49)	1.27 (1.09-1.48)	1.27 (1.09-1.48)
	7	1.21 (0.99-1.47)	1.20 (0.98-1.48)	1.20 (0.98-1.48)	1.21 (0.99-1.47)	1.21 (0.99-1.47)
	8	1.17 (0.92-1.49)	1.14 (0.88-1.46)	1.14 (0.88-1.46)	1.14 (0.89-1.46)	1.14 (0.89-1.46)
Parental death during childhood	No			*Ref*		*Ref*
	Yes			1.02 (0.91-1.14)		1.00 (0.89-1.11)
Own education	Middle school or less				*Ref*	*Ref*
	High school				0.83 (0.74-0.94)	0.83 (0.74-0.94)
	College/university				0.88 (0.72-1.08)	0.88 (0.72-1.08)
Geography	Urban				*Ref*	*Ref*
	Rural				0.85 (0.78-0.92)	0.85 (0.78-0.92)
Smoking status	Never smoker				*Ref*	*Ref*
	Ever smoker				1.25 (1.11-1.41)	1.25 (1.11-1.41)
Obesity status	Not obese				*Ref*	*Ref*
	Obese				1.33 (1.23-1.42)	1.33 (1.23-1.42)
Birth cohort∗Age interaction	Post-war (1954-1961)∗Age		*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)∗Age		0.95 (0.93-0.98)	0.95 (0.93-0.98)	0.96 (0.94-0.98)	0.96 (0.94-0.98)
	Korean liberation (1945-1949)∗Age		0.98 (0.97-1.00)	0.98 (0.97-1.00)	0.99 (0.97-1.00)	0.99 (0.97-1.00)
	Korean War (1950-1953)∗Age		0.99 (0.97-1.00)	0.99 (0.97-1.00)	0.99 (0.97-1.00)	0.99 (0.97-1.00)
Log-likelihood (df)		-48,514,972 (13)	-48,462,810 (16)	-48,461,945 (17)	-47,834,403 (21)	-47,834,367 (22)

Note: Results were computed using Poisson regression models with clustered standard errors.

[a] Age is centered at the mean of the sample: 62.9 years

Table 2. Incidence rate ratios with 95% confidence intervals for disease accumulation across four birth cohorts if **at least one parent had an elementary school education**, adjusted for age, early-life exposures, and later-life characteristics, using data from the Korean Longitudinal Study of Aging (2006-2020)

		Model 0	Model 1	Model 2	Model 3	Model 4
Intercept		0.79 (0.54-1.17)	0.80 (0.54-1.19)	0.79 (0.53-1.17)	0.79 (0.53-1.18)	0.77 (0.52-1.16)
Birth cohort	Post-war (1954-1961)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)	0.78 (0.46-1.31)	0.92 (0.58-1.47)	0.92 (0.58-1.48)	0.96 (0.60-1.51)	0.96 (0.60-1.51)
	Korean liberation (1945-1949)	1.03 (0.73-1.44)	1.00 (0.71-1.43)	1.00 (0.70-1.42)	1.00 (0.71-1.40)	0.99 (0.70-1.39)
	Korean War (1950-1953)	1.10 (0.86-1.41)	1.03 (0.80-1.33)	1.03 (0.80-1.33)	1.04 (0.81-1.33)	1.04 (0.81-1.34)
Age[a]		1.07 (1.04-1.10)	1.09 (1.05-1.13)	1.09 (1.05-1.13)	1.08 (1.05-1.12)	1.08 (1.05-1.12)
Sex	Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Female	1.18 (1.05-1.32)	1.18 (1.05-1.32)	1.18 (1.05-1.32)	1.09 (0.94-1.27)	1.10 (0.95-1.27)
Wave	1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	2	1.09 (1.04-1.15)	1.14 (1.08-1.20)	1.14 (1.08-1.20)	1.16 (1.10-1.23)	1.17 (1.10-1.23)
	3	1.11 (1.01-1.22)	1.18 (1.08-1.30)	1.18 (1.08-1.30)	1.22 (1.11-1.34)	1.22 (1.11-1.34)
	4	1.09 (0.94-1.25)	1.17 (1.03-1.34)	1.18 (1.03-1.35)	1.22 (1.07-1.40)	1.22 (1.07-1.40)
	5	1.08 (0.89-1.32)	1.17 (0.97-1.41)	1.18 (0.97-1.42)	1.24 (1.03-1.49)	1.24 (1.03-1.49)
	6	1.06 (0.83-1.37)	1.15 (0.90-1.47)	1.15 (0.90-1.47)	1.22 (0.96-1.56)	1.23 (0.96-1.56)
	7	1.00 (0.73-1.37)	1.07 (0.78-1.46)	1.07 (0.78-1.46)	1.15 (0.85-1.56)	1.15 (0.85-1.57)
	8	0.92 (0.63-1.33)	0.97 (0.66-1.41)	0.97 (0.66-1.41)	1.06 (0.73-1.52)	1.06 (0.73-1.52)
Parental death during childhood	No			*Ref*		*Ref*
	Yes			1.14 (0.97-1.33)		1.14 (0.97-1.33)
Own education	Middle school or less				*Ref*	*Ref*
	High school				0.81 (0.71-0.92)	0.81 (0.71-0.92)
	College/university				0.75 (0.61-0.92)	0.76 (0.62-0.93)
Geography	Urban				*Ref*	*Ref*
	Rural				0.93 (0.82-1.05)	0.93 (0.83-1.05)
Smoking status	Never smoker				*Ref*	*Ref*
	Ever smoker				1.02 (0.87-1.19)	1.02 (0.87-1.19)
Obesity status	Not obese				*Ref*	*Ref*
	Obese				1.53 (1.39-1.68)	1.53 (1.39-1.69)
Birth cohort∗Age interaction	Post-war (1954-1961)∗Age		*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)∗Age		0.96 (0.93-0.98)	0.95 (0.93-0.98)	0.96 (0.93-0.98)	0.96 (0.93-0.98)
	Korean liberation (1945-1949)∗Age		0.97 (0.96-0.99)	0.97 (0.96-0.99)	0.97 (0.96-0.99)	0.97 (0.96-0.99)
	Korean War (1950-1953)∗Age		0.98 (0.96-1.00)	0.98 (0.96-1.00)	0.98 (0.96-1.00)	0.98 (0.96-1.00)
Log-likelihood (df)		-30,051,561 (13)	-30,018,455 (16)	-30,001,068 (17)	-29,439,976 (21)	-29,423,550 (22)

Note: Results were computed using Poisson regression models with clustered standard errors.

[a] Age is centered at the mean of the sample: 62.9 years

Table 3. Incidence rate ratios with 95% confidence intervals for disease accumulation across four birth cohorts if **at least one parent had middle-school education or more**, adjusted for age, early-life exposures, and later-life characteristics, using data from the Korean Longitudinal Study of Aging (2006-2020)

		Model 0	Model 1	Model 2	Model 3	Model 4
Intercept		0.83 (0.46-1.51)	0.81 (0.44-1.46)	0.78 (0.43-1.41)	0.80 (0.45-1.44)	0.79 (0.44-1.40)
Birth cohort	Post-war (1954-1961)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)	0.84 (0.39-1.85)	0.94 (0.46-1.94)	0.94 (0.46-1.92)	1.00 (0.53-1.91)	1.01 (0.53-1.90)
	Korean liberation (1945-1949)	0.81 (0.48-1.37)	0.84 (0.49-1.43)	0.83 (0.49-1.41)	0.93 (0.58-1.50)	0.93 (0.58-1.50)
	Korean War (1950-1953)	1.18 (0.78-1.78)	1.10 (0.73-1.67)	1.11 (0.73-1.67)	1.08 (0.73-1.61)	1.09 (0.73-1.61)
Age[a]		1.08 (1.04-1.13)	1.10 (1.04-1.15)	1.10 (1.04-1.15)	1.08 (1.03-1.13)	1.08 (1.03-1.13)
Sex	Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Female	1.02 (0.84-1.24)	1.02 (0.84-1.24)	1.03 (0.85-1.25)	0.95 (0.76-1.19)	0.95 (0.76-1.19)
Wave	1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	2	1.10 (1.00-1.20)	1.14 (1.04-1.25)	1.15 (1.05-1.26)	1.17 (1.07-1.28)	1.17 (1.07-1.28)
	3	1.10 (0.95-1.29)	1.19 (1.02-1.38)	1.19 (1.03-1.39)	1.26 (1.10-1.46)	1.27 (1.10-1.46)
	4	1.01 (0.80-1.27)	1.11 (0.88-1.40)	1.12 (0.89-1.40)	1.21 (0.97-1.51)	1.21 (0.98-1.51)
	5	1.00 (0.73-1.36)	1.11 (0.81-1.51)	1.11 (0.82-1.51)	1.25 (0.93-1.67)	1.25 (0.93-1.67)
	6	1.01 (0.68-1.50)	1.13 (0.76-1.68)	1.14 (0.77-1.69)	1.31 (0.90-1.90)	1.31 (0.91-1.90)
	7	0.92 (0.56-1.49)	1.02 (0.63-1.68)	1.04 (0.64-1.69)	1.22 (0.77-1.93)	1.23 (0.78-1.94)
	8	0.87 (0.48-1.55)	0.97 (0.54-1.74)	0.98 (0.55-1.75)	1.22 (0.70-2.11)	1.23 (0.71-2.11)
Parental death during childhood	No			*Ref*		*Ref*
	Yes			1.25 (0.95-1.64)		1.12 (0.88-1.41)
Own education	Middle school or less				*Ref*	*Ref*
	High school				0.72 (0.58-0.88)	0.72 (0.59-0.89)
	College/university				0.50 (0.39-0.63)	0.51 (0.40-0.64)
Geography	Urban				*Ref*	*Ref*
	Rural				1.21 (0.95-1.54)	1.21 (0.95-1.54)
Smoking status	Never smoker				*Ref*	*Ref*
	Ever smoker				1.21 (0.94-1.56)	1.21 (0.94-1.56)
Obesity status	Not obese				*Ref*	*Ref*
	Obese				1.61 (1.35-1.92)	1.61 (1.35-1.92)
Birth cohort∗Age interaction	Post-war (1954-1961)∗Age		*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)∗Age		0.97 (0.93-1.00)	0.97 (0.93-1.00)	0.98 (0.95-1.02)	0.98 (0.95-1.02)
	Korean liberation (1945-1949)∗Age		0.97 (0.94-1.00)	0.97 (0.94-0.99)	0.97 (0.95-1.00)	0.97 (0.95-1.00)
	Korean War (1950-1953)∗Age		0.96 (0.93-0.99)	0.96 (0.93-0.99)	0.96 (0.93-0.99)	0.96 (0.93-0.99)
Log-likelihood (df)		-14,334,414 (13)	-14,310,563 (16)	-14,290,895 (17)	-13,747,915 (21)	-13,742,994 (22)

Note: Results were computed using Poisson regression models with clustered standard errors.

[a] Age is centered at the mean of the sample: 62.9 years

Appendix III. Sensitivity analyses

Table 1. Incidence rate ratios with 95% confidence intervals for disease accumulation across four birth cohorts **excluding hypertension**, adjusted for age, sex, early-life exposures, and later-life characteristics, using data from the Korean Longitudinal Study of Aging (2006-2020)

		Model 0	Model 1	Model 2	Model 3	Model 4
Intercept		0.43 (0.33-0.56)	0.46 (0.35-0.61)	0.49 (0.37-0.64)	0.43 (0.33-0.57)	0.43 (0.33-0.57)
Birth cohort	Post-war (1954-1961)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)	0.87 (0.62-1.23)	1.02 (0.75-1.39)	1.00 (0.73-1.36)	1.00 (0.74-1.35)	0.99 (0.73-1.34)
	Korean liberation (1945-1949)	1.06 (0.84-1.34)	0.95 (0.74-1.21)	0.93 (0.73-1.19)	0.94 (0.74-1.19)	0.93 (0.74-1.19)
	Korean War (1950-1953)	1.13 (0.95-1.35)	1.00 (0.83-1.20)	0.98 (0.81-1.18)	0.97 (0.81-1.16)	0.97 (0.81-1.16)
Age[a]		1.07 (1.05-1.09)	1.10 (1.08-1.13)	1.10 (1.07-1.13)	1.09 (1.06-1.11)	1.09 (1.06-1.11)
Sex	Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Female	1.33 (1.22-1.44)	1.33 (1.23-1.44)	1.33 (1.23-1.44)	1.39 (1.25-1.55)	1.40 (1.25-1.56)
Wave	1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	2	1.11 (1.07-1.15)	1.16 (1.12-1.20)	1.17 (1.13-1.21)	1.18 (1.14-1.22)	1.18 (1.14-1.22)
	3	1.13 (1.07-1.20)	1.22 (1.15-1.29)	1.23 (1.16-1.30)	1.24 (1.17-1.31)	1.24 (1.17-1.31)
	4	1.13 (1.03-1.23)	1.23 (1.13-1.33)	1.24 (1.14-1.35)	1.26 (1.16-1.37)	1.26 (1.16-1.37)
	5	1.14 (1.01-1.28)	1.24 (1.10-1.39)	1.25 (1.11-1.41)	1.29 (1.15-1.45)	1.29 (1.15-1.45)
	6	1.13 (0.97-1.33)	1.21 (1.04-1.42)	1.24 (1.06-1.45)	1.30 (1.11-1.51)	1.30 (1.11-1.51)
	7	1.07 (0.88-1.31)	1.12 (0.91-1.37)	1.14 (0.93-1.40)	1.22 (1.00-1.48)	1.22 (1.00-1.49)
	8	0.99 (0.78-1.26)	1.01 (0.79-1.29)	1.04 (0.81-1.33)	1.12 (0.88-1.43)	1.12 (0.88-1.43)
Parental death during childhood	No			*Ref*		*Ref*
	Yes			1.09 (0.98-1.21)		1.05 (0.95-1.17)
Parental education	No formal education			*Ref*		*Ref*
	Elementary school			0.89 (0.82-0.97)		0.97 (0.89-1.07)
	Middle school or more			0.81 (0.71-0.92)		0.97 (0.84-1.12)
Own education	Middle school or less				*Ref*	*Ref*
	High school				0.74 (0.67-0.82)	0.75 (0.67-0.83)
	College/university				0.60 (0.51-0.70)	0.61 (0.52-0.72)
Geography	Urban				*Ref*	*Ref*
	Rural				0.91 (0.84-0.99)	0.91 (0.84-0.99)
Smoking status	Never smoker				*Ref*	*Ref*
	Ever smoker				1.30 (1.16-1.46)	1.30 (1.16-1.46)
Obesity status	Not obese				*Ref*	*Ref*
	Obese				1.34 (1.25-1.44)	1.34 (1.25-1.44)
Birth cohort∗Age interaction	Post-war (1954-1961)∗Age		*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)∗Age		0.94 (0.92-0.95)	0.94 (0.92-0.96)	0.95 (0.93-0.96)	0.95 (0.93-0.96)
	Korean liberation (1945-1949)∗Age		0.97 (0.96-0.98)	0.97 (0.96-0.98)	0.97 (0.96-0.99)	0.97 (0.96-0.99)
	Korean War (1950-1953)∗Age		0.97 (0.95-0.98)	0.97 (0.95-0.98)	0.97 (0.96-0.98)	0.97 (0.96-0.98)
Log-likelihood (df)		-72,897,562 (13)	-72,769,583 (16)	-72,626,400 (19)	-71,554,894 (21)	-71,545,928 (24)

Note: Results were computed using Poisson regression models with clustered standard errors. [a] Age is centered at the mean of the sample: 62.9 years

Table 2. Incidence rate ratios with 95% confidence intervals for disease accumulation across four birth cohorts **excluding arthritis**, adjusted for age, sex, early-life exposures, and later-life characteristics, using data from the Korean Longitudinal Study of Aging (2006-2020)

		Model 0	Model 1	Model 2	Model 3	Model 4
Intercept		0.65 (0.52-0.81)	0.67 (0.54-0.85)	0.69 (0.54-0.86)	0.63 (0.50-0.80)	0.63 (0.49-0.79)
Birth cohort	Post-war (1954-1961)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)	0.88 (0.65-1.19)	1.01 (0.77-1.33)	1.00 (0.77-1.32)	1.01 (0.77-1.32)	1.01 (0.77-1.31)
	Korean liberation (1945-1949)	1.04 (0.85-1.27)	0.97 (0.79-1.20)	0.97 (0.78-1.19)	0.97 (0.79-1.20)	0.97 (0.79-1.19)
	Korean War (1950-1953)	1.11 (0.96-1.28)	1.02 (0.87-1.19)	1.01 (0.86-1.18)	1.01 (0.87-1.17)	1.00 (0.86-1.17)
Age[a]		1.06 (1.04-1.08)	1.08 (1.06-1.10)	1.08 (1.05-1.10)	1.07 (1.05-1.09)	1.07 (1.05-1.09)
Sex	Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Female	0.97 (0.91-1.04)	0.97 (0.91-1.04)	0.97 (0.91-1.04)	0.97 (0.89-1.07)	0.98 (0.89-1.07)
Wave	1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	2	1.10 (1.06-1.13)	1.14 (1.10-1.17)	1.14 (1.10-1.17)	1.14 (1.11-1.18)	1.14 (1.11-1.18)
	3	1.15 (1.09-1.21)	1.21 (1.15-1.28)	1.22 (1.16-1.28)	1.22 (1.16-1.29)	1.22 (1.16-1.29)
	4	1.17 (1.08-1.27)	1.25 (1.16-1.35)	1.26 (1.16-1.36)	1.27 (1.18-1.37)	1.27 (1.18-1.37)
	5	1.20 (1.08-1.34)	1.28 (1.15-1.42)	1.29 (1.16-1.44)	1.31 (1.18-1.46)	1.31 (1.18-1.46)
	6	1.22 (1.05-1.40)	1.28 (1.11-1.48)	1.30 (1.13-1.49)	1.33 (1.16-1.53)	1.33 (1.16-1.53)
	7	1.17 (0.98-1.40)	1.21 (1.01-1.45)	1.23 (1.03-1.47)	1.27 (1.07-1.52)	1.27 (1.07-1.52)
	8	1.13 (0.91-1.40)	1.15 (0.92-1.43)	1.17 (0.94-1.45)	1.22 (0.99-1.51)	1.22 (0.99-1.51)
Parental death during childhood	No			*Ref*		*Ref*
	Yes			1.08 (0.98-1.19)		1.05 (0.96-1.16)
Parental education	No formal education			*Ref*		*Ref*
	Elementary school			0.97 (0.90-1.05)		1.01 (0.94-1.10)
	Middle school or more			0.88 (0.78-0.98)		0.97 (0.86-1.10)
Own education	Middle school or less				*Ref*	*Ref*
	High school				0.85 (0.79-0.93)	0.86 (0.79-0.94)
	College/university				0.74 (0.66-0.84)	0.75 (0.66-0.86)
Geography	Urban				*Ref*	*Ref*
	Rural				0.88 (0.82-0.95)	0.88 (0.82-0.95)
Smoking status	Never smoker				*Ref*	*Ref*
	Ever smoker				1.14 (1.03-1.25)	1.14 (1.03-1.25)
Obesity status	Not obese				*Ref*	*Ref*
	Obese				1.42 (1.33-1.50)	1.41 (1.33-1.50)
Birth cohort∗Age interaction	Post-war (1954-1961)∗Age		*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)∗Age		0.95 (0.94-0.97)	0.95 (0.94-0.97)	0.96 (0.95-0.98)	0.96 (0.95-0.98)
	Korean liberation (1945-1949)∗Age		0.98 (0.97-0.99)	0.98 (0.97-0.99)	0.98 (0.97-0.99)	0.98 (0.97-0.99)
	Korean War (1950-1953)∗Age		0.98 (0.97-0.99)	0.98 (0.97-0.99)	0.98 (0.97-0.99)	0.98 (0.97-0.99)
Log-likelihood (df)		-84,840,893 (13)	-84,758,333 (16)	-84,685,292 (19)	-83,634,617 (21)	-83,621,049 (24)

Note: Results were computed using Poisson regression models with clustered standard errors.

[a] Age is centered at the mean of the sample: 62.9 years

Table 3. Incidence rate ratios with 95% confidence intervals for disease accumulation across four birth cohorts **excluding hypertension and arthritis**, adjusted for age, sex, early-life exposures, and later-life characteristics, using data from the Korean Longitudinal Study of Aging (2006-2020)

		Model 0	Model 1	Model 2	Model 3	Model 4
Intercept		0.35 (0.25-0.47)	0.36 (0.26-0.50)	0.37 (0.27-0.51)	0.33 (0.24-0.46)	0.32 (0.23-0.45)
Birth cohort	Post-war (1954-1961)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)	0.86 (0.57-1.30)	1.05 (0.72-1.53)	1.04 (0.71-1.51)	1.04 (0.72-1.51)	1.04 (0.72-1.51)
	Korean liberation (1945-1949)	1.03 (0.78-1.36)	0.93 (0.69-1.25)	0.92 (0.69-1.23)	0.93 (0.69-1.24)	0.92 (0.69-1.23)
	Korean War (1950-1953)	1.11 (0.91-1.36)	0.99 (0.80-1.22)	0.98 (0.79-1.21)	0.97 (0.79-1.20)	0.97 (0.79-1.20)
Age[a]		1.07 (1.04-1.09)	1.09 (1.06-1.12)	1.09 (1.06-1.12)	1.08 (1.05-1.11)	1.08 (1.05-1.11)
Sex	Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Female	0.94 (0.85-1.03)	0.94 (0.85-1.03)	0.94 (0.85-1.03)	1.01 (0.89-1.15)	1.01 (0.89-1.15)
Wave	1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	2	1.12 (1.07-1.17)	1.17 (1.12-1.23)	1.18 (1.13-1.23)	1.18 (1.13-1.24)	1.18 (1.13-1.24)
	3	1.16 (1.08-1.25)	1.25 (1.17-1.35)	1.26 (1.17-1.35)	1.27 (1.18-1.36)	1.27 (1.18-1.36)
	4	1.19 (1.06-1.33)	1.30 (1.17-1.45)	1.31 (1.18-1.46)	1.33 (1.20-1.48)	1.33 (1.20-1.48)
	5	1.24 (1.06-1.44)	1.36 (1.17-1.57)	1.37 (1.18-1.59)	1.40 (1.21-1.63)	1.40 (1.21-1.62)
	6	1.27 (1.04-1.54)	1.37 (1.12-1.67)	1.39 (1.14-1.69)	1.43 (1.18-1.75)	1.43 (1.18-1.75)
	7	1.21 (0.95-1.56)	1.28 (1.00-1.65)	1.30 (1.01-1.68)	1.37 (1.06-1.75)	1.36 (1.06-1.75)
	8	1.16 (0.86-1.56)	1.19 (0.88-1.62)	1.21 (0.89-1.65)	1.29 (0.96-1.74)	1.29 (0.95-1.74)
Parental death during childhood	No			*Ref*		*Ref*
	Yes			1.11 (0.97-1.27)		1.07 (0.94-1.23)
Parental education	No formal education			*Ref*		*Ref*
	Elementary school			0.95 (0.85-1.06)		1.01 (0.90-1.14)
	Middle school or more			0.87 (0.75-1.02)		1.01 (0.85-1.19)
Own education	Middle school or less				*Ref*	*Ref*
	High school				0.81 (0.72-0.91)	0.81 (0.71-0.91)
	College/university				0.67 (0.57-0.79)	0.67 (0.56-0.81)
Geography	Urban				*Ref*	*Ref*
	Rural				0.88 (0.80-0.98)	0.88 (0.80-0.98)
Smoking status	Never smoker				*Ref*	*Ref*
	Ever smoker				1.31 (1.15-1.49)	1.31 (1.15-1.49)
Obesity status	Not obese				*Ref*	*Ref*
	Obese				1.28 (1.18-1.40)	1.28 (1.18-1.40)
Birth cohort∗Age interaction	Post-war (1954-1961)∗Age		*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)∗Age		0.94 (0.92-0.96)	0.94 (0.92-0.96)	0.94 (0.92-0.96)	0.94 (0.92-0.96)
	Korean liberation (1945-1949)∗Age		0.97 (0.96-0.99)	0.97 (0.96-0.99)	0.98 (0.96-0.99)	0.98 (0.96-0.99)
	Korean War (1950-1953)∗Age		0.97 (0.95-0.99)	0.97 (0.95-0.99)	0.97 (0.95-0.99)	0.97 (0.95-0.99)
Log-likelihood (df)		-61,061,579 (13)	-60,972,630 (16)	-60,921,517 (19)	-60,334,080 (21)	-60,325,841 (24)

Note: Results were computed using Poisson regression models with clustered standard errors.

[a] Age is centered at the mean of the sample: 62.9 years

Table 4. Incidence rate ratios with 95% confidence intervals for disease accumulation across four birth cohorts **for age range 50-70 years**, adjusted for age, sex, early-life exposures, and later-life characteristics, using data from the Korean Longitudinal Study of Aging (2006-2020)

		Model 0	Model 1	Model 2	Model 3	Model 4
Intercept		0.74 (0.58-0.96)	0.69 (0.54-0.89)	0.73 (0.57-0.93)	0.64 (0.50-0.83)	0.64 (0.49-0.83)
Birth cohort	Post-war (1954-1961)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)	0.76 (0.53-1.09)	1.14 (0.83-1.57)	1.12 (0.81-1.54)	1.13 (0.82-1.55)	1.13 (0.82-1.55)
	Korean liberation (1945-1949)	0.91 (0.71-1.18)	0.95 (0.74-1.22)	0.94 (0.73-1.21)	0.97 (0.76-1.24)	0.97 (0.76-1.23)
	Korean War (1950-1953)	1.02 (0.86-1.20)	1.03 (0.87-1.23)	1.02 (0.86-1.21)	1.03 (0.87-1.22)	1.03 (0.87-1.21)
Age[a]		1.08 (1.06-1.11)	1.09 (1.07-1.12)	1.09 (1.06-1.12)	1.08 (1.05-1.10)	1.08 (1.05-1.10)
Sex	Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Female	1.16 (1.08-1.25)	1.16 (1.08-1.25)	1.16 (1.08-1.25)	1.16 (1.04-1.28)	1.16 (1.05-1.29)
Wave	1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	2	1.08 (1.04-1.13)	1.13 (1.09-1.18)	1.14 (1.10-1.18)	1.15 (1.11-1.20)	1.15 (1.11-1.20)
	3	1.10 (1.02-1.18)	1.19 (1.10-1.27)	1.19 (1.11-1.28)	1.22 (1.14-1.31)	1.22 (1.14-1.31)
	4	1.09 (0.97-1.22)	1.19 (1.07-1.33)	1.21 (1.08-1.35)	1.25 (1.13-1.40)	1.25 (1.13-1.40)
	5	1.05 (0.89-1.23)	1.15 (0.99-1.35)	1.17 (1.00-1.37)	1.24 (1.07-1.45)	1.24 (1.07-1.45)
	6	1.01 (0.82-1.24)	1.11 (0.91-1.36)	1.14 (0.93-1.39)	1.23 (1.02-1.49)	1.23 (1.02-1.49)
	7	0.94 (0.73-1.21)	1.03 (0.80-1.32)	1.06 (0.82-1.35)	1.17 (0.92-1.48)	1.17 (0.92-1.48)
	8	0.88 (0.65-1.18)	0.95 (0.71-1.28)	0.98 (0.73-1.32)	1.11 (0.84-1.48)	1.11 (0.84-1.48)
Parental death during childhood	No			*Ref*		*Ref*
	Yes			1.05 (0.95-1.17)		1.03 (0.93-1.14)
Parental education	No formal education			*Ref*		*Ref*
	Elementary school			0.93 (0.85-1.01)		1.00 (0.92-1.09)
	Middle school or more			0.81 (0.72-0.92)		0.95 (0.83-1.08)
Own education	Middle school or less				*Ref*	*Ref*
	High school				0.77 (0.71-0.84)	0.78 (0.71-0.85)
	College/university				0.67 (0.58-0.76)	0.68 (0.59-0.79)
Geography	Urban				*Ref*	*Ref*
	Rural				0.90 (0.83-0.98)	0.90 (0.83-0.98)
Smoking status	Never smoker				*Ref*	*Ref*
	Ever smoker				1.17 (1.05-1.30)	1.17 (1.05-1.30)
Obesity status	Not obese				*Ref*	*Ref*
	Obese				1.47 (1.38-1.57)	1.47 (1.38-1.57)
Birth cohort∗Age interaction	Post-war (1954-1961)∗Age		*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)∗Age		0.94 (0.91-0.96)	0.94 (0.91-0.96)	0.95 (0.92-0.97)	0.95 (0.92-0.97)
	Korean liberation (1945-1949)∗Age		0.98 (0.97-0.99)	0.98 (0.97-0.99)	0.99 (0.97-1.00)	0.99 (0.97-1.00)
	Korean War (1950-1953)∗Age		0.98 (0.97-0.99)	0.98 (0.97-0.99)	0.98 (0.97-0.99)	0.98 (0.97-0.99)
Log-likelihood (df)		-75,355,570 (13)	-75,303,832 (16)	-75,165,967 (19)	-73,799,116 (21)	-73,788,413 (24)

Note: Results were computed using Poisson regression models with clustered standard errors.

[a] Age is centered at the mean of the sample: 62.9 years

Table 5. Incidence rate ratios with 95% confidence intervals for disease accumulation across four birth cohorts **for age range 55-70 years**, adjusted for age, sex, early-life exposures, and later-life characteristics, using data from the Korean Longitudinal Study of Aging (2006-2020)

		Model 0	Model 1	Model 2	Model 3	Model 4
Intercept		0.82 (0.62-1.09)	0.77 (0.58-1.01)	0.80 (0.61-1.05)	0.70 (0.53-0.93)	0.70 (0.53-0.93)
Birth cohort	Post-war (1954-1961)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)	0.81 (0.57-1.15)	1.07 (0.78-1.48)	1.06 (0.77-1.46)	1.07 (0.78-1.47)	1.07 (0.78-1.46)
	Korean liberation (1945-1949)	0.95 (0.74-1.21)	0.95 (0.74-1.21)	0.94 (0.73-1.20)	0.97 (0.76-1.22)	0.96 (0.76-1.22)
	Korean War (1950-1953)	1.03 (0.87-1.21)	1.01 (0.85-1.19)	0.99 (0.84-1.18)	1.00 (0.85-1.18)	1.00 (0.85-1.18)
Age[a]		1.08 (1.05-1.10)	1.09 (1.06-1.12)	1.09 (1.06-1.11)	1.07 (1.05-1.10)	1.07 (1.05-1.10)
Sex	Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Female	1.17 (1.09-1.27)	1.17 (1.09-1.27)	1.18 (1.09-1.27)	1.19 (1.08-1.32)	1.19 (1.08-1.32)
Wave	1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	2	1.10 (1.05-1.14)	1.13 (1.09-1.18)	1.14 (1.09-1.18)	1.14 (1.10-1.19)	1.15 (1.10-1.19)
	3	1.13 (1.05-1.21)	1.21 (1.13-1.31)	1.22 (1.13-1.32)	1.23 (1.14-1.33)	1.23 (1.14-1.33)
	4	1.13 (1.01-1.26)	1.24 (1.11-1.39)	1.25 (1.12-1.40)	1.28 (1.14-1.43)	1.28 (1.15-1.43)
	5	1.08 (0.92-1.26)	1.19 (1.02-1.39)	1.21 (1.04-1.41)	1.26 (1.09-1.46)	1.26 (1.09-1.46)
	6	1.04 (0.85-1.26)	1.15 (0.95-1.40)	1.18 (0.97-1.42)	1.25 (1.04-1.50)	1.25 (1.04-1.50)
	7	0.97 (0.76-1.24)	1.08 (0.85-1.36)	1.10 (0.87-1.39)	1.19 (0.94-1.49)	1.19 (0.94-1.49)
	8	0.92 (0.69-1.23)	1.00 (0.75-1.33)	1.03 (0.78-1.36)	1.14 (0.87-1.49)	1.14 (0.87-1.49)
Parental death during childhood	No			*Ref*		*Ref*
	Yes			1.05 (0.95-1.17)		1.03 (0.92-1.14)
Parental education	No formal education			*Ref*		*Ref*
	Elementary school			0.94 (0.86-1.02)		1.01 (0.93-1.10)
	Middle school or more			0.83 (0.73-0.94)		0.96 (0.84-1.09)
Own education	Middle school or less				*Ref*	*Ref*
	High school				0.79 (0.72-0.86)	0.79 (0.73-0.87)
	College/university				0.66 (0.58-0.76)	0.68 (0.58-0.78)
Geography	Urban				*Ref*	*Ref*
	Rural				0.89 (0.82-0.96)	0.89 (0.82-0.96)
Smoking status	Never smoker				*Ref*	*Ref*
	Ever smoker				1.20 (1.08-1.33)	1.20 (1.08-1.33)
Obesity status	Not obese				*Ref*	*Ref*
	Obese				1.43 (1.34-1.52)	1.43 (1.34-1.52)
Birth cohort∗Age interaction	Post-war (1954-1961)∗Age		*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)∗Age		0.93 (0.91-0.96)	0.94 (0.91-0.97)	0.95 (0.92-0.98)	0.95 (0.92-0.98)
	Korean liberation (1945-1949)∗Age		0.98 (0.96-1.00)	0.98 (0.96-1.00)	0.99 (0.97-1.01)	0.99 (0.97-1.00)
	Korean War (1950-1953)∗Age		0.98 (0.96-0.99)	0.98 (0.96-0.99)	0.98 (0.97-1.00)	0.98 (0.97-1.00)
Log-likelihood (df)		-65,287,326 (13)	-65,255,556 (16)	-65,151,301 (19)	-64,004,486 (21)	-63,996,882 (24)

Note: Results were computed using Poisson regression models with clustered standard errors.

[a] Age is centered at the mean of the sample: 62.9 years

Table 6. Incidence rate ratios with 95% confidence intervals for disease accumulation across four birth cohorts **for age range 55-75 years**, adjusted for age, sex, early-life exposures, and later-life characteristics, using data from the Korean Longitudinal Study of Aging (2006-2020)

		Model 0	Model 1	Model 2	Model 3	Model 4
Intercept		0.79 (0.63-0.98)	0.86 (0.68-1.08)	0.88 (0.70-1.12)	0.81 (0.64-1.03)	0.81 (0.63-1.03)
Birth cohort	Post-war (1954-1961)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)	0.93 (0.72-1.21)	0.95 (0.74-1.23)	0.94 (0.73-1.21)	0.95 (0.74-1.21)	0.94 (0.74-1.21)
	Korean liberation (1945-1949)	1.09 (0.91-1.29)	0.96 (0.78-1.17)	0.95 (0.78-1.16)	0.96 (0.79-1.16)	0.95 (0.79-1.16)
	Korean War (1950-1953)	1.12 (0.98-1.28)	0.99 (0.85-1.16)	0.98 (0.84-1.14)	0.98 (0.84-1.14)	0.97 (0.84-1.13)
Age[a]		1.06 (1.04-1.07)	1.08 (1.06-1.11)	1.08 (1.06-1.10)	1.07 (1.05-1.10)	1.07 (1.05-1.10)
Sex	Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Female	1.21 (1.14-1.29)	1.21 (1.14-1.29)	1.21 (1.14-1.29)	1.21 (1.12-1.32)	1.22 (1.12-1.32)
Wave	1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	2	1.10 (1.07-1.14)	1.13 (1.10-1.16)	1.13 (1.10-1.16)	1.14 (1.11-1.17)	1.14 (1.11-1.17)
	3	1.16 (1.11-1.21)	1.21 (1.16-1.27)	1.22 (1.17-1.28)	1.22 (1.17-1.28)	1.22 (1.17-1.28)
	4	1.17 (1.09-1.25)	1.24 (1.16-1.33)	1.25 (1.17-1.34)	1.25 (1.17-1.34)	1.25 (1.17-1.34)
	5	1.17 (1.07-1.29)	1.25 (1.14-1.37)	1.26 (1.15-1.38)	1.27 (1.17-1.39)	1.27 (1.17-1.39)
	6	1.17 (1.03-1.32)	1.23 (1.09-1.39)	1.25 (1.11-1.41)	1.27 (1.13-1.43)	1.28 (1.14-1.43)
	7	1.12 (0.96-1.31)	1.15 (0.99-1.34)	1.17 (1.01-1.37)	1.21 (1.04-1.41)	1.21 (1.04-1.41)
	8	1.08 (0.90-1.29)	1.07 (0.89-1.29)	1.10 (0.91-1.32)	1.15 (0.96-1.37)	1.15 (0.96-1.38)
Parental death during childhood	No			*Ref*		*Ref*
	Yes			1.07 (0.98-1.17)		1.04 (0.96-1.14)
Parental education	No formal education			*Ref*		*Ref*
	Elementary school			0.94 (0.88-1.01)		0.99 (0.93-1.07)
	Middle school or more			0.85 (0.76-0.94)		0.96 (0.86-1.08)
Own education	Middle school or less				*Ref*	*Ref*
	High school				0.82 (0.76-0.88)	0.82 (0.76-0.89)
	College/university				0.69 (0.61-0.77)	0.70 (0.62-0.79)
Geography	Urban				*Ref*	*Ref*
	Rural				0.89 (0.83-0.95)	0.89 (0.83-0.95)
Smoking status	Never smoker				*Ref*	*Ref*
	Ever smoker				1.17 (1.07-1.28)	1.17 (1.07-1.28)
Obesity status	Not obese				*Ref*	*Ref*
	Obese				1.40 (1.32-1.47)	1.40 (1.32-1.47)
Birth cohort∗Age interaction	Post-war (1954-1961)∗Age		*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)∗Age		0.95 (0.93-0.97)	0.95 (0.94-0.97)	0.96 (0.94-0.98)	0.96 (0.94-0.98)
	Korean liberation (1945-1949)∗Age		0.98 (0.96-0.99)	0.98 (0.96-0.99)	0.98 (0.97-1.00)	0.98 (0.97-1.00)
	Korean War (1950-1953)∗Age		0.98 (0.96-0.99)	0.98 (0.96-0.99)	0.98 (0.97-1.00)	0.98 (0.97-1.00)
Log-likelihood (df)		-83,091,649 (13)	-83,021,773 (16)	-82,906,474 (19)	-81,628,558 (21)	-81,618,090 (24)

Note: Results were computed using Poisson regression models with clustered standard errors.

[a] Age is centered at the mean of the sample: 62.9 years

Table 7. Incidence rate ratios with 95% confidence intervals for disease accumulation across four birth cohorts **including Mini Mental State Examination (MMSE) score**, adjusted for age, sex, early-life exposures, and later-life characteristics, using data from the Korean Longitudinal Study of Aging (2006-2020)

		Model 0	Model 1	Model 2	Model 3	Model 4
Intercept		1.12 (0.82-1.53)	1.24 (0.90-1.71)	1.23 (0.89-1.70)	0.99 (0.71-1.36)	0.99 (0.71-1.36)
Birth cohort	Post-war (1954-1961)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)	0.88 (0.63-1.24)	1.05 (0.77-1.42)	1.03 (0.76-1.40)	1.03 (0.76-1.38)	1.02 (0.76-1.38)
	Korean liberation (1945-1949)	1.09 (0.87-1.37)	0.97 (0.76-1.24)	0.96 (0.76-1.22)	0.96 (0.76-1.22)	0.96 (0.76-1.21)
	Korean War (1950-1953)	1.15 (0.97-1.36)	1.00 (0.83-1.19)	0.98 (0.82-1.17)	0.98 (0.82-1.16)	0.97 (0.82-1.16)
Age[a]		1.06 (1.04-1.08)	1.09 (1.07-1.12)	1.09 (1.07-1.12)	1.08 (1.06-1.11)	1.08 (1.06-1.11)
Sex	Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	Female	1.29 (1.19-1.39)	1.29 (1.19-1.39)	1.29 (1.19-1.40)	1.37 (1.22-1.52)	1.37 (1.23-1.53)
Wave	1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
	2	1.12 (1.08-1.16)	1.18 (1.14-1.22)	1.18 (1.14-1.22)	1.19 (1.15-1.23)	1.19 (1.15-1.23)
	3	1.15 (1.08-1.22)	1.25 (1.18-1.32)	1.25 (1.19-1.33)	1.26 (1.19-1.33)	1.26 (1.19-1.33)
	4	1.18 (1.08-1.29)	1.30 (1.20-1.42)	1.31 (1.21-1.43)	1.32 (1.22-1.44)	1.32 (1.22-1.44)
	5	1.20 (1.06-1.35)	1.31 (1.17-1.48)	1.33 (1.18-1.49)	1.35 (1.20-1.51)	1.35 (1.20-1.51)
	6	1.21 (1.03-1.41)	1.31 (1.12-1.53)	1.33 (1.13-1.55)	1.36 (1.17-1.59)	1.36 (1.17-1.59)
	7	1.15 (0.94-1.40)	1.21 (0.98-1.48)	1.23 (1.00-1.51)	1.28 (1.05-1.56)	1.28 (1.05-1.56)
	8	1.07 (0.85-1.36)	1.09 (0.85-1.40)	1.12 (0.87-1.43)	1.18 (0.92-1.49)	1.18 (0.93-1.50)
Parental death during childhood	No			*Ref*		*Ref*
	Yes			1.07 (0.96-1.19)		1.04 (0.93-1.16)
Parental education	No formal education			*Ref*		*Ref*
	Elementary school			0.92 (0.84-1.00)		0.98 (0.89-1.07)
	Middle school or more			0.82 (0.72-0.94)		0.95 (0.82-1.08)
Own education	Middle school or less				*Ref*	*Ref*
	High school				0.78 (0.71-0.86)	0.79 (0.71-0.88)
	College/university				0.66 (0.57-0.77)	0.68 (0.58-0.80)
Geography	Urban				*Ref*	*Ref*
	Rural				0.90 (0.83-0.98)	0.90 (0.83-0.98)
Smoking status	Never smoker				*Ref*	*Ref*
	Ever smoker				1.28 (1.14-1.44)	1.28 (1.14-1.44)
Obesity status	Not obese				*Ref*	*Ref*
	Obese				1.34 (1.26-1.44)	1.34 (1.26-1.44)
MMSE score		0.96 (0.96-0.97)	0.96 (0.96-0.97)	0.96 (0.96-0.97)	0.97 (0.96-0.97)	0.97 (0.96-0.97)
Birth cohort∗Age interaction	Post-war (1954-1961)∗Age		*Ref*	*Ref*	*Ref*	*Ref*
	Japanese annexation (1932-1944)∗Age		0.93 (0.91-0.95)	0.93 (0.91-0.95)	0.94 (0.92-0.96)	0.94 (0.92-0.96)
	Korean liberation (1945-1949)∗Age		0.96 (0.95-0.98)	0.97 (0.95-0.98)	0.97 (0.96-0.98)	0.97 (0.96-0.98)
	Korean War (1950-1953)∗Age		0.97 (0.95-0.98)	0.97 (0.95-0.98)	0.97 (0.96-0.98)	0.97 (0.96-0.98)
Log-likelihood (df)		-69,058,320 (14)	-68,911,261 (17)	-68,810,983 (20)	-67,979,689 (22)	-67,970,565 (25)

MMSE: Mini Mental State Examination

Note: Results were computed using Poisson regression models with clustered standard errors. [a] Age is centered at the mean of the sample: 62.9 years