

A Survival Analysis of Mortality Data from State Examination Passers in Chosŏn Korea, 1405-1774

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Abstract

Analyses of mortality data of the Korean past have relied largely on genealogies and individual biographical accounts. This paper introduces a major new source: mortality data of passers of the high civil state examination (munkwa) of Chosŏn Korea, from 1405 to 1774. The use of survival analysis on these data resulted in the first comprehensive estimation of the mortality curves of socially elite males in this period who had first survived to pass the state examination. Kaplan-Meier analysis revealed a median age of death of 58, with $p(25)=49$ and $p(75)=67$. Cox regression indicated a hazard ratio of 2.1 for the sixteenth-century Imjin War period (1592-1598) for those 60 years and younger and 2.2 for the Injo Restoration of 1623 among men 65 and younger, but no significant increase in the hazard ratio for the seventeenth-century Manchu Invasions (1627, 1636-1637). Mortality varied somewhat by province of residence, but difference was statistically significant solely in the case of Pyŏngan Province.

Keywords: Korean history, Chosŏn period, mortality, survival analysis

Introduction

Historians of the Chosŏn period in Korea (1392-1910) are the beneficiaries of a wealth of documents ranging from massive royal court histories to vast literary compendia to land records, household registers, local gazetteers, plus a large and growing collection of diaries, letters, uncollected poems, travel accounts, and philosophical tracts. It assuredly will take historians in Korea much of the next century to survey this bounty fully. Yet, behind this prospective bounty for the future lurks a general paucity of research into many basic topics, among them a reliable survey of mortality among Korean living from the fifteenth through the nineteenth centuries. Pioneering demographic studies exist that make use of important clusters of genealogies (Lee and Son, 2012) and biographical accounts (Pak, 2006). However, to date these have necessarily been limited in time and place, captive to the vagaries of extant documents.

This study addresses both a broader and earlier set of mortality data, newly available, derived from examination rosters the state-administered Chosŏn High State Examination, or *munkwa*. Given 741 times over the course of the dynasty, comprising 14,607 passers out of the many million over five centuries who sat for it, the examination was at the center of a complex system of bureaucratic rule. (Yi, 1994) Thanks to the efforts of scholars Edward Wagner and June-ho Song (Wagner, 1976) and the Academy of Korean Studies (Academy of Korean Studies Electronic Database, 2013), we now have access a comprehensive list of all passers across the centuries, together with a variety of associated personal information, including mortality data.

The *munkwa* data detail the lives and careers of a coherent social group of elite males of the aristocratic or *yangban* class, deriving from every region and locale in Chosŏn Korea. A study of their mortality patterns from 1393-1774 holds the promise hitherto unavailable of providing a general baseline of demographic information for this socially and politically vital part of the Chosŏn past.

The roster of examination passers for whom mortality data exists comprise 3,359 men who died over the period 1393-1774 or about 23% of the total 14,607 passers. To the extent the missing data is biased it is likely in the direction of the young, childless, and socially obscure. Hence, if anything the data may overrepresented the older, fecund, and illustrious members of their cohorts. This data therefore should be taken as representative of highly successful males, who were commemorated by their descendant, and not of society as a whole or even of the entire *yangban* class.

The men in the dataset comprised national group, with listed residences of their examination years based in of the eight provinces, although the capital, Seoul, is overrepresented, comprising fully 1,793 or 69.15% of the individuals. However, the life of an official in the Chosŏn period was highly mobile and involved frequent relocation to often quite distant locations, as well as periods of official or self-exile. Accordingly, the residence of their examination years was not necessarily or even likely the place they eventually died.

Apart from birth and death dates together with site of residence, the data also include information on the examination passers' lineage affiliation (*pon'gwan*). These patrilineal descent groups began forming in Korea during the Koryŏ period (918-1392) but reached their zenith of social influence in the latter Chosŏn period during the 18th and 19th centuries. (Deuchler, 1995; Palais, 1996). They varied widely in size and prominence, a disparity reflected in the data. The top quartile of exam passers came from only nine national lineages, including the largest, the Chŏnju Yi, with fully 217 individuals, or 6.5% of the total. The second quartile comprised 23 lineages, the third 54 lineages, and the bottom quarter 201 lineages. Accordingly, even among this elite class, whose members had scaled the examination heights, there was considerable diversity in social background.

Overall Results of Analysis

The Kaplan-Meier survival estimate curve, the Nelson-Aalen Cumulative hazard curve and the smoothed hazard curve for the period 1405-1744 are shown in Figures 1-3. The median survival age for the period 1405-1774 as a whole was 58 years (95% confidence interval = 58-59 years), with $p(25)=49$ years (95% CI=48-49 years) and $p(75)=67$ years (95% CI=67-68 years). Elite Korean men of the fifteenth through eighteenth century who survived long enough to pass the high state examination might well expect to live into their fifth decade and likely longer.

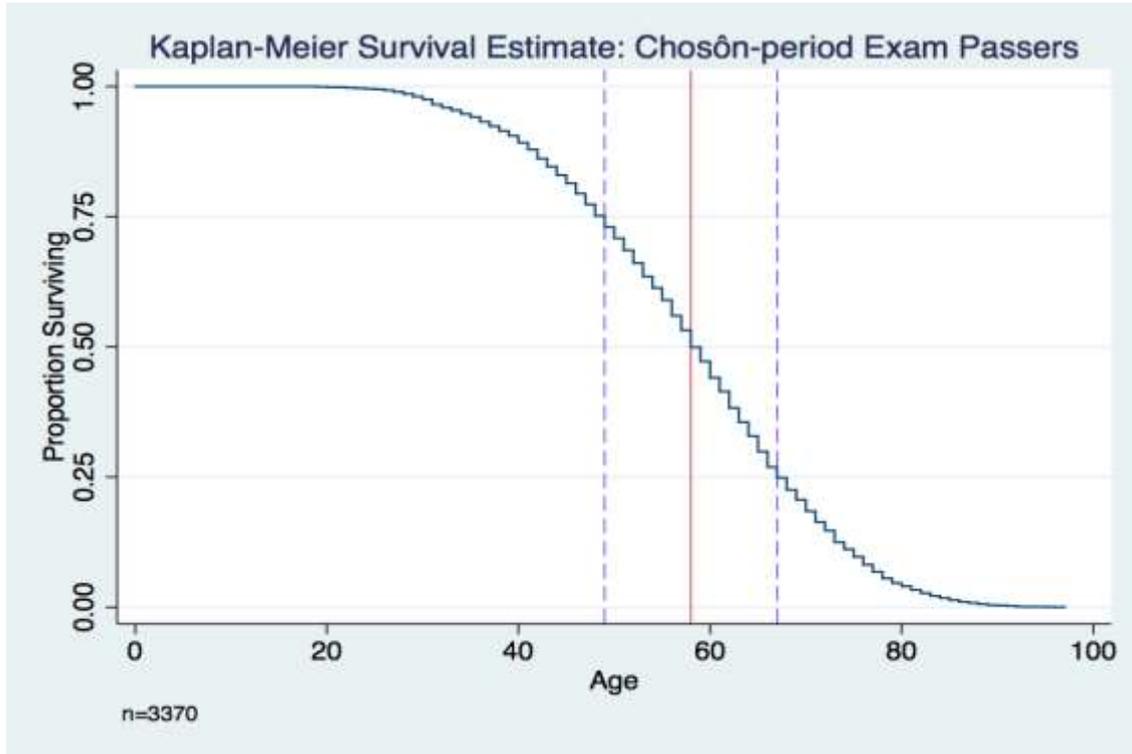


Fig.1. Kaplan-Meier Survival Estimate, 1405-1774

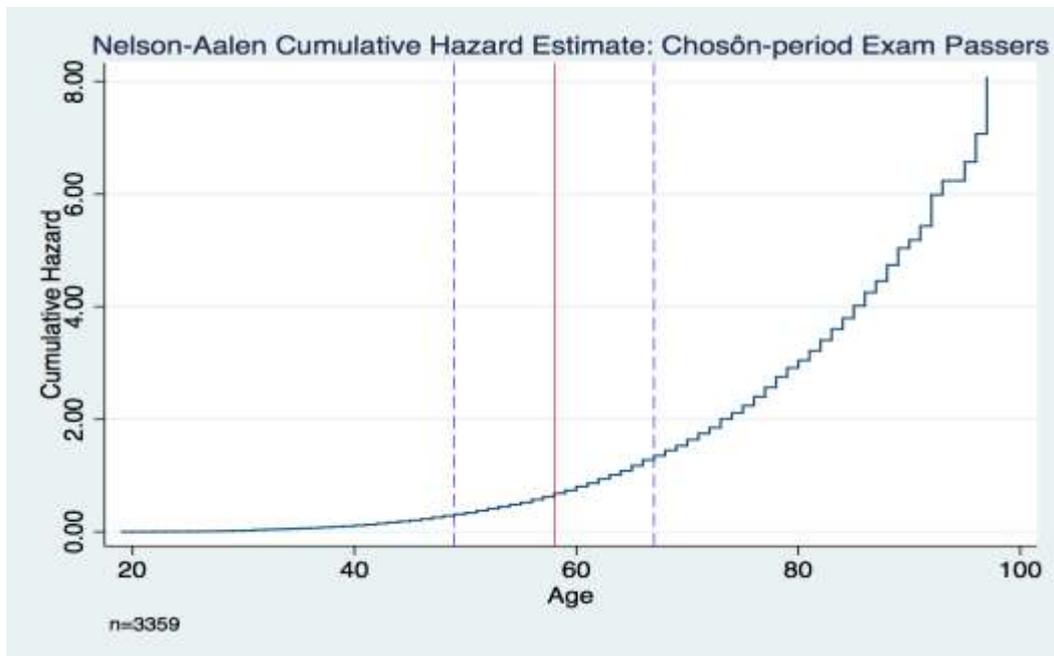


Fig.2. Nelson-Aalen Cumulative Hazard Estimate, 1405-1774

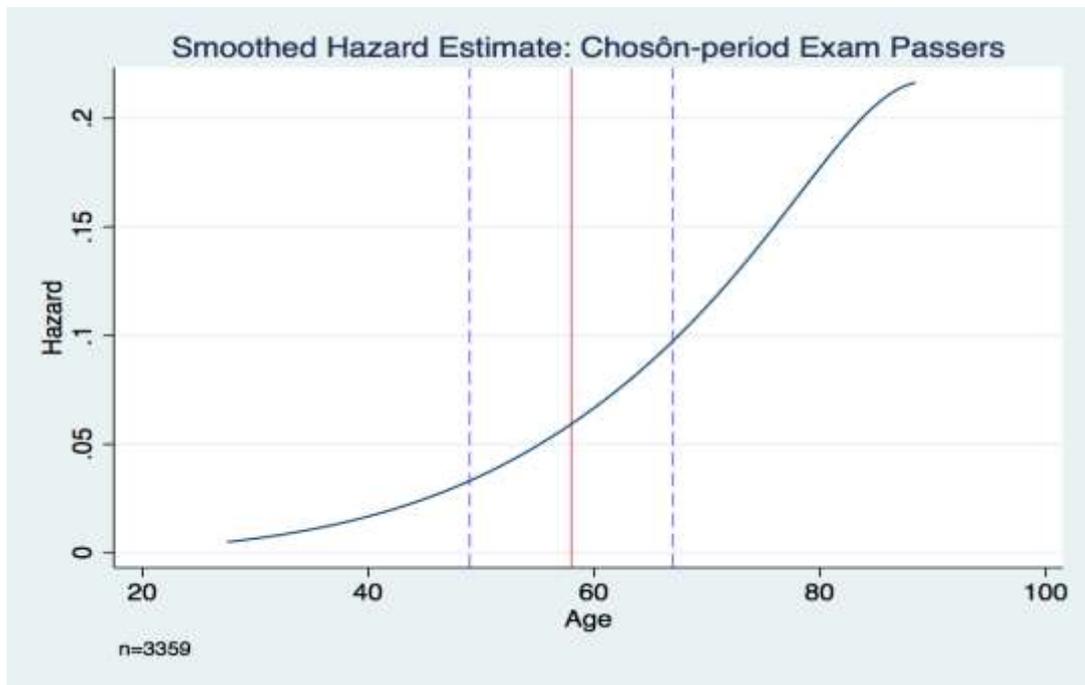


Fig.3. Smoothed hazard Estimate, 1405-1744

The survival curves varied somewhat over time. As is indicated graphically in Figures 4-6, the median rate ranged from 59 years (95% CI=56-61 years) in the 15th century to 56 years in the sixteenth century (95% CI=56-61 years 55-57 years) to 59 years in the seventeenth century (95% CI=58-60 years) to 59 years in the eighteenth century (CI=58-60 years). An important reason for at least part of the decline in the 16th century was the Imjin War of 1592-1598 (see below for a detailed discussion). On the whole, the pattern of survival curves was generally stable over this this long period, indicating social continuity.

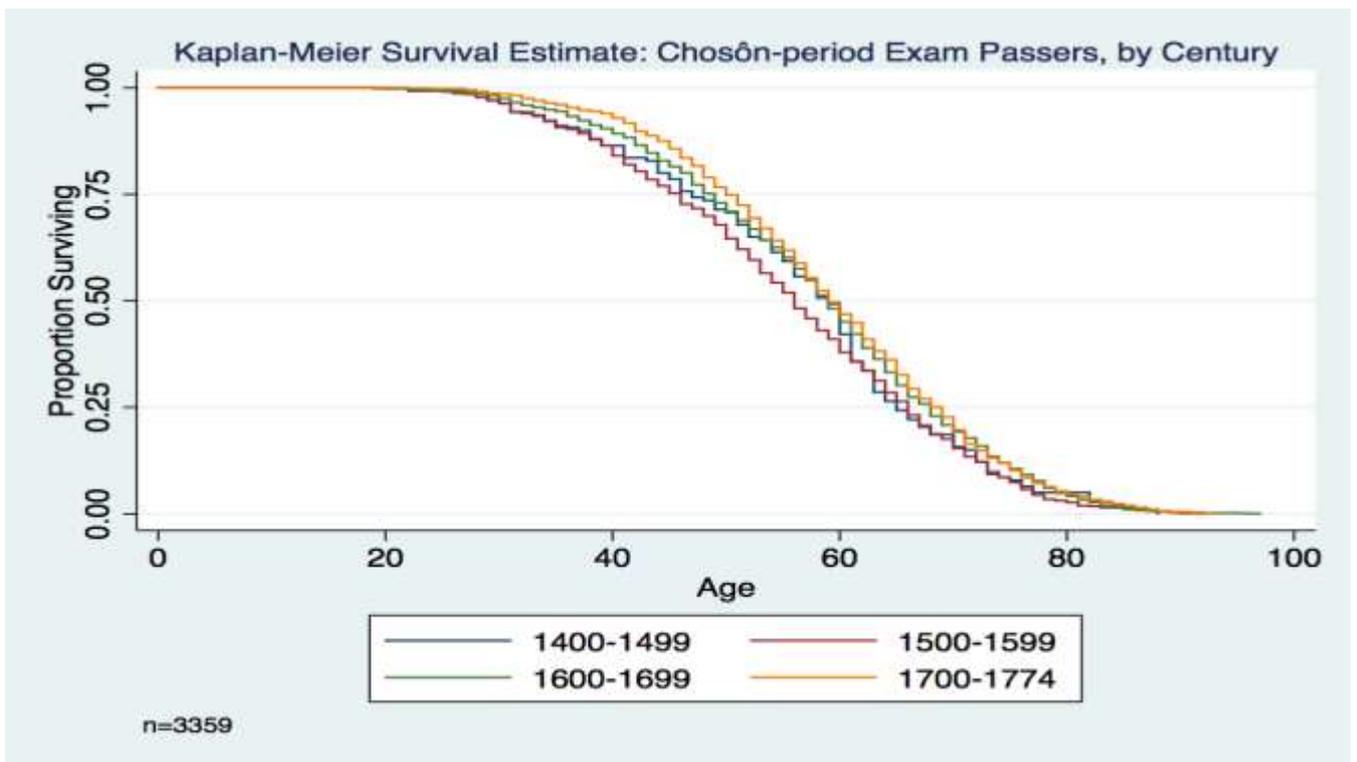


Fig. 4. Kaplan-Meier Survival Estimate, by Century of Death, 1405-1774

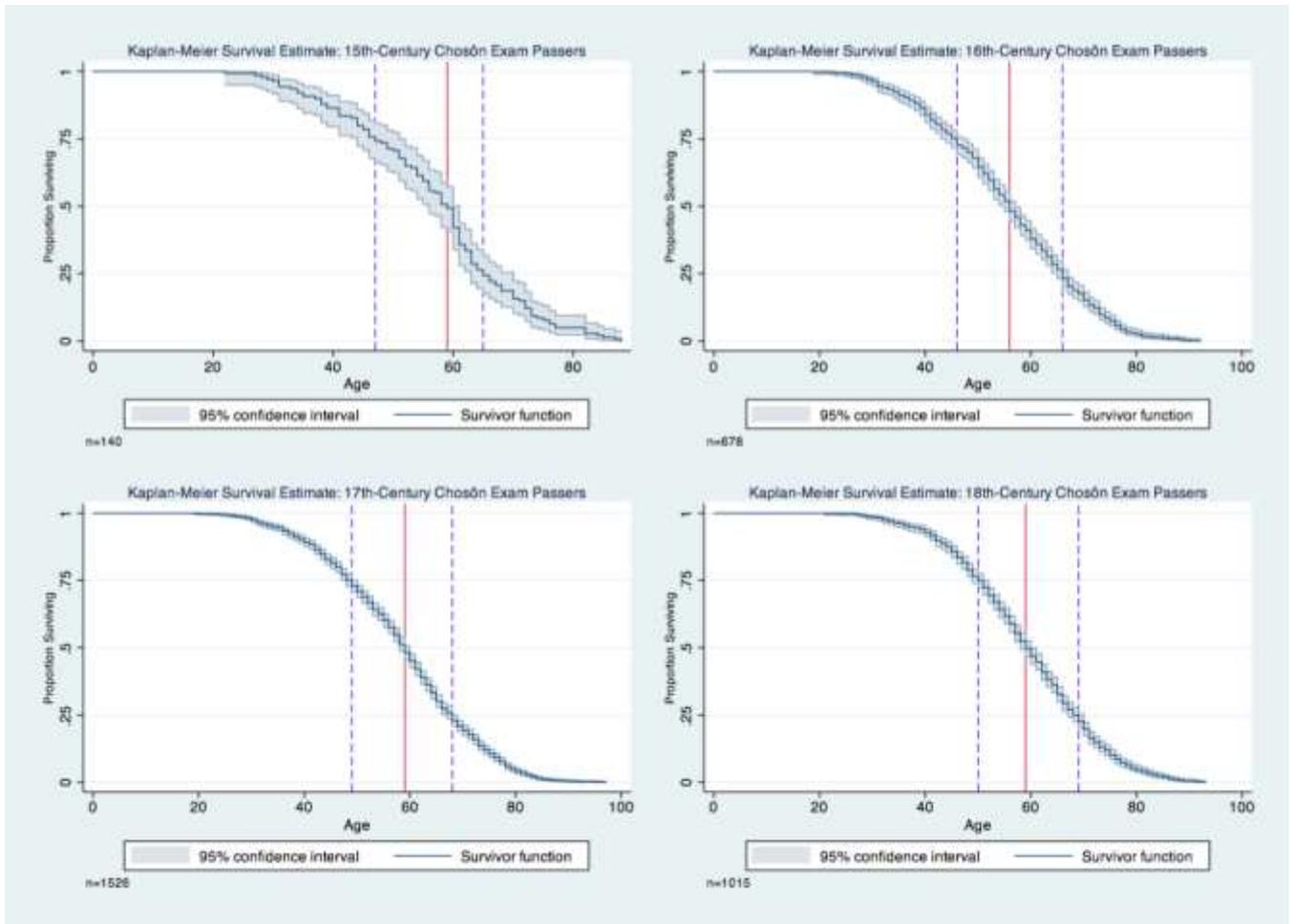


Fig.5. Kaplan-Meier Survival Estimates, by Individual Century of Death, 1405-1774

Fig.6. Age of Death vs. Year of Death, with Lowess Estimate of Mean, 1405-1774

Violence and Mortality in the Sixteenth and Seventeenth Centuries

The examination roster data provide a unique means of assessing the risks of mortality among elite Korean men during two famed, bloody intervals in the Chosŏn period: the Imjin War from 1592-98 when the state of Chosŏn was invaded by a large military force from Japan resulting in major devastation and wholesale loss of life (Hawley, 2005), and the twin invasions in 1627 and 1636-37 when Manchu soldiers invaded Chosŏn from the north and, on the second occasion, also laid siege for a prolonged period to the Korean King Injo's (r. 1623-1649) mountain fortress in the dead of winter 1636-1637. (Lee, K. B., 1984) If there was concomitant death during these invasions for the officials attending King Injo, then it should be reflected in the estimated survival curves.

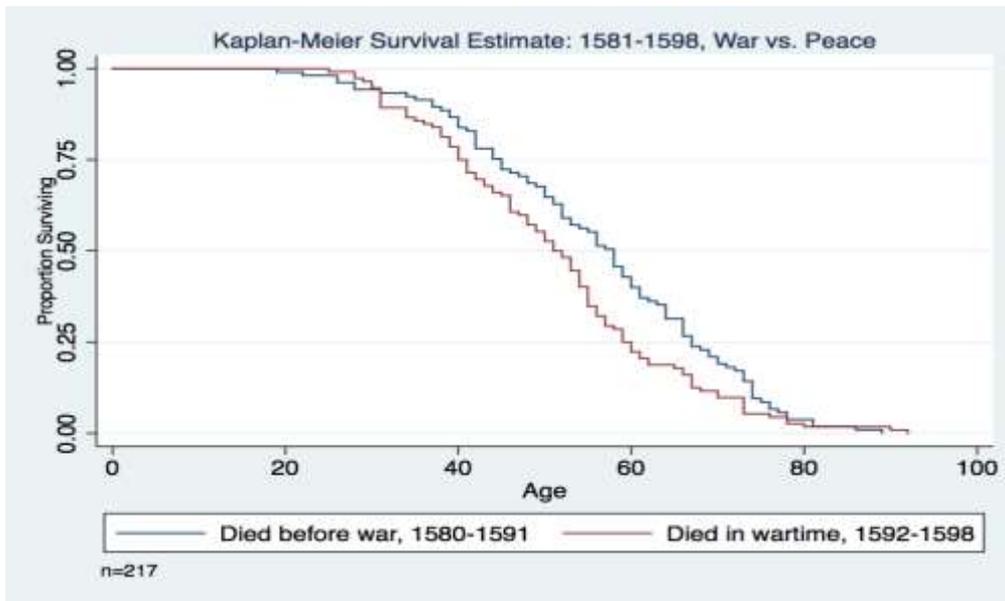


Fig.7. Kaplan-Meier Survival Estimates of Imjin War Period vs. Pre-War Period

As is reflected both in the differing survival curves in Figure 7 and in the lowest curve in Figure 8 of age of death vs. year of death, there is a marked change in the pattern of mortality during period of the Imjin War (1592-98). This impression is borne out statistically by comparing the survival curves of the 106 men dying between 1580 and 1599, and the 3253 men living at other periods in the data. A non-parametric log-rank test between survival curves of Imjin vs. non-Imjin group provides strong evidence for rejecting the null hypothesis of equality of the two groups ($p=0.000$). Hence statistically it seems clear that the period of the war is associated (Harrington and Fleming, 1982) with a change in survival patterns.

Moreover, using a semi-parametric Cox regression metric with an indicator variable for deaths during the Imjin War, it is possible to estimate the hazard ratio of during in this period vs. other times. In order to meet the proportional hazard assumption, a time-varying model was used with men dying at over 60 years modeled separately. For men 60 years in age or under the hazard rate during the Imjin War was 2.04 times that of other times (95% confidence interval 1.64 – 2.54). For men over 60 years the hazard rate was 0.413 times that of other periods (95% confidence interval 0.257 - 0.664). These hazard ratios were both significantly different from 1 under the Wald test at $p=0.000$. The proportional hazard test using Schoenfeld residuals was not significant at $p=0.706$, indicating no evidence to reject the null hypothesis of the proportional hazards assumption being met. In sum, the data indicate that elite men 60 and under were dying a hazard rate twice normal during this brutal period. See Figure 9 for the estimated comparative survival and hazard curves for the data. (Cox, 1972)

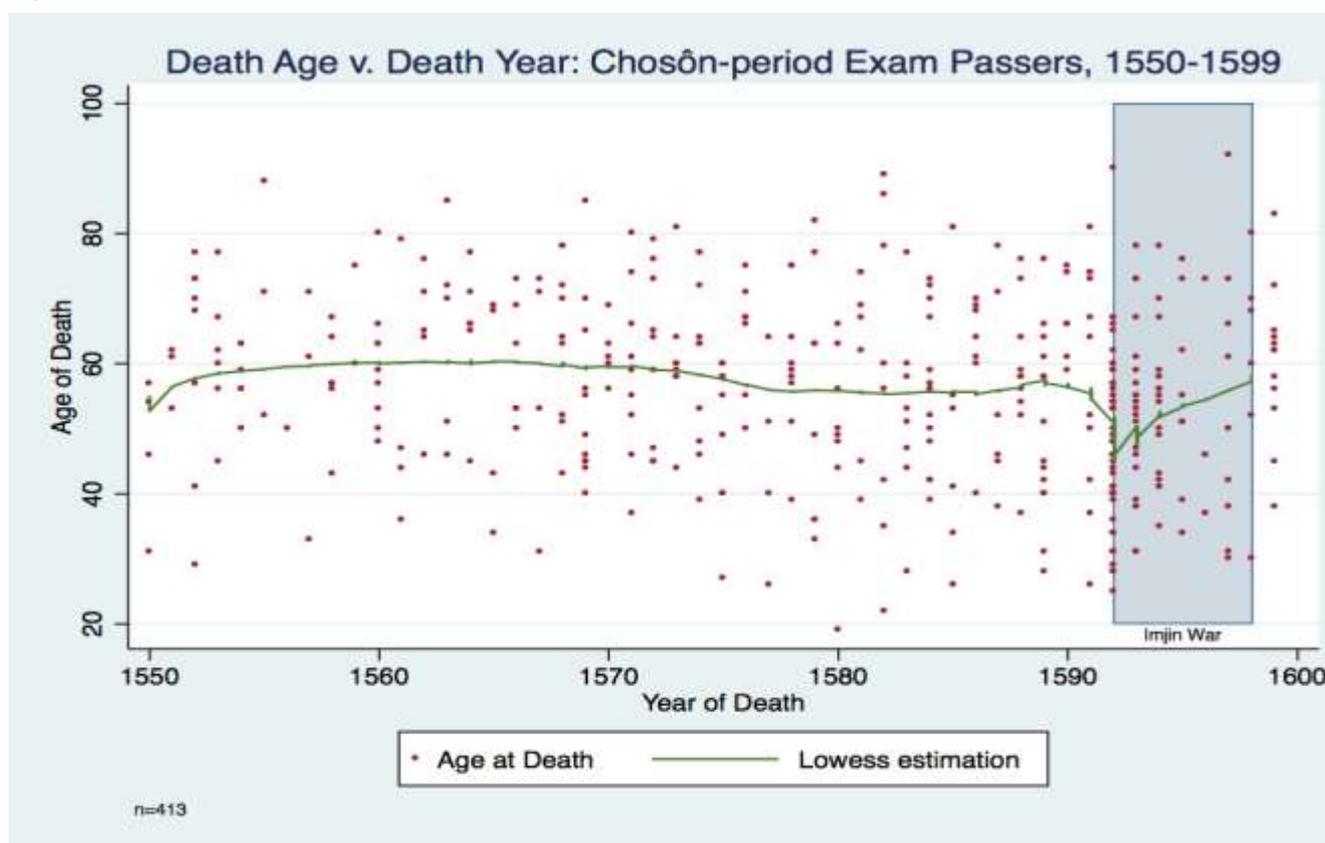


Fig.8. Age of Death vs. Year of Death, 1550-1599, with Lowess Estimation of Mean

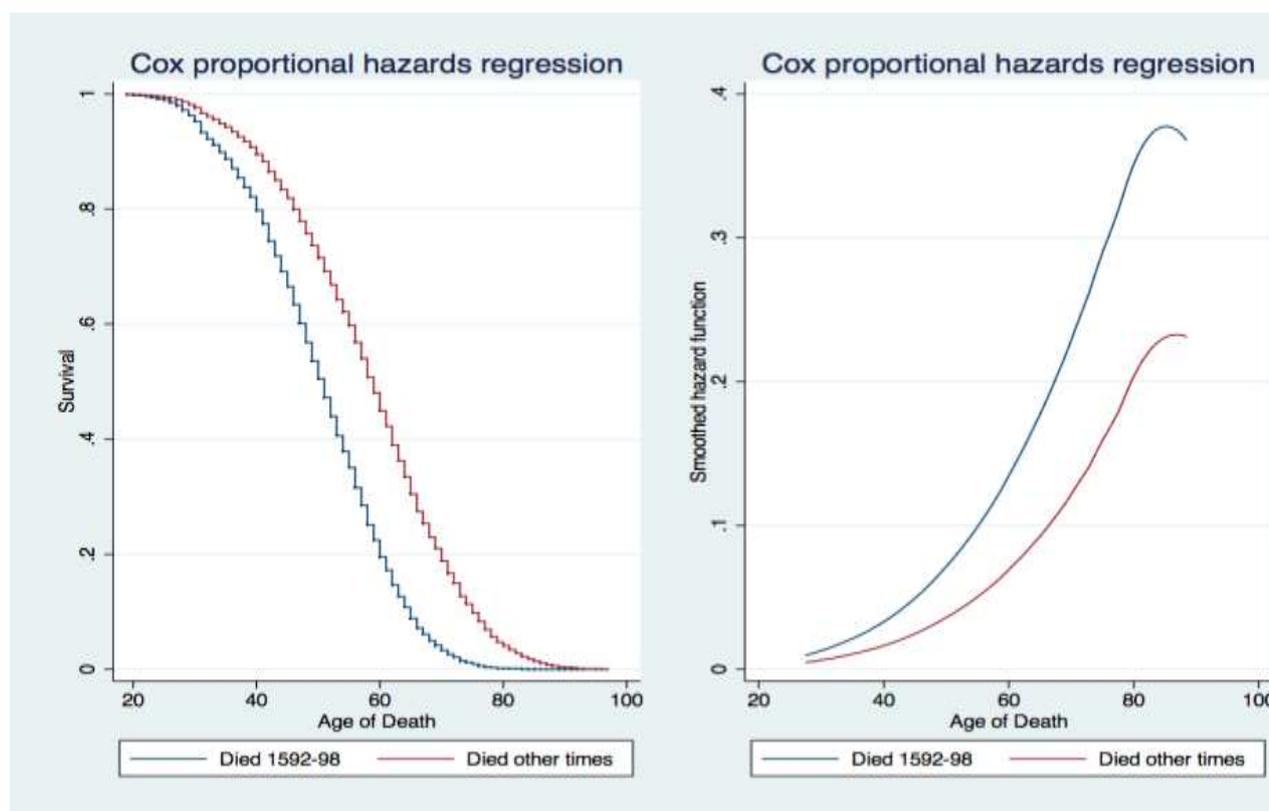


Fig.9. Predicted Survival and Hazard Curves of Cox regression, 1592-1598 vs. Other Periods

Figure 10 shows a marked number of deaths in the year 1623 and sharp dip in the lowest estimate of mean death age, prompting closer attention. This was the year of the coup d'état known as the Injo Restoration (Injo Panjŏng), which replaced one king (Kwanghae-gun) from the ruling Chŏnju Yi lineage with a collateral relative (Injo) and deposed the ruling Northerners (Pugin) political faction for the Westerners (Sŏ'in) group. (Oh, 2009) The bloodletting at the time seems greater than has been generally suspected. Fully 47 men in the dataset died that year versus the 17 who died in 1621 and the 9 who died in 1622.

Through a Cox regression model, it is possible to estimate the hazard rate for the year of 1623 for men 65 and under as 2.15 times that of other years (95% CI = 1.59 - 2.90), while for the elderly over 65 year in age it was 0.322 (95% CI = .115 - .899). The hazard ratio for men 65 and under was statistically significant at the $p=0.000$ level and for those over 65, $p=0.031$. The proportional hazard test using Schoenfeld residuals was not significant at $p=0.673$, indicating no evidence to reject the null hypothesis of the proportional hazards assumption being met. Clearly the events of 1623 were violent and deadly, with the hazard rate of death for elite Korean officials over double that of other times.

By contrast, Figure 10 also indicates that, counter to expectation, the Manchu invasions appear to have been surprisingly benign in terms of loss of life, at least among the men of this dataset. Indeed, if anything, fewer lives were lost in the years 1627 and 1636-1637 than other periods, by the log-rank test. However, at $p=0.0634$ this test result just misses being statistically significant at the $p=0.05$ level, hence provides no convincing evidence that men in these years fared better than those other times in their survival curves. Similarly, a test solely of the second, and presumably bloodier invasion of 1636-1637 produced no statistically significant difference in survival curves from other periods under the log-rank test, at $p=0.264$. A similar result of a test examining the first invasion in 1627 also produces no statistically significant evidence ($p=0.792$) that the deaths that year were different in their influence on survival curves compared to other years.

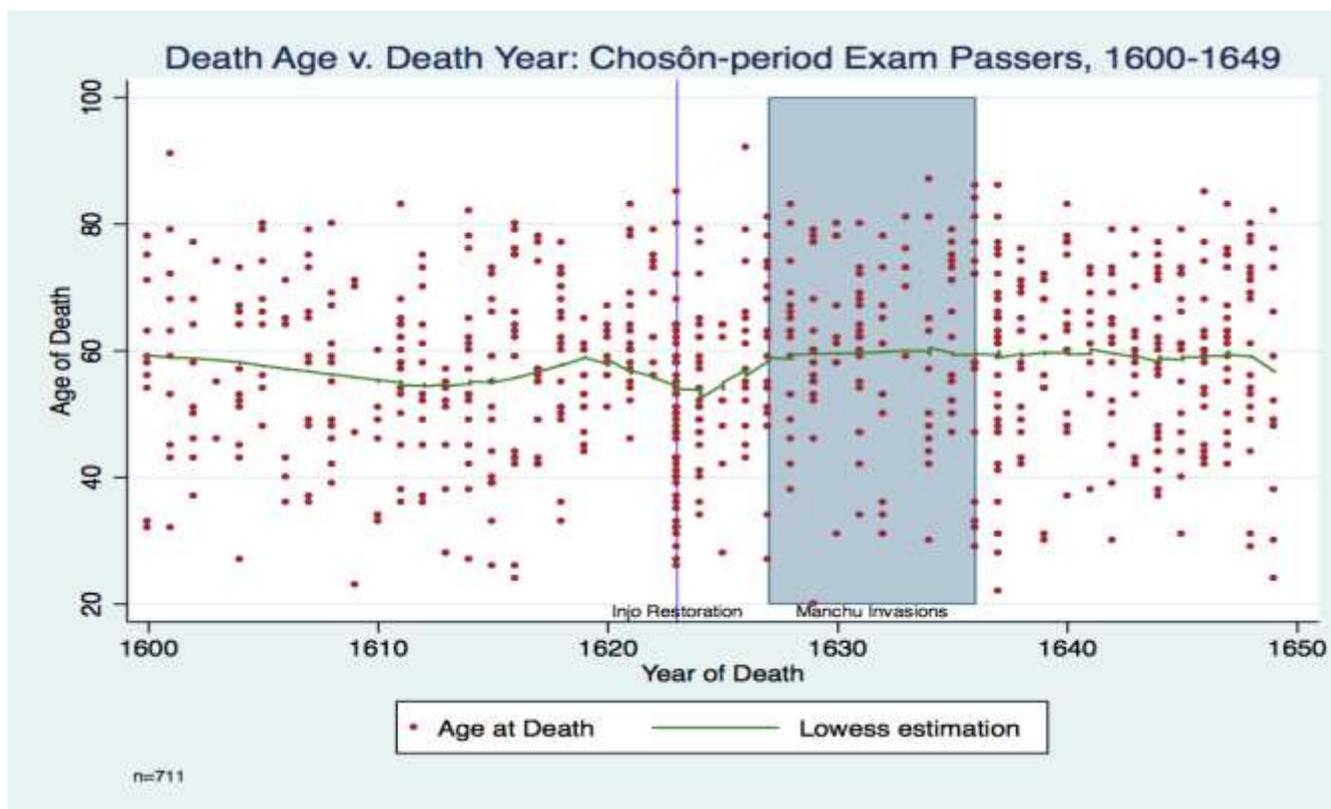


Fig.10. Age of Death vs. Year of Death, 1600-1649, with Lowess estimator of Mean

In sum, the spasms of violence wracking the Chosŏn kingdom due both to foreign invasion in 1592-1598 and domestic upheaval in 1623 left broad indications in the mortality patterns of the officials in this dataset. By contrast, however, there was no convincing evidence at all to indicate that the Manchu invasions had a substantial impact on the mortality of elite officials.

Regional Disparities in Survival

As displayed in the map in Figure 11, among the eight provinces in Chosŏn Korea, the median survival age varied from a high of Hamgyŏng Province of 60 to a low of 56 in Pyŏngan Province, with that of Seoul at 58 years. However, the log-rank test indicates that only P'yŏngan Province (see Fig. 12) differs statistically in its survival pattern from the other regions ($p=0.020$). This result is borne out by the results of a Cox regression, stratifying over the five centuries of the period, giving a hazard ratio of 1.572 (95% CI= 1.141 – 2.166, $p=0.006$), a model for which there is no evidence to reject the proportional hazards assumption (by the Schoenfeld residuals test, $p=0.685$). By this analysis, then, the munkwa passers in the data with P'yŏngan as their residence were statistically at a roughly 50% higher hazard for death overall than other members of their cohort having an examination residence elsewhere. It would perhaps have been the case, that members of this group were less likely to have acquired posting in the central government and thereby remained subject to regional mortality influences, including proximity to Ming and Qing China, a continual source of epidemics in Chosŏn Korea arriving across the border from the north. However, given the small number ($n=39$) of P'yŏngan residents in the dataset, the search for more definitive answers must wait further investigation.

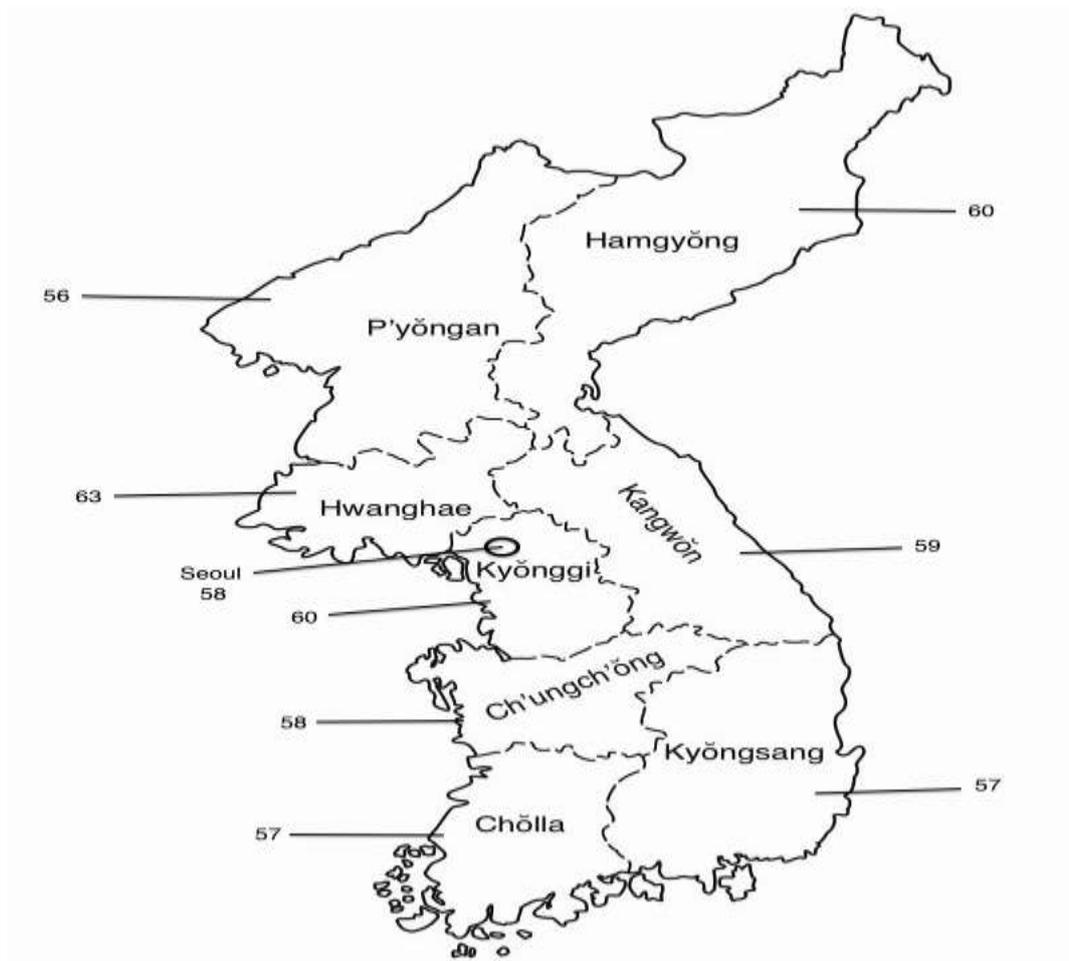


Fig.11. Median Survival Rates among Munkwa Passers in Chosŏn Korea, 1405-1774, By Province of Examination Residence

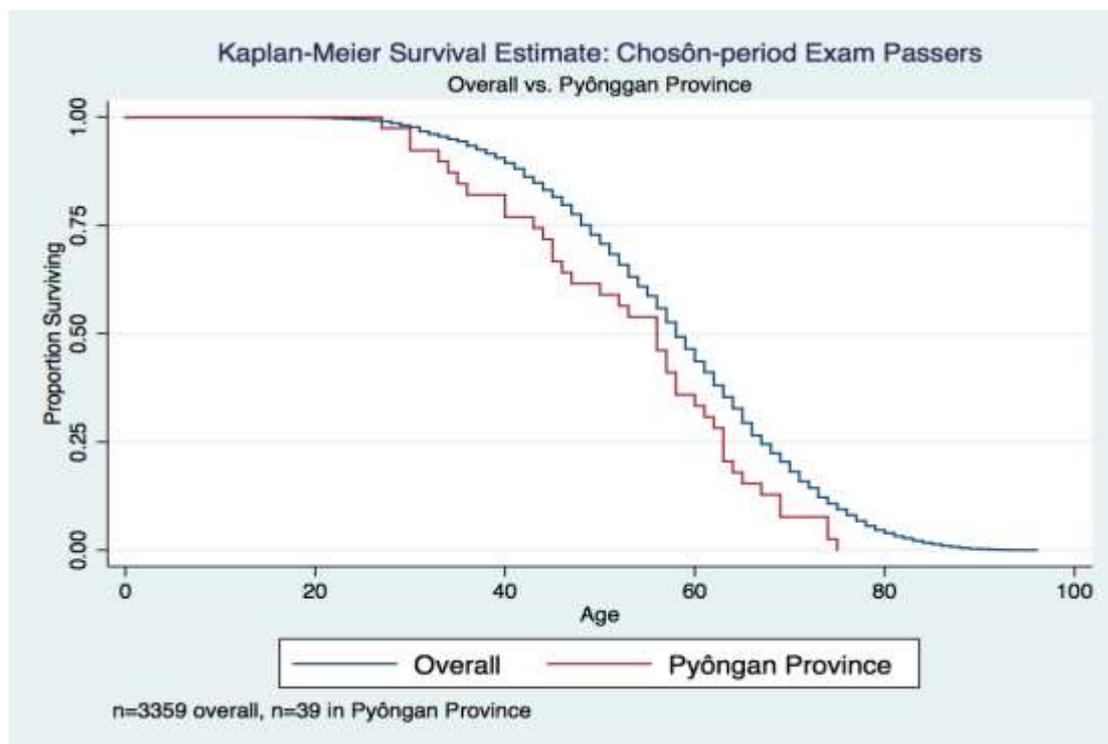


Fig.12. Predicted Survival and Hazard Curves of Cox Regression, P'yŏngan Province

Conclusion

An examination of the survival data of morality *munkwa* examination passers in Chosŏn Korea from the fifteenth to the eighteenth centuries provided fresh information concerning a research topic difficult to address from other sources and hitherto little studied. Using the Kaplan-Meier survival estimation, it was determined the median survival age for these elite males from across Korea who had lived longed enough to pass the examination was 58 years, varying somewhat by period and province.

The data confirmed the general understanding of the Imjin War (1592-1598) as deadly and the results of a Cox regression found that for the elite male members of society in this study the hazard rate of data increased over 100% (to 2.04) during this period for examination passers 60 years and younger. By contrast, the Manchu invasions of 1627 and 1636-1637 produce no statistically perceptible change in the survival pattern of men in the study. Rather, it was a surprising result that the 1623 Injo Restoration was far more disruptive and produced a brief elevation in the hazard ratio to 2.15 for examination passers 65 years and younger.

The use of Cox regression also allowed statistical testing of the important issue of whether region of examination residence was associated with different survival rates. Only in the case of P'yŏngan province did this prove to be case, although the small size of the data set urges caution in generalizing. On the whole the pattern of mortality argues for an understanding of this group of elite males as sharing a common lifestyle and enjoying a similar pattern of survival nationwide with general collective stability.

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