# Adult Mortality in East Asia: Trends and Patterns

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## INTRODUCTION

East Asian countries have experienced rapid demographic transitions. Compared to the developed world, East Asian countries have been able to take on the medical and the industrial technologies all at once and, as a result, mortality – especially childhood mortality – decreased sharply. At the regional level[1], the under-five mortality rate decreased from 212 per 1,000 live births in 1960 to 43 in 2001 [1]. In addition, socioeconomic development, changes in parental attitude towards child health and education, and highly effective family planning programs contributed to fast fertility decline [2,3]. Especially China, South Korea, and Taiwan showed by and large comparable fertility trends despite dissimilarities in family planning policies and the sequences of total fertility rates. The total fertility rate declined from about 6 in the 1950 to about 2.5 around 1980 and below the replacement level currently [3-6]. Furthermore, the demographic transition in this region - in particular the fertility transition - has been studied extensively related with the rapid economic development [7-9].

However, compared to fertility and child mortality, adult mortality in this region has been relatively less explored. Studies of adult mortality in less developed countries are often challenged by difficulties in data collection. Incomplete vital registration, inaccurate censuses, and age misreporting in both death and population reporting are often reported challenges [10,11]. Nevertheless, it is increasingly important to understand adult mortality better in order to respond to emerging issues regarding rapid population aging in the developing world. Changes in the burden of disease among the population and social security policy would be of particular interest.

The purpose of this paper is to identify trends and patterns of adult mortality in East Asia, using data from China, South Korea, and Taiwan, covering long time periods. Specific aims include: (1) to assess adult mortality data quality in the three countries; (2) to estimate levels and trends of mortality; and (3) to study changes in age and sex patterns of mortality over time.

[1] For the East Asia and Pacific region defined by the UNICEF

## DATA AND METHODS

### Data

Population age distribution data come from censuses. A total of four (covering a period between 1964 and 2000), ten (covering 1955-2000), and twelve (covering 1905-2000) censuses were obtained from China, South Korea, and Taiwan, respectively. For each inter-censal period, the average annual number of deaths by age and sex was obtained from various sources including vital registration records, household deaths from censuses, and a special surveillance system. In addition, data from Japan were included in order to compare changes in mortality patterns by age and sex. A total of 10 censuses (covering a period between 1950 and 2000) and annual number of deaths by age and sex for the corresponding period were obtained. More information regarding data sources is presented in Appendix 1.

### Methods

For adult mortality estimation in a non-stable population, death distribution methods are widely used. They compare the distribution of deaths by age with the age distribution of the living and provide age pattern of mortality in a defined reference period. There are two major approaches: (1) the General Growth Balance method and (2) the Synthetic Extinct Generation method.

Brass (1975) first pioneered the Growth Balance method, describing that, for any open-ended age segment ***a*+** of a closed population, the entry rate into the segment is equal to the growth rate of the segment plus the exit rate of the segment [12]. The method was later generalized to non-stable populations using segment-specific growth rates from two censuses [13]. The Generalized Growth Balance method explains,

$e(a+) - r(a+) = d(a+)$ (1)

where $e(a+)$ is the entry rate of the population $a+$, $N(a)/N(a+)$; $r(a+)$ is the growth rate of the segment; and $d(a+)$ is the death rate of the segment, $D(a+)/N(a+)$. The difference between $e(a+)$ and $r(a+)$ provides a consistency check for $d(a+)$.

Two typical major data errors are incomplete death recording and changes in coverage from one census to another. If deaths are registered with age invariant completeness $c$,

$D(a+) = \{1/\mathbf{c}\}D^o(a+)$ [2] (2)

And, assuming exponential growth between two censuses,

$r(a+) = \{1/t\} \ln\{N2(a+)/N1(a+)\}$ (3)

Then, if coverage of the second census differs from that of the first by an age invariant factor $k$,

$r(a+) = \{1/t\} \ln\{[N2^o(a+)/N1^o(a+)]*[1/\mathbf{k}]\} = r^o(a+) - \{1/t\}\ln(k)$ (4)

Replacing true values with observed values,

$$\frac{N(a)}{N(a+)} - r^o(a+) = \tfrac{1}{t}\ln(k) + \tfrac{1}{c} * \frac{D^o(a+)}{N(a+)} \qquad (5)$$

Thus the residual estimate of the death rate in each open-ended age group should be linearly related to the observed death rate in the age group. The intercept, $(1/t)\ln(\mathbf{k})$, is a function of any change in completeness of population recording and the length of the interval. The slope, $1/\mathbf{c}$, is the reciprocal of completeness of death recording and provides an adjustment factor for deaths [14].

[2] Superscript $^o$ refers to an observed value.

Alternatively, the Synthetic Extinct Generation method is based on the idea that, with perfect recording of deaths, the population age *a* at time *t* could be estimated by accumulating the deaths to that cohort after time *t* until the cohort was *extinct* [15].

$$\ell(a) = \sum_{x=a}^{\varpi} {}_1d_x \tag{6}$$

Bennett and Horiuchi (1981;1984) generalized the method to non-stable closed populations by using the age-specific growth rate [16,17]. The population at age *a* can be estimated from the deaths above that age *a* by applying summed age-specific growth rates to allow for the demographic history of the population.

$$N(a) = \int_a^{\varpi} D(x) e^{\int_a^x r(y)dy} dx \tag{7}$$

The ratio of the population age *a* estimated in this way from the deaths to the observed population age *a* calculates the completeness of death recording relative to census coverage.

However, both methods require numerous assumptions about the population. The General Growth Balance method requires (1) a closed population, (2) invariant coverage of population and deaths by age, and (3) accurate recording of age for both population and deaths. The Synthetic Extinct Generation method imposes invariant coverage of population across time, in addition to three required in the General Growth Balance method. A study examined the effects of violated assumptions in these methods such as migration, age misreporting in population and deaths, age-varying coverage of population and death, and changing coverage of censuses [18]. As implied in assumptions, the Synthetic Extinct Generation method was very sensitive to coverage change in censuses. It was also reported that the General Growth Balance method is more sensitive to typical age misreporting errors[3], whereas the Synthetic Extinct Generation is more sensitive to migration. As a result of 44 simulated cases, it was suggested that a strategy combining these two methods - Synthetic Extinct Generation method adjusted to the census coverage change based on General Growth Balance results – was more robust to typical error patterns than either individually.

In our analysis, therefore, we used a strategy combining these two methods. In order to assess data quality, the completeness of death recording relative to that of censuses was estimated for each five-year age group. Age-specific mortality rates (ASMR) and, as a measure of overall adult mortality, the probability of dying between 15 and 59 years of age (45q15) were calculated. As a measure of trends, annual rates of change in 45q15 and ASMR were examined across sex and time. In addition, in order to examine the age pattern of mortality, age-specific levels were estimated in comparison to the Coale-Demeny West Model life tables, as well as male-to-female ratios of ASMR.

[3] The author used transition probabilities of age misreporting estimated by Mari Bhat (1990).

## RESULTS

### Data quality: completeness of death recording

Death recording completeness relative to population recording improved in China and South Korea over time (Table 1). In China, death recording completeness was about 80 % of population recording during the 1964-1982 period but increased to 85-90 % in the 1990s. In South Korea, vital registration had less than 50 % completeness compared to censuses in the 1950s, but it improved to a level similar to that of census completeness by the late 1970s. In the 1990s, completeness of death recording even exceeded that of population recording. On the other hand, Taiwan had showed death recording completeness comparable to census coverage since the beginning of the 20th century, except the 1940-1956 period when vital registration completeness was about 75 % compared to population recording.

### Levels and trends of adult mortality

All three countries had experienced remarkable reductions in adult mortality (Figure 1). In China, 45q15 declined from 0.246 and 0.212 during the 1964-1982 period to 0.176 and 0.126 during the 1990-2000 period for males and females, respectively. In South Korea, for males and females respectively, 45q15 decreased from 0.438 and 0.302 during the 1955-1960 period to 0.173 and 0.066 during the 1995-2000 period. Finally, in Taiwan, it reduced from 0.786 and 0.634 during the 1905-1915 period to 0.174 and 0.081 during the 1990-2000 period for males and females, respectively (Appendix 2).

Importantly, each country experienced a fairly constant reduction rate over time. Average annual per cent decline of 45q15 was estimated for males and females to be about 1.5 % and 2.4

%, 2.1 % and 4.0 %, and 2.0 % and 2.7 % in China, South Korea, and Taiwan, respectively. Females had faster mortality decline in all countries. Furthermore, bivariate log-linear regressions suggested that more than 90 % of variance in 45q15 was explained by time alone in all populations (Table 2). Nevertheless, some exceptional periods were observed as shown in Figure 1. Both males and females in South Korea experienced slightly increased 45q15 between 1966-1970 and 1970-1975. In addition, reduction in 45q15 among Taiwanese men slowed down significantly during the 1980s and 1990s whereas women had experienced by and large constant decline since the 1960s.

In terms of trends in ASMR, females had faster mortality decline than males in all age groups. The gap appeared to be especially large for age groups between 20 and 44 in all countries. Annual reduction rates in ASMR were on average about 30 to 50 % smaller for males than for females in these age groups[4] (results not shown).

**Changes in patterns of sex differentials in mortality**

Patterns of mortality by age and sex also changed considerably in South Korea and Taiwan over time (Figure 2). The Far Eastern mortality pattern - excess mortality of older men compared to men at younger ages and women, in comparison to the West model life tables [19]- was observed in South Korea and Taiwan until the 1980s and the mid 1960s, respectively. For age groups 60-64 and 65-69, in particular, females had about 6 to 9 higher West levels implied by ASMR than males, although earlier Taiwanese data from 1915 to 1935 showed the Far Eastern mortality pattern to a far lesser extent[5] (Figure 3.a).

[4] For the comparison purpose, early periods until 1956 were excluded in Taiwan.
[5] For the period 1935-1940, the oldest age group is 55+.

Since then, large excess male mortality among the older age group had decreased and the apparent Far Eastern pattern had disappeared. In particular, between the periods 1956-1966 and 1966-1980, Taiwanese sex differentials in West levels decreased to an astonishing extent for age groups between 55 and 69. In South Korea, sex differences in West levels declined, but differences still remained at around two levels (Figure 3.b). Importantly, however, Figure 3.b also illustrates increased excess male mortality among the younger ages. In South Korea, absolute differences in West levels increased up to 4-5 for age groups in the 40s during the 1980s, although they decreased somewhat in the 1990s. For those in the 40s in Taiwan, the absolute differences had increased steadily since the 1966-1980 period, but only up to 2.

Interestingly, China did not appear to experience the typical Far Eastern mortality pattern. During the 1964-1982 period, lower West levels of the older ages compared to the younger was observed in both men and women and, consequently, there were only fairly small sex differences among older age groups (Figure 2). In fact, although differences were small, females in all age groups between 15 and 59 had lower West levels than males until 1990 (results for the 1982-1990 period are not shown). For the 1990-2000 period, males in their 30s and 40s had slightly lower West levels than females. Nevertheless, West levels were estimated to be by and large comparable across age in both males and females in the 1980s and 1990s.

We also examined male-to-female ratios of ASMR (Figure 4). In all three countries, young females had higher mortality rates than males in earlier periods, perhaps due to maternal mortality risk. However, the ratios around early and mid adulthood had increased dramatically in South Korea and Taiwan since the 1980s, whereas high ratios were more concentrated among older ages before. Especially during the latest three periods in South Korea, the highest ratios were found at around 3 in the 40s and early 50s, and ratios in the 30s were higher than ratios in the younger age groups. In Taiwan, on the other hand, highest ratios were observed at around 2.5 in ages 15-19 in the 1980s. However, sex ratios in all age groups between 15 and 44 exceeded 2.5 in the 1990s and, in particular, ratios in ages 25-34 were slightly higher than the ratio in ages 15-19. The age pattern of mortality ratios by sex was further compared to the West model life tables and Japan. Mortality levels from the West levels 18 to 25 and Japanese data between 1950 and 1995 were comparable to those in South Korea and Taiwan during the last two decades (Appendix 3). In both populations, the ratios increased substantially among younger age groups as the mortality level decreased, especially between ages 15 and 24 (Figure 5). In addition, the figure shows bimodal age patterns of ratios with a primary peak between 15 to 24 and a secondary one between 55 and 64. However, for age groups in the 30s and 40s, neither population indicated huge increases in ratios as observed in South Korea and Taiwan.

## DISCUSSION

Historic and contemporary data from selected developed countries show relative completeness of deaths to populations, ranging from 0.9 to 1.1 throughout the last century (Figure 6) [20]. Taiwanese data showed comparable recording completeness between deaths and populations throughout the last century for both men and women, with one post-World War II exception. In South Korea, there was substantial underreporting of deaths relative to populations until the early 1960s, but populations and deaths recording had become comparable since the late 1970s and relative completeness improved to levels observed in developed countries. Finally, Chinese data also showed gradual improvement. In particular for males, household death recording from the latest two censuses indicated over 90 % of coverage relative to population recording, indicating census questions on deaths in a reference period are considered to be a satisfactory substitute for registered deaths in estimating adult mortality in resource limited settings [14]. Relative completeness for females was consistently lower than for males in China, as it was until the late 1970s in South Korea.

The probability of dying between 15 and 59 declined significantly and female mortality decreased faster than male mortality in all three countries. In particular, South Korean females had the highest reduction rate of about 4 % per year. Reduction rates generally seem to be comparable to the rates showed in Japan and higher than those observed in historical data from selected developed countries (Figure 7). In Taiwan, however, male 45q15 had practically unchanged for the last two decades.

Mortality patterns by age and sex also changed considerably. In South Korea and Taiwan, two broad stages with different patterns of sex differential by age were identified: (1) the Far Eastern mortality pattern prior to the 1980s and the mid 1960s, respectively, and (2) the expanding excess male mortality including younger adults in their 30s and 40s for the last two decades. Goldman (1980) first identified a unique pattern of adult mortality observed in East Asia by comparing Far Eastern mortality schedules with those in the West model life tables [19]. Excess mortality of older men compared to men at younger ages and women was characterized. Respiratory tuberculosis was considered to be the most likely explanation for the existence and later attenuation of this pattern [19,21]. In our analysis, the Far Eastern mortality pattern was observed in South Korea and Taiwan until the 1980s and the mid 1960s, respectively.

The pattern has disappeared progressively since then, with decreasing excess male mortality among older ages. In particular, absolute sex differences in West levels among the older ages were minimal in Taiwan during the period 1966-1980. However, while excess male mortality among older ages decreased, it increased among younger ages, especially those in their 40s. Changes in male-to-female ratios of ASMR (Figure 4) also emphasized rapidly increasing sex differentials in mortality in the 40s.

On the other hand, China showed rather unique mortality patterns. Most of all, despite more prevalent health adverse behaviors among men such as smoking, sex differentials in mortality rates seem relatively minimal and invariant by age [22]. Compared to both European and neighboring Asian populations, it is absolutely distinctive that males and females had comparable mortality rates across age groups. In addition, we did not observe the Far Eastern mortality pattern. During the period 1964-1982, both men and women showed excess mortality of older ages compared to younger ages[6]. However, Chinese adult mortality during this period was lower than adult mortality levels in South Korea and Taiwan during the periods when the Far Eastern mortality pattern was prominent. Campbell (2001) found the progressive disappearance of the Far Eastern mortality pattern using a long historic series of the Beijing population [24]. It is, therefore, possible that we included periods only after the pattern had become attenuated.

During the epidemiologic transition in developed countries, men and women both initially enjoyed comparable reductions in mortality, largely due to rapid decline in mortality from infectious diseases. With the emergence of degenerative diseases, however, mortality reduction among females exceeded that among males. In addition to evolutionary and biologic aspects, behavior became an increasingly important influence on mortality differentials by sex. High risk behaviors among young males contribute to excess male mortality in early adulthood [25]. Health adverse behaviors such as smoking and drinking raise excess male mortality in later life [26,27]. Kruger (2004) recently examined male to female ratios of ASMR using historic data from five developed countries (France, Japan, Sweden, UK, and US) and found increasing sex ratios primarily in two age groups [28]. The first – and sharp – peak was observed in early adulthood. The ratios increased rapidly beginning around 1940 and have reached about 2.5- 3 most recently. The second and more rounded peak was identified around age 65. Although there was variation in magnitude of ratios, all countries had an asymmetric bimodal pattern, which is comparable to what we observed in the West model life table (Figure 5). However, using

[6] However, UN Regional Life Tables defines the Far Eastern pattern only by excess mortality at older ages compared to the younger and Chinese pattern in 1964-1982 meets this definition [23].

European populations in the late 1970s, Lopez (1983) isolated a group of countries with similar patterns of sex ratios of ASMR observed in South Korea and Taiwan [29]. These countries, mainly in southern and eastern Europe, had peak ratios of about 3 in ages 15-24, but also had higher ratios in the 30s and 40s than in ages above 50. Their pattern was distinctive from those of two other groups which showed varying degrees of bimodal patterns of ratios across age groups.

Excess male mortality in the 30 and 40s can be a combined effect of external and internal causes. Unfortunately, our analysis is limited to trends and patterns of mortality. However, implications of this excess male mortality in younger ages can be devastating economically and socially. Further studies with cause of death information would be valuable to investigate contributing factors to this male excess mortality and to develop intervention strategies eventually. In addition, we limited our analysis to ages 15 to 59 because of likely age exaggeration in older ages and varying open age intervals by data source.

Finally, we need to discuss the performance of the indirect method in these populations. The combined strategy - Synthetic Extinct Generation method adjusted to the census coverage change based on General Growth Balance results – is expected to work reasonably well. Especially in China, age reporting is suggested to be highly accurate, thanks to the 12-year cycle of “animal years” [30,31]. In addition, international migration is relatively insignificant given big population sizes [30,31]. Banister and Hill (2004) used the General Growth Balance method and showed remarkably comparable estimates of death recording completeness relative to population recording [31]. In Taiwan and South Korea, age reporting is expected to be reasonably accurate, given that both countries also traditionally regard the birth year, month, date, and even hour as an essential part of an individual's life. While international migration is relatively more important in these countries, the combined strategy is expected not to be sensitive to migration errors [18]. However, while age varying census coverage is suggested to be one of the most troublesome errors affecting the combined strategy as well as the General Growth Balance method, we know little about census coverage by age group in the three countries [18].

In conclusion, adult mortality decreased dramatically in China, South Korea, and Taiwan. In China, we did not observe the Far Eastern mortality pattern and, most of all, sex differentials in mortality were relatively minimal and age invariant. On the other hand, age patterns of sex differentials changed significantly in both South Korea and Taiwan. Excess male mortality among older ages was prominent in earlier periods but progressively disappeared. During the recent two decades, male to female ratios of mortality rates increased in all age groups between 15 and 59. As previously demonstrated in Japan and western European countries, sex ratios of mortality increased especially in early adulthood. However, high sex ratios of mortality rates in their 30s and 40s appear to be distinctive in comparison with those populations.

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Table 1. Data quality indicators by sex

| Country | Census 1 | Census 2 | Relative Completeness: deaths to population [a] | | Relative Completeness: Census 1 to Census 2 [b] | |
|---|---|---|---|---|---|---|
| | | | Male | Female | Male | Female |
| China | 1964 | 1982 | 0.80 | 0.78 | 0.98 | 0.99 |
| | 1982 | 1990 | 0.87 | 0.84 | 1.00 | 0.99 |
| | 1990 | 2000 | 0.90 | 0.85 | 0.98 | 0.98 |
| South Korea | 1955 | 1960 | 0.46 | 0.45 | 0.98 | 1.00 |
| | 1960 | 1966 | 0.60 | 0.50 | 0.98 | 0.99 |
| | 1966 | 1970 | 0.85 | 0.71 | 1.00 | 1.00 |
| | 1970 | 1975 | 0.94 | 0.77 | 0.99 | 1.00 |
| | 1975 | 1980 | 1.06 | 0.97 | 1.00 | 1.00 |
| | 1980 | 1985 | 1.06 | 1.06 | 0.99 | 0.99 |
| | 1985 | 1990 | 0.99 | 0.96 | 0.97 | 0.99 |
| | 1990 | 1995 | 1.06 | 1.19 | 1.02 | 1.03 |
| | 1995 | 2000 | 1.06 | 1.08 | 1.02 | 1.02 |
| Taiwan | 1905 | 1915 | 0.94 | 0.96 | 0.99 | 0.99 |
| | 1915 | 1920 | 0.95 | 0.96 | 1.00 | 1.00 |
| | 1920 | 1925 | 0.97 | 0.98 | 1.00 | 1.00 |
| | 1925 | 1930 | 0.99 | 0.97 | 0.98 | 0.98 |
| | 1930 | 1935 | 1.00 | 1.01 | 1.00 | 1.01 |
| | 1935 | 1940 | 0.95 | 0.96 | 0.99 | 0.99 |
| | 1940 | 1956 | 0.73 | 0.77 | 0.73 | 0.85 |
| | 1956 | 1966 | 0.92 | 1.00 | 0.85 | 1.00 |
| | 1966 | 1980 | 1.12 | 1.03 | 0.96 | 0.98 |
| | 1980 | 1990 | 1.02 | 1.03 | 1.01 | 1.02 |
| | 1990 | 2000 | 0.99 | 1.03 | 1.00 | 0.99 |

[a] Average relative completeness between age groups 15+ to 55+

[b] Values are estimated from the General Growth Balance method and applied to the Synthetic Extinct Generation method.

Figure 1. Trends of the probability of dying between 15 and 59 by sex

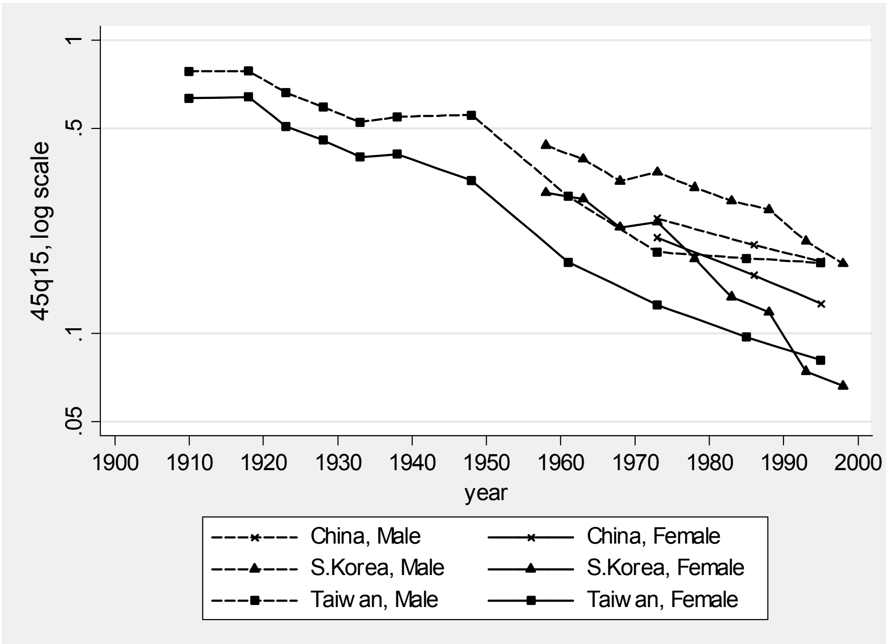


Table 2. Linear regression analyses of ln(45q15) on calendar year [a]

| Country | Period | Male | | | | Female | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Coeff. | t | $R^2$ | N | Coeff. | t | $R^2$ | N |
| China | 1964-2000 | -0.015 | -40.0 | 0.999 | 3 | -0.024 | -47.7 | 0.999 | 3 |
| South Korea | 1955-2000 | -0.021 | -9.8 | 0.931 | 8 | -0.040 | -11.5 | 0.949 | 8 |
| Taiwan | 1905-2000 | -0.020 | -14.7 | 0.941 | 11 | -0.027 | -25.7 | 0.980 | 11 |
| | 1905-1940 | -0.016 | -5.5 | 0.881 | 6 | -0.019 | -5.8 | 0.887 | 6 |
| | 1956-2000 | -0.014 | -2.7 | 0.758 | 4 | -0.023 | -14.6 | 0.990 | 4 |

[a] Robust standard error estimates.

Figure 2. West levels of mortality implied by age-specific mortality rates, for selected years

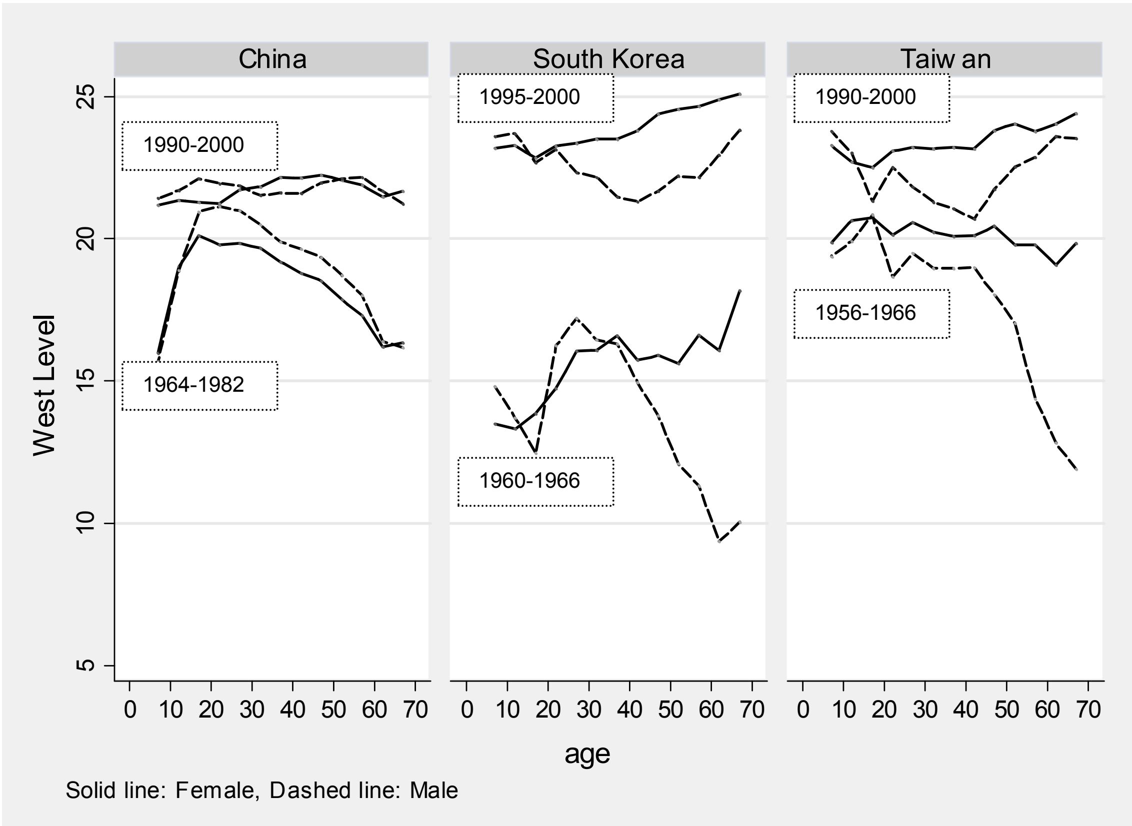
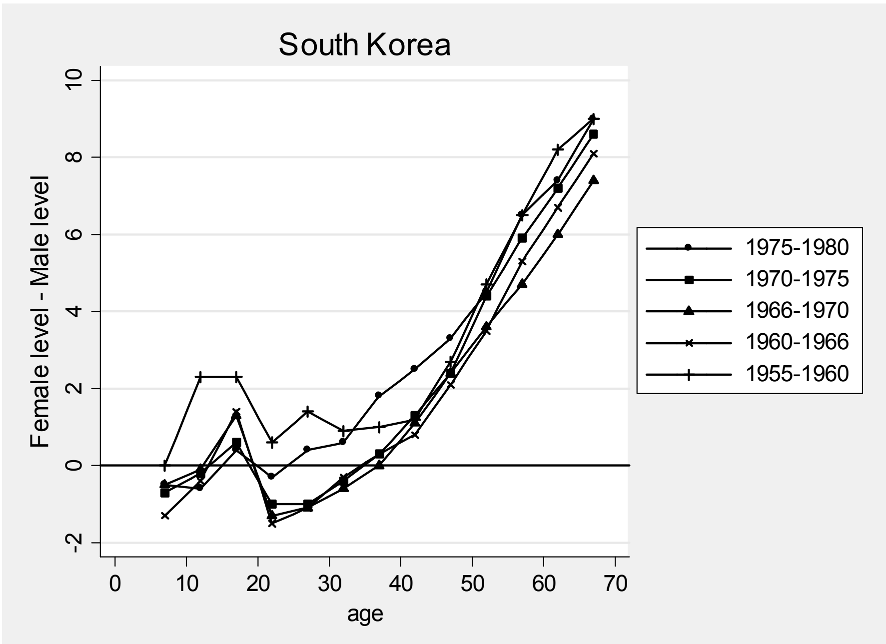
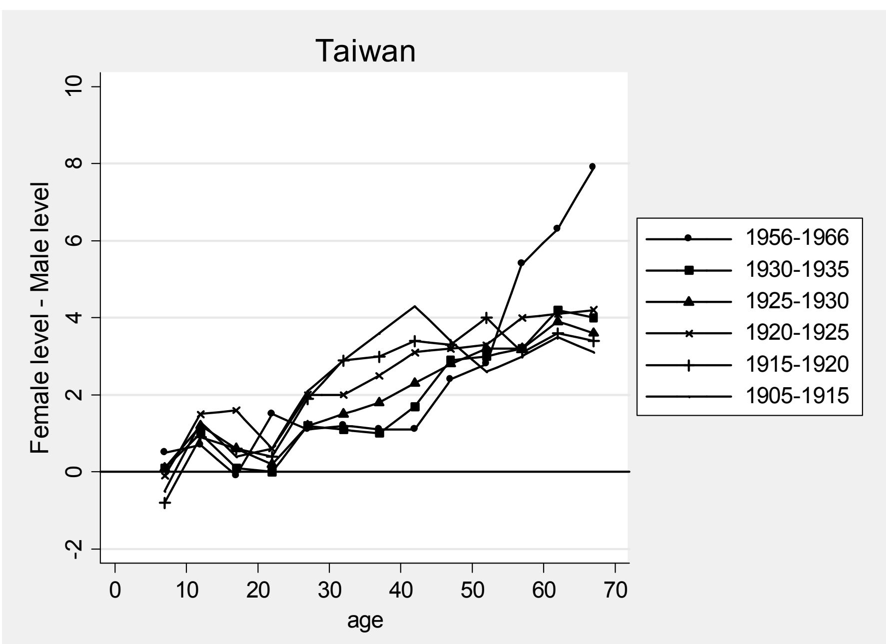


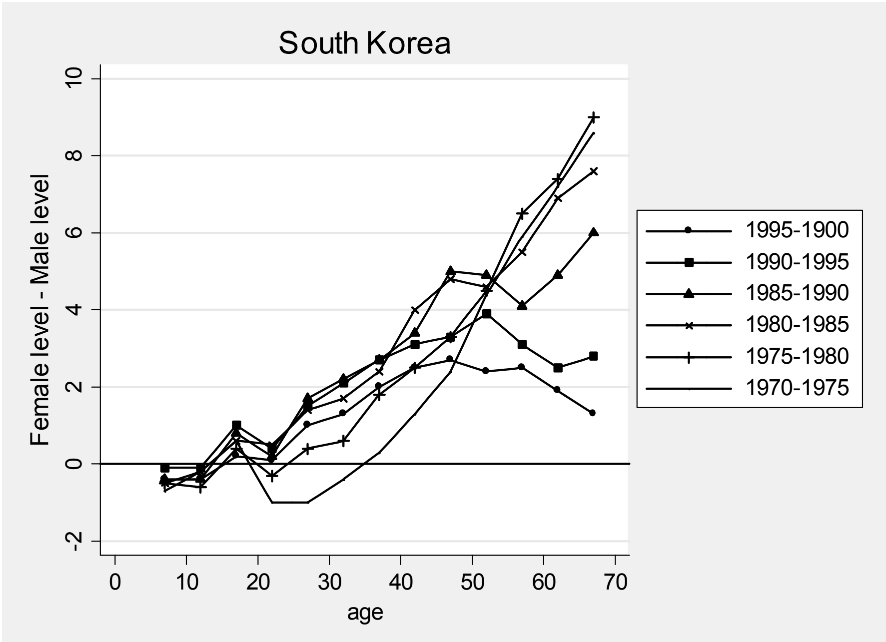
Figure 3. Absolute differences in West levels implied by sex in South Korea and Taiwan

a. Earlier periods with the Far East mortality pattern



b. later periods without the Far East mortality pattern



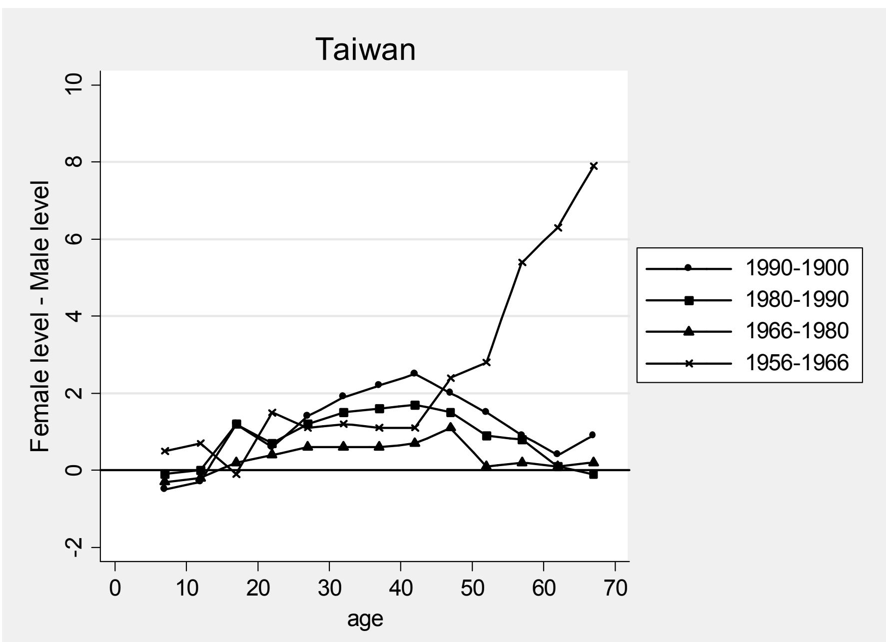



Figure 4. Male-to-female ratios of the age-specific mortality rate in selected periods

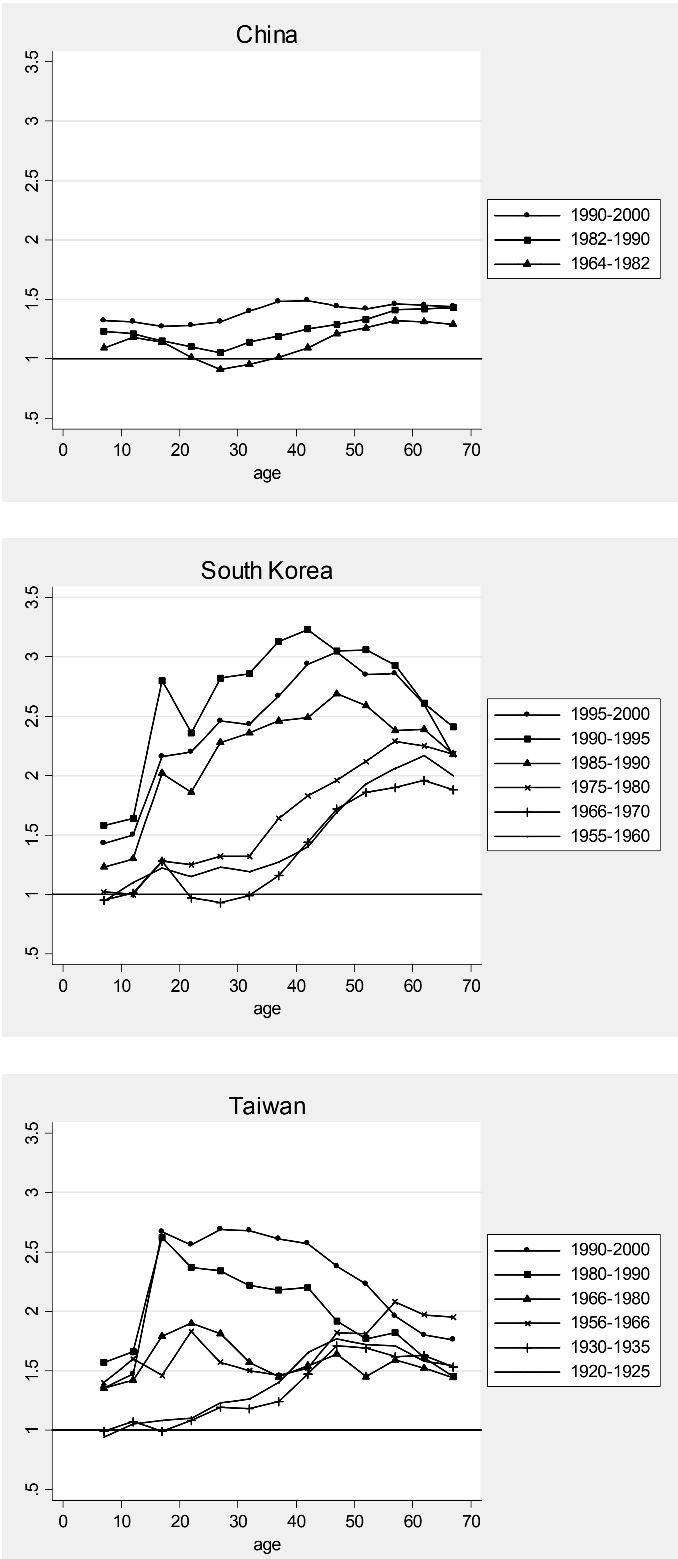
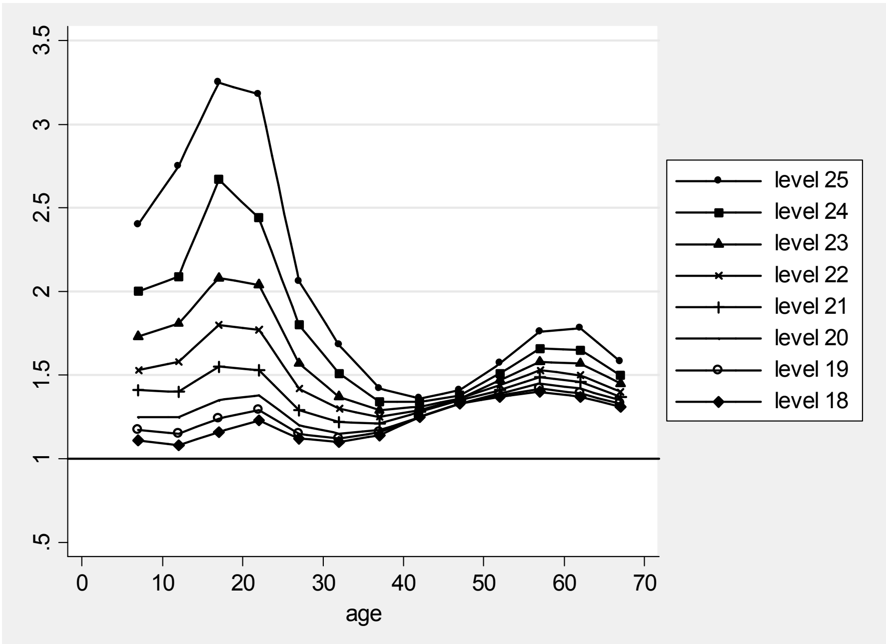


Figure 5. Male-to-female ratios of the age-specific mortality rate: selected levels from the West model life tables levels 18-25 and Japan 1950-1995



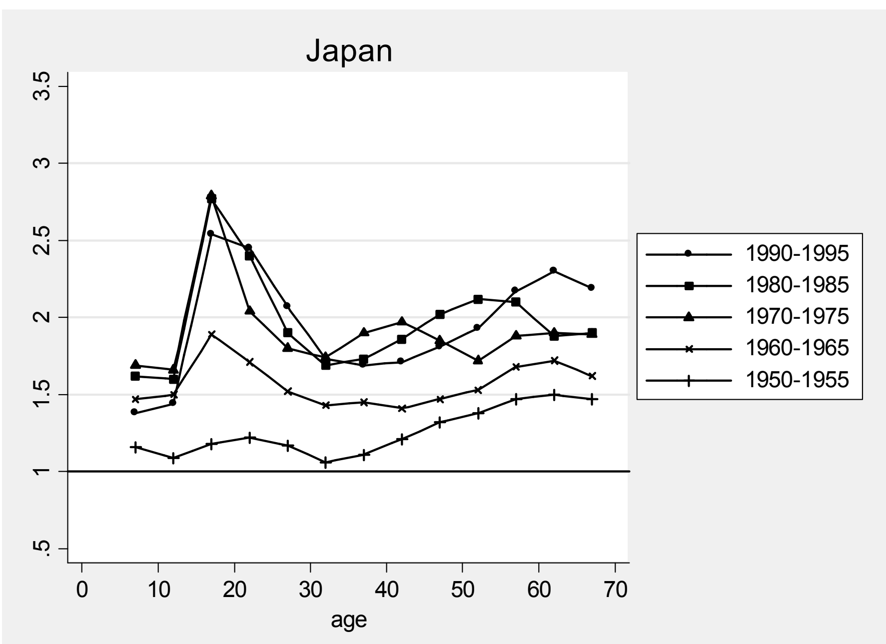



Figure 6. Trends of completeness of death recording relative to population recording by selected country (Source for England & Wales and the United States: Wilmoth, 2004)

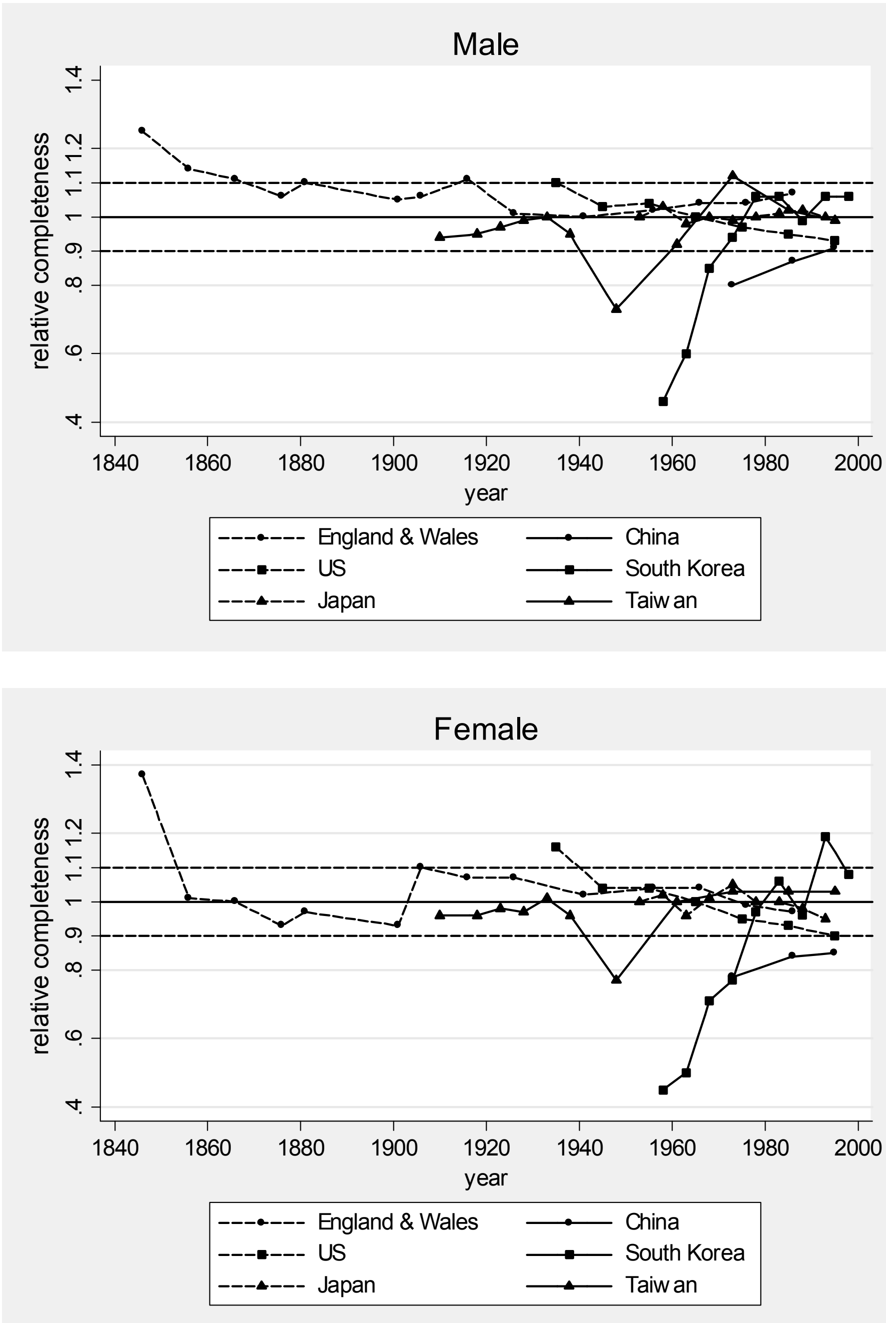
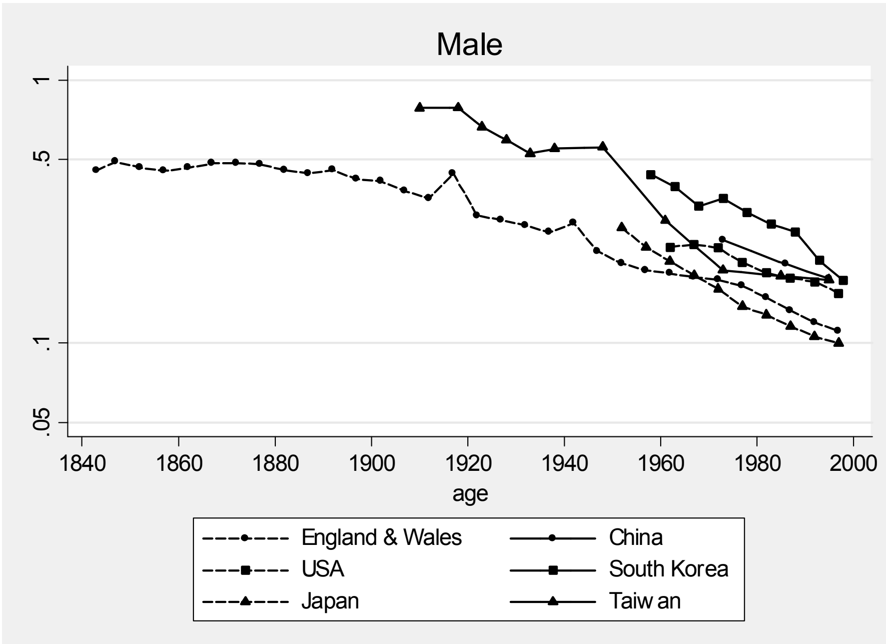
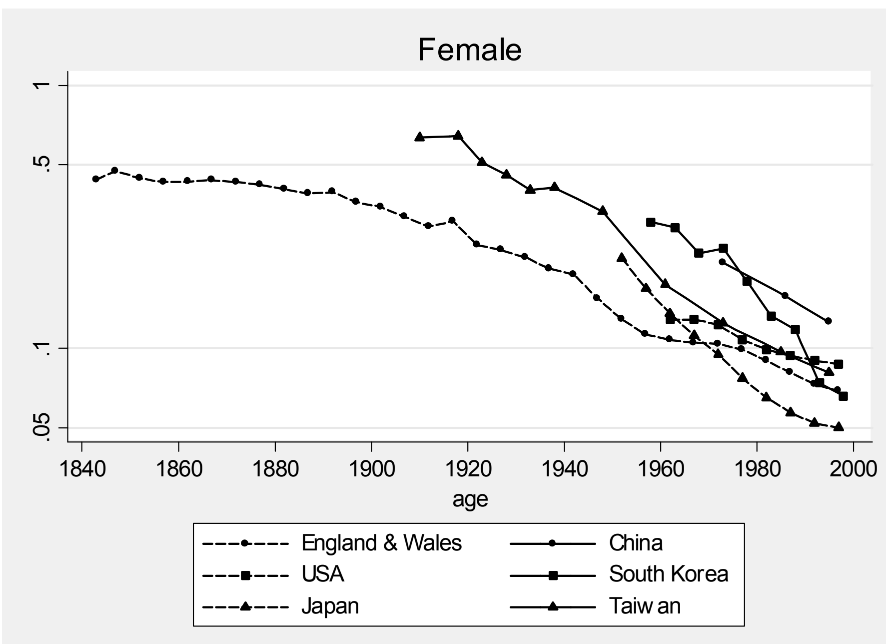


Figure 7. Trends of the probability of dying between 15 and 59 from historical data from selected developed countries (Source for England & Wales and the United States: Wilmoth, 2004)



APPENDIX 1. Source of Data by Country

| | Data Sources | |
|---|---|---|
| | Population | Deaths |
| China | - 1964 census<br>- 1982 census<br>- 1990 census<br>- 2000 census | - Special Cancer Surveillance (1973-1975) [2]<br>- 1982 census [3]<br>- 1990 census [4]<br>- 2000 census [3] |
| South Korea | - 1955 census<br>- 1960 census<br>- 1966 census<br>- 1970 census<br>- 1975 census<br>- 1980 census<br>- 1985 census<br>- 1990 census<br>- 1995 census<br>- 2000 census | - 1957-1960 vital registration<br>- 1962-1964 vital registration<br>- 1967 vital registration<br>- 1970-1971 vital registration<br>- 1974-2000 vital registration |
| Taiwan | - 1905 census [1]<br>- 1915 census [1]<br>- 1920 census [1]<br>- 1925 census [1]<br>- 1930 census<br>- 1935 census<br>- 1940 census<br>- 1956 census<br>- 1966 census<br>- 1980 census<br>- 1990 census<br>- 2000 census | - 1906-1926 vital registration [1]<br>- 1927-1943 vital registration<br>- 1950-2000 vital registration |
| Japan | - 1950 census<br>- 1955 census<br>- 1960 census<br>- 1965 census<br>- 1970 census<br>- 1975 census<br>- 1980 census<br>- 1985 census<br>- 1990 census<br>- 1995 census | - 1950-1995 vital registration |

1. Age was recorded in Chinese age and was adjusted to western age.
2. Age-specific mortality rates were obtained.
3. The number of deaths during 12 months prior to the census
4. The number of deaths during 18 months prior to the census

Appendix 2. Estimates of probabilities of dying between 15 and 59 (45q15)

| Country | Intercensal period | 45q15 | |
|---|---|---|---|
| | | Male | Female |
| China | 1964 - 1982 | 0.246 | 0.212 |
| | 1982 - 1990 | 0.200 | 0.158 |
| | 1990 - 2000 | 0.176 | 0.126 |
| South Korea | 1955 - 1960 | 0.438 | 0.302 |
| | 1960 - 1966 | 0.393 | 0.288 |
| | 1966 - 1970 | 0.331 | 0.230 |
| | 1970 - 1975 | 0.355 | 0.240 |
| | 1975 - 1980 | 0.314 | 0.180 |
| | 1980 - 1985 | 0.283 | 0.133 |
| | 1985 - 1990 | 0.264 | 0.118 |
| | 1990 - 1995 | 0.206 | 0.074 |
| | 1995 - 2000 | 0.173 | 0.066 |
| Taiwan | 1905 - 1915 | 0.786 | 0.634 |
| | 1915 - 1920 | 0.786 | 0.642 |
| | 1920 - 1925 | 0.664 | 0.509 |
| | 1925 - 1930 | 0.593 | 0.457 |
| | 1930 - 1935 | 0.526 | 0.400 |
| | 1935 - 1940 | 0.549 | 0.409 |
| | 1940 - 1956 | 0.557 | 0.332 |
| | 1956 - 1966 | 0.293 | 0.175 |
| | 1966 - 1980 | 0.189 | 0.125 |
| | 1980 - 1990 | 0.180 | 0.097 |
| | 1990 - 2000 | 0.174 | 0.081 |

Appendix 3. West levels implied by the probability of dying between 15 and 59: for selected periods in South Korea, Taiwan, and Japan

| Country | Period | Male | | Female | |
|---|---|---|---|---|---|
| | | 45q15 | Implied West Level | 45q15 | Implied West Level |
| South Korea | | | | | |
| | 1980-1985 | 0.283 | 18.2 | 0.133 | 21.7 |
| | 1985-1990 | 0.264 | 18.8 | 0.118 | 22.2 |
| | 1990-1995 | 0.206 | 21.0 | 0.074 | 23.8 |
| | 1995-2000 | 0.173 | 22.0 | 0.066 | 24.2 |
| Taiwan | | | | | |
| | 1980-1990 | 0.180 | 21.8 | 0.097 | 23.0 |
| | 1990-2000 | 0.174 | 22.0 | 0.081 | 23.6 |
| Japan | | | | | |
| | 1950-1955 | 0.262 | 18.9 | 0.208 | 18.9 |
| | 1955-1960 | 0.223 | 20.4 | 0.161 | 20.7 |
| | 1960-1965 | 0.203 | 21.1 | 0.135 | 21.6 |
| | 1965-1970 | 0.178 | 21.9 | 0.109 | 22.5 |
| | 1970-1975 | 0.158 | 22.5 | 0.088 | 23.3 |
| | 1975-1980 | 0.135 | 23.2 | 0.074 | 23.8 |
| | 1980-1985 | 0.126 | 23.4 | 0.064 | 24.2 |
| | 1985-1990 | 0.112 | 23.9 | 0.057 | 24.5 |
| | 1990-1995 | 0.105 | 24.1 | 0.055 | 24.6 |