Paths to Low Mortality: Relationship between Mortality Level, Age pattern of Deaths and Cause-of-death Pattern

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Abstract

In this paper, I examine the relationship between mortality level, age pattern and disease pattern during mortality transition by comparing provincial data of the 1990s in China. The analyses show that there is no necessary connection between mortality level, age pattern of deaths and cause-of-death pattern. Populations with similar mortality levels and/or age patterns may have quite distinct cause-of-death patterns, and populations with different mortality levels and/or age patterns may display similar disease patterns. The comparisons between Chinese provinces suggest that populations may not follow similar changes in their cause-of-death patterns to reach low mortality, and there may be more than one path to low mortality in connecting to cause-of-death change.

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Introduction

It is generally believed that major changes in mortality in the human population over time have been associated with fundamental shifts in the distribution of deaths by cause and, importantly, by age. In his theory of the Epidemiological Transition, Omran (1971) first posited that there is a systematic relationship between the overall level of mortality and the cause-of-death structure. Omran's theory also first formalized the nature of the relation between the age pattern and the cause-of-death pattern of mortality: age at death shifted primarily from the young to the old, as the principal causes of death shifted from infectious and parasitic diseases to chronic degenerative diseases. Himes' study on Sweden, Japan and the United States examined this relationship and found similar cause-of-death patterns can translate into different age patterns of mortality once countries reach low levels of overall mortality and countries at low levels of mortality are not moving toward a common disease and age pattern (Himes, 1994). Himes' study focused on countries that have reached low level of mortality. It remains unclear if regions that have similar mortality levels or age patterns of mortality have similar cause-of-death patterns during transition, when mortality has not reached as low as those in Western countries. In this paper, I examine the relationship between mortality level, age pattern and disease pattern by comparing provincial data in China. By analyzing province-specific Chinese mortality transitions, this study will help us to better understand the mechanism underlying the relationship between overall mortality, age pattern of mortality and cause-of-death pattern of mortality, and to shed light on understanding whether populations achieve low mortality in similar ways related to cause-of-death change.

Data and Methods

The data used here are from two sources. Mortality rates in the 1990s for each province are derived from 1990 and 2000 censuses data and are adjusted by using the General Growth Balance (GGB) Method, which is an indirect method to evaluate and adjust adult mortality, to account for misreporting[2]. Causes-of-death data are from the Chinese Disease Surveillance Point (DSP) system. The DSP system was designed primarily to collect information on births, causes of death, incidence of infectious diseases, and immunizations. By 1990, there were 145 surveillance points scattered throughout 31 provinces based on random sampling, and a population of about 10 million (a little under 1% of the national population) resides in the areas covered by the DSP system[3].

The methods used here are adopted and revised from those used in Himes' paper (1994). Mortality Schedules in the 1990s between two provinces are compared with each other, and a straight line is fitted to the relationship. Let $Y^a(x)$ and $Y^b(x)$ denote the logit value of mortality rate at age x in province a and province b, respectively. That is to say, $Y^a(x) = \log(m^a(x)/(1-m^a(x)))$, and $Y^b(x) = \log(m^b(x)/(1-m^b(x)))$. The estimated model,

[2] For details about the evaluation and adjustment of mortality rates, refer to You (2007).
[3] For details about the DSP system, refer to Yang, etc (2005).

$$Y^a(x) = \alpha + \beta Y^b(x), \qquad (1)$$

yields a value indicating the level of mortality in province a relative to that in province b, α, and a value indicating a deviation in the age pattern of mortality, β. The intercept α is a rough indicator of the level of mortality in province a relative to that in province b, but alone it is unable to indicate the relative levels of mortality across ages. The value of β for province a indicates the extent and pattern of deviation over ages from province b. In cases where the value of β is less than 1, the values of the difference, $Y^a(x) - Y^b(x)$, decrease with age; mortality rates at younger ages are higher relative to the standard than at older ages. On the other hand, a value of β that is greater than 1 indicates an increase in mortality with age in relation to the standard. A value of β that is very close or equal to 1 indicates very similar age patterns of mortality. It is worth mentioning that the mortality rates $m(x)$ used in this method are not necessarily in the range between 0 and 1. Using the probability of dying is more reasonable. However, following Himes, I also use the mortality rates $m(x)$ in this method. Here, I exclude the age range 0-19 and set the starting age as 20 for the regression to ensure a monotonous increase of the mortality schedule on the whole, and each province is compared to all other provinces to get the relationship of mortality between any two provinces.

The difference in cause-of-death patterns between two populations is indicated by an index of dissimilarity. The index of dissimilarity (Duncan and Duncan, 1955) summarizes the difference between any percentage distributions of two populations. When the distribution of deaths by age and cause is used, the index for age group x, D_x, is calculated as

$$D_x = 1/2 \sum_{j=1}^{k} \left| p_{jx}^{a} - p_{jx}^{b} \right|, \tag{2}$$

where p_{jx}^{a} and p_{jx}^{b} represent the percentage of deaths attributable to cause j at age x for population a and b, respectively. In this context, the index can be regarded as representing the proportion of deaths in population a (or in population b) that have to be redistributed to make the cause-of-death distributions between population a and b the same.

To compare cause-of-death pattern between populations, following Himes (1994), causes of death are divided into seven broad categories: infectious and parasitic, malignant neoplasm, circulatory system, respiratory system, digestive system, other diseases, and external causes, based on the ninth revision of the International Statistical Classification of Diseases (WHO, 1977).

Some caution is necessary in connecting the mortality schedule and the cause-of-death pattern: the mortality schedule data are from censuses and represent the mortality level or age pattern in each province of China, whereas cause-of-death data are sampled and may not represent the provincial level very well, although a multi-stage cluster probability sampling with stratification is used in the DSP system to select the surveillance points and it is generally believed that the data are representative at the national level. However, these are the only data available and the cluster probability sampling with stratification at the provincial level more or less ensures accurate representative at the provincial level.

Results

Considering that mortality and cause-of-death are age-sex-specific, I use the data for males and females separately to explore the relationship between level or age pattern of mortality and disease pattern. The results based on male data are listed in the body text of the paper. Analyses based on female data shows similar results.

According to male life expectancy at birth, the provinces in China can be categorized into 5 groups as listed in Table 1. Life expectancies or mortality levels are more or less similar for provinces in the same group.

Figure 1 illustrates the age pattern of male mortality in the 1990s for all of the provinces in China. Although differences exist between high and low mortality schedules, the differences are not substantial for provinces in between. Figure 2 compares the age patterns of mortality for provinces in the same mortality level group. We can see that the age patterns of mortality for provinces with similar mortality level are also similar, and it is interesting to find that the age pattern of mortality for Tibet does not show a large difference compared to the age patterns of provinces in Group IV (Figure 2(d)), although Tibetan male life expectancy at birth is about 8-10 years lower.

Figures 1 and 2 give only a rough picture about the similarity or difference of the age pattern of mortality between provinces, so we are unable to observe small difference. Now I turn to the regression mentioned before to examine how the age pattern of mortality in one province is related to the pattern in another province.

Table 1 Grouping of Provinces Based on Mortality Level Measured by Male Life Expectancy at Birth

	Group I	Group II	Group III	Group IV	Group V
life expectancy at birth	70-75	68-69	66-67	63-65	55.51
province	Shanghai Beijing Tianjin Zhejiang Jiansu Liaoning Shandong Guangdong	Hebei Ningxia Shanxi Fujian Hainan Henan Anhui Shaanxi Inner Mongolia	Guangxi Jiangxi Jilin Gansu Hunan Sichuan Hubei Heilongjiang	Yunnan Qinhai Guizhou Xinjiang	Tibet

Figure 1 Mortality Rates for Males by Age and Province (in Logarithmic Scale)

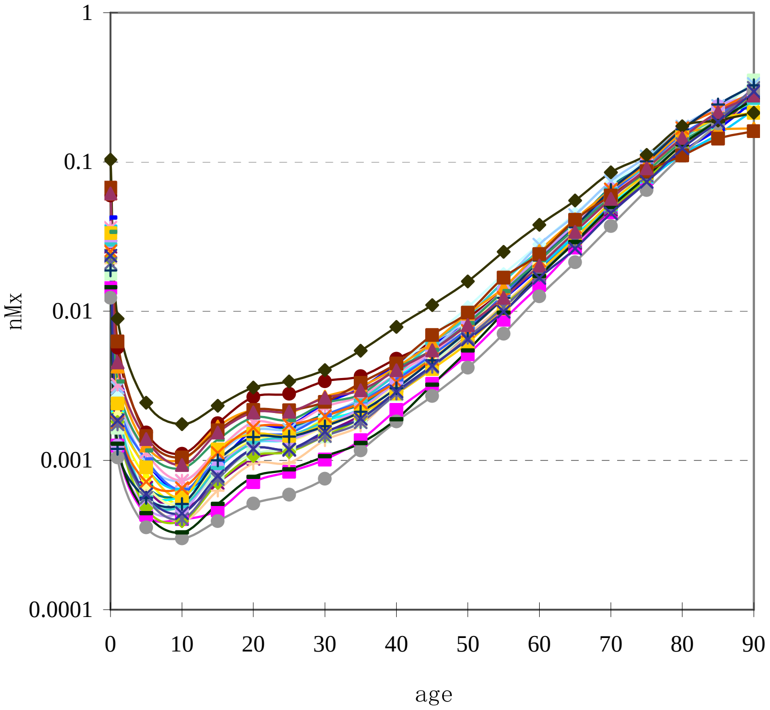
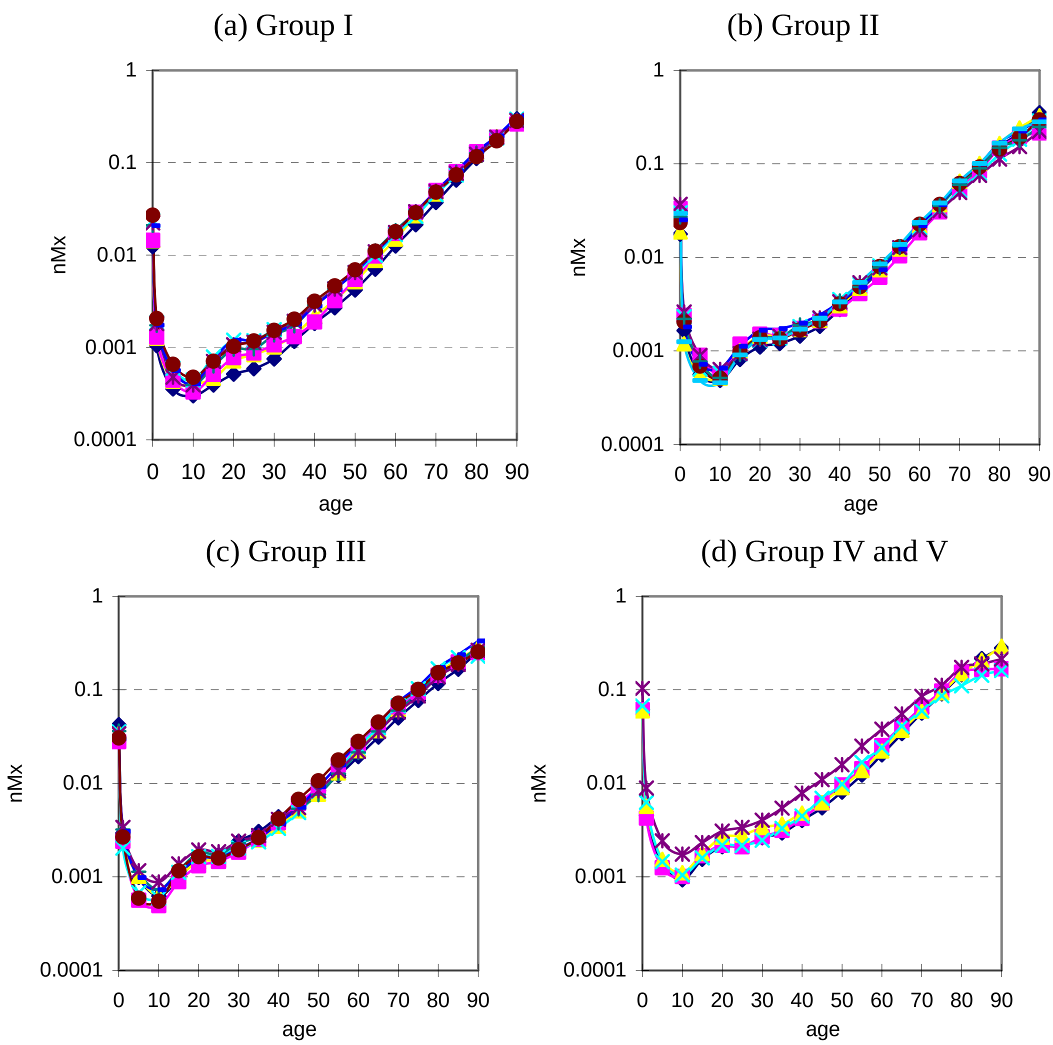


Figure 2 Age Pattern of Mortality for Provinces in the Same Group of Mortality Level



Because mortality levels can be compared by using life expectancy at birth or other mortality indices, and the value of the intercept α alone is insufficient to indicate the relative relationship between two age patterns, I list only the results of the slope β of the regression in the body text here (for the estimated results of intercept α, see Table A1 in Appendices). Table 2 displays the estimated value of slope β of regressing mortality of each province in the column on mortality of each province in the row by using equation 1 described before. The estimated value of β in a cell with row i and column j in this table indicates the deviation of age pattern for the corresponding province in row i from the age pattern of the province in column j. Take two examples: the value in the cell with the 2nd row and the 3rd column, 0.90, means that, male mortality rate in Anhui at younger ages is higher in relation to Beijing than at older ages, and the value in the 2nd row and the 4th column, 1.00, indicates that the age pattern of mortality in Anhui is almost the same with that in Fujian. Compared to the age pattern of the national mortality, Shanghai, Beijing, Tianjin, Hebei have higher mortality rates at older ages than at younger ages. Hainan, Sichuan, Guizhou, Guangxi, Yunnan, Xinjiang and Tibet have higher mortality rates at younger ages than at older ages, and other provinces have similar age patterns as the national one.

Considering that the slope β is a value indicating deviation in the age pattern of mortality, the Multidimensional Scaling (MDS) method can be used to picture the dissimilarity or similarity of age pattern of deaths between provinces. The MDS method takes a set of dissimilarities and returns a set of points such that the distances between the points are approximately equal to the dissimilarities (Carroll and Kruskal, 1978). Here, two dimensional distances between points are chosen from the slope β. According to

Table 2, using MDS method, I obtained Figure 3. In the MDS plot, provinces with similar age patterns of deaths are located close to each other and provinces with very different age patterns of death are scattered far apart. From Figure 3 we find that the results of the classification based on age pattern of mortality are not exactly the same with those based on mortality level. For example, Xinjiang's mortality level is much closer to that of Yunnan, Qinhai, and Guozhou than to that of Tibet, but its age pattern of mortality is more similar to Tibet's, where life expectancy is about 8 years lower than that in Xinjiang. Guizhou, Qinghai, Yunnan and Xinjiang have similar mortality levels but their age patterns of mortality are not very similar. These indicate that populations with different mortality level may have similar age patterns, and on the other hand, populations with similar mortality levels may also have different age patterns, but the differences are not huge for the Chinese cases, which can be seen in Figures 2 and 3 and the results of the slope β. Because the dissimilarity is not huge, we can say that a general pattern still exists between mortality level and age pattern of mortality in China.

Table 2 Slope Obtained by Regressing Mortality of Each Province in the Column on That of Each Province in the Row

	Anhui	Beijing	Fujian	Gansu	Guangdong	Guangxi	Guizhou	Hainan	Heilongjiang	Hebei
Anhui	1.00	0.90	1.00	1.00	0.98	1.08	1.10	1.05	1.02	0.92
Beijing	1.11	1.00	1.12	1.11	1.09	1.20	1.23	1.16	1.13	1.02
Fujian	0.99	0.90	1.00	0.99	0.98	1.08	1.10	1.04	1.01	0.92
Gansu	1.00	0.90	1.00	1.00	0.98	1.08	1.10	1.05	1.02	0.92
Guangdong	1.01	0.91	1.02	1.01	1.00	1.10	1.12	1.06	1.03	0.93
Guangxi	0.92	0.83	0.93	0.91	0.91	1.00	1.02	0.96	0.93	0.85
Guizhou	0.90	0.81	0.90	0.90	0.89	0.98	1.00	0.94	0.91	0.83
Hainan	0.95	0.86	0.96	0.95	0.94	1.03	1.05	1.00	0.97	0.88
Heilongjiang	0.98	0.88	0.99	0.98	0.97	1.06	1.08	1.03	1.00	0.90
Hebei	1.09	0.98	1.09	1.08	1.07	1.18	1.20	1.14	1.10	1.00
Henan	1.03	0.93	1.03	1.02	1.01	1.11	1.13	1.08	1.04	0.95
Hubei	1.04	0.93	1.04	1.03	1.02	1.12	1.14	1.09	1.05	0.95
Hunan	0.97	0.88	0.98	0.97	0.96	1.06	1.08	1.02	0.99	0.90
Inner Mongolia	1.04	0.94	1.05	1.04	1.03	1.13	1.15	1.09	1.06	0.96
Jiangsu	1.06	0.95	1.06	1.05	1.04	1.15	1.17	1.11	1.07	0.97
Jiangxi	1.01	0.91	1.01	1.01	0.99	1.09	1.11	1.06	1.02	0.93
Jilin	1.00	0.90	1.00	0.99	0.98	1.08	1.09	1.04	1.01	0.92
Liaoning	1.04	0.93	1.04	1.03	1.02	1.12	1.14	1.08	1.05	0.95
Ningxia	1.00	0.90	1.00	0.99	0.98	1.08	1.10	1.04	1.01	0.92
Qinghai	0.90	0.80	0.90	0.89	0.88	0.97	0.98	0.94	0.91	0.82
Shaanxi	1.02	0.92	1.02	1.02	1.00	1.10	1.13	1.07	1.03	0.94
Shandong	1.05	0.94	1.05	1.04	1.03	1.14	1.16	1.10	1.06	0.96
Shanghai	1.15	1.04	1.16	1.14	1.13	1.25	1.27	1.20	1.17	1.06
Shanxi	1.06	0.96	1.07	1.06	1.04	1.15	1.17	1.11	1.08	0.98
Sichuan	0.94	0.85	0.95	0.94	0.93	1.02	1.04	0.99	0.96	0.87
Tianjin	1.11	1.00	1.11	1.10	1.09	1.20	1.22	1.16	1.13	1.02
Tibet	0.83	0.75	0.83	0.83	0.82	0.90	0.91	0.87	0.85	0.76
Xinjiang	0.85	0.77	0.85	0.85	0.84	0.92	0.94	0.89	0.87	0.78
Yunnan	0.95	0.85	0.95	0.94	0.93	1.03	1.05	0.99	0.96	0.87
Zhejiang	1.02	0.92	1.03	1.02	1.01	1.11	1.13	1.07	1.04	0.94
Nation	1.00	0.90	1.01	1.00	0.99	1.09	1.11	1.05	1.02	0.92

Table 2 Slope Obtained by Regressing Mortality of Each Province in the Column on That of Each Province in the Row (Cont'd)

	Henan	Hubei	Hunan	Inner Mongolia	Jiangsu	Jiangxi	Jilin	Liaoning	Ningxia	Qinghai
Anhui	0.97	0.96	1.02	0.96	0.94	0.99	1.00	0.96	1.00	1.11
Beijing	1.08	1.07	1.14	1.06	1.05	1.10	1.11	1.07	1.11	1.23
Fujian	0.97	0.96	1.02	0.95	0.94	0.98	1.00	0.96	0.99	1.10
Gansu	0.97	0.96	1.03	0.96	0.94	0.99	1.00	0.96	1.00	1.12
Guangdong	0.99	0.98	1.04	0.97	0.96	1.00	1.02	0.98	1.01	1.12
Guangxi	0.89	0.89	0.94	0.88	0.87	0.91	0.92	0.89	0.92	1.02
Guizhou	0.88	0.87	0.93	0.86	0.85	0.89	0.90	0.87	0.90	1.00
Hainan	0.93	0.92	0.98	0.91	0.90	0.94	0.96	0.92	0.95	1.06
Heilongjiang	0.95	0.95	1.00	0.94	0.93	0.97	0.99	0.95	0.98	1.09
Hebei	1.06	1.05	1.11	1.04	1.03	1.08	1.09	1.05	1.09	1.21
Henan	1.00	0.99	1.05	0.98	0.97	1.02	1.03	0.99	1.03	1.14
Hubei	1.01	1.00	1.06	0.99	0.98	1.03	1.04	1.00	1.04	1.15
Hunan	0.95	0.94	1.00	0.93	0.92	0.97	0.97	0.94	0.98	1.08
Inner Mongolia	1.01	1.01	1.07	1.00	0.99	1.03	1.05	1.01	1.05	1.16
Jiangsu	1.03	1.02	1.08	1.01	1.00	1.05	1.06	1.02	1.06	1.17
Jiangxi	0.98	0.97	1.03	0.97	0.95	1.00	1.01	0.97	1.01	1.12
Jilin	0.97	0.96	1.02	0.95	0.94	0.99	1.00	0.96	1.00	1.11
Liaoning	1.01	1.00	1.06	0.99	0.98	1.03	1.04	1.00	1.04	1.15
Ningxia	0.97	0.96	1.02	0.95	0.94	0.99	1.00	0.96	1.00	1.11
Qinghai	0.87	0.86	0.91	0.86	0.84	0.88	0.90	0.86	0.90	1.00
Shaanxi	0.99	0.98	1.04	0.97	0.96	1.01	1.02	0.98	1.02	1.13
Shandong	1.02	1.01	1.07	1.00	0.99	1.04	1.05	1.01	1.05	1.16
Shanghai	1.12	1.11	1.18	1.10	1.09	1.14	1.15	1.11	1.15	1.27
Shanxi	1.03	1.02	1.09	1.02	1.00	1.05	1.06	1.02	1.06	1.18
Sichuan	0.92	0.91	0.97	0.90	0.89	0.93	0.94	0.91	0.94	1.05
Tianjin	1.08	1.07	1.14	1.06	1.05	1.10	1.11	1.07	1.11	1.23
Tibet	0.81	0.80	0.85	0.80	0.78	0.82	0.84	0.80	0.83	0.93
Xinjiang	0.83	0.82	0.87	0.82	0.80	0.84	0.86	0.82	0.85	0.95
Yunnan	0.92	0.91	0.97	0.90	0.89	0.94	0.94	0.91	0.95	1.05
Zhejiang	0.99	0.98	1.05	0.98	0.97	1.01	1.02	0.99	1.02	1.13
Nation	0.97	0.97	1.03	0.96	0.95	0.99	1.00	0.97	1.00	1.11

Table 2 Slope of Regressing mortality of each province in the column on that of each province in the row (cont'd)

	Shaanxi	Shandong	Shanghai	Shanxi	Sichuan	Tianjin	Tibet	Xinjiang	Yunnan	Zhejiang	Nation
Anhui	0.98	0.95	0.87	0.94	1.06	0.90	1.20	1.17	1.05	0.97	1.00
Beijing	1.09	1.06	0.96	1.05	1.18	1.00	1.33	1.30	1.17	1.08	1.11
Fujian	0.97	0.95	0.86	0.94	1.05	0.90	1.19	1.16	1.05	0.97	0.99
Gansu	0.98	0.95	0.87	0.94	1.06	0.90	1.20	1.17	1.05	0.98	1.00
Guangdong	0.99	0.97	0.88	0.95	1.07	0.91	1.21	1.18	1.07	0.99	1.01
Guangxi	0.90	0.88	0.80	0.87	0.98	0.83	1.10	1.07	0.97	0.90	0.92
Guizhou	0.89	0.86	0.78	0.85	0.96	0.81	1.07	1.05	0.95	0.88	0.90
Hainan	0.93	0.91	0.83	0.90	1.01	0.86	1.14	1.11	1.00	0.93	0.95
Heilongjiang	0.96	0.93	0.85	0.92	1.04	0.89	1.18	1.15	1.03	0.96	0.98
Hebei	1.06	1.04	0.94	1.02	1.15	0.98	1.30	1.27	1.14	1.06	1.08
Henan	1.01	0.98	0.89	0.97	1.09	0.93	1.23	1.20	1.08	1.00	1.03
Hubei	1.02	0.99	0.90	0.98	1.10	0.94	1.24	1.21	1.09	1.01	1.04
Hunan	0.96	0.93	0.85	0.92	1.03	0.88	1.16	1.14	1.03	0.95	0.97
Inner Mongolia	1.02	0.99	0.91	0.98	1.11	0.94	1.25	1.22	1.10	1.02	1.04
Jiangsu	1.04	1.01	0.92	1.00	1.12	0.95	1.27	1.23	1.11	1.03	1.06
Jiangxi	0.99	0.96	0.88	0.95	1.07	0.91	1.21	1.18	1.06	0.99	1.01
Jilin	0.97	0.95	0.86	0.94	1.05	0.90	1.20	1.17	1.05	0.97	0.99
Liaoning	1.01	0.99	0.90	0.98	1.10	0.93	1.24	1.21	1.09	1.01	1.03
Ningxia	0.98	0.95	0.86	0.94	1.06	0.90	1.19	1.16	1.05	0.97	0.99
Qinghai	0.88	0.85	0.77	0.84	0.95	0.81	1.07	1.05	0.94	0.87	0.89
Shaanxi	1.00	0.97	0.88	0.96	1.08	0.92	1.22	1.19	1.07	0.99	1.02
Shandong	1.03	1.00	0.91	0.99	1.11	0.94	1.25	1.22	1.10	1.02	1.05
Shanghai	1.13	1.10	1.00	1.08	1.22	1.04	1.37	1.34	1.21	1.12	1.15
Shanxi	1.04	1.01	0.92	1.00	1.13	0.96	1.27	1.24	1.12	1.04	1.06
Sichuan	0.93	0.90	0.82	0.89	1.00	0.85	1.13	1.10	0.99	0.92	0.94
Tianjin	1.09	1.06	0.96	1.04	1.17	1.00	1.33	1.29	1.17	1.08	1.11
Tibet	0.81	0.79	0.72	0.78	0.88	0.75	1.00	0.97	0.87	0.81	0.83
Xinjiang	0.83	0.81	0.74	0.80	0.90	0.77	1.02	1.00	0.89	0.83	0.85
Yunnan	0.93	0.90	0.82	0.89	1.00	0.85	1.13	1.10	1.00	0.92	0.94
Zhejiang	1.00	0.98	0.89	0.96	1.08	0.92	1.22	1.19	1.08	1.00	1.02
Nation	0.98	0.96	0.87	0.94	1.06	0.90	1.20	1.17	1.06	0.98	1.00

Now we turn to a comparison of the similarity or dissimilarity between provincial cause-of-death patterns. The values of index of dissimilarity that are calculated based on equation 2 are displayed in Table 3. The value in a cell with row i and column j in this table indicates the percentage of deaths in the province in row i or in the province in column j that would have to be redistributed to make the distribution of cause-of-death the same between the province in row i and the province in column j.

Based on Table 3, an MDS graph is plotted as shown in Figure 4. Here, two dimensional distances among points are chosen from Duncan's function of dissimilarity. In this MDS plot, provinces with similar cause-of-death compositions are close to each other, while provinces having very different cause-of-death patterns are far away from each other. From Figure 4, it is clear that Tibet has a very different cause-of-death pattern compared to all other provinces. All of the values of the index of dissimilarity between Tibet and other provinces are greater than 20, and even as high as 43 when compared to Zhejiang, which means 43 percent of deaths in Tibet would need to be redistributed to make its cause-of-death distribution the same as in Zhejiang. Obviously, Tibet is in a different epidemiological transition stage compared to other provinces.

More exploration of Figures 3 and 4 helps us to find interesting results concerning the relationship between mortality levels or age patterns of mortality and disease patterns.

First, populations with similar mortality levels and/or age patterns of death do not necessarily have similar disease patterns. In Figure 4, one clear observation is that Beijing and Tianjin are located in the upper-right of the plot, while Shanghai, Zhejiang, and Jinagsu are located far away, in the upper-left panel of the plot, and we find that, based on Table 3, the indices of dissimilarity of causes-of-death patterns between Beijing or Tianjin and Shanghai or Zhejiang or Jiangsu are all above 20., We know that these five provinces have similar mortality levels according to Table 1 and the age patterns of these five provinces are also more or less similar to each other (except Zhejiang) based on Figure 3. The other example is Guangdong, which has a mortality level and age pattern of death similar to those of Beijing, Tianjin, Shanghai, Zhejiang, and Jiangsu, but its disease pattern is very different from these provinces' disease patterns. We also see that Xinjiang and Tibet have different mortality levels but have similar age patterns, and they differ in significant ways with regard to causes of death. Comparing Figures 3 and 4, we find that Ningxia, Jiangxi, Anhui and Shaanxi are clustered together in Figure 3, indicating that the age patterns of deaths of the four provinces are similar, whereas the four provinces are widely scattered in Figure 4, suggesting that their cause-of-death compositions differ from each other.

Second, populations with different mortality levels and/or age patterns of death may have similar disease patterns, or in other words, populations with similar disease patterns may have quite different age patterns. For instance, compared to Shanxi, Heilongjiang and Jilin, Beijing has a much lower mortality level, and Beijing's age pattern of death is not very similar to those of the three other provinces, but its disease pattern is similar to those of the three provinces. Beijing is close to Shanxi, Heilongjiang and Jilin in the upper-right panel of Figure 4, and only about 7-9 percent of deaths need to be redistributed to make the cause-of-death distribution the same as in Shanxi, Heilongjiang or Jilin. As another example, Guangxi and Jiangxi, or Guizhou and Hunan, have different age patterns of mortality, but have very similar cause-of-death patterns.

Third, the disease patterns follow certain geographic strata, indicating that socioeconomic development, climate, diet, life style or culture might play important roles in the composition of causes of death. In Figure 4, we see that all of the provinces in the upper-right side are located in the east or northeast of China except Henan and Hubei (Beijing, Tianjin, Hebei, Shanxi, Heilongjiang, Jilin, and Liaoning). The provinces Shanghai, Zhejiang, Jinagsu, Anhui and Fujian, which are neighboring geographically in the middle-east of China, are all close to each other in the upper-left panel of the plot. Shaanxi, Sichuan and Qinhai are close to each other both geographically and in disease patterns. Hunan, Jinagxi, Guangxi, Guizhou and Yunnan, which are all located in the south of China, are also similar with respect to disease patterns. These findings indicate that the geographic components do matter in the composition of causes of death, as shown more clearly in Figure 5. Based on Figure 4, I obtained Figure 5 which maps the strata of disease patterns. From the map, we can see that, in general, the disease strata have a geographic pattern, although there are several exceptions. The obvious exception is Gansu, which is located in the west of China, but similar in disease patterns to Anhui, Shanghai, Jiangsu, and Zhejiang. Shandong province is also an exception, as it differs in disease patterns from its neighboring provinces. Ningxia and Hainan are two provinces that are not close to each other, but their disease patterns are similar to each other and different from their respective neighbors. Guangdong and Fujian are two provinces located in the southeast of China, and their cause-of-death compositions are much closer to those of Sichuan, Qinhai and Shaanxi than to their neighbors, such as Guangxi, Jiangxi, Yunnan, Guizhou and Hunan.

Although there are exceptions, the general geographic patterns of disease strata indicate that socioeconomic development, environment factors including climate and pollution, diet, life style and culture may play certain roles in the composition of causes of death for a province or region. Socioeconomic development also has a geographic pattern at a broad level, suggesting that the geographic patterns of cause-of-death composition might imply the influence of socioeconomic level on causes of death. Climate and diet may also play important roles in cause-of-death patterns. The provinces located in the north or northeast of China are in general dry and cold in winter, and the main food source is flour, while the provinces located in the middle-east are more humid and warmer and their main food supply is rice. These factors may help explain why Beijing, Tian and Shanghai, Zhejiang, Jiangsu, which are similar in mortality levels and age patterns of death, are so different in their cause-of-death patterns. Culture or life style is also similar for neighboring provinces, which might also affect the cause-of-death composition.

Table 3 The Values of Dissimilarity Index for Cause-of-death Patterns between Provinces in the 1990s

	Anhui	Beijing	Fujian	Gansu	Guangdong	Guangxi	Guizhou	Hainan	Hebei	Heilongjiang
Anhui	***0.00***	23.73	***8.60***	***9.15***	***8.42***	11.65	17.27	16.38	16.58	18.66
Beijing	23.73	***0.00***	25.95	25.23	17.63	21.20	25.08	23.63	***9.70***	***8.34***
Fujian	***8.60***	25.95	***0.00***	***8.73***	***9.68***	11.35	16.19	18.23	21.00	23.36
Gansu	***9.15***	25.23	***8.73***	***0.00***	12.43	13.18	12.97	23.55	18.48	19.57
Guangdong	***8.42***	17.63	***9.68***	12.43	***0.00***	10.75	14.72	12.09	15.45	14.91
Guangxi	11.65	21.20	11.35	13.18	10.75	***0.00***	11.08	18.69	20.37	21.95
Guizhou	17.27	25.08	16.19	12.97	14.72	11.08	***0.00***	26.32	23.46	25.04
Hainan	16.38	23.63	18.23	23.55	12.09	18.69	26.32	***0.00***	19.76	20.96
Hebei	16.58	***9.70***	21.00	18.48	15.45	20.37	23.46	19.76	***0.00***	***4.76***
Heilongjiang	18.66	***8.34***	23.36	19.57	14.91	21.95	25.04	20.96	***4.76***	***0.00***
Henan	17.10	12.05	21.49	18.71	15.95	20.69	23.77	18.21	***4.11***	***5.36***
Hubei	17.80	10.86	22.80	19.22	18.78	18.56	21.06	22.32	***7.08***	***6.49***
Hunan	13.39	21.36	12.94	10.17	12.50	10.26	***4.86***	22.75	18.92	20.78
Inner Mongolia	11.51	15.20	17.96	17.36	12.71	19.73	22.82	18.36	***6.77***	***9.94***
Jiangsu	***8.53***	26.18	***8.89***	***9.55***	11.34	17.81	20.30	20.34	20.58	21.22
Jiangxi	12.42	21.69	***9.86***	11.39	10.72	***5.64***	***7.22***	20.10	20.85	22.43
Jilin	23.23	***7.32***	24.42	23.71	18.37	19.31	23.79	20.18	***8.55***	***7.38***
Liaoning	18.63	11.05	19.65	20.13	15.10	17.50	23.00	15.22	***5.69***	***8.54***
Ningxia	12.12	16.86	12.81	14.72	10.42	12.81	17.93	12.75	10.64	12.71
Qinghai	10.69	22.51	***9.53***	***6.40***	11.98	***8.34***	***9.12***	23.57	20.25	21.82
Shaanxi	***8.41***	21.97	***9.74***	***5.61***	10.12	***9.13***	***9.80***	21.70	17.16	18.65
Shandong	***9.69***	17.66	12.30	***8.90***	10.93	13.96	13.97	20.93	11.12	12.39
Shanghai	10.56	25.71	***8.56***	13.45	11.08	18.93	22.42	18.84	23.06	23.80
Shanxi	20.16	***8.83***	25.30	21.90	20.00	23.68	26.77	21.43	***5.68***	***5.73***
Sichuan	12.72	21.70	12.94	***5.67***	13.75	10.39	***9.45***	24.94	19.70	21.64
Tianjin	19.37	***6.64***	19.97	20.34	12.74	15.28	20.78	20.32	***9.85***	***9.58***
Tibet	36.75	34.38	36.44	38.28	29.46	25.10	26.15	24.94	34.38	33.72
Xinjiang	23.34	11.92	23.47	25.99	17.01	17.09	19.76	16.21	12.81	12.85
Yunnan	17.11	26.02	14.69	11.54	15.29	10.12	***3.67***	25.20	25.19	26.77
Zhejiang	11.81	29.51	***8.19***	***7.22***	14.20	18.50	18.56	23.61	23.42	25.38

Note: The bold italic values are less than 10. The underlined values are greater than 25.

Table 3 The Values of Dissimilarity Index for Cause-of-death Patterns between Provinces in the 1990s (cont'd)

	Henan	Hubei	Hunan	Inner Mongolia	Jiangsu	Jiangxi	Jilin	Liaoning	Ningxia	Qinghai
Anhui	17.10	17.80	13.39	11.51	***8.53***	12.42	23.23	18.63	12.12	10.69
Beijing	12.05	10.86	21.36	15.20	<u>26.18</u>	21.69	***7.32***	11.05	16.86	22.51
Fujian	21.49	22.80	12.94	17.96	***8.89***	***9.86***	24.42	19.65	12.81	***9.53***
Gansu	18.71	19.22	10.17	17.36	***9.55***	11.39	23.71	20.13	14.72	***6.40***
Guangdong	15.95	18.78	12.50	12.71	11.34	10.72	18.37	15.10	10.42	11.98
Guangxi	20.69	18.56	10.26	19.73	17.81	***5.64***	19.31	17.50	12.81	***8.34***
Guizhou	23.77	21.06	***4.86***	22.82	20.30	***7.22***	23.79	23.00	17.93	***9.12***
Hainan	18.21	22.32	22.75	18.36	20.34	20.10	20.18	15.22	12.75	23.57
Hebei	***4.11***	***7.08***	18.92	***6.77***	20.58	20.85	***8.55***	***5.69***	10.64	20.25
Heilongjiang	***5.36***	***6.49***	20.78	***9.94***	21.22	22.43	***7.38***	***8.54***	12.71	21.82
Henan	***0.00***	***4.11***	19.24	10.26	21.76	21.17	***6.13***	***6.50***	***9.61***	20.59
Hubei	***4.11***	***0.00***	16.86	12.56	24.47	18.46	***5.67***	***8.46***	10.69	17.93
Hunan	19.24	16.86	***0.00***	18.28	16.48	***5.30***	20.53	19.27	14.24	***8.88***
Inner Mongolia	10.26	12.56	18.28	***0.00***	16.46	20.21	15.22	10.05	11.79	19.61
Jiangsu	21.76	24.47	16.48	16.46	***0.00***	16.30	<u>25.53</u>	22.03	17.97	11.93
Jiangxi	21.17	18.46	***5.30***	20.21	16.30	***0.00***	19.79	18.72	13.64	***6.99***
Jilin	***6.13***	***5.67***	20.53	15.22	<u>25.53</u>	19.79	***0.00***	***7.14***	12.41	20.99
Liaoning	***6.50***	***8.46***	19.27	10.05	22.03	18.72	***7.14***	***0.00***	***7.09***	19.75
Ningxia	***9.61***	10.69	14.24	11.79	17.97	13.64	12.41	***7.09***	***0.00***	14.68
Qinghai	20.59	17.93	***8.88***	19.61	11.93	***6.99***	20.99	19.75	14.68	***0.00***
Shaanxi	17.39	15.86	***7.58***	16.44	11.10	***6.23***	20.46	18.12	13.04	***3.40***
Shandong	12.85	12.78	***9.44***	***9.00***	13.78	11.37	17.49	12.43	***9.36***	10.76
Shanghai	24.54	<u>27.65</u>	19.17	18.94	***4.25***	17.42	<u>27.56</u>	22.82	19.18	14.26
Shanxi	***4.23***	***5.70***	22.23	11.10	<u>25.13</u>	24.16	***5.85***	***7.86***	13.45	23.55
Sichuan	21.49	18.65	***7.25***	19.17	14.21	***7.88***	20.76	20.39	16.01	***6.34***
Tianjin	11.74	11.27	17.05	12.21	21.29	16.49	***9.21***	***7.75***	12.69	17.62
Tibet	<u>31.18</u>	<u>31.58</u>	<u>28.91</u>	<u>36.69</u>	<u>39.92</u>	<u>27.79</u>	<u>28.66</u>	<u>28.69</u>	<u>26.68</u>	<u>33.43</u>
Xinjiang	13.89	13.56	16.36	17.20	<u>27.30</u>	16.60	12.17	***9.31***	14.46	22.97
Yunnan	<u>25.51</u>	22.80	***7.30***	24.55	20.14	***6.42***	24.13	22.49	17.41	***9.65***
Zhejiang	24.44	<u>26.43</u>	16.30	19.07	***8.55***	16.99	<u>27.99</u>	24.40	19.07	11.99

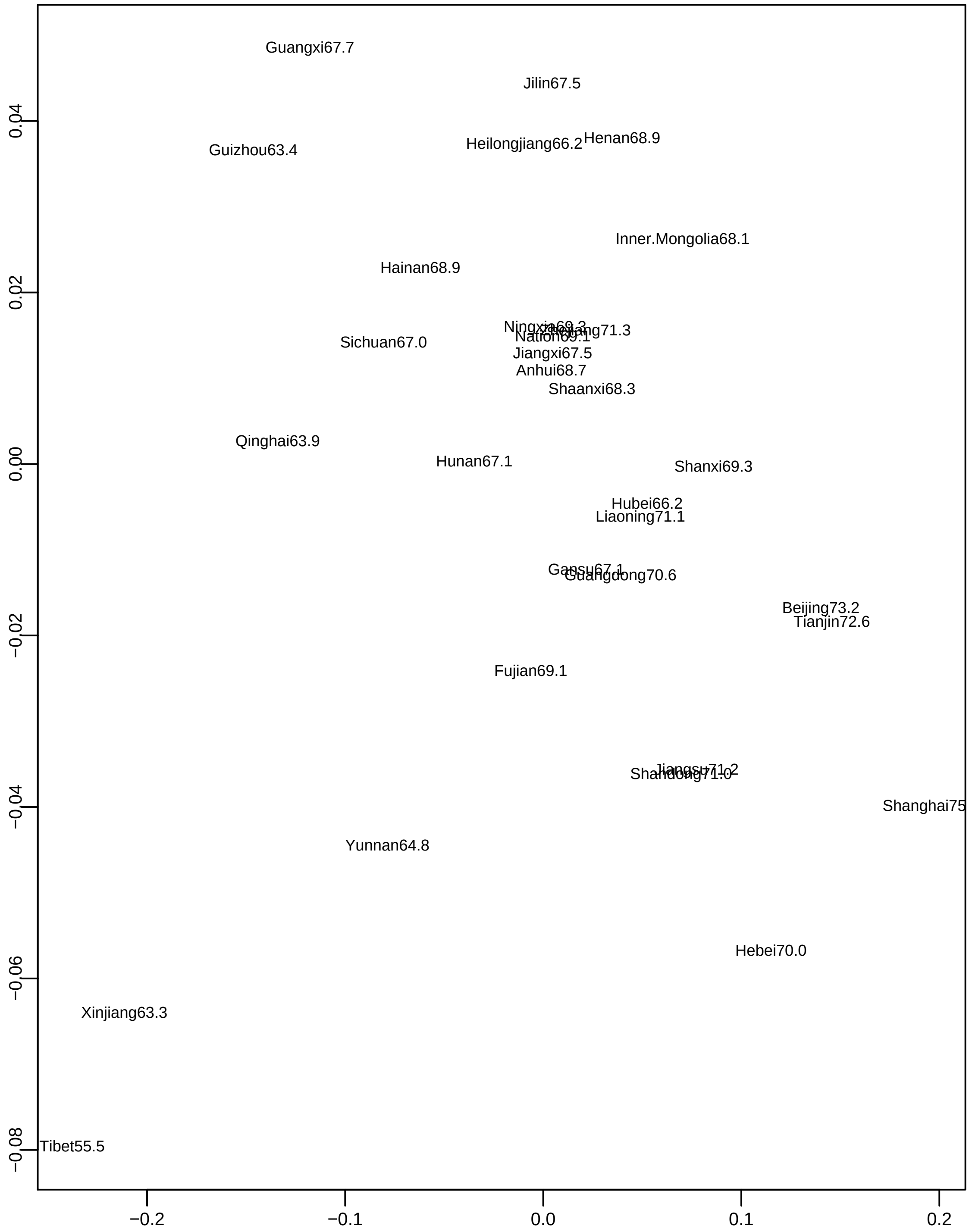
Note: The bold italic values are less than 10. The underlined values are greater than 25.

Table 3 The Values of Dissimilarity Index for Cause-of-death Patterns between Provinces in the 1990s (cont'd)

	Shaanxi	Shandong	Shanghai	Shanxi	Sichuan	Tianjin	Tibet	Xinjiang	Yunnan	Zhejiang
Anhui	***8.41***	***9.69***	10.56	20.16	12.72	19.37	36.75	23.34	17.11	11.81
Beijing	21.97	17.66	25.71	***8.83***	21.70	***6.64***	34.38	11.92	26.02	29.51
Fujian	***9.74***	12.30	***8.56***	25.30	12.94	19.97	36.44	23.47	14.69	***8.19***
Gansu	***5.61***	***8.90***	13.45	21.90	***5.67***	20.34	38.28	25.99	11.54	***7.22***
Guangdong	10.12	10.93	11.08	20.00	13.75	12.74	29.46	17.01	15.29	14.20
Guangxi	***9.13***	13.96	18.93	23.68	10.39	15.28	25.10	17.09	10.12	18.50
Guizhou	***9.80***	13.97	22.42	26.77	***9.45***	20.78	26.15	19.76	***3.67***	18.56
Hainan	21.70	20.93	18.84	21.43	24.94	20.32	24.94	16.21	25.20	23.61
Hebei	17.16	11.12	23.06	***5.68***	19.70	***9.85***	34.38	12.81	25.19	23.42
Heilongjiang	18.65	12.39	23.80	***5.73***	21.64	***9.58***	33.72	12.85	26.77	25.38
Henan	17.39	12.85	24.54	***4.23***	21.49	11.74	31.18	13.89	25.51	24.44
Hubei	15.86	12.78	27.65	***5.70***	18.65	11.27	31.58	13.56	22.80	26.43
Hunan	***7.58***	***9.44***	19.17	22.23	***7.25***	17.05	28.91	16.36	***7.30***	16.30
Inner Mongolia	16.44	***9.00***	18.94	11.10	14.21	21.29	39.92	27.30	20.14	***8.55***
Jiangsu	11.10	13.78	***4.25***	25.13	***7.88***	16.49	27.79	16.60	***6.42***	16.99
Jiangxi	***6.23***	11.37	17.42	24.16	20.76	***9.21***	28.66	12.17	24.13	27.99
Jilin	20.46	17.49	27.56	***5.85***	20.39	***7.75***	28.69	***9.31***	22.49	24.40
Liaoning	18.12	12.43	22.82	***7.86***	19.17	12.21	36.69	17.20	24.55	19.07
Ningxia	13.04	***9.36***	19.18	13.45	16.01	12.69	26.68	14.46	17.41	19.07
Qinghai	***3.40***	10.76	14.26	23.55	***6.34***	17.62	33.43	22.97	***9.65***	11.99
Shaanxi	***0.00***	***7.59***	14.46	20.38	***5.69***	17.08	33.84	22.20	***9.97***	12.35
Shandong	***7.59***	***0.00***	16.27	13.54	10.88	13.63	34.24	19.10	15.71	15.81
Shanghai	14.46	16.27	***0.00***	27.61	17.66	21.69	40.30	26.14	21.79	10.76
Shanxi	20.38	13.54	27.61	***0.00***	22.95	13.28	34.51	16.38	28.50	27.72
Sichuan	***5.69***	10.88	17.66	22.95	***0.00***	17.39	35.14	22.92	***8.03***	10.10
Tianjin	17.08	13.63	21.69	13.28	17.39	***0.00***	30.80	***9.00***	20.26	24.62
Tibet	33.84	34.24	40.30	34.51	35.14	30.80	***0.00***	22.46	27.25	42.79
Xinjiang	22.20	19.10	26.14	16.38	22.92	***9.00***	22.46	***0.00***	19.95	30.57
Yunnan	***9.97***	15.71	21.79	28.50	***8.03***	20.26	27.25	19.95	***0.00***	17.13
Zhejiang	12.35	15.81	10.76	27.72	10.10	24.62	42.79	30.57	17.13	***0.00***

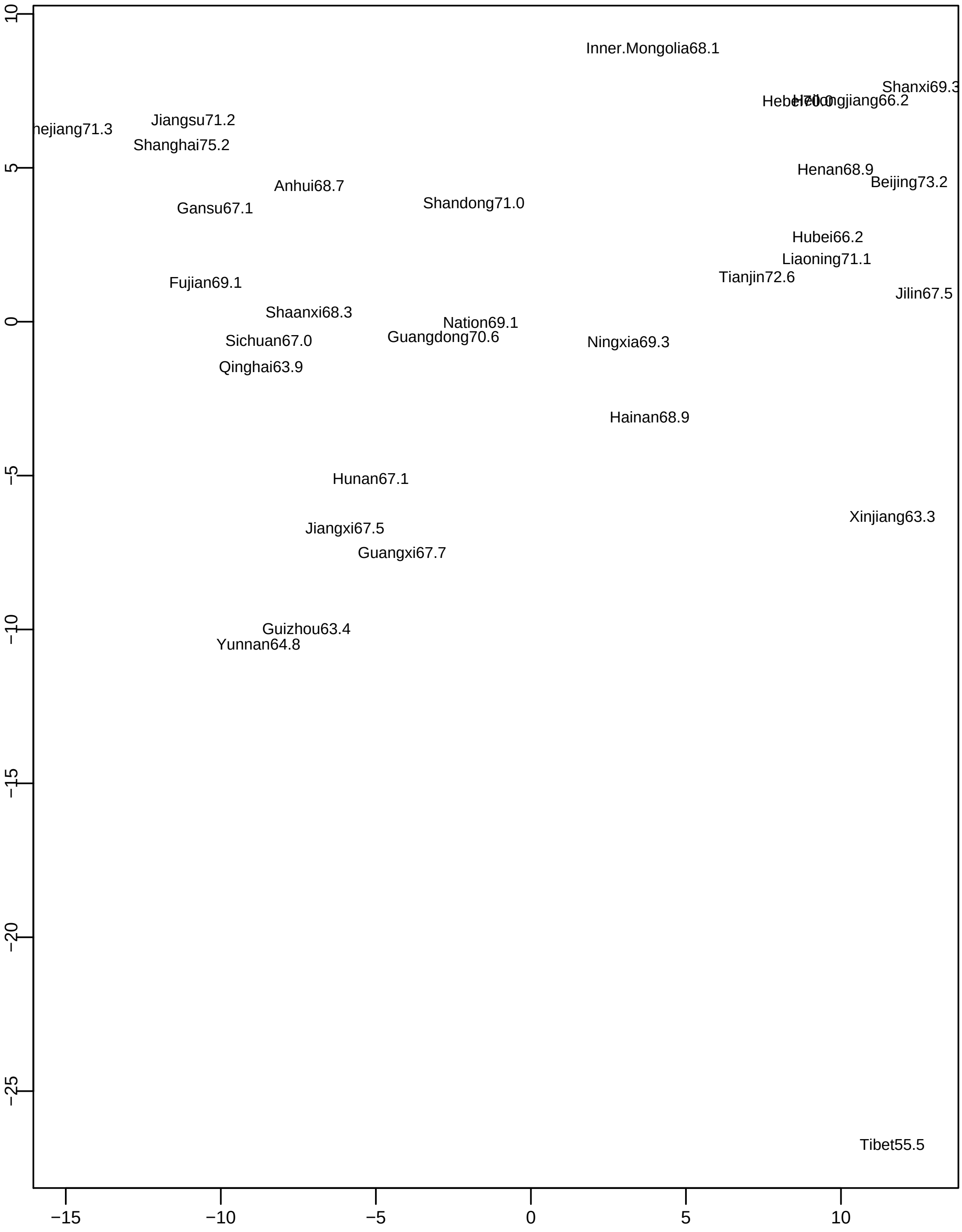
Note: The bold italic values are less than 10. The underlined values are greater than 25.

Figure 3 MDS Plot for Dissimilarity of Age Patterns of Death



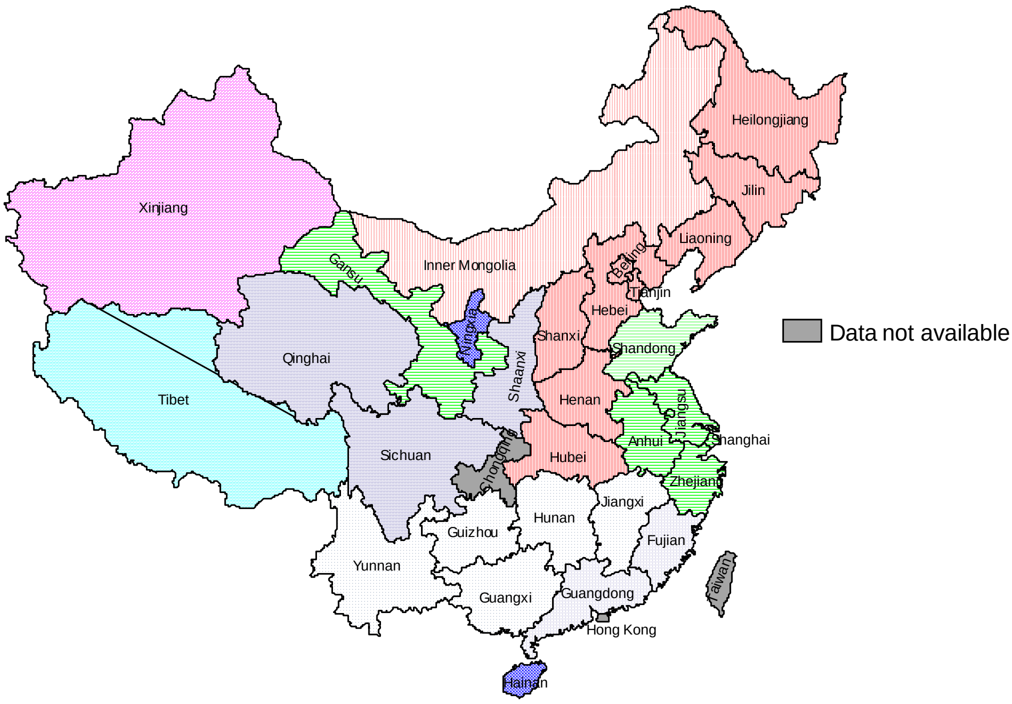
Note: the number following the name of a province is the life expectancy at birth of this province.

Figure 4 MDS Plot for Dissimilarity of Composition of Causes of Death



Note: the number following the name of a province is the life expectancy at birth of this province.

Figure 5 Stratum of Cause-of-death Pattern



Note: Provinces having similar filled colors and patterns have similar compositions of causes of death.

Conclusion and Discussion

In general, the relationship between the cause-of-death structure and the age pattern of mortality can be interpreted from two broad perspectives---the "bottom-up" and "top-down" theories (Himes, 1994). The "bottom-up" theory posits that the overall mortality rate at any one age can be regarded as the result of a sum of individual causes of death at that age. The overall age pattern of mortality, then, is a result of a multitude of individual causes with different age structures acting independently. In this case, we would expect to find populations with similar cause-of-death structures to have similar age patterns of mortality. The 'top-down" theory assumes that the overall age pattern is fixed and deaths are distributed "downward" among several possible causes, depending on cultural, nutritional, and environmental differences (Gavrilov and Gavrilova, 1991). This theory implies that we could find similar age patterns of mortality with very different underlying cause-of-death patterns.

In line with Himes' study of Japan, Sweden and the United States, the results based on thirty Chinese provinces in this study confirm that there are no invariously relationships between mortality level, age pattern of mortality and cause-of-death composition, and that not all populations reach low mortality in the same way. Declines in specific causes of death are not necessary to create similar age patterns of mortality. Populations with similar age patterns of mortality may have quite different underlying cause-of-death structures, and similar cause-of-death patterns do not necessarily result in similar age patterns of mortality. The results support Gavrilov and Gavrilova's idea that the patterns of age-specific mortality remain relatively stable as life expectancy increases, although the causes of death that make up those mortality patterns may vary. If Gavrilov and Gavrilova's theory about "nonspecific vulnerability" is true, i.e., if we view mortality as due to the movement of individuals into a state of nonspecific vulnerability, then any public health interventions or improvements in medical technology which delay this movement should result in a decline in mortality, even though no individual cause of death is eliminated (Himes, 1994).

The results from the thirty Chinese provinces suggest that as to the cause-of-death structure, there may be more than one path to reach low mortality. Besides regional development, climate, diet, life style and culture may influence the composition of causes of death in a population. It is possible that different populations may reach low mortality through different changes in the cause-of-death structure.

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Appendices

Table A1 Intercept Obtained by Regressing Mortality of Each Province in the Column on that of Each Province in the Row

	Anhui	Beijing	Fujian	Gansu	Guangdong	Guangxi	Guizhou	Hainan	Heilongjiang	Hebei
Anhui	0.000	-0.121	0.036	-0.110	0.075	0.309	0.143	0.282	-0.119	-0.308
Beijing	0.127	0.000	0.175	0.002	0.221	0.482	0.297	0.445	-0.006	-0.208
Fujian	-0.047	-0.160	0.000	-0.162	0.040	0.273	0.104	0.240	-0.165	-0.345
Gansu	0.101	-0.023	0.131	0.000	0.169	0.404	0.247	0.380	-0.019	-0.211
Guangdong	-0.091	-0.205	-0.042	-0.210	0.000	0.238	0.063	0.202	-0.211	-0.395
Guangxi	-0.302	-0.404	-0.258	-0.409	-0.219	0.000	-0.156	-0.038	-0.415	-0.578
Guizhou	-0.163	-0.264	-0.123	-0.260	-0.088	0.130	0.000	0.089	-0.284	-0.432
Hainan	-0.275	-0.387	-0.235	-0.383	-0.196	0.025	-0.140	0.000	-0.384	-0.565
Heilongjiang	0.106	-0.014	0.142	-0.003	0.181	0.405	0.231	0.388	0.000	-0.197
Hebei	0.326	0.201	0.374	0.202	0.418	0.672	0.493	0.637	0.196	0.000
Henan	0.133	0.011	0.175	0.018	0.215	0.455	0.285	0.427	0.012	-0.179
Hubei	0.357	0.234	0.399	0.243	0.440	0.682	0.511	0.652	0.234	0.042
Hunan	-0.015	-0.128	0.025	-0.122	0.064	0.296	0.143	0.260	-0.137	-0.310
Inner Mongolia	0.261	0.137	0.301	0.148	0.343	0.587	0.412	0.558	0.139	-0.059
Jiangsu	0.072	-0.050	0.121	-0.050	0.164	0.411	0.228	0.377	-0.052	-0.247
Jiangxi	0.104	-0.014	0.144	-0.006	0.185	0.423	0.260	0.390	-0.019	-0.203
Jilin	0.075	-0.045	0.113	-0.036	0.154	0.383	0.206	0.361	-0.035	-0.232
Liaoning	-0.003	-0.120	0.045	-0.121	0.088	0.331	0.158	0.295	-0.128	-0.313
Ningxia	-0.112	-0.231	-0.079	-0.212	-0.040	0.196	0.047	0.165	-0.236	-0.419
Qinghai	-0.284	-0.399	-0.263	-0.374	-0.229	-0.020	-0.163	-0.037	-0.390	-0.568
Shaanxi	0.165	0.046	0.203	0.058	0.243	0.485	0.331	0.450	0.036	-0.145
Shandong	0.067	-0.051	0.116	-0.052	0.158	0.405	0.236	0.367	-0.061	-0.245
Shanghai	0.097	-0.030	0.154	-0.036	0.202	0.473	0.277	0.430	-0.041	-0.246
Shanxi	0.309	0.186	0.353	0.195	0.394	0.645	0.479	0.610	0.179	-0.011
Sichuan	-0.134	-0.243	-0.095	-0.237	-0.057	0.166	0.016	0.133	-0.250	-0.419
Tianjin	0.146	0.015	0.190	0.026	0.233	0.491	0.309	0.462	0.016	-0.191
Tibet	-0.155	-0.259	-0.130	-0.246	-0.096	0.095	-0.053	0.081	-0.246	-0.417
Xinjiang	-0.493	-0.599	-0.467	-0.583	-0.433	-0.237	-0.384	-0.250	-0.585	-0.759
Yunnan	-0.099	-0.205	-0.058	-0.199	-0.021	0.206	0.066	0.167	-0.222	-0.383
Zhejiang	-0.070	-0.184	-0.020	-0.187	0.022	0.264	0.099	0.223	-0.197	-0.374
Nation	0.006	-0.110	0.048	-0.105	0.088	0.324	0.161	0.292	-0.115	-0.297

Table A1 Intercept Obtained by Regressing Mortality of Each Province in the Column on that of Each Province in the Row (Cont'd)

	Henan	Hubei	Hunan	Inner Mongolia	Jiangsu	Jiangxi	Jilin	Liaoning	Ningxia	Qinghai
Anhui	-0.133	-0.347	0.005	-0.254	-0.078	-0.107	-0.084	-0.008	0.097	0.298
Beijing	-0.017	-0.255	0.139	-0.151	0.048	0.013	0.035	0.127	0.236	0.450
Fujian	-0.175	-0.388	-0.037	-0.296	-0.114	-0.150	-0.128	-0.045	0.046	0.237
Gansu	-0.034	-0.247	0.106	-0.151	0.018	-0.005	0.015	0.089	0.208	0.411
Guangdong	-0.222	-0.439	-0.081	-0.345	-0.159	-0.195	-0.173	-0.088	0.003	0.197
Guangxi	-0.421	-0.618	-0.289	-0.533	-0.363	-0.394	-0.379	-0.298	-0.213	-0.040
Guizhou	-0.279	-0.472	-0.142	-0.390	-0.229	-0.250	-0.249	-0.160	-0.062	0.098
Hainan	-0.399	-0.604	-0.270	-0.514	-0.343	-0.376	-0.350	-0.278	-0.186	0.004
Heilongjiang	-0.023	-0.234	0.104	-0.141	0.032	-0.002	0.032	0.097	0.194	0.401
Hebei	0.187	-0.047	0.338	0.052	0.249	0.214	0.235	0.326	0.431	0.639
Henan	0.000	-0.221	0.141	-0.126	0.057	0.025	0.048	0.129	0.232	0.435
Hubei	0.222	0.000	0.366	0.095	0.280	0.248	0.271	0.353	0.459	0.663
Hunan	-0.142	-0.350	0.000	-0.261	-0.087	-0.114	-0.102	-0.016	0.087	0.270
Inner Mongolia	0.123	-0.100	0.267	0.000	0.183	0.151	0.176	0.256	0.365	0.573
Jiangsu	-0.065	-0.292	0.081	-0.193	0.000	-0.038	-0.013	0.073	0.170	0.376
Jiangxi	-0.028	-0.244	0.115	-0.150	0.029	0.000	0.018	0.101	0.206	0.402
Jilin	-0.057	-0.270	0.075	-0.175	0.001	-0.033	0.000	0.068	0.166	0.372
Liaoning	-0.136	-0.358	0.010	-0.262	-0.074	-0.108	-0.089	0.000	0.098	0.294
Ningxia	-0.244	-0.456	-0.099	-0.362	-0.193	-0.214	-0.201	-0.119	0.000	0.194
Qinghai	-0.407	-0.598	-0.285	-0.511	-0.363	-0.383	-0.360	-0.302	-0.191	0.000
Shaanxi	0.031	-0.186	0.180	-0.092	0.086	0.061	0.074	0.161	0.275	0.469
Shandong	-0.067	-0.292	0.083	-0.196	-0.005	-0.039	-0.023	0.071	0.171	0.366
Shanghai	-0.050	-0.297	0.112	-0.190	0.022	-0.019	0.003	0.104	0.207	0.423
Shanxi	0.172	-0.055	0.324	0.043	0.230	0.201	0.217	0.308	0.420	0.622
Sichuan	-0.256	-0.458	-0.121	-0.372	-0.203	-0.230	-0.216	-0.135	-0.037	0.142
Tianjin	0.002	-0.236	0.154	-0.132	0.063	0.030	0.055	0.141	0.255	0.475
Tibet	-0.268	-0.446	-0.160	-0.365	-0.222	-0.248	-0.218	-0.168	-0.079	0.101
Xinjiang	-0.606	-0.789	-0.495	-0.707	-0.562	-0.587	-0.558	-0.504	-0.411	-0.229
Yunnan	-0.221	-0.423	-0.079	-0.336	-0.168	-0.192	-0.186	-0.097	0.006	0.178
Zhejiang	-0.200	-0.420	-0.053	-0.326	-0.138	-0.172	-0.158	-0.064	0.033	0.220
Nation	-0.124	-0.339	0.017	-0.246	-0.067	-0.097	-0.079	0.005	0.106	0.299

Table A1 Intercept Obtained by Regressing Mortality of Each Province in the Column on that of Each Province in the Row (Cont'd)

	Shaanxi	Shandong	Shanghai	Shanxi	Sichuan	Tianjin	Tibet	Xinjiang	Yunnan	Zhejiang	Nation
Anhui	-0.173	-0.078	-0.103	-0.300	0.134	-0.135	0.170	0.558	0.078	0.048	-0.011
Beijing	-0.061	0.049	0.025	-0.200	0.282	-0.021	0.311	0.743	0.223	0.192	0.120
Fujian	-0.217	-0.114	-0.136	-0.340	0.092	-0.179	0.117	0.502	0.038	0.014	-0.052
Gansu	-0.068	0.019	-0.008	-0.197	0.236	-0.033	0.273	0.666	0.183	0.145	0.089
Guangdong	-0.265	-0.159	-0.180	-0.390	0.050	-0.226	0.076	0.468	-0.005	-0.028	-0.096
Guangxi	-0.457	-0.362	-0.381	-0.572	-0.171	-0.425	-0.153	0.202	-0.218	-0.242	-0.305
Guizhou	-0.303	-0.218	-0.244	-0.419	-0.028	-0.282	-0.029	0.323	-0.065	-0.101	-0.164
Hainan	-0.442	-0.345	-0.366	-0.560	-0.146	-0.402	-0.111	0.261	-0.201	-0.224	-0.283
Heilongjiang	-0.071	0.026	0.004	-0.192	0.233	-0.026	0.283	0.666	0.171	0.148	0.093
Hebei	0.142	0.252	0.225	0.006	0.478	0.182	0.503	0.927	0.420	0.391	0.320
Henan	-0.043	0.058	0.032	-0.172	0.274	-0.004	0.305	0.707	0.217	0.189	0.125
Hubei	0.180	0.281	0.255	0.050	0.500	0.219	0.531	0.936	0.442	0.412	0.349
Hunan	-0.175	-0.082	-0.107	-0.299	0.124	-0.145	0.140	0.521	0.077	0.044	-0.020
Inner Mongolia	0.082	0.182	0.158	-0.050	0.402	0.122	0.440	0.847	0.346	0.315	0.252
Jiangsu	-0.111	-0.002	-0.024	-0.242	0.218	-0.069	0.249	0.658	0.159	0.134	0.065
Jiangxi	-0.065	0.031	0.006	-0.194	0.244	-0.031	0.271	0.664	0.192	0.160	0.097
Jilin	-0.103	-0.005	-0.025	-0.226	0.205	-0.058	0.253	0.640	0.144	0.121	0.063
Liaoning	-0.178	-0.072	-0.095	-0.307	0.143	-0.140	0.166	0.569	0.089	0.061	-0.007
Ningxia	-0.273	-0.187	-0.215	-0.403	0.028	-0.245	0.053	0.443	-0.019	-0.060	-0.120
Qinghai	-0.440	-0.365	-0.388	-0.556	-0.169	-0.407	-0.124	0.225	-0.220	-0.254	-0.299
Shaanxi	0.000	0.093	0.065	-0.132	0.309	0.029	0.329	0.727	0.261	0.223	0.159
Shandong	-0.107	0.000	-0.026	-0.238	0.217	-0.071	0.233	0.642	0.164	0.135	0.064
Shanghai	-0.097	0.022	0.000	-0.240	0.260	-0.055	0.285	0.729	0.200	0.172	0.093
Shanxi	0.135	0.236	0.208	0.000	0.460	0.169	0.481	0.896	0.407	0.372	0.304
Sichuan	-0.290	-0.199	-0.224	-0.410	0.000	-0.260	0.018	0.387	-0.048	-0.078	-0.139
Tianjin	-0.043	0.063	0.036	-0.183	0.297	0.000	0.333	0.767	0.237	0.204	0.137
Tibet	-0.306	-0.229	-0.246	-0.411	-0.051	-0.269	0.000	0.321	-0.104	-0.126	-0.169
Xinjiang	-0.645	-0.567	-0.586	-0.752	-0.384	-0.607	-0.337	0.000	-0.436	-0.462	-0.505
Yunnan	-0.248	-0.159	-0.185	-0.370	0.040	-0.224	0.046	0.416	0.000	-0.036	-0.101
Zhejiang	-0.238	-0.133	-0.158	-0.366	0.078	-0.205	0.091	0.487	0.028	0.000	-0.072
Nation	-0.162	-0.064	-0.089	-0.289	0.146	-0.127	0.171	0.562	0.094	0.064	0.000