Title : **Do the Parents and Siblings of the Longevous Chinese also Live Longer? --Familial Factors on Mortality**

Author: Danzhen You

Department of Demography, University of California at Berkeley

2232 Piedmont Avenue

Berkeley, CA 94720-2120

Tel: (510)559-8304 Fax: (510)643-8558

Email: danzhen@demog.berkeley.edu

Do the Parents and Siblings of the Longevous Chinese also Live Longer?
---Familial Factors on Mortality

Danzhen You

Abstract

The paper use the data from the survey on "Determinants of Health Longevity in China (1998)" to explore the mortality and life expectancy of the parents and siblings of the 8803 longevous respondents who were 80 years old and over on the date of the survey, and to find the familial factors on mortality.

The parents are a cohort born in about 1840 to 1900 and the siblings born in about 1870 to 1940. Life tables for these two cohorts are constructed, and Cox regression is used to explore the familial factors on mortality.

The results show the parents and siblings of the longevous respondents also live longer than their peers. A positive correlation between the mortality risk of the respondents' parents and that of the siblings and an across-sex inheriting relationship, are found. Birth order has different effects on the mortality of the respondents' male siblings and on that of the female siblings. No significant differential of mortality between different-ordered male births except the very-high births. However, the females' mortality increased over the birth order.

Human's life expectancy had been longer and longer over time and still increases. There are many factors that make mortality decline and life expectancy increase: sufficient nutrition, human's behavior change, better living and work condition and biomedical improvements. All of the factors can be grouped into three main categories: environment, behavior and genes. In fact, many demographers have studied the environmental and behavioral causes of mortality decline and medical researchers focus on the genetic factor. In this paper, I try to check the familial factor on mortality from demographic perspective. The familial factor not only includes genetic factor but also the environmental and behavioral causes. Family offers not

only the genes but also an environment which determine whether the children's nutrition is enough, whether the living condition is good or whether people can easily accesses the medical care. And correlation in mortality across Families would arise because of infectious disease or other factors that may be largely random but that strike a whole family all at once; Family also shapes the children's behavior to some extent. Intuitively it seems family has a strong effect on the factors that can influence mortality and life expectancy. We may expect there exist some relationships between family members' mortality experiences.

Here, the author will check the mortality relationships between family members, using the data of China. Unfortunately, I can not distinguish the genetic factor from the environmental and behavioral factors since there is no relevant information in the data. However, it is still meaningful to see whether there is a correlation between family members. The author will also construct two cohort life tables of the birth cohort born in 1840's to 1900's and born in 1870's to 1940's.

Data

The data come from the survey of "Determinants of Health Longevity in China (1998)". This survey interviewed 9073 elderly people aged 80 and over in 22 provinces. I exclude the data of respondents' who were over 105 years old because their information is not correct in most degree so the number of the respondents is 8803 and the respondents aged from 80 to 105. This is a group that has been in a longevity state compared to the recent life expectancy (male 68, female 72, total population 71 according to 1995 1% sample survey). The respondents were invited to offer some information about their parents' birth year and death age and their still-alive siblings' current age and their dead siblings' death age. So, we can use this simple information to see whether these longevous people's parents and siblings are also longevous compared to the average level of their times and see if there exist familial factors on mortality.

Parent's death age and mortality

The data include 5256 fathers' and 5783 mothers' information. Since there are 8803 families, 3547 fathers' death age and 3520 mothers' death age were not reported. This will raise the possibility of selectivity bias if this is caused mainly by the facts that the respondents didn't know their fathers' or mothers' death age because their parents died when he or she was so young. Fortunately, it seems most of the un-report is caused by the respondents' bad health; 2616 respondents didn't report both their fathers' and mothers' death age. But we still can not say the death age distribution of the missing cases is the same with the reported cases and it will make the analysis results more uncertainty.

Among the reported 5256 fathers and 5783 mothers, the lowest death age is 20 for fathers and 18 for mothers and the highest is 115 for fathers and 114 for mothers. The mean and median age at death is 64 years old and 66 years old respectively for fathers and 68 and 71 for mothers. Among the fathers, 81.27 percent survived to at least 50-59 years old and 65.49 percent survived to at least 60-69 and 42.98 survived to at least 70-79; among the mothers, 83.56, 72.76 and 54.81 percent survived to at least 50-59, at least 60-69, and at least 70-79 years old respectively (Table 1). Since the parents birth years focus on the range from 1840 to 1900 (the median birth year is 1870), it seems the parents of the respondents also were long-lived people on average.

Table 1 The fathers' and mothers' death age distribution

	Father		mother	
death age	%	Inverse Cumulative %	%	Inverse Cumulative %
20-29	2.29	100.00	2.87	100.00
30-39	6.17	97.71	5.58	97.13
40-49	10.27	91.54	8.00	91.55
50-59	15.78	81.27	10.80	83.56
60-69	22.52	65.49	17.95	72.76
70-79	24.02	42.98	22.55	54.81
80-89	16.11	18.95	22.95	32.25
90-99	2.60	2.84	8.15	9.31
100+	0.24	0.24	1.16	1.16
Case	5256		5783	

Now I will construct the cohort life tables for fathers and mothers. One thing that must be pointed out is the respondents' parents are a group that had survived to the age of childbearing; this will affect the results when we construct the life table for this selected group and compare to the whole population. We can truncate a part of the parents' life to reduce this bias. Since there was no death risk to the parents before the respondent was born, we should truncate this period in their life, and then calculate the cohort age specific death rate. Using this method, I found the life expectancy at age 20-24 is 40.80 years for the fathers and 44.86 for mothers and mothers' death rate is lower than fathers' at almost all of ages. It is believed that the life expectancy at birth before the year1949 is lower than 40 (Table 2). The life expectancy for these parents is relatively higher than the average level of their times, considering they were

Table 2 The death rate and life expectancy of fathers and mothers

	Father		mother	
age	death rate	life expectancy	death rate	Life expectancy
15-19			0.002692	49.23
20-24	0.006108	40.80	0.009147	44.86
25-29	0.009229	36.98	0.008091	41.85
30-34	0.010046	33.61	0.009133	38.47
35-39	0.011325	30.22	0.008452	35.15
40-44	0.014585	26.83	0.011261	31.56
45-49	0.013692	23.67	0.009144	28.25
50-54	0.020458	20.17	0.016026	24.45
55-59	0.025041	17.08	0.013700	21.28
60-64	0.044589	14.03	0.028506	17.61
65-69	0.041976	11.92	0.027454	14.93
70-74	0.081651	9.13	0.055844	11.77
75-79	0.089968	7.53	0.056018	9.77
80-84	0.170861	5.44	0.120821	7.14
85-89	0.196325	4.83	0.137690	6.16
90-94	0.226804	4.32	0.178384	5.01
95-99	0.276151	4.08	0.244550	4.05
100-104	0.139535	6.12	0.267148	3.92
105-109	0.133333	5.00	0.160920	4.63
110-114	0.545455	2.50	0.545455	2.50

born almost before 1900. This death rate and life expectancy can not represent the average level of that period because of the selected bias. Though we have reduced the bias come from the parents had survived to the age of childbearing, the bias raised by the missing cases and the bias from the fact that the data don't include those people who were never married and who had no child and who had children but the children didn't survive to 80. So, the result is only limited to this group and will largely overstate the average level if it is used to estimate the overall level.

Sibling's death age and mortality

The respondents have 1975 male alive siblings, 2002 female alive siblings and 7756 male dead siblings and 5486 female dead siblings.

Among the 1975 male alive siblings, there are 83.1 percent has survived to over 70 years old in 1998; among the 2002 female alive siblings, 86.7 percent has survived to over 70. However, we can not say whether the respondents' siblings live long or not from the alive siblings' information. We should see the dead siblings' death age.

The mean age and median age is 61 and 68 years old for dead male siblings and 62, 70 for dead female siblings. The death age distribution of the dead siblings by sex is showed in table 3.

Table 3 The death age distribution of siblings

	male		female	
Age	%	Inverse Cumulative %	%	Inverse Cumulative %
0-20	8.90	100.00	9.79	100.00
20-40	12.48	91.10	10.88	90.21
40-60	15.87	78.62	13.14	79.33
60-80	35.65	62.75	32.88	66.19
80+	27.10	27.10	33.30	33.30
Case	7756		5486	

Since the death age of the siblings is from zero and there is no non-reported bias of their death risks, we can construct cohort life tables for the siblings (table 4). There are no siblings' birth year information, we can estimate a wide birth year range from 1870's to 1940's for them since the respondents were born from 1893 to 1918. We found the life expectancy at birth is 61.28 for male siblings and 62.99 for female siblings. For this birth cohort people, life expectancy of 61.28 for male and 62.99 for female is high; this level is close to 1970's level (Banister, 1987) and very high compared to the life expectancy before 1949, which is believed below 40. Here, we should point out that the report error perhaps raises the siblings' life expectancy. From

Table 4 The death rate and life expectancy of siblings

	Male		female	
age	death rate	life expectancy	death rate	life expectancy
0	0.002841	61.28	0.002007	62.99
1-4	0.006604	60.46	0.009786	62.11
5-9	0.004265	58.03	0.003563	60.52
10-14	0.003479	54.22	0.003437	56.57
15-19	0.005056	50.14	0.005428	52.51
20-24	0.007320	46.36	0.007531	48.89
25-29	0.006763	43.00	0.005716	45.69
30-34	0.007824	39.41	0.006678	41.95
35-39	0.007694	35.90	0.005901	38.32
40-44	0.008096	32.23	0.008272	34.40
45-49	0.008898	28.49	0.006546	30.77
50-54	0.014238	24.69	0.011542	26.73
55-59	0.014093	21.36	0.010058	23.20
60-64	0.027797	17.74	0.021983	19.27
65-69	0.027837	15.07	0.022416	16.27
70-74	0.055892	11.96	0.048078	12.94
75-79	0.058206	10.09	0.046639	10.85
80-84	0.108182	7.71	0.096905	8.09
85-89	0.131910	6.63	0.110218	6.73
90-94	0.155710	5.76	0.187559	5.02
95-99	0.212953	4.98	0.215539	4.53
100+	0.180851	5.53	0.232558	4.30

figure 1, we can see the death rate curve is not in "J shape" and the infant mortality rate is very low and the mortality rate at age zero is even lower than at age 1-4. This is not normal to this cohort who was born before 1950. The reasonable explanation is the number of death in childhood is underreported. This is possible because the respondents perhaps didn't know their old brother or sister's death or they were not willing to mention their sibling's death which happens in their sibling's childhood. The infant mortality may be more heavily underreported since there are no people aged "zero" in China: the baby is "one" years old as soon as it is born (from figure 2 and 3, it is obvious that the death at age 1 jumps up). This custom is one of the causes which make the mortality at age zero even lower than age 1-4. Since the child mortality is more underreported than the adult, it is better to use the adult's mortality rate or life expectancy to evaluate the cohort mortality level. From the life table, we find the life expectancy at age 20-24 is 43.36 for respondents' male siblings and 48.89 for female siblings, which is higher than their fathers' (40.80) and their mothers' (44.86). From figure 4, we can see the life expectancy of respondents' siblings is higher than their parents' at almost every age group; but the male siblings' life expectancy is only slightly higher than their mothers'. However, male's life expectancy improves much fast than females.

Figure 1: Death Rates of Siblings by Age and Sex

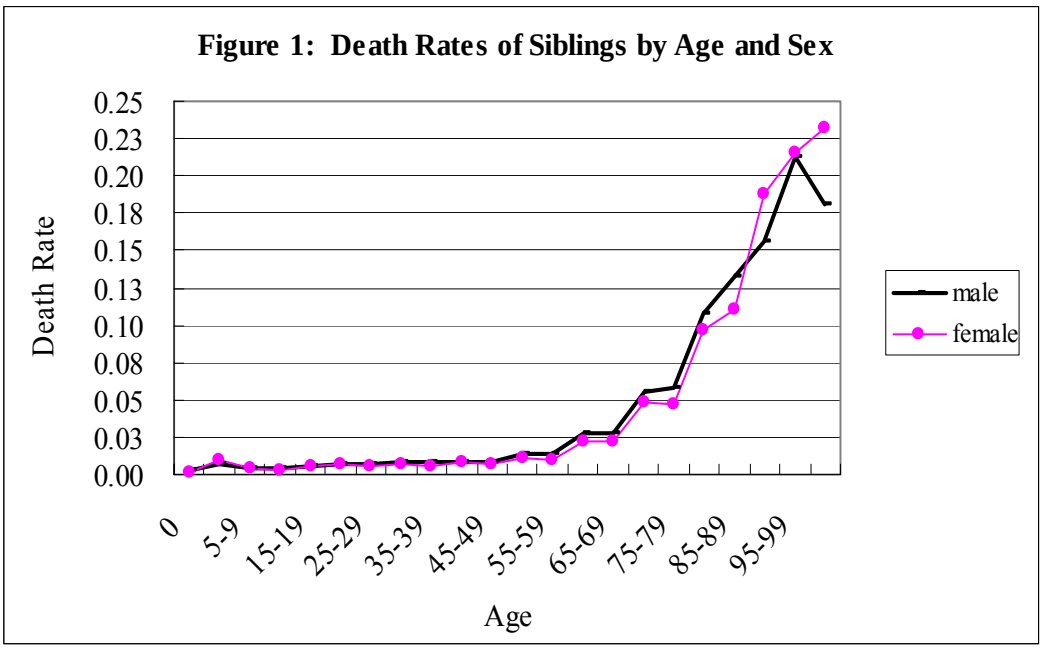


Figure 2 : Death Age Distribution of male Siblings

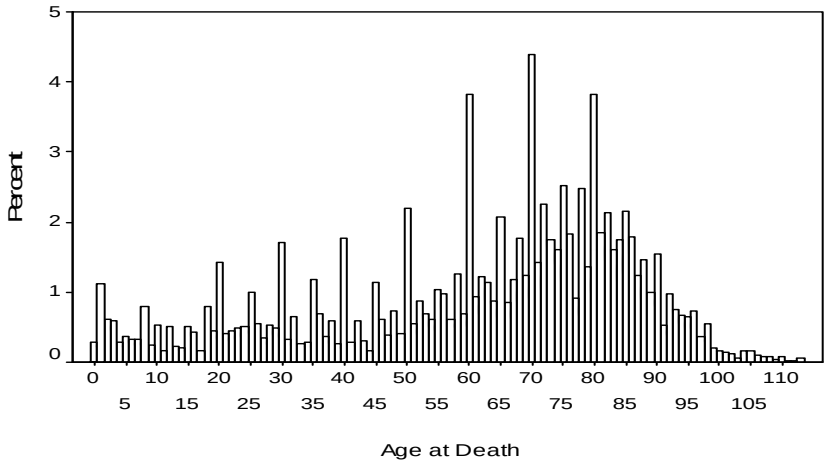
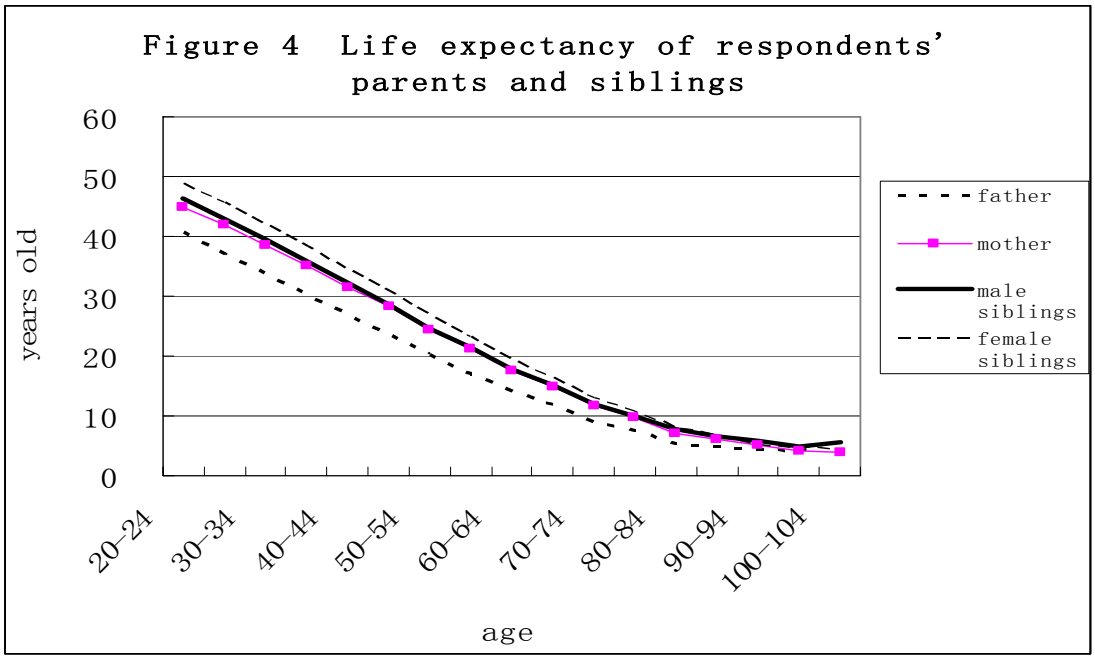


Figure 3: Death Age Distribution of Female Siblings



From Figure 2 and 3, we can see another problem: age heaping in reported death age. There is a heavy age heaping at those ages that end with "0" and a small heaping at those ages that end with "5", and this also happens among the parents' death age. This is not a strange phenomenon in China and some Asian countries. It seems necessary that the age heaping will affect the mortality rate in our studies. Since the people is tend to up-report their age, that is, the age they reported is often older than they actually is, we may be say, the death age heaping will underestimate the mortality.

The familial factors

The above results show though the mortality of the longevous respondents' parents and siblings is affected by bias result from selected group and by report errors such as age heaping and no "zero" age, we still found that the life expectancy is high and mortality rate is low for the parents and siblings of these longevous respondents. It seems there is a strong correlation between family members. Now, we will use the information of the respondent' parents and respondent' siblings to see whether there exists a relationship between parent's and children's death age and between the mortality and the children's sex and birth order.

From table 5, we find that with the increasing of parents' death age, more children died after 80 years old. Among the male children whose fathers' death age is below 60, only 20.7 percent of the male children died after 80 years old; and this percentage increases to 29.7 among those children whose fathers survived to at least 80 years old. This positive relationship of death age also exists between mothers and sons, between fathers and daughters and between mothers and daughters.

Table 6 shows that with increasing of the birth order, the percentage of the children who survived to at least 80 years old decreases. It seems there exists a positive relationship between children's mortality and birth order.

Table 5 The death age distribution of respondents' siblings by parents' death age (%)

		Male siblings' death age			Female siblings' death age		
		below 60	60-80	80+	below 60	60-80	80+
Father's	below 60	40.4	38.9	20.7	32.2	39.1	28.7
death age	60-80	32.9	44.9	22.2	29.6	41.3	29.1
	80+	29.7	40.7	29.7	25.7	41.0	33.3
Mother's	below 60	40.2	37.9	21.9	35.0	36.5	28.6
death age	60-80	34.8	43.0	22.2	29.8	42.4	27.8
	80+	29.7	45.4	24.9	23.6	42.8	33.6

Table 6 The death age distribution of respondents' siblings by birth order (%)

Birth	Male siblings' death age			Female siblings' death age			All siblings' death age		
order	below 60	60-80	80+	below 60	60-80	80+	below 60	60-80	80+
1	37.6	32.1	30.4	28.1	26.6	45.3	33.9	30.0	36.1
2	32.2	38.5	29.3	25.9	34.6	39.5	29.6	36.9	33.5
3	32.2	42.7	25.1	26.2	42.2	31.5	29.7	42.5	27.9
4	31.1	48.3	20.6	27.5	46.4	26.1	29.5	47.4	23.1
5	30.8	49.8	19.4	29.7	49.5	20.8	30.2	49.6	20.1
6	36.3	47.1	16.6	30.4	51.1	18.5	33.5	49.0	17.6
7	30.9	52.2	16.9	33.7	49.6	16.7	32.5	50.7	16.7
8+	39.9	52.3	7.8	36.0	47.2	16.8	38.4	49.5	12.1

Now I use Cox proportional hazard model to see the respondents' siblings' death hazard rate and to check the familial factors. The results of Cox regression (table 7) show the death age of respondents' parents has significant effect on the death hazard rate of respondents' siblings, that is to say, there exist a relationship between the mortality of parents and the mortality of children. From table 7, we find both father's and mother's death age have a negative effect on children's death hazard rate: if father's death age increase one year, the death hazard rate of children will decrease by a factor of 0.9941; if mother's death age increase one year, the children's hazard rate will decline by a factor of 0.9961. From the results, we also find the respondents' sister have a lower hazard rate of death than their brothers; and it seems the mortality hazard rate of first birth doesn't significantly differ from the rates of the other births except the births that rank at least 8^{th}. The eighth and above eighth births have a

higher hazard rate than the first birth, and the hazard rate ratio for the eighth and over births to the first birth is 1.25.

Table 7 Cox regression results for death hazard rate of respondents' siblings

Variable	B	Exp(B)	Sig
Father's death age	-.0059***	.9941	.0000
Mother's death age	-.0039***	.9961	.0000
Sibling' Sex	-.2120***	.8089	.0000
Birth order(reference birth order: 1)			.0317
2	-.0564	.9451	.0795
3	-.0019	.9981	.9553
4	.0011	1.0011	.9771
5	-.0183	.9818	.6755
6	.0174	1.0175	.7489
7	-.0126	.9875	.8614
≥8	.2232**	1.2500	.0023
-2 Log Likelihood: 138305.799 Chi-square: 215.915 df: 10 sig: 0.000 Events: 8254 Censored: 2361			

Note: *** significance level ≤ 0.001; ** significance level ≤ 0.01; * significance level ≤ 0.05

The above analyses don't separate the different sexes of the dependent variables, and after analyzing the male siblings or the female siblings alone, we get the same effects of parents' death age on children's mortality. And we also find slight across-sex inheriting relationship between the parents' and children's death risk. The effect of mothers' death age on sons' death risk is more than on daughters'. And the fathers' mortality affects more on daughters' death risk than on sons'.

We also get different results of the birth order effects on male siblings' mortality and female siblings' mortality (table 8, 9). For the respondents' male siblings, except the eighth and above eighth births, the other births have a slightly lower mortality rate than the first births though the effect is not significant. However, for female siblings, the hazard rate of second birth is non-significantly lower than that of the first births, but for the other births, the hazard rate is higher compared to that of the first births.

The reasons for the relationship between death hazard rate and sex and birth order are not clear. One possible explanation is the "son preference". In China, there

was and still is a strong belief of "more sons, more fortune"; boy preference was very strong. Sons are fortune, so they are paid more attention than daughters and given more and better take care, food, cloth, education and so on. Daughters do not belong to the family since they will get to marry and live with their husbands' family when they grow up; "the married daughter is the water you threw out", so the daughters are not important to parents and to their patriarchal clan. Based on this sex preference, it seems reasonable that the daughters' mortality increases over the birth order and the sons' mortality have no significant difference between different births except the very-high-birth-order sons have relatively higher death hazard rate. One interesting thing is that although the daughters' mortality increases over birth order perhaps due to sex discrimination, their average mortality level is lower than their brothers'. From the results of Cox regression, we know if a son is the first child, his death risk is slightly higher than his little brothers except the eighth and above eighth brothers. This perhaps results from the lack of rearing experience of parents. Why are the very-high-birth-order children (both sons and daughters) more likely to die than their older siblings? One explanation is the biological factors such as mothers' higher age and bad health when they give these births; another possible reason is the family become poorer after they have so many children.

Table 8 Cox regression results for death hazard rate of respondents' male siblings

Variable	B	Exp(B)	Sig
Father's death age	-.0074***	.9926	.0000
Mother's death age	-.0027**	.9973	.0015
Birth order(reference birth order: 1)			.0514
2	-.0876*	.9162	.0347
3	-.0722	.9304	.0978
4	-.0997*	.9051	.0433
5	-.1215*	.8856	.0397
6	-.0940	.9102	.2131
7	-.1264	.8813	.2066
≥8	.1791	1.1961	.0789
-2 Log Likelihood: 73873.591			
Chi-square: 94.953 df:9 sig: 0.000 Events: 4742 Censored: 1193			

Note: *** significance level ≤ 0.001; ** significance level ≤ 0.01; * significance level ≤ 0.05

Table 9 Cox regression results for death hazard rate of respondents' female siblings

Variable	B	Exp(B)	Sig
Father's death age	-.0038***	.9962	.0006
Mother's death age	-.0056***	.9944	.0000
Birth order(reference birth order: 1)			.0080
2	-.0066	.9935	.8979
3	.1059**	1.1118	.0460
4	.1393*	1.1495	.0159
5	.1209	1.1285	.0661
6	.1702*	1.1856	.0305
7	.1375	1.1474	.1893
≥8	.2972*	1.3461	.0051
-2 Log Likelihood: 53187.581 Chi-square: 65.525 df:9 sig: 0.000 Events: 3512 Censored: 1168			

Note: *** significance level ≤ 0.001; ** significance level ≤ 0.01; * significance level ≤ 0.05

Conclusion

In this paper the author checked if the familial factors on mortality exist, using the longevity survey of China in 1998. The above analyses suggested there does exist familial factors on mortality: the correlation between family members' mortality and survival duration is strong. The author finds three main findings as follows:

First, the longevous respondents' parents and siblings also lived longer than the average level of their peers; the life expectancy of the respondents' siblings improved compared to that of their parents and male's improved faster than females'.

Second, there is a positive correlation between parents' death age and children's death age. If a father or a mother lives longer, his or her child will also live longer generally. An across-sex inheriting relationship is also found, that is,

Third, birth order has different effects on sons' mortality and on daughters' mortality. There is no significant difference between different male births except the very-high-birth-order sons (eighth and above eighth births) have relative higher mortality and shorter life. However the daughters' mortality increased over the birth order except the second birth. Son preference and discrimination to daughters are possible explanations for this.