Gender difference in improvement of health status among the Chinese elderly with respect to health expectancies, 1992-2002

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Abstract: Numerous studies have indicated that there is a trend in improvement in different dimensions of health among the elderly in developed nations. However, few such studies are conducted in developing countries. Using two Chinese unique nation-wide cross-sectional data sets for the elderly in 1992 and 2002, this study aims to investigate gender differentials in the improvement in health status in terms of disability, morbidity, and self-rated health over the 10-year period under controlling various confounders. The results show that all three indicators are improved with largest improvement observed for self-rated health, even in the presence of different controllers. Females improved more than males except for disability. The gender differentials in the increased active life expectancy, disease-free life expectancy, and healthy life expectancy from 1992 to 2000 are also estimated using Sullivan method, and contribution of improvement of each health indicator to its corresponding increased health expectancies is discussed as well.

1. INTRODUCTION

Health improvement and health expectancies among the elderly have attracted significant attentions recently by researchers and policymakers as a consequence of increase in longevity (e.g., Crimmins 2004; Freedman, Martin, and Schoeni 2002; Freedman et al. 2004; Robine et al. 2003). However, empirical studies have demonstrated that improvement in health conditions among the elderly is not universal. Patterns of health changes might be country-specific because of different stage of epidemiologic transition that each country is in (e.g., Myers, Lamb, and Agree 2003; Robine and Michel 2004). It also depends on which dimension of health is measured in the study given that the trend in one dimension does not necessarily represent trends in other dimensions; and, in fact, change in all dimensions does not have to be similar (Crimmins 2004). Furthermore, the research results in the same country might be inconsistent with each other due to difference in sampling frame, survey methods, wording of questions (e.g., getting help or having difficulty in disability), and methodological strategies (Freedman et al. 2004).

Majority of studies have showed a clear deterioration trend in the prevalence of diseases both fatal and non-fatal among the elderly on average in low-mortality countries including England, Finland, France, the Netherlands, and the United States in 1980-190s (Crimmins and Saito 2000; Robine and Michel 2004), although few studies observed a reduction in the prevalence of some non-fatal diseases among elderly in the U.S. in 1980s (Manton, Stallard, an Corder 1995). The increase in prevalence of chronic disease conditions mainly due to the increased survival from many mortal conditions and little evidence of reductions in disease incidence (Crimmins and Saito 2000).

In accompanied with mostly similar pattern in increased disease conditions over time, the pattern of changes in functional limitations or disability is widely divided in Western nations. For instance, physical functioning and instrumental activities of daily living (IADL) have witnessed an improvement in 1980s and 1990s in the U.S. and France (Robine and Michel 2004), while on opposite trend was found in New Zealand (Grundy 1997), Australia (Davis, Mathers, and Graham 2003), Taiwan (Zimmer, Martin, and Chang 2002), and other countries as Canada, Great Britain and the Netherlands (Robine and Michel 2004). No change in physical functional limitations was observed among Dutch elderly from 1992 to 1998 (Portrait and Alessie 2002). Severe disability in terms of activities of daily living (ADL) seemed to decline in most European countries, stagnate in the U.S., and increase in Japan and Australia in 1990s (Robine and Michel 2004).

Self-reported health (SRH) and healthy life expectancy (HLE) have witnessed a relatively similar improvement in most Western nations in 1980s and 1990s as in Finland (Aromaa, Koskinen, and Huttunen 1999), Austria (Doblhammer and Kytir 2001), and the U.S. (Zack et al. 2004).

Gender differentials in changes in health states and health expectancies are well-recognized (e.g., Crimmins and Cambois 2003; Crimmins and Saito 2000; 2001; Crimmins, Saito, and Ingegneri 1997; Freedman & Martin 1998; Freedman et al. 2002). However, the findings are inconclusive. For instance, Crimmins and Saito (2000) found that American elderly males experienced a greater increase in disease prevalence with no improvement in functioning and IADL disability from 1984 to 1995, while elderly females witnessed a smaller in smaller increase in disease prevalence with an improvement in functioning and IADL disability. They also found that both males and females had a similar amount of improvement in ADL. Most of other studies relevant to disability in the U.S. found old women either had a same or larger amount improvement from 1980s to 1990s as old men (See Freedman, Martin, and Schoeni 2002). Gender difference in improvement in healthy expectancy is largely dependent on how the category of fair is classified (Doblhammer and Kytir 2001). When restricted concept is applied, elderly females had a larger improvement in healthy life expectancy from

1991 to 1998 for elderly aged before age 80. When the wider concept is used elderly males had a larger improvement in healthy life expectancy for age before age 85.

In explanation of health change with relevancy to health expectancies under context of population aging, scholars have proposed several hypotheses including compression of morbidity, expansion of morbidity, and dynamic equilibrium. Some scholars hold that patterns of disability change are associated with disability transition theories (Myers, Lamb, and Agree 2003). In different stage of disability transition, the patterns of health changes are expected to be different. Robine and Michel (2004) proposed a general theory of healthy aging by summarizing four components concerning disability and mortality with relevancy to disability transition. They argue that expansion of morbidity would be more likely if sick persons have a higher improved survival rate than normal persons; equilibrium between the reduction in mortality and increase in disability would be resulted from control of the progression of chronic diseases; compression of morbidity would occur if health status and health behavior are improved; and a new expansion of morbidity would appear if the very old and frail populations emerge. These theories are very helpful in explaining differential in health change in relevancy with life expectancy for different countries in different time periods.

One of key points in studying of health changes is that whether patterns in health changes persistent under controlling various confounders and how health improvements contribute to health expectancies. These questions are important in explanation of health changes and realization of healthy aging but are still not well-understood. The literature suggests that numerous factors including sociodemographic, health resources, and health behavior might affect disability, morbidity, and self-reported health (e.g., Crimmins and Cambois 2003; Crimmins 2004). In the presence of these factors, the results would be largely different as compare with ones in the absence of these factors (e.g., Freedman et al. 2004; Sazflarski and Cubbins 2004). In other words, some improvement in health status might be due to changes in structures of some covariates or health behavior rather than health condition itself. Therefore, it is worthy to investigate how the change in prevalence rate is modified by other confounders.

One inadequacy of the existing literature is that little evidence in changes of health status is from developing countries. According to disability transition theories, the health changes in China might have a different pattern as compared to those Western nations given that China is in a different stage of disability transition from those Western nations. This study using two Chinese nation-wide cross-sectional data sets in 1992 and 2000 aims to examine gender differentials in the improvement in health status in terms of disability, morbidity, and self-rated health over the 10-year period under controlling different confounders; to estimate the relative contribution of improvement of each health indicator to its corresponding increased health expectancies in the presence of different confounders.

2. DATA AND METHODS

2.1. Data sources

The data used in this study are from both the Old-age Support Survey of the Chinese Elderly in 1992 and the 2002 wave of the Chinese Longitudinal Healthy Longevity Survey (CLHLS). The Old-age Support Survey was conducted in 13 provinces, while the CLHLS covered 22 provinces. These two surveys have 12 provinces in common including Beijing, Tianjin, Hebei, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Hubei, Guangxi, Sichuan, Chongqing, and Shaanxi.

2.1.1. Old-age Support Survey of Chinese Elderly

The purpose of the survey is to collect information on old-age support system in China and to conduct policy analysis. The 1992 survey was a multistage random sampling according to stratum first classified by economic condition, urbanization, and population aging of each province, then further classified by city population size and economic development of county. The survey unit is village in rural and street block in urban. Its total survey units are 95 consisting of 48 from urban and 47 from rural in 13 provinces. The total sample size reached 20,083 with 9,588 males and 10,495 females aged 60 and over. The detailed survey design could be found in its data book and analysis shows that data quality of the survey is quite good (CNRCA 1994).

2.1.2. Chinese Longitudinal Healthy Longevity Survey

The aim of the CLHLS focuses on the determinants of healthy longevity in its first five-year period. In the second five-year period, care needs/costs and policy analyses are added to its objectives. The first three waves of the CLHLS were conducted in randomly selected half of the counties/cities in 22 provinces of China in 1998, 2000, and 2002 with special sample design. For each centenarian with a pre-designated random code, one nearby octogenarian and one nearby nonagenarian with pre-designated age and sex were interviewed. The term 'nearby' mainly indicate the same village or the same street if applicable, or the same town, county, city. The purpose is to have comparable numbers of more or less randomly selected male and female octogenarians and nonagenarians at each age from 80 to 99 (see endnote 4 in Zeng et al. 2002 for details). The first three waves collected data for 8,961, 11,161, and 11, 175 oldest-old respondents aged 80 and over respectively. The 2002 wave also extended its age coverage to include 4,845 young elderly aged 65 to 79 for the first time of the CLHLS to conduct comparative research between different age groups.

A detailed description of the sampling design and data quality of the CLHLS can be found in elsewhere (Gu 2005a; 2005b; Zeng et al. 2001; 2002)

2.1.3. Combined data in the present study

Information regarding basic demographic variables, healthcare resources in terms of marital status, number of living children and source of medical payments, and health conditions in terms of ADL, chronic conditions and SRH was collected in both surveys, which enables us to make comparisons. The total samples in the 1992 survey used in this study are 12,620 respondents aged 65 and over with 6,590 females and 6,030 males. Of 12,620 interviewees, 1,454 are oldest-old aged 80 and over with 11,166 respondents aged 65 to 79. Because the 1992 survey didn't gather the data for institutionalized elders, we have dropped those institutionalized elders in the 2002 CLHLS. The total valid number of samples of the 2002 CLHLS used in the present study is 9,583 with 5,493 females and 4,090 males. Due its specific sampling, the oldest-old respondents in the CLHLS reach 6,544 with 3,039 young elderly aged 65 to 79. The combined sample size of these two surveys used in this study reaches 22,203.

2.2. Defining variables

2.2.1. Health indicators

Heath status is measure in terms of ADL disability, chronic conditions, and SRH in the study. Although there are six activities such as bathing, dressing, toileting, indoor transferring, continence, and eating in the 2002 survey, the 1992 survey only has bathing, dressing, toileting, and easting. Given that bathing and eating rank the highest and lowest position of the ADL hierarchy on average, ADL disability based on four times could be approximate of Katz ADL index [1]. If none of the four ADL activities is impaired, the elder is classified as 'ADL active'; if one or more activities are impaired, the elder is classified as 'ADL impaired'. Chronic conditions are measured as having at least one diseases or having no any diseases.[2] SRH is collapsed into two categories: good and not-good.[3]

2.2.2. Control variables

When we examine the health dynamic change from 1992 to 2000, demographic variables, social economic status (SES), and healthcare resources are used as controllers. The demographic variables consist of age, sex, urban/rural residence, and ethnicity. SES includes education and economic well-being that is measured in terms of having sufficient financial resources in daily life. Marital status, living alone, number of living children, and whether the respondent is covered by free public medical services serve as the proximate measure of healthcare resources.

2.3. Methodologies

2.3.1. Standardization

The literature has implied that when comparing the health change across times, the survey design feature is very important (Freedman et al. 2004). Otherwise, some possible bias might be introduced. Furthermore, according to numerous studies differences in health status and its dynamics are observed between males and females (e.g., Feldman et al. 2002; 2004), and between urban and rural (e.g., Gu and Zeng 2004; Zeng et al. 2001; Laditka 2005). Because of the uniqueness of design of these two surveys, especially for the CLHLS, we first applied a weight for each survey to match the total age-sex-urban/rural-specific frequency distribution in twelve sampled provinces in 1992 and 2002 respectively. Then, we standardize age-sex-urban/rural composition for the two data sets. This standardization is a prerequisite in studying of changes or trends of health status (Freedman et al. 2004). As a consequence, a new weight is generated to reflecting both total population in the sampled provinces in two survey years and the same structure of age-sex-urban/rural composition. All analyses are based on this second weight.

2.3.2. Logistic regression

Multiple logistics regression was employed to examine how the improvement of health status is modified by different confounders. We use the following regression model and delta method to estimate the annual change of health status (Waidmann and Liu, 2000; Greene, 2000): $\log(\frac{p_j}{1-p_j}) = \beta_{0j} + \sum_i \beta_{ij} x_{ij} + \gamma_j t$, where p_j is the probability of being in a given category or event for observation j, $\beta_{ij} x_{ij}$ is product of explanatory variable x_{ij} and the unknown β_{ij} coefficient for observation j. Note that a variable of t distinguishing the year of 1992 and the year of 2002 is added to normal logistic regression in order to estimate the change between these two years. γ_j is an unknown coefficient. Previous research has indicated that elderly males and females have different trajectories of morbidity and disability (e.g., Lamb 1997). All regressions are run by male and female separately. Sequential model approach is designed to explore how each confounding factor affects the health dynamics. Four sequential models are constructed. Model I investigates the annual rate of change for each of three health indicators under controlling age, urban/rural residence, and ethnicity. [4] This model is basic and serves as a very general standardization as done in most of previous studies. Model II examines how the annual change rate of each of three health indicators is modified by adding additional SES variables into Model I. Model III reviews the annual change of health indicators in the presence of healthcare resources in addition to variables in Model II. Model IV further addresses how such annual change rate of each of three health statuses is affected by other two health indicators. To reduce the influence of the number of respondents who have missing items on data analyses and inference, the multiple imputation approach was applied in this study.

2.3.3. Life table approach

In many cases, one might be more interested to know the effects of such health improvements on life expectancy and health expectancies. Given that our current data sets are cross-sectional, we are unable to examine how improved health status decreases mortality, i.e., increases the life expectancy. Therefore, we will focus on how improved health increases the health expectancies. Age-sex-specific mortality scheme in 1992 was interpolated based on published census data for these twelve provinces in 1990 and 2000, while the mortality scheme in 2002 was extrapolated from the 1990 and 2000 censuses. Age-specific disability-free, disease-free, and self-reported good health prevalence rates are estimated from sequential models for males and females separately. In order to estimate the health expectancies, Sullivan method has been employed. The Sullivan method is the most widely used approach when the data set is cross-sectional. Following the literature, three health expectancies are estimated based the corresponding health indicators: Active life expectancy (ALE), disease-free life expectancy (DFLE), and healthy life expectancy (HLE) (Mathers, Robine, and Wilkins 1994; Robine et al. 2003). ALE, also known as disability-free life expectancy, aims to calculate the life expectancy without disability. DFLE measures life expectancy without disease, and HLE estimates life expectancy with self-reported (or perceived) good health (Mathers 1994). The estimated life expectancy and health expectancies based on regressions aim to provide pictures of difference in these measurements that would be in 2002 as compared to 1992 assuming that these two years have the same conditions.

2.3.4. Decomposition of the improvement in health expectancies

The improvement of health expectancies from 1992 to 2002 could be due to either improvement in health status or mortality. Following method is applied to decompose the improvement of health expectancies:

$$HE_x^{t2-t1} = HE_x^{t2} - HE_x^{t1} = \int_x^{\omega} l_x^{t2} h_x^{t2} d_x - \int_x^{\omega} l_x^{t1} h_x^{t1} d_x = \int_x^{\omega} (l_x^{t2} - l_x^{t1}) h_x^{t2} dx + \int_x^{\omega} (h_x^{t2} - h_x^{t1}) l_x^{t1} dx,$$

where HE_x^{t2-t1} is the change of health expectancies at age x between time $t1$ and time $t2$; HE_x^{t1} and HE_x^{t2} are the health expectancies at age x for time $t1$ and time $t2$ respectively; h_x^{t1} and h_x^{t2} are the prevalence rate of health status at age x for time $t1$ and time $t2$ respectively (i.e., ADL active, or no any disease, or good self-reported health in this study); l_x^{t1} and l_x^{t2} are survival probabilities at age x for time $t1$ and time $t2$ respectively. The first part at the right side of the equation $\int_x^{\omega} (l_x^{t2} - l_x^{t1}) h_x^{t2} dx$ estimates the change in health expectancy due to survival probability, i.e., mortality, whereas the second part $\int_x^{\omega} (h_x^{t2} - h_x^{t1}) l_x^{t1} dx$ measures the change in health expectancy due to the change of prevalence rate of a specific health indicator. In other words, we can estimate the proportion of contribution in changed health expectancy due to either mortality change or health status change by dividing the two parts at the right side of the equation over the total change of HE_x^{t2-t1}. Since we have examined how the change of health status (h_x^{t2} - h_x^{t1}) is modified by different confounders in logistic regression, we are able to further investigate how contribution of change in health status to health expectancies is affected in the presence of different controllers. However, because the data are cross-sectional, we could not examine how (l_x^{t2} - l_x^{t1}) is affected by different controllers; thus we are unable to do further exploration as we do for (h_x^{t2} - h_x^{t1}).

3. RESULTS

3.1. Annual rate of improvement in health status

Table 1 presents the sample distribution of the two surveys by covariates. Table 2 summarizes the average annual change rates of three health indicators from 1992 to 2002 based on logistic regression after applying weights. The results show that improvement in all of three health indicators is observed in 2002 as compared to 1992. For disability, it is interesting to note that annual decline rates for female elderly are much smaller than those for male elderly although such reductions for both males and females are not statistically significant. Furthermore, when disease condition and SRH were controlled the reduction in disability for males disappeared, and women's disability increased over the time. This means women's disability in 2002 was worsened given the same disease condition and SRH in 1992. The reductions of chronic disease condition for both male and female elders reached around 1% annually and are statistically significant. Although such reductions are modified by covariates, they are still significant if we don't control disability and SRH. But when these two health indicators are controlled, the reductions in disease prevalence for both sexes were largely reduced and turned to be insignificant. This suggests that given the same level of disability and SRH and other equal conditions, both elderly males and females almost didn't gain any reduction for disease prevalence in 2002 as compared to 1992. The self-reported health gained largest improvement among three health indicators under study. The annual decline rate of self-reported not-good health is more than 2.4% for males and more than 2.7% for females. The annual change rates were reduced to 1.39-1.97% for males and 2.35-2.39% for females after controlling different confounders. Even in the presence of disability and disease condition, such declines for both genders are still significant, indicating improvement of SRH is independent from disability and disease conditions.

3.2. Health expectancies increased

Table 3 provides the age-sex-specific TLE, ALE, DFLE, and HLE in 1992 and 2002 based on Model I, i.e., under controlling urban/residence, and ethnicity. Although females enjoy longer life expectancy and health expectancies in both 1992 and 2002, males have higher proportion of healthy lives. Such a gender disparity for ALE gets wide with increase of age, while it gets narrow for DFLE and HLE. This pattern is also true under controlling different covariates (not shown).

Table 4 and Table 5 show that females gained more in both absolute number of years and relative proportions in life expectancy, DFLE, and HLE from 1992 to 2002 compared to males although such gains are reduced for both males and females under in the presence of other covariates. In relative term, both males and females had a higher increased in DFLE and HLE as in TLE. It is interesting to note that oldest-old gained relative more DFLE and HLE for both males and females.

As for ALE, female elderly gained more absolute years before age 80 than male elderly. But in relative term, males gained more in all ages above 65 than females. Compared to TLE, the relative increase of ALE for males is higher across ages if disease prevalence or SRH is not controlled (results in Model II and Model III not shown). However, when disease prevalence and SRH are controlled plus SES and healthcare resources, the males' relative increase for ALE is smaller than that for TLE. For females, the relative increase of ALE is smaller than that of TLE before age 85 without controlling any covariate. After controlling SES, and/or other covariates, females' increased proportion of ALE is smaller than that of TLE in all ages. The age pattern of relative increase in ALE for males tends to have an upward trend regardless of presence of covariates, while females tends to have such a pattern only in the case where there is no any covariate controlled.

3.3. Decomposition of the increased health expectancies

Given that we don't have to examine how mortality is improved for population with different characteristic, we assume that all people gain the same rate of improvement in mortality. Under such assumption, we examine how the improvement in health status affects its contribution to the increased health expectancies in the presence of different confounders.

Figure 1 illustrates percentage distribution of contribution in the increased ALE due to improvement in disability by gender under different models. In all cases, the contribution of the increased ALE from 1992 to 2002 due to improvement in ADL functioning would be larger among elderly males than among elderly females. For instance, in Model I, the disability decline shares 15% of the increased active life expectancy for males age 65, while the corresponding proportion is 5% for females at same age. Furthermore, the contribution due to decline in disability goes up with advancement of age with a more significant trend observed in male elders. However, the contribution due to improved ADL functioning is disappeared in men when SES, healthcare resources, and disease conditions and SRH are controlled. Such contribution turns to be negative for women. This suggests that the increased male ALE from 1992 to 2002 is due to improvements in disease conditions and SRH and changes in other covariates. As indicated in Table 2, women's ADL disability from 1992 to 2002 was actually increased given the same conditions in disease prevalence, SRH and other covariates. Indeed, without controlling SES, healthcare resources, or other health measurements, the proportion of ALE out of TLE is slightly lower in 2002 as compared to 1992. This evidence suggests that women observed an expansion of disability.

Figure 2 provides relative contributions for improvement in disease condition to the increased DFLE by gender under different models. Assuming 2002 and 1992 have the same composition of demographic and/or SES, the increased DFLE from 1992 to 2002 due to improvement in disease condition would be around 60-70% for both males and females. By further assuming that these two years have same additional composition of healthcare resources, the contribution would experience a minor decrease for males, while it gets a slight increase for females. Once the disability and perceived health condition are assumed to be equal in addition to above assumptions, the contributions due to disease condition improvement go down to 15% and 25% for males females, respectively. This change indicates that improvement of disability and perceived health status have large influence on the contribution of disease condition to the DFLE among both males and females. Unlike the age pattern observed in the case of ALE, the contribution of the improved disease condition to the increased DFLE across ages is almost flat for all models although Model IV has a much lower relative contribution rate.

Results in Figure 3 suggest that contributions of the improved perceived health to the increased HLE are almost same across all ages for females under different context, which is around 80-85%. For males, controlling of demographic and SES factors, the contribution of the improved perceived health to the increased HLE is around 80%. After control healthcare resources, disability, and disease conditions, the contribution gets download to 70%. But it still plays a dominant role to the increased HLE. These results imply that the increased HLE from 1992 to 2002 is mainly due to improved perceived good health, not due to other component changes.

4. CONCLUDING REMARKS

The present study is unique because it investigates evidence relevant to the compression of morbidity hypothesis with two large nation-wide datasets from China, a developing country with a largest population of the elderly in the contemporary world. Our study shows that the elderly men had a higher annual decline rate in disability and a higher increase rate of ALE as compared to the elderly women under controlling SES and healthcare resources. This gender disparity is consistent with disability transition theories, which state that as the transition progresses, females are at higher risk of becoming disabled at older ages and living longer with these disabilities (Myers, Lamb, and Agree 2003). Our results further show that under controlling of disease prevalence and SRH plus SES and healthcare resources, there is no any reduction in disability nor any improvement in ALE for males from 1992 to 2002, while the ADL functioning and ALE of females were deteriorated from 1992 to 2002. This indicates that improved ALE for both males and females are due to decline in disease prevalence and/or SRH, or changes in composition of covariates. This supports the argument that disability could be relatively stable if the progression of chronic disease could be controlled. Further studies on mechanism from disease to disability are clearly warranted. Furthermore, according to Freedman et al. (2004), changes in the prevalence of disability reflect changes not only in the underlying capacity of the population but also in adaptations and accommodations made by persons and in the accessibility of the environment. This implies that the improvement of ADL functioning in 2002 as compared to 1992 might be because of more availability of bathing and other facilities or assisted equipments at home that help the elderly keep function. If it is the case, the ADL functioning of Chinese elderly in 2002 might be overestimated. Future surveys should collect this kind of information to enable research identify the true trend.

Our analyses reveal that the elderly women have higher annual improvement rates in disease conditions and SRH with higher relative contributions in DFLE and HLE regardless of the presence of covariates. The improvement in disease condition from 1992 to 2002 might be due improvement in availability and accessibility to health facilities or changes in mechanism from disease to disability (Robine, Mormiche, and Sermet 1998). The improvement might be also because of less frequency of doctor visits or hospital visits given that the senior had to pay a portion of medical cost by themselves after medical reform in middle of 1990s. As a result, they might not know the disease suffering especially the less severe form and report no disease. Therefore, the improvement in chronic disease might be overestimated. On the other hand, it is possible that people are more aware of less severe diseases at an earlier state due to increased knowledge and technology of diagnosis. If it is true, then the improvement in chronic disease might be underestimated. Recent studies suggest that improvement in health behaviors, such as better nutrition, smoking reduction, or increase in physical activities, would reduce morbidity more than increase longevity (e.g., Fries 2002). Given that the unavailability of the data, we are unable to provide a good answer for this question at this moment. In a relative term, SRH witnessed a much higher improvement rate than disability and chronic diseases. This might be because SRH is sensitive to socioeconomic factor, expectation, and perception (Nicholson et al. 2005). As compared to 1992, the overall economic condition of Chinese senior is improved in 2002, which might make more seniors rate their health as good/very good. Another possible answer of a higher improvement in SRH could be due to changes in response pattern in 2002. More studies are clearly warranted to shed some lights on.

There is significant gender difference for relative contribution of the decline of disability to the increased ALE, whereas the gender patterns in relative contributions of improved disease conditions and SRH to the corresponding increased DFLE and HLE are very similar. The relative contribution of improved ADL functioning to the increased ALE is always larger for males than for females in Model

I, Model II, and Model III. In Model IV, the relative contribution for males turns to be zero, while females experienced a worsening trend. Therefore, there is no relative contribution for females. In the case of disease conditions, the relative contributions of improvement to the increased DFLE are around 60-70% for both males and females in models I, II, and III with a relative large variation across models in males. In Model IV, the relative contribution goes down to 15% for males and 25% for females. For SRH, the relative contribution of improvement to the increased HLE is around 70%-85% for males and 80-85% for females in all models. Larger variation across models is also observed for males.

Another noteworthy finding is that the oldest-old gained more than young elderly in relative term of health expectancies for both males and females. But decomposition analyses show that there is no age difference in the relative contributions of improved disease condition to the increased DFLE and improved perceived health to the increased HLE, and such an age pattern will not change even after controlling various confounders although the size of relative contribution of DFLE due to improvement of disease condition is reduced, especially for males, in the case of DFLE under controlling disability and perceived health. These results suggest improvements in DFLE and HLE are universal across ages. The picture of age pattern seems to be different in the case of disability. The gained ALE is bigger among the oldest-old than among the young elders for both males and females, and there is an upward trend across ages for contribution of disability decline to ALE. However, after controlling other two health indicators, the relative contribution to increased ALE across ages disappeared in men. For females, the relative contribution to increase ALE is negative.

Our study further indicates that improvements in three major health indicators could be at different steps and patterns, which provides additional evidence to argue that health change is not necessary similar for different dimension (Crimmins 2004).

In summary, both Chinese elderly men and women witnessed improvements in ADL functioning, disease condition, and SRH from 1992 to 2002. Males experienced a greater improvement in ADL functioning, while females improved more in diseases condition and SRH. These results support the compression of morbidity. The same direction of improvements in all three major health indicators among Chinese elderly from 1992 to 2002 is not in line with most previous studies in developed nations where researchers find that improvement in disability accompanied by increases in disease prevalence (Robine and Michel 2004). This is possibly because that China is in a different epidemiologic transition stage as Western societies.

The findings of the present study have some important policy implications given that the number of elderly people will burgeon dramatically in the next few decades and most family practice filial piety. According to 2000 census, the number of the old-old reached 13 million in 2000. It is projected that there will be 240 million and 350 million elderly people aged 65+ in China in 2030 and 2050 respectively. The corresponding figures for the oldest-old aged 80+ are 40 million in 2030 and 114 million in 2050 (Population Division, U.N. 2005). If the future Chinese elderly could continue to gain some healthy lives, we would expect a considerable reduction in medical expenditure and long term care needs, which might be together with demographic bonus before 2030 to yield some positive effects on China's economic development (Zeng et al. 2006).

Despite its unique contribution to the literature of the present study, we also recognize several weaknesses. First, since the institutionalized elderly were not covered by the 1992 survey, some bias might exist when one generalizes the conclusion barely relying on the present study although the health difference between institutionalized elderly and community-residing elderly is much smaller as compared to the Western countries. Second, as we have emphasized earlier that we could not establish the relation of covariate with survival due to unavailability of data, which precludes us to address the improvement in mortality caused by the improvement of health status, we have to assume that there is no difference in improvement of mortality across different individuals. Thus the contribution of each three health statuses to its own health life expectancy might be different if mortality improvement is also integrated. Third, given the fact that answer about health trend might be depended on the prevalence, incidence, and duration of health conditions that used in the study, the current data could not provide answers about health trend in terms of incidence. We will conduct such research as long as the longitudinal data with sufficient length and waves is available. Fourth, given the limited data information, we are unable to examine changes in the social and economic forces influenced the options available for responding to health problems, nor the possible improvement in health behavior including seeking specific treatment for some specific disease. These exclusions might cause some bias. Fifth, we have to assume that the awareness, attitudes, and pattern to report health conditions didn't change much over time including progress of medical technology. This might not be the case. Lastly, in analyzing chronic conditions, we didn't break down to disease-specific prevalence and no disease-specific free life expectancy was studied.

Table 1 Sample distribution of the two surveys used in the study by selected covariates

	The 1992 survey					The 2002 CLHLS				
	Sample size		ADL disabled	1+ diseases	Selfreported Not-good health	Sample size		ADL disabled	1+ diseases	Selfreported Not-good health
	#[a]	%[a]	%[b]	%[b]	%[b]	#[a]	%[a]	%[b]	%[b]	%[b]
Total	12,620	100.00	7.91	66.66	65.60	9,583	100.00	7.27	60.39	50.59
Sex										
Female	6,590	52.22	8.95	68.72	69.83	5,493	57.32	8.61	61.94	53.11
Male	6,030	47.78	6.75	64.36	60.88	4,090	42.68	5.78	58.66	47.77
Residence										
Rural	6,391	50.64	6.05	60.06	63.56	4,987	52.04	6.15	54.69	50.32
Urban	6,229	49.36	10.91	77.33	68.89	4,596	47.96	9.07	69.59	51.02
Ethnicity										
Minorities	543	4.30	5.99	60.53	68.50	701	7.32	4.52	44.81	49.20
Han	12,077	95.70	8.01	66.97	65.45	8,882	92.68	7.38	61.03	50.65
Education										
0 year of schooling	7,141	56.58	7.93	65.49	68.44	5,812	60.65	8.78	59.29	53.84
1-6 years of schooling	3,960	31.38	7.54	66.60	61.88	2,735	28.54	5.28	59.18	47.98
7+ years of schooling	1,519	12.04	8.85	73.62	59.92	1,036	10.81	6.79	67.03	45.58
Economic well-being										
No	3,621	28.69	9.87	71.60	77.89	1,924	20.08	7.81	67.96	69.80
Yes	8,999	71.31	6.99	64.34	59.83	7,657	79.90	7.14	58.55	45.92
Marital status										
Currently not married	5,129	40.64	9.67	66.47	67.48	6,396	66.74	10.48	59.96	54.40
Currently Married	7,491	59.36	6.54	66.81	64.14	3,187	33.26	5.23	60.66	48.17
Living alone										
No	10,762	85.28	8.48	66.48	65.19	8,222	85.80	7.74	60.48	48.91
Yes	1,858	14.72	4.70	67.66	67.95	1,361	14.20	4.11	59.80	61.93
Number of living children										
0	334	2.65	9.04	68.16	74.09	940	9.81	10.58	55.00	59.03
1-2	3,019	23.92	9.65	68.43	68.22	2,544	26.55	6.97	60.82	49.17
3-4	4,425	35.06	7.23	66.43	64.47	3,360	35.06	7.13	61.46	50.79
5+	4,842	38.37	7.32	65.58	64.28	2,739	28.58	7.18	59.66	50.07
Covered by free public medical services										
No	5,389	42.70	7.88	61.67	64.40	8,294	86.55	7.12	58.12	51.28
Yes	3,526	27.94	8.01	82.27	69.35	1,275	13.30	8.08	72.36	46.95

Note: a, unweighted; b, weighted.

Table 2 Average annual change rates of three health indicators from 1992 to 2002 among Chinese elderly aged 65+

	Males (%)				Females (%)			
	Model I	Model II	Model III	Model IV	Model I	Model II	Model III	Model IV
ADL disabled	-1.72	-1.37	-0.81	-0.07	-0.50	-0.22	-0.42	0.75
Suffering 1+ chronic disease	-0.96***	-0.82*	-0.62*	-0.09	-1.06***	-0.90***	-0.82***	-0.19
Self-rated not-good health	-2.43***	-1.87***	-1.44***	-1.39***	-2.74***	-2.35***	-2.37***	-2.39***

Note: (1) *, p<0.05; **, p<0.01; ***, p<0.001.

Table 3 Comparison of total life expectancy and three health expectancies between 1992 and 2002 among Chinese elderly aged 65+

	Males				Females			
Sex and age	TLE	ALE	DFLE	HLE	TLE	ALE	DFLE	HLE
1992 (LE in years)								
65	12.86	11.89	4.48	4.93	15.11	13.56	4.60	4.48
70	9.90	8.93	3.33	3.57	11.89	10.30	3.52	3.37
75	7.46	6.50	2.42	2.52	9.14	7.52	2.64	2.47
80	5.51	4.55	1.72	1.73	6.88	5.23	1.93	1.77
85	4.07	3.11	1.22	1.18	5.14	3.47	1.40	1.25
90	3.02	2.06	0.87	0.80	3.83	2.17	1.01	0.88
95	2.32	1.34	0.63	0.56	2.89	1.28	0.73	0.62
100	1.85	0.86	0.48	0.41	2.24	0.71	0.55	0.45
2002 (LE in years)								
65	14.05	13.08	5.69	7.17	16.85	15.03	6.27	7.74
70	10.84	9.88	4.26	5.28	13.22	11.39	4.81	5.87
75	8.23	7.28	3.14	3.81	10.15	8.32	3.60	4.35
80	6.05	5.10	2.22	2.64	7.55	5.73	2.61	3.11
85	4.60	3.63	1.63	1.88	5.74	3.87	1.93	2.26
90	3.39	2.41	1.15	1.29	4.32	2.46	1.41	1.63
95	2.62	1.62	0.85	0.92	3.28	1.46	1.03	1.17
100	2.09	1.06	0.65	0.67	2.52	0.82	0.77	0.85
Proportion of health expectancies out of TLE 1992 (%)								
65	100.00	92.46	34.84	38.38	100.00	89.72	30.44	29.67
70	100.00	90.26	33.69	36.11	100.00	86.68	29.65	28.37
75	100.00	87.12	32.50	33.79	100.00	82.30	28.84	27.04
80	100.00	82.64	31.26	31.41	100.00	76.05	28.00	25.68
85	100.00	76.42	29.98	28.99	100.00	67.47	27.13	24.30
90	100.00	68.16	28.66	26.57	100.00	56.54	26.23	22.89
95	100.00	57.95	27.32	24.17	100.00	44.08	25.30	21.48
100	100.00	46.51	25.97	21.85	100.00	31.74	24.34	20.07
Proportion of health expectancies out of TLE 2002 (%)								
65	100.00	93.11	40.54	51.06	100.00	89.19	37.20	45.93
70	100.00	91.17	39.34	48.72	100.00	86.23	36.37	44.43
75	100.00	88.41	38.10	46.24	100.00	81.98	35.49	42.87
80	100.00	84.43	36.78	43.60	100.00	75.88	34.57	41.20
85	100.00	78.82	35.40	40.85	100.00	67.49	33.60	39.45
90	100.00	71.29	33.99	38.02	100.00	56.81	32.59	37.63
95	100.00	61.65	32.52	35.11	100.00	44.60	31.55	35.76
100	100.00	50.52	31.03	32.21	100.00	32.40	30.45	33.82

Note: (1) This table is based on Model I. (2) TLE, total life expectancy; ALE, active life expectancy; DFLE, Disease-free life expectancy; HLE, Healthy life expectancy.

Table 4 Number of years increased in life expectancy, health expectancies in 2002 as compared with 1992 among Chinese elderly aged 65+

	Males (in years)				Females (in years)			
Sex and age	TLE	ALE	DFLE	HLE	TLE	ALE	DFLE	HLE
Mode I								
65	1.19	1.19	1.22	2.24	1.74	1.47	1.67	3.26
70	0.94	0.95	0.93	1.70	1.33	1.09	1.28	2.50
75	0.78	0.78	0.71	1.29	1.00	0.79	0.96	1.88
80	0.54	0.55	0.50	0.91	0.67	0.50	0.68	1.34
85	0.52	0.51	0.41	0.70	0.59	0.40	0.53	1.01
90	0.36	0.35	0.28	0.48	0.49	0.29	0.40	0.75
95	0.30	0.27	0.22	0.36	0.38	0.18	0.30	0.55
100	0.24	0.20	0.17	0.27	0.28	0.11	0.22	0.40
Mode IV								
65	1.19	1.03	0.49	1.54	1.74	1.30	0.75	2.98
70	0.94	0.79	0.38	1.19	1.33	0.92	0.58	2.30
75	0.78	0.63	0.31	0.91	1.00	0.63	0.43	1.75
80	0.54	0.41	0.21	0.65	0.67	0.34	0.30	1.26
85	0.52	0.37	0.20	0.52	0.59	0.27	0.25	0.97
90	0.36	0.23	0.14	0.37	0.49	0.17	0.20	0.73
95	0.30	0.16	0.11	0.29	0.38	0.10	0.15	0.55
100	0.24	0.10	0.09	0.22	0.28	0.05	0.11	0.41

Note: (1) TLE, total life expectancy; ALE, active life expectancy; DFLE, Disease-free life expectancy; HLE, Healthy life expectancy.

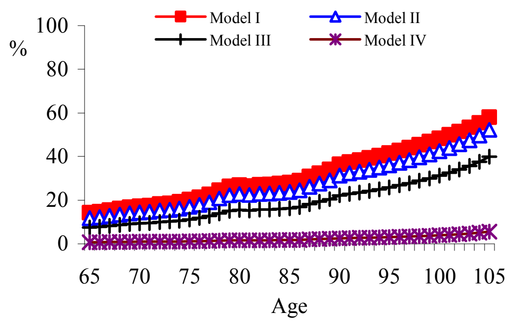
Table 5 Proportion of years increased in life expectancy, health expectancies in 2002 as compared with 1992 among Chinese elderly aged 65+

	Males (%)				Females (%)			
Sex and age	TLE	ALE	DFLE	HLE	TLE	ALE	DFLE	HLE
Model I								
65	9.27	10.04	27.16	45.38	11.53	10.86	36.32	72.63
70	9.48	10.60	27.87	47.69	11.17	10.59	36.35	74.12
75	10.40	12.04	29.42	51.08	10.99	10.56	36.58	75.93
80	9.79	12.16	29.17	52.43	9.75	9.51	35.49	76.06
85	12.87	16.42	33.30	59.05	11.55	11.59	38.16	81.12
90	11.99	17.13	32.80	60.26	12.73	13.27	40.09	85.31
95	13.14	20.37	34.68	64.33	13.16	14.48	41.12	88.39
100	12.93	22.66	34.94	66.46	12.49	14.80	40.72	89.59
Model IV								
65	9.27	8.68	10.75	30.99	11.53	9.52	16.09	65.82
70	9.48	8.84	11.00	31.81	11.17	8.86	15.76	66.16
75	10.40	9.71	11.96	33.51	10.99	8.26	15.61	66.77
80	9.79	9.02	11.37	33.37	9.75	6.43	14.35	65.80
85	12.87	12.00	14.53	37.75	11.55	7.32	16.26	69.46
90	11.99	11.15	13.67	37.36	12.73	7.46	17.52	72.23
95	13.14	12.27	14.85	39.44	13.16	6.88	18.00	73.92
100	12.93	12.19	14.64	39.85	12.49	5.39	17.27	73.86

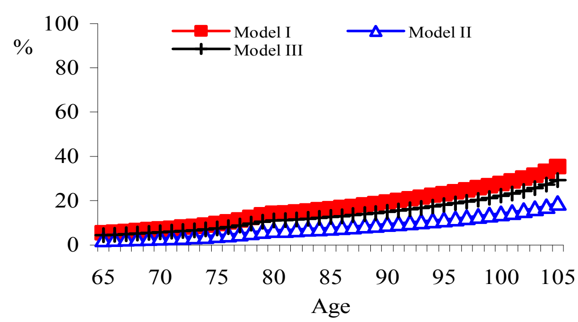
Note: (1) TLE, total life expectancy; ALE, active life expectancy; DFLE, Disease-free life expectancy; HLE, Healthy life expectancy.

Figure 1 Proportion of contribution due to improvement in disability to the increased disability-free life expectancy from 1992 to 2002, China

Males



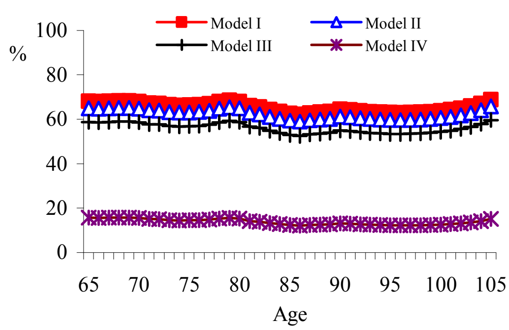
Females*



Note: *, In Model IV, females' ALE in 2002 was worsened as compared to that in 1992. Therefore, it is not presented.

Figure 2 Proportion of contribution due to improvement in disease conditions to the increased disease-free life expectancy from 1992 to 2002, China

Males



Females

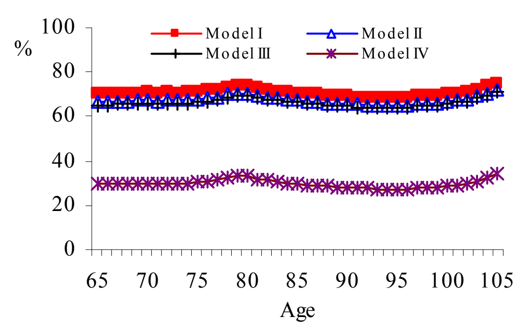
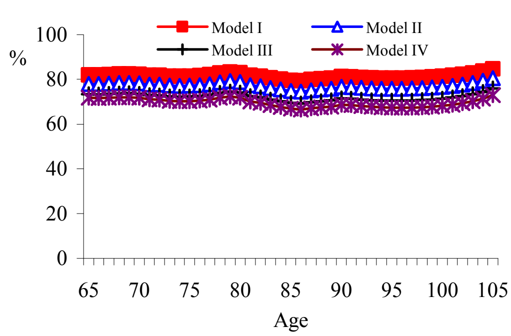
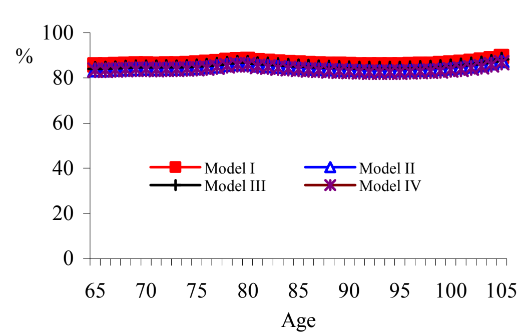


Figure 3 Proportion of contribution due to improvement in perceived health to the increased healthy life expectancy from 1992 to 2002, China

Males



Females



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[1] According to Freedman et al. (2004), the number of activities considered in the definition of disability appears to be far less important as compared to wording (e.g., use help, or have difficult, or use equipment), and methodological techniques (e.g., age standardization). We have tested the results using three items including bathing and easting plus either toileting or dressing. The analyses show very close results to our four-item result, which validates our results. The wordings of four ADL items in two surveys are almost identical. The wording for self-reported health is the same except the choices are different. The 1992 survey has three categories: good, so so, and bad, while the 2002 CLHLS has six categories: very good, good, so so, bad, very bad, and unable to answer. Given that the category of "unable to answer" means the respondent was too sick to receive an interview. Therefore, we believe such a classification would be adequate. A recent study in Spain also used these four items only to examine the self-care functioning change (Sagardui-Villamor et al. 2005).

[2] The CLHLS asked seventeen diseases including hypertension, stroke, heart diseases, cerebra-vascular diseases, pneumonia, Parkinson's disease, and so forth. A comparison shows that the total prevalence rate of chronic conditions in the CLHLS is comparable to other sources such as the Chinese National Health Services Survey (MOH 2002; 2005) and the 2000 Chinese Elderly Survey (CNRCA 2003), indicating the data quality in the CLHLS relevant to chronic condition is reliable and valid. The 1992 survey collected almost the same data on disease conditions except Parkinson's disease.

[3] The 1992 survey designed into three categories: good, so so, and bad, while the 2002 CLHLS designed into six categories: very good, good, so so, bad, very bad, and unable to answer. The category of "unable to answer" in the 2002 CLHLS means that the elderly was too sick to receive interview. Therefore, we assume SRH of this group of respondents is very bad. We combine very good and good as category of "good" while grouping the rest as "not-good" for the 2002 CLHLS, whereas we treated so so and bad in the 1992 survey as not-good.

[4] Age square and interaction of age with year are also examined, but neither is significant in all models.