Changes in the Subnational Lifespan Inequality and Disease-Specific Contribution — Evidence from China

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Abstract

The past decades have witnessed China's rapid socioeconomic development and an overall increase in life expectancy. Previous research suggests that the health inequality situation in China has improved too, with the observation that the gap between life expectancy in the urban and rural population is gradually shrinking. However, not many studies have further examined the regional lifespan inequality or break down the changes in population health outcome to understand the reasons and components. This study quantifies the health inequality level of urban and rural population in China with lifespan disparity (an indicator measuring inequality in lifespan with lost years of life in a population), then use decomposition methods to analyse the age-specific contribution of changes in life expectancy between 2006 to 2016, discuss the urban-rural difference in lifespan disparity, and look into the lifespan inequality contributed by the different causes of death in the urban and rural sector respectively.

Keywords: Urban-rural inequality, Life expectancy, Lifespan disparity, Causes of death

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I. Introduction

The past 40 years have witnessed perhaps the most drastic changes in the Chinese society. Since the Reform and Opening in 1978 and the enactment of the One-child policy one year after, China has experienced rapid economic growth and significant changes in population structure. While the policy-enforced fertility decline accelerated the process of population ageing, the economic development has led to general improvement in population health. The fast economic growth contributed to the reduction in mortality through the improvement of people's living standard, sanitation, and the enhancement in availability and accessibility of medical services and health facilities. However, considerable health inequalities still exist between the urban and rural population in China (Xie 2009; Liu, Fang, and Zhao 2013).

The urban-rural health inequality in China has been measured by comparing indicators such as life expectancy and mortality rates or calculating indices such as Gini coefficient and Concentration Index (Fang et al 2010; Zhou et al 2015), and has been explained by the inequality in income, education, and health care (Liu, Hsiao, and Eggleston 1999; Zimmer, Kaneda, and Spess 2007; Cai, Coyte, and Zhao 2017). But previous research often failed to integratedly understand the urban-rural health inequality with the difference in the age pattern of mortality and epidemics. This paper makes an attempt to fill in this research gap in the literature studying urban-rural health inequality in China by 1) using lifespan disparity as the measure of within-population health inequality to compare across rural and urban sector; 2) adopting decomposition methods to analyse the changes in life expectancy and lifespan disparity 2006 to 2016 in urban and rural population, and 3) discussing the reasons behind the urban-rural health gap and examining the mortality patterns associated with different causes of death.

Data sources:

The major data source used in this paper is the Cause of Death Surveillance Points (CDSP) data produced by Chinese Centre for Disease Control and Prevention (CCDCP) from 2006 to 2016. The data was gathered from over 160 surveillance points across the country, covering over 264 million people by 2016 (about 19.14% of the total population). This dataset contains information on age-specific mortality rates, causes of death, and structure of the population covered (all aggregated on regional level2). Such information would allow researchers to produce regional life tables and conduct further analysis. It is worth mentioning that the CDSP data suffers from the problem of under-reporting, and the level of under-reporting varies across regions, age groups, gender, and causes of death. To address this problem, the CCDCP has conducted under-reporting surveys every three years to make some adequate adjustments, but careful examination on data quality and necessary adjustments are still much needed before using this data to reach any

conclusions. In this paper, I use age-specific mortality rates from CDSP data and make under-reporting adjustment with the under-reporting rates from the 2006 under-reporting survey, which is the only openly published under-reporting information by CCDCP. Apart from the CDSP data, life tables from Human Mortality Database, infant mortality rates from Chinese Maternal and Children Health Surveillance data are used to construct a two-dimensional mortality model for the purpose of conducting sensitivity test to examine the data quality.

II. Methodology

1. Life disparity (e †) as a measure of dispersion in lifespan

Several indices with different properties have been used by scholars to measure the inequality in population health, and some of the most popular ones include life disparity, Gini coefficient, Theil's index, standard deviation, and interquartile range (van Raalte and Castel 2013; Shkolnikov 2003; Wilmoth and Horiuchi 1999). This paper chooses life disparity (e †) proposed by Vaupel and Canudas-Romo as a measure of dispersion in lifespan (Vaupel 1986; Vaupel and Canudas-Romo 2003). Life disparity is defined as the total years of life lost due to death, and could be expressed by the following equation.

$$e^{\dagger} = \int_0^{\omega} d(a)e(a)da \qquad (1)$$

Here $d(a)$ denotes the deaths distribution, ω as the open-ended age interval, and $e(a)$ the remaining life expectancy at age a.

2. Decomposition of life expectancy and lifespan disparity

- Examine the age-specific contribution to changes in life expectancy between 2006 to 2016 for the urban and rural population respectively with Arriaga's decomposition method (Arriaga 1984).
- Another decomposition method to break down the total urban-rural difference in life disparity into direct and compositional components (Shkolnikov 2011)

$$\Delta e^{\dagger}_{dir} = e^{\dagger}(\lambda \cdot M_u) - e^{\dagger}(M_u) \qquad (2a)$$

$$\Delta e^{\dagger}_{comp} = e^{\dagger}(M_r) - e^{\dagger}(\lambda \cdot M_u) \qquad (2b)$$

Here M_u and M_{1r} are two vectors of age-specific death rates in the urban and rural sector respectively, λ is the average rate of mortality change, and $m_{x,u}$, $m_{x,r}$ being the elements in vectors M_u and M_r. λ could be calculated from the equation below.

$$\lambda = \frac{1}{\omega} \cdot \sum_{x} (m_{x,r} / m_{x,u}) \qquad (2c)$$

3. Decomposition of life expectancy and lifespan disparity by causes of death

- Measure the disease-specific contribution to life expectancy and lifespan disparity by removing deaths from a specific cause and compare the values of life expectancy and lifespan disparity before and after the deaths removal. The contribution of each disease could be expressed with the below equations, where i denotes a particular type disease, and M'_i is a vector contains mortality rates with deaths from disease i removed.

$$\Delta e_0 \ = e_0^{-i} - e_0 \qquad (3a)$$

$$\Delta e_i^{\dagger} = (e^{\dagger})^{-i} - e^{\dagger} \qquad (3b)$$

III. Preliminary results

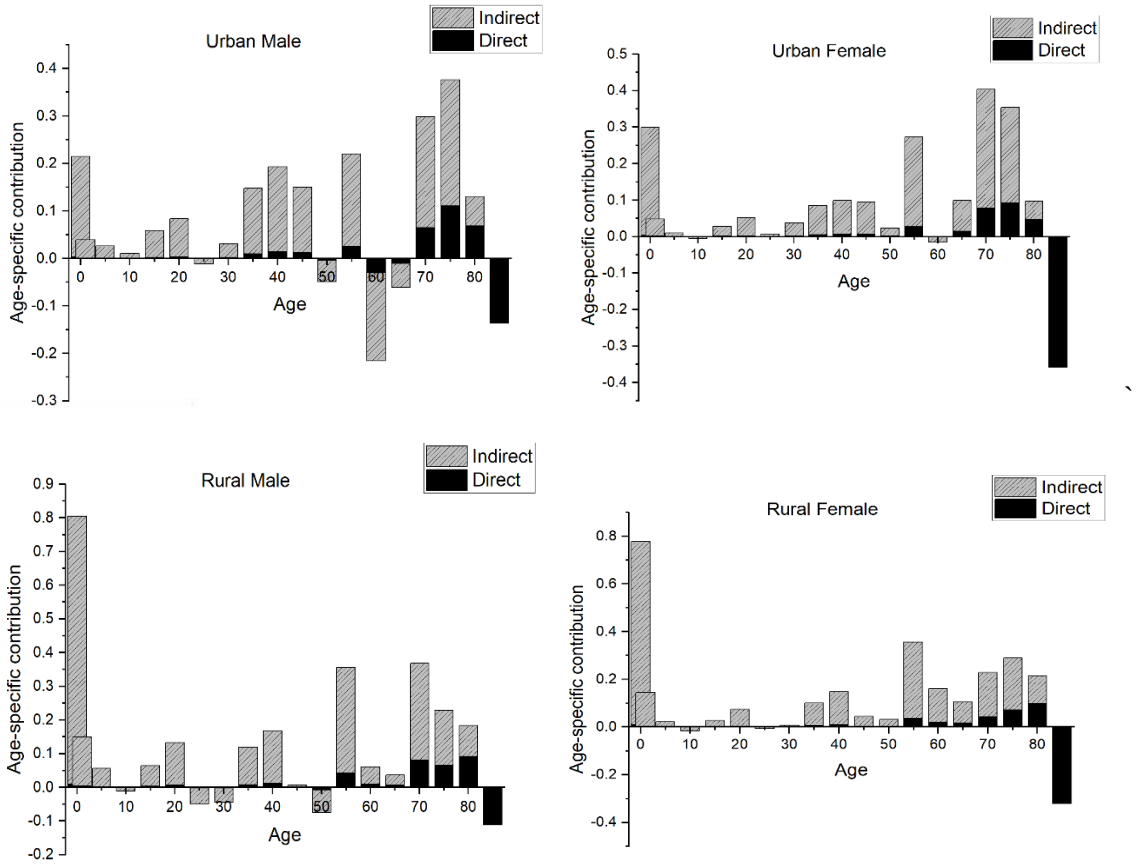
1. Life expectancy, median age at death, and lifespan disparity

Table 1. Life expectancy, lifespan inequality, and median age at death in 2006 and 2016

	Life expectancy at birth (e_0)	Median Age at Death (Md)	Lifespan inequality ($e^{\dagger}$)
2006			
Urban Male	73.46	76.99	12.52
Urban Female	78.41	81.77	11.93
Rural Male	70.98	75.04	13.96
Rural Female	76.88	80.54	13.20
2016			
Urban Male	74.97	78.68	11.76
Urban Female	80.04	83.84	10.34
Rural Male	73.42	76.99	12.84
Rural Female	79.27	82.77	11.29

2. Age-specific contribution of changes in life expectancy

Figure 1. Age-specific contribution to changes in life expectancy between 2006 and 2016



3. Decomposition of the urban-rural differences in lifespan disparity at the same time point

Table 2. Direct and compositional components of differences between lifespan disparity in Urban and Rural population in 2006 and 2016 (in years)

	Urban	Rural	Even Reduction	Total Difference	Direct	Compositional (Residual)
Male						
2006	12.52	13.96	12.63	-1.44	-0.11	-1.33
2016	11.76	12.84	11.97	-1.08	-0.21	-0.87
Female						
2006	11.93	13.20	11.72	-1.27	0.21	-1.48
2016	10.34	11.29	10.25	-0.95	0.09	-1.04

4. Disease-specific contribution to life expectancy and lifespan disparity

Figure 2. Potential years in life expectancy at birth lost due to deaths from particular diseases in the urban and rural area, in year 2006 and 2016.

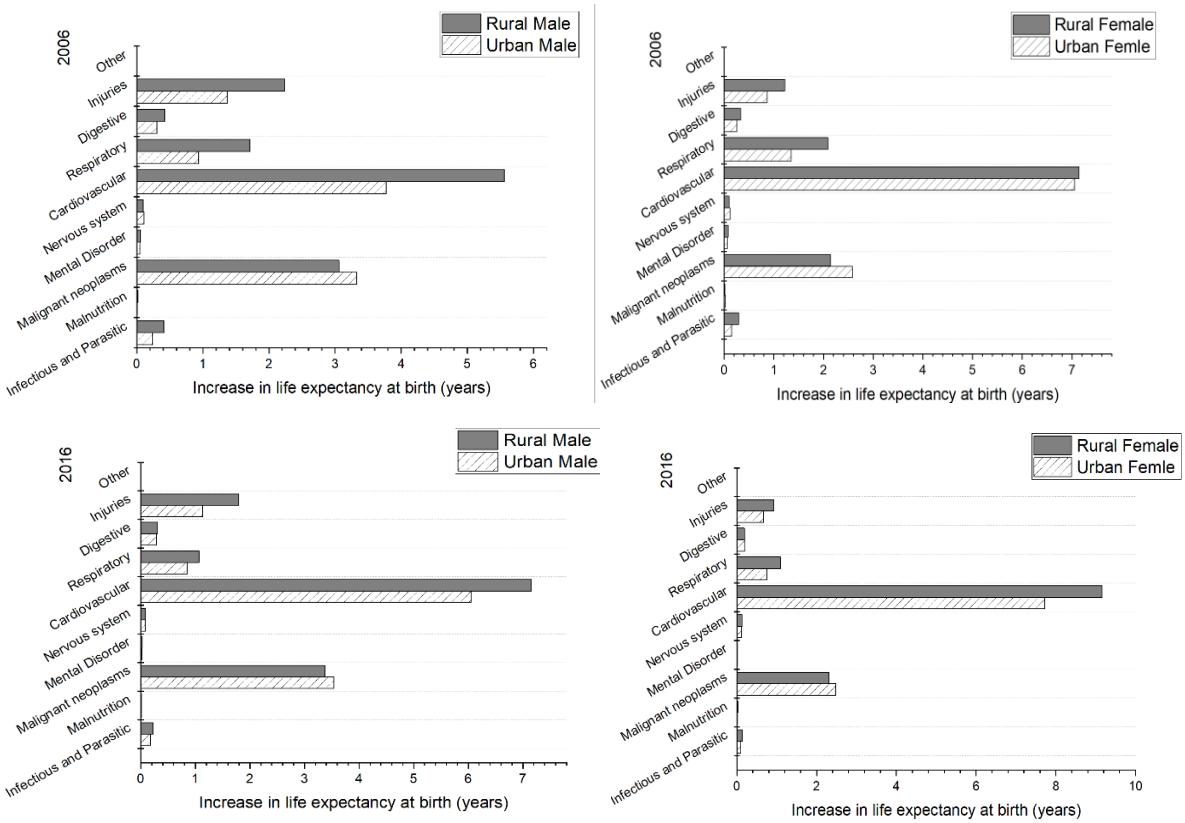
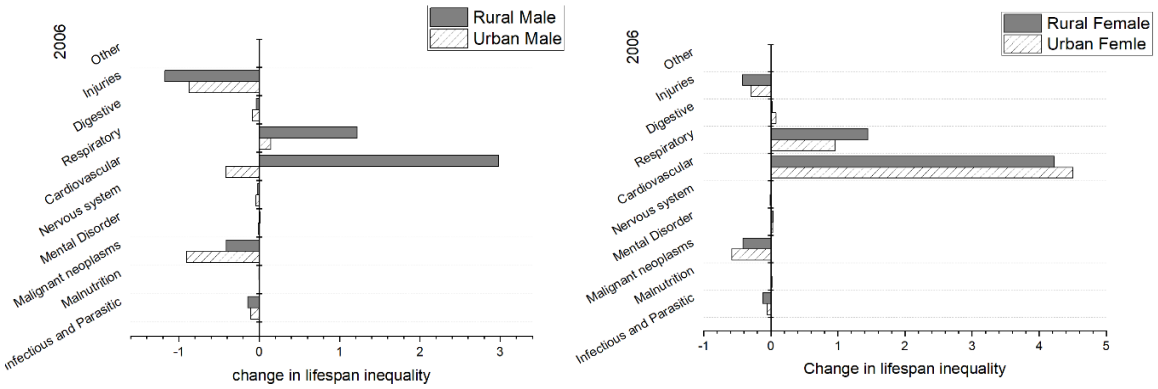
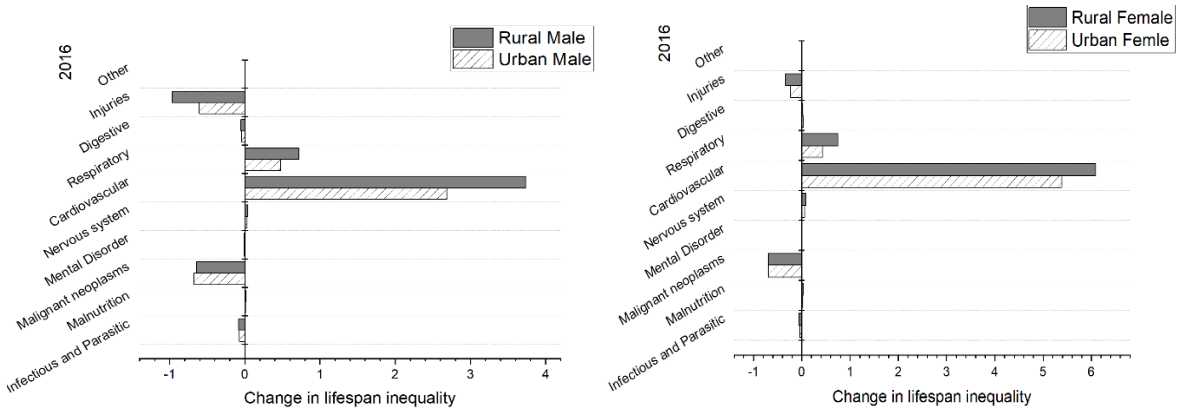


Figure 3. Potential lifespan disparity change due to deaths from particular diseases in the urban and rural area, in year 2006 and 2016.





IV. Key findings

- Over the 10 years between 2006 and 2016, the urban-rural gap in life expectancy is shrinking, but the gender gap remains high in each sector.
- The male population is becoming more heterogenous in lifespan than the female population.
- The direct impact from reduction of mortality positively contributed to the increase in life expectancy at mature ages, but the indirect effect remains the driving force of increase in life expectancy, suggesting the increasing number of survivors in each age group is having an indirect yet significant impact on the person-years lived.
- At the same time point, the urban-rural difference in lifespan disparity is mainly explained by the compositional effect, and the male population has more excess loss in life years brought by pre-mature deaths.
- In both urban and rural, male and female population in China, deaths from cardiovascular diseases (CVD) lead to most lost in potential life expectancy years, followed by malignant neoplasms (or cancers). These two diseases continues to take even more years of life in 2016 than in 2006. But malignant neoplasm results in more pre-mature deaths than CVD, thus become an important force in driving up lifespan disparity.
- Compared with the urban population, rural population still suffers more from injuries, diseases in the digestive and respiratory system, and communicable diseases such as infectious and parasitic diseases, while the harm brought by malignant neoplasm is more severe in the urban sector.
- There are still substantial urban-rural differences in the age pattern of the distribution of disease-specific mortality and in the dynamic of change in these patterns over time. A clear understanding of such differences would help the professionals working in public health to better target the groups vulnerable to certain diseases and wisely allocate the resources

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