



Statistical Study on Mortality in China

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Abstract. With the recently released data of China's Population Statistics Yearbook 2020, this paper conducts a statistical analysis of the general situation of Mortality in China. By using RStudio to clean up the data formats and dive deeper into all data points regarding mortality rates, the paper examines the factors affecting China's Mortality Rates including provinces, geographic regions, gender, age groups, and urban and rural populations, and then compares to data in the past (since 2001) to predict general trends and identify key improvement areas. A cross-country data comparison concludes that China's Mortality rate has decreased steadily and remains low compared to global average. With a multi-factor linear analysis taking all three factors into consideration, gender, age, urban vs rural and comparing across data from previous years, the author confirms a general mortality trend of the population as the age increases. The paper also explains the changing landscapes and inconsistencies in recent years, such as Central China's higher mortality rate compared to Eastern and Western China, and Shandong and Chongqing with the highest mortality rate in the country. These will require further studies for answers.

Keywords: Mortality · China · Region Differentials · Urban-Rural Differentials · Age Differentials

1 Introduction

Population death is one of the determinants of population change, and it also has an important impact on economic development [1]. Due to various reasons, the research on Mortality in China is insufficient. On the one hand, it is difficult to obtain accurate and reliable death data in China. On the other hand, under the influence of Chinese traditional culture, people usually take an evasive attitude towards the phenomenon and problems of "death" [2].

Foreign scholars have studied the problem of population death earlier and proposed several population mortality models. As early as 1724, De Moivre put forward the population mortality model [3]. After that, Benjamin Gompertz put forward a new population mortality model in 1825 [4]. He believed that the population mortality showed a gradual upward trend with the increase of age. After that, there was a series of deaths rate, such as Weibull (1951) [5], Heiligam (1980) [6]. The last death rate model was proposed by Frank J. Fabozzi in 2012, which can better fit the sample data than the classical Lee Carter model, covering up the specific years between regions [7].

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A. Luqman et al. (Eds.): PMIS 2022, AHCS 6, pp. 4–13, 2023.

https://doi.org/10.2991/978-94-6463-016-9_2

After 1990, domestic scholars began to notice the work of the foreign researchers and began to study the problem of Mortality in China. The existing research results mainly focused on the following aspects. First, the factors affecting population death. Zhao pointed out that the main factors affecting population death are biological factors, environmental factors, the level of socio-economic development, culture and education, and medical and health care [8]. In addition, the characteristics of population structure are also important factors affecting mortality rate [9]. Second focus was about comparison of different population groups. Generally speaking, the mortality rate of male residents is higher than that of female residents [10]. Since the 1980s, there has been a positive spatial autocorrelation in the death rate of various provinces in China, but the correlation level has decreased with time [11, 12]. The death rate of the population decreases with the increase of educational level, which may be caused by the differences in occupation, socio-economic status, self-care awareness and habits of people with different educational backgrounds [13]. Thirdly, the trend of mortality rate. Tian and Wang analyzed the characteristics of population death in China's Qinghai Tibet Plateau and found that the death rate has gone through three stages: decline, stability and slight increase [14].

Through this literature review process, it is discovered that the existing research on Mortality in China is relatively immature. Most focused on early data. With the development of economy and the improvement of living standards, mortality in different regions and ages will change greatly. Therefore, this paper focuses on the changes of mortality in different regions and age groups in China since 2001.

2 Overview of China's Mortality

The following analysis was based on the recently released 2020 China Statistical Year Book [15]. The author used RStudio to clean up the inconsistent data formats, and calculated the trends using a linear regression model.

Since 1978, the Mortality in China has changed steadily, generally between 6.25‰ to 7.16‰. Since 1978, China's rapid social and economic development has been accompanied by a gradual reduction in infant death, resulting from the improvement of living conditions, nutrition and health care [16].

From 1978 to 2019, China's mortality rate was relatively stable, but there were still small fluctuations. In the rising stage from 1978 to 1983, China's mortality rate increased from 6.25‰ in 1978 to 6.9‰ in 1983. Since 1984, the mortality rate decreased from 6.82‰ in 1984 to 6.4‰ in 2003. Finally, it has increased from 6.42‰ in 2004 to 7.14‰ in 2019. The slight fluctuation of mortality during this period is mainly related to the improvement of medical care, the aging of China's population and some metabolic diseases caused by the improvement of living standards (Fig. 1).

Compared with other countries, China's mortality rate is at a lower level. By comparing the mortality rate between China and other countries in the world in 2019 (Fig. 2), it can be concluded that the mortality rate in China is lower than that in most countries, such as the United States, France, Britain, Germany, India, Pakistan, etc. In addition, several representative countries, including Japan with population aging, India with large population, Britain and the United States were selected to be compared with China. It is found that after entering the 21st century, China's mortality is still lower than that of

other countries, although China’s population aging problem has been exacerbated during this period (Table 1).

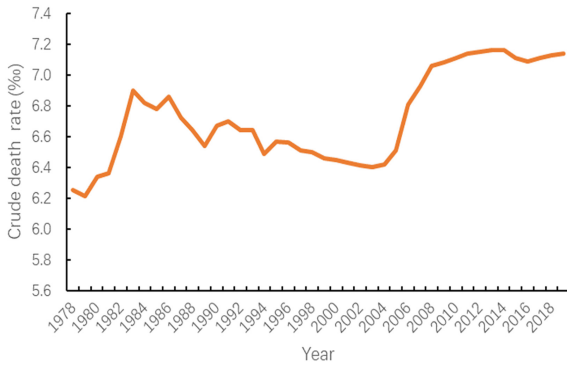


Fig. 1. China’s Mortality from 1978 to 2019 (self-plotted figure). Data Source: China Population Statistics Yearbook 2020.

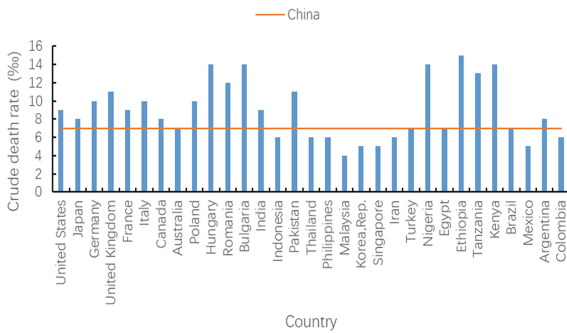


Fig. 2. Mortality of the world (%) (self-plotted figure). Data Source: Population Reference Bureau of United States, 2019 World Population Data Sheet. China Population Statistics Yearbook 2020.

Table 1. Mortality of five countries from 2001 to 2019(‰) (self-plotted Table)

	China	Japan	India	United Kingdom	United States
2001	6	8	9	11	9
2002	6	8	9	10	9
2003	6	8	8	10	9
2004	6	8	8	10	8
2005	7	8	8	10	8
2006	7	8	8	10	8
2007	7	9	8	10	8

(continued)

Table 1. (continued)

	China	Japan	India	United Kingdom	United States
2008	7	9	8	9	8
2009	7	9	7	9	8
2010	7	9	7	9	8
2011	7	9	7	9	8
2012	7	10	7	9	8
2013	7	10	7	9	8
2014	7	10	7	9	8
2015	7	10	7	9	8
2016	7	10	7	9	8
2017	7	10	7	9	8
2018	7	11	6	9	9
2019	7	11	6	9	9

Data Source: Population Reference Bureau of United States, 2001–2019 World Population Data Sheet. China Population Statistics Yearbook (2002–2020).

3 Analysis of Regional Differences in Mortality

3.1 Region-Specific Mortality Differentials

There are great differences in mortality rates among different regions within China. In 2001, the mortality rates of Yunnan and Guizhou were higher, which were 7.57‰ and 7.23‰ respectively, while that of Ningxia was the lowest, only 4.84‰; In 2005, the mortality in Guizhou, Jiangsu and Tibet also exceeded 7‰, which was at a high level. The mortality in Guangdong was still the lowest, only 4.68‰. In 2019, the provinces with higher mortality rates have changed greatly. Chongqing and Shandong have become the provinces with higher mortality, which are 7.57‰ and 7.50‰ respectively, while the mortality rates of Sichuan, Hunan, Jiangsu, Hebei, Liaoning and Hubei have also exceeded 7‰, and the province with the lowest mortality rate is Xinjiang, which is 4.45‰ (Table 2).

The trend of mortality in the South and the North is roughly the same. The mortality in the South is higher than that in the North, but the gap between the two regions is narrowing. From 2001 to 2019, the mortality rates in both the South and the North experienced a process of a decline followed by a slow increase. Among them, the mortality in the South decreased from 6.31‰ in 2001 to 5.91‰ in 2010, and then gradually increased. By 2019, the mortality of the South was 6.22‰; The mortality rate in the North decreased from 5.89‰ in 2001 to 5.66‰ in 2010, and increased to 6.19‰ in 2019. As time went on, the mortality gap between the South and the North gradually narrowed. In 2001, the mortality gap between the South and the North was 0.42‰, and then narrowed continuously. By 2019, the gap was only 0.03‰.

Table 2. The mortality of 31 provinces in China (%) (self-plotted Table)

	2001	2005	2010	2015	2019
Beijing	5.30	5.20	4.41	4.95	5.49
Tianjin	5.94	6.01	5.58	5.61	5.30
Hebei	6.18	6.75	6.41	5.79	6.12
Shanxi	5.90	6.00	5.38	5.56	5.85
Inner Mongolia	5.79	5.46	5.54	5.32	5.66
Liaoning	6.10	6.04	6.26	6.59	7.25
Jilin	5.38	5.32	5.88	5.53	6.90
Heilongjiang	5.49	5.20	5.03	6.60	6.74
Shanghai	5.97	6.08	5.07	5.07	5.50
Jiangsu	6.62	7.03	6.88	7.03	7.04
Zhejiang	6.25	6.08	5.54	5.50	5.52
Anhui	5.85	6.23	5.95	5.94	6.04
Fujian	5.52	5.62	5.16	6.10	6.10
Jiangxi	6.06	5.96	6.06	6.24	6.03
Shandong	6.24	6.31	6.26	6.67	7.50
Henan	6.26	6.30	6.57	7.05	6.84
Hubei	6.07	5.69	6.02	5.83	7.08
Hunan	6.72	6.75	6.70	6.86	7.28
Guangdong	5.12	4.68	4.21	4.32	4.46
Guangxi	6.07	6.09	5.48	6.15	6.14
Hainan	5.76	5.72	5.73	6.00	6.11
Chongqing	6.90	6.40	6.40	7.19	7.57
Sichuan	6.79	6.80	6.62	6.94	7.09
Guizhou	7.23	7.21	6.55	7.20	6.95
Yunnan	7.57	6.75	6.56	6.48	6.20
Tibet	6.50	7.15	5.55	5.10	4.46
Shaanxi	6.34	6.01	6.01	6.28	6.28
Gansu	6.43	6.57	6.02	6.15	6.75
Qinghai	6.44	6.21	6.31	6.17	6.08
Ningxia	4.84	4.95	5.10	4.58	5.69
Xinjiang	5.69	5.04	4.14	4.51	4.45

Data source: China Population Statistics Yearbook (2002, 2006, 2011, 2016, 2020).

This is generally speaking an indication of equal footing in economic development and living standard of both northern and southern China (Fig. 3).

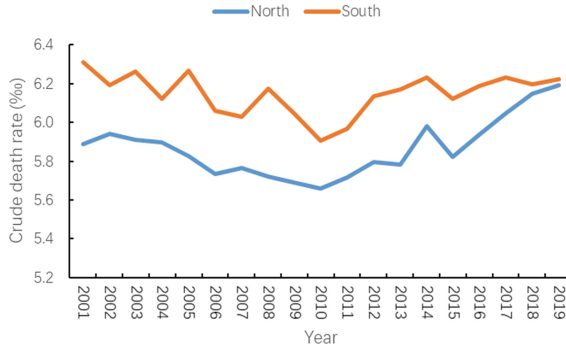


Fig. 3. The Mortality of the South and the North in China since 2001 (self-plotted figure). Note: According to China’s North-South Division Standard bounded by Qinling Mountains-Huaihe River Line, the northern region includes Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shandong, Henan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang; The southern region includes Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Hubei, Hunan, Guangdong, Guangxi, Hainan, Chongqing, Sichuan, Guizhou, Yunnan, Tibet. Data source: China Population Statistics Yearbook (2002–2020).

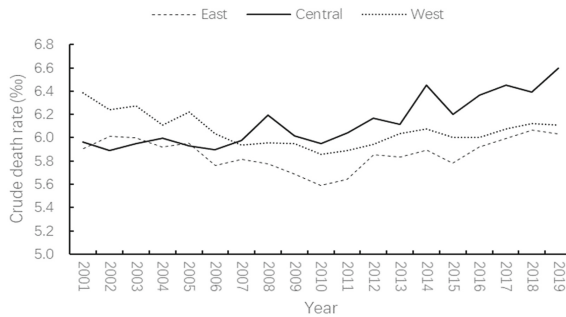


Fig. 4. The Mortality of east, central and west regions since 2001 (self-plotted figure). Note: The east region includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Shandong, Fujian, Guangdong, Hainan; The central region includes Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan; the west region includes Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang. Data source: China Population Statistics Yearbook (2002–2020).

The mortality in the East has remained at a low level, while the mortality ranking in the Middle and the West has shifted. Before 2007, the mortality in the western region was higher, while that in the central and eastern regions was relatively close. Since 2007, the mortality rate in the central region has been rising, ranked the highest among the three regions, while the western region’s rate has been declining. The mortality rate in the eastern region is still the lowest (Fig. 4).

3.2 Urban-Rural Mortality Differentials

The China Population Statistics Yearbook divides the population into three categories, the cities, counties and the rural areas. The trend of mortality in cities, counties and rural areas is the same, but the mortality in rural regions is the highest and that in cities is the lowest. The mortality of rural areas remains between 6–9‰, the urban mortality rate remains between 2–5‰, and the county mortality rate remains between 4–6‰. The high mortality rate in rural areas is due to poor medical conditions and the low living standards in China (Fig. 5). In the early stage, the mortality rate over 90 years old was the highest in cities, the second in rural areas and the lowest in counties. However, over the years, the mortality rate in rural areas has become the highest in all age groups (Fig. 6).

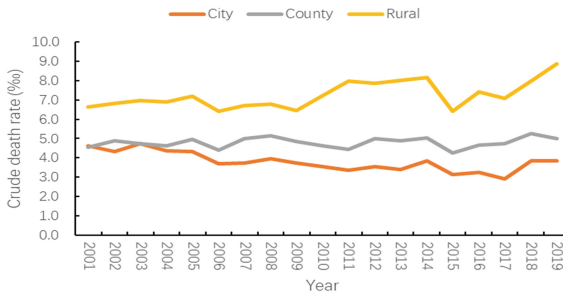


Fig. 5. The Mortality of city, county and rural areas since 2001 (self-plotted figure). Data source: China Population Statistics Yearbook (2002–2020).

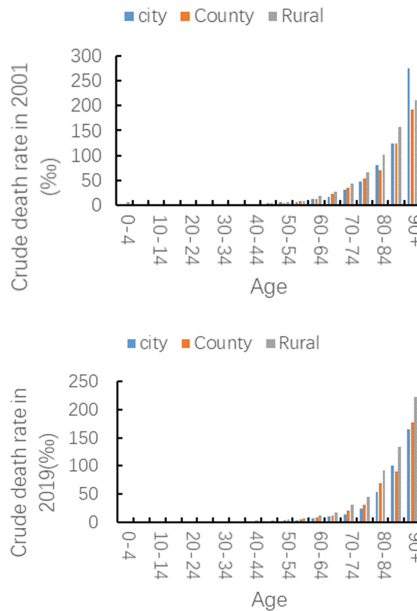


Fig. 6. The Mortality of different ages in 2001 and 2019 (self-plotted figure). Data source: China Population Statistics Yearbook (2002, 2020).

3.3 Age-Specific Mortality Differentials

Age plays an important factor in determining the mortality rate. The mortality rate is relatively high between 0 and 4 years of age and after the population becomes 5 years old, the mortality rate goes down. However, once the population passes the 35 years old threshold, the mortality rate starts to climb again.

From Table 3, we can know that, with the increase of age, the mortality rate shows an upward trend. In 2019, the mortality rate between the ages of 5–9 was 0.16‰, and then increased continuously. After the age of 35, the mortality rate began to exceed 1‰. After the age of 65, the mortality rate began to exceed 10‰. Once the population passed the age of 85, the mortality rate exceeded 100‰. Before the person turns 35 years old, the mortality was the highest between 0 and 4 years of age, which is 1.05‰.

When we take both age and urban-rural factors into consideration, we can discover more details. In all age groups, the mortality rate is the highest in rural areas and the lowest in urban areas. For example, for 0–4 years old, the mortality rates in city, county and rural areas are 0.40‰, 1.16‰ and 1.61‰ respectively, and for over 90 years, the

Table 3. Mortality rates of different age groups in 2019 (‰) (self plotted table)

Year	Age	Male			Female			Average
		City	County	Rural	City	County	Rural	
2019	0–4	0.62	1.30	1.56	0.17	1.01	1.65	1.05
2019	5–9	0.09	0.20	0.51	0.01	0.02	0.10	0.16
2019	10–14	0.30	0.11	0.64	0.02	0.21	0.54	0.30
2019	15–19	0.00	0.20	1.10	0.08	0.02	0.40	0.30
2019	20–24	0.10	0.18	1.29	0.06	0.14	0.80	0.43
2019	25–29	0.08	0.92	1.22	0.05	0.13	0.85	0.54
2019	30–34	0.43	1.07	1.35	0.08	0.34	0.45	0.62
2019	35–39	0.43	1.67	2.82	0.52	0.57	0.65	1.11
2019	40–44	0.81	0.43	3.57	0.47	0.92	0.98	1.20
2019	45–49	1.19	2.20	3.75	0.74	0.98	1.52	1.73
2019	50–54	2.78	3.28	7.25	0.98	1.44	2.66	3.07
2019	55–59	3.84	5.53	9.12	1.62	3.14	3.26	4.42
2019	60–64	8.94	9.93	14.96	4.37	5.99	7.21	8.57
2019	65–69	12.89	16.61	21.02	6.20	8.18	12.57	12.91
2019	70–74	17.59	25.19	36.59	11.12	16.67	23.79	21.83
2019	75–79	24.64	38.29	60.27	24.05	23.47	32.20	33.82
2019	80–84	69.27	81.76	109.99	40.34	60.54	78.12	73.34
2019	85–89	112.49	124.01	167.47	88.96	67.98	111.02	111.99
2019	90+	203.59	242.42	261.08	141.84	142.86	205.18	199.50

Data source: China Population Statistics Yearbook (2020).

mortality rates in city, county and rural areas are 172.72‰, 192.64‰ and 233.13‰ respectively.

In addition, the mortality rate of men is higher than that of women for most age groups. For example, for 5–9 years old, the mortality rates for male and female residents are 0.27‰ and 0.04‰ respectively, and for 85–89 years old, the mortality rates for male and female residents are 143.66‰ and 89.32‰ respectively. This is generally speaking quite consistent in the past few years.

4 Conclusion

With the development of the economy and the improvement of living standards, mortality in different regions and age groups will continue to change. This paper gives an overall description of the characteristics and facts of Mortality in China, and then focuses on the changes of mortality in different regions and age groups in China since 2001. Finally, this paper draws the following conclusions.

First, since 1978, the Mortality in China has changed steadily, generally between 6.25‰–7.16‰. Compared with other countries, China's mortality rate is at a lower level.

Second, there are great differences in mortality among regions. In 2001, the mortality rates of Yunnan and Guizhou were higher, which were 7.57‰ and 7.23‰ respectively, while that of Ningxia was the lowest, only 4.84‰; In 2019, Chongqing and Shandong have become the provinces with higher mortality.

Third, the trend of mortality in the South and the North is roughly the same. The mortality in the South is higher than that in the North, but the gap between the two regions is narrowing. The mortality in the East has remained at a low level, while the mortality ranking in the middle and West has changed. In all age groups, the mortality rate is the highest in rural areas and the lowest in urban areas.

The paper also discovered that between age 5 to 35, the mortality rate remains low, and begins to increase once the population passes the 35 year old line.

In addition, the mortality rate of men is higher than that of women for most age groups.

Acknowledgment. Thanks to Professor Junni Zhang and Dr. Pingping Wang at Peking University for their academic guidance.

References

1. Huang RQ, Zhuang RE (2004) Differences of population death rate. *Popul J* (6):3–7
2. Liang MY (2018) Spatial characteristics of population Mortality in China. *Trop Geogr* 38(2):208–216
3. De Moivre (1992) Modeling and forecasting U.S. mortality. *J Am Stat Assoc* 87(419):659–671
4. Benjamin G (1825) Two-factor model for stochastic mortality with parameter uncertainty: theory and calibration. *J Risk Insur* 73
5. Weibull W (1951) A statistical distribution function of wide applicability. *J Appl Mech* 18(3):293–297

6. Heiligam P (1980) Computational methods for fitting and extrapolating the Lee-Carter model of mortality change. University of California, Berkeley
7. Frank JF (2012) Lee-Carter mortality forecasting with age-specific enhancement. *Insurance: Math Econ* 33
8. Zhao JH (1994) China's population death trend analysis of the social and economic factors. *Northwest Popul J* 15(4):49–53
9. Song LJ (2007) Population mortality of Fujian Province regional difference analysis. *J Shenyang Agric Univ (Soc Sci Ed)* 9(4):539–541
10. Chang JJ, Wang SM (1995) The minority of Dai and Lisu mortality rate and the average life expectancy and its difference. *Popul J* 15(2):38–48
11. Liu HM, Niu SW, Yang Z (2008) Spatial analysis on the level of Mortality in China. *Chin J Popul Sci* 23(1):44–52
12. Gui FY, Wei CH, Chen S (2013) Spatial statistical analysis of Chinese provincial mortality level based on the sixth census data. *J Minzu Univ China (S1)*:41–44
13. Zeng P, Yuan L, Wang J (1998) Our country population mortality and culture degree of relationship. *Prev Med Tribune* 4(3):240–241
14. Tian ZX, Wang Y (2004) The Qinghai-Tibet plateau population death characteristics analysis. *Qinghai Sci Technol* 11(1):35–39
15. China Statistical Yearbook 2020 (2020). China Statistics Press. <http://www.stats.gov.cn/tjsj/ndsj/2020/indexeh.htm>
16. Tyers R, Shi Q (2007) Demographic change and policy responses: implications for the global economy. *World Econ* 30(4):537–566

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