Postprint of a Study on Trends in Life Expectancy and Disease Spectrum Among Residents of Jing' an District, Shanghai, 2016-2021

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Abstract

Background With continuous improvements in socioeconomic conditions and population health status, mortality patterns and disease spectra have undergone changes, altering the impact of different diseases on life expectancy variations.

Objective To analyze the trends in life expectancy and its influencing factors among residents in Jing' an District, Shanghai.

Methods Using population and mortality data of Jing' an District residents in Shanghai from 2016 to 2021, the abridged life table method and Arriaga' s decomposition method were applied to compare the effects of different age groups and diseases on life expectancy.

Results From 2016 to 2021, the life expectancy of registered residents in Jing' an District ranged from 83.68 to 84.40 years, representing an increase of 0.72 years. Specifically, male life expectancy increased from 81.47 to 82.15 years (a gain of 0.68 years), while female life expectancy increased from 85.95 to 86.74 years (a gain of 0.79 years). The 65-84 age group contributed most positively to life expectancy gains (83.29% contribution rate), whereas the 15-44 age group contributed most negatively (-17.18% contribution rate). Reduced mortality from neoplasms and respiratory diseases were the primary drivers of life expectancy improvement, with contribution rates of 56.20% and 53.55%, respectively. Conversely, increased mortality from injuries and poisonings, and endocrine, nutritional, and metabolic diseases negatively impacted life expectancy gains, with contribution rates of -35.69% and -17.25%, respectively.

Conclusion The increase in life expectancy in Jing' an District is mainly attributable to reduced mortality among the elderly population, as well as declines in neoplasms and respiratory diseases. Future efforts should continue to

strengthen disease prevention and control in the elderly population while emphasizing the prevention and treatment of injuries and poisonings, and endocrine, nutritional, and metabolic diseases.

Full Text

Study on Trends in Life Expectancy and Disease Spectrum Among Residents of Shanghai Jing' an District, 2016-2021

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Abstract

Background: With improvements in socioeconomic conditions and population health, mortality patterns and disease spectra have undergone significant transformations, altering the relative impact of different diseases on changes in life expectancy.

Objective: To analyze trends in life expectancy and their influencing factors among residents of Shanghai Jing' an District.

Methods: Population and mortality data for Jing' an District residents from 2016 to 2021 were collected. Abridged life tables and Arriaga' s decomposition method were employed to assess the contributions of age groups and causes of death to changes in life expectancy.

Results: Life expectancy among registered residents of Jing' an District increased from 83.68 to 84.40 years between 2016 and 2021, a gain of 0.72 years. Male life expectancy rose from 81.47 to 82.15 years (+0.68 years), while female life expectancy increased from 85.95 to 86.74 years (+0.79 years). The 65-84 age group made the largest positive contribution to this increase (83.29%), whereas the 15-44 age group exerted the greatest negative contribution (-17.18%). Reduced mortality from tumors and respiratory diseases were the primary drivers of life expectancy gains, contributing 56.20% and 53.55%, respectively. Conversely, increased mortality from injuries/poisonings and endocrine, nutritional, and metabolic diseases had negative effects, contributing -35.69% and -17.25%, respectively.

Conclusion: The increase in life expectancy in Jing' an District is primarily attributable to reduced mortality among older adults and declines in deaths

from tumors and respiratory diseases. Future efforts should continue strengthening disease prevention and control among elderly populations while addressing injuries/poisonings and endocrine, nutritional, and metabolic diseases.

Key words: Life expectancy; Decomposition of life expectancy; Mortality

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Life expectancy serves as a crucial indicator of population health. The 14th Five-Year Plan outlines the goal of building a comprehensive Healthy China with improved healthcare systems and increasing average life expectancy by one year. As socioeconomic conditions and population health improve, mortality patterns and disease spectra evolve, altering how different diseases influence life expectancy changes. In recent years, Jing' an District has actively explored disease prevention and control mechanisms to enhance residents' health. This study utilizes cause-of-death surveillance data from 2016–2021 to analyze the impact of different age groups and diseases on life expectancy gains and trends in Jing' an District, evaluate population health status, and provide evidence for disease control strategies and health policy formulation.

1.1 Data Sources

Population and mortality data for registered residents of Jing' an District from 2016–2021 were collected. Population data were obtained from the Shanghai Municipal Public Security Bureau Jing' an Branch. Mortality data were derived from the Jing' an District Cause-of-Death Surveillance System. Causes of death were classified according to the International Classification of Diseases, 10th Revision (ICD-10), with underlying cause of death used for statistical analysis.

Jing' an District CDC has established mortality data underreporting control measures and investigation mechanisms, conducts regular underreporting surveys and quality supervision, and cross-checks data monthly with public security departments. All death records are reviewed by professional staff with a 100% review rate. The cause-of-death surveillance data demonstrate high completeness and reliability, with excellent data quality [**?**].

1.2 Statistical Analysis

Excel 2016 and R 3.5.1 were used for statistical analysis. Abridged life table methods were employed to calculate life expectancy for different periods, and Arriaga' s decomposition method [**?**, **?**] was applied to analyze the impact of age-specific and cause-specific mortality on life expectancy changes. The formulas are as follows:

1.2.1 Decomposition by Age Group:

$$TE_x = \left[\frac{l_x^1}{l_0^1} \times \left(\frac{L_x^2}{l_x^2} - \frac{L_x^1}{l_x^1}\right)\right] + \left[\frac{L_x^1}{l_0^1} \times \left(\frac{l_x^2}{l_x^1} - \frac{l_{x+n}^2}{l_{x+n}^1}\right)\right] + \left[\frac{T_{x+n}^1}{l_0^1} \times \left(\frac{l_{x+n}^2}{l_{x+n}^1} - \frac{l_{x+n}^1}{l_{x+n}^1}\right)\right]$$

where TE_x represents the total contribution between ages x and $x+n$, l_x is the number of survivors at age x, l_0 is the initial population size, L_x is the person-years lived between ages x and $x+n$, T_{x+n} is the total person-years lived beyond age $x+n$, and l_{x+n} is the number of survivors at age $x+n$. Superscripts "1" and "2" denote data for 2016 and 2021, respectively.

1.2.2 Decomposition by Cause of Death:

$$C_x^i = TE_x \times \frac{R_x^i}{S_x}$$

where C_x^i is the total contribution rate of cause i between ages x and $x+n$, R_x^i is the mortality rate from cause i between ages x and $x+n$, and S_x is the all-cause mortality rate between ages x and $x+n$.

2.1 Trends in Life Expectancy

Life expectancy among residents of Shanghai Jing' an District ranged from 83.68 to 84.40 years between 2016–2021, representing an increase of 0.72 years (average annual gain: 0.12 years). Male life expectancy consistently remained lower than female life expectancy, with males gaining from 81.47 to 82.15 years (+0.68 years; +0.11 years annually) and females from 85.95 to 86.74 years (+0.79 years; +0.13 years annually). See Table 1 .

Table 1 Trends in Life Expectancy (Years) Among Jing' an District Residents, 2016–2021

2.2 Impact of Age-Specific Mortality Changes on Life Expectancy

The 65–84 age group made the largest positive contribution to life expectancy gains in Jing' an District from 2016–2021, adding 0.60 years (contribution rate: 83.29%). This contribution was 0.44 years (64.96%) for males and 0.82 years (102.77%) for females. The 0-year and 15–44 age groups exerted negative contributions, with the 15–44 age group showing the greatest negative impact (-0.12 years; -17.18%). This negative contribution was -0.07 years (-10.71%) for males and -0.18 years (-22.31%) for females. Additionally, the 85+ age group negatively impacted female life expectancy growth (-0.08 years; -9.86%). See Table 2 .

Table 2 Impact of Age-Specific Mortality Changes on Life Expectancy in Shanghai Jing' an District, 2016–2021

2.3 Impact of Major Causes of Death on Life Expectancy

Tumors made the largest positive contribution to life expectancy gains, adding 0.41 years (contribution rate: 56.20%). The male contribution (0.43 years, 63.68%) exceeded the female contribution (0.38 years, 47.96%). Except for

the 85+ age group, all age groups showed positive contributions from tumor mortality reductions, with the 45–64 and 65–84 age groups showing particularly large contributions of 25.02% (male: 35.65%, female: 84.49%) and 48.12% (male: 35.43%, female: 67.38%), respectively.

Respiratory diseases ranked second in positive contributions, adding 0.39 years (53.55%). Again, male contributions (0.42 years, 61.70%) exceeded female contributions (0.35 years, 43.87%). All age groups showed positive contributions from respiratory disease mortality reductions, with the 65–84 and 85+ age groups contributing 41.98% (male: 46.29%, female: 36.20%) and 43.72% (male: 34.66%, female: 55.86%), respectively.

Injuries and poisonings represented the primary cause of negative contributions to life expectancy growth, reducing it by 0.26 years (contribution rate: -35.69%). Female contributions (-0.19 years, -23.66%) exceeded male contributions (-0.06 years, -8.72%). The 15–44 and 85+ age groups showed the largest negative contributions at 79.41% (male: 73.10%, female: 84.49%) and 19.99% (male: 24.90%, female: 16.23%), respectively.

Endocrine, nutritional, and metabolic diseases ranked second in negative contributions, reducing life expectancy by 0.12 years (contribution rate: -17.25%). Female contributions (-0.30 years, -37.95%) exceeded male contributions (-0.22 years, -31.77%). The 85+ age group showed the largest negative contribution at 77.74% (male: 85.01%, female: 76.76%). See Figure 1 [Figure 1: see original paper].

Figure 1 Impact of Mortality Changes by Cause of Death on Life Expectancy Among Jing' an District Residents, 2016–2021

3 Discussion

Life expectancy among registered residents of Jing'an District ranged from 83.68 to 84.40 years between 2016–2021 (male: 81.47–82.15 years; female: 85.95–86.74 years), substantially higher than the national average (male: 74.5 years; female: 79.9 years in 2017) [**?**] and comparable to high-income countries such as New Zealand, Switzerland, and Singapore [**?**]. While life expectancy growth has slowed or stagnated in some regions after periods of rapid improvement [**?**], our findings show that Jing' an District' s life expectancy growth has decelerated in recent years, with an average annual gain lower than Shanghai' s during 1990–2010 (0.35 years) [**?**].

Unlike the rapid growth phase where life expectancy gains were driven primarily by reduced infant mortality [**?**], recent improvements in Jing' an District are mainly attributable to mortality declines in the 65–84 age group, consistent with findings from China [**?**] and Hong Kong [**?**]. The contribution of older age groups was greater for females than males, aligning with previous research [**?**]. As survival curves become increasingly "rectangular," the impact of younger age groups on life expectancy becomes more limited while the influence of el-

derly mortality grows [?]. Jing' an District faces severe population aging, with residents aged 60+ comprising 40.1% of the total population [?], indicating an ultra-aging society. This underscores the need to address elderly care requirements, improve health status among older adults, and further reduce mortality in this population.

Reduced tumor mortality played a primary role in driving life expectancy gains, particularly in the 45–84 age groups. This may be attributed to improving cancer survival rates [?], declining tumor mortality among younger generations [?], and advances in medical care alongside expanded cancer screening programs [?, ?]. Notably, tumors remain a leading cause of premature death and life expectancy reduction [?]. China' s cancer incidence and mortality rates exceed global averages [?], and the country' s cancer profile is transitioning from developing to developed nation patterns [?], complicating prevention and control efforts.

Declining respiratory disease mortality also contributed significantly to life expectancy gains. Recent studies show overall decreasing trends in respiratory disease mortality across all age groups in China [?]. Unlike Italy, where reductions were primarily driven by younger populations [?], Jing' an District' s improvements mainly stemmed from mortality declines among those aged 65+. Major influencing factors include smoking and ambient particulate pollution [?]. Recent improvements in air quality [?] and declining smoking rates [?], combined with evidence that pneumococcal vaccination improves respiratory symptoms in older adults [?], may have contributed to reduced elderly respiratory disease mortality. Future efforts should continue controlling risk factors while promoting pneumococcal vaccination and strengthening management of elderly respiratory disease patients.

Injuries and poisonings represented the leading cause of negative contributions to life expectancy growth, with the greatest impact in the 15–44 age group, consistent with previous Chinese studies [?]. Research indicates that suicide and traffic accidents are the main causes of injury in this age group [?], highlighting the need for enhanced psychological support and traffic safety education. Additionally, injury/poisoning mortality in the 85+ age group negatively impacted life expectancy growth. Injury/poisoning mortality increases with age, with accidental falls being the leading cause among older adults [?], suggesting a need to focus on fall prevention and safety awareness in this population.

Notably, diabetes and other endocrine, nutritional, and metabolic diseases negatively impacted life expectancy growth, consistent with findings from Tianjin [?] and Wuxi [?]. Diabetes mortality and prevalence have been increasing [?, ?], particularly among the oldest old [?]. The 85+ age group contributed most to increased mortality from these conditions in Jing' an District, accounting for approximately half of diabetes deaths [?], likely reflecting population aging. With intensifying population aging, diabetes prevention and control face mounting challenges. Shanghai residents already exhibit high diabetes prevalence [?] and poor glycemic control [?], indicating elevated mortality risk. Future efforts must

prioritize diabetes prevention and reduce mortality among the oldest old.

Gender differences exist in age-specific contributions across diseases. Overall, males showed greater contributions from tumors and respiratory diseases to life expectancy gains than females, indicating larger mortality reductions in these conditions among men—consistent with trends elsewhere [**?**, **?**]. Males have higher incidence and mortality from tumors and respiratory diseases [**?**] and exhibit higher prevalence of risk factors such as obesity, smoking, and overweight [**?**]. While male cancer incidence in Shanghai continues to decline, female rates have stagnated [**?**], and gender differences in risk factor prevalence are narrowing [**?**], explaining why male mortality is declining faster than female mortality.

In conclusion, life expectancy gains in Jing'an District are primarily attributable to reduced mortality among older adults, with tumors and respiratory diseases making major contributions, while injuries/poisonings and endocrine, nutritional, and metabolic diseases exerted negative effects. Future efforts should continue strengthening disease prevention and control among elderly populations to further improve life expectancy.

Author Contributions: Chu Xiaoting conceived and designed the study and drafted the manuscript; Wan Qiuping and Zhang Guohui collected and analyzed the data; Xiong Jianjing and Fang Jialie supervised the study and ensured quality control; Yang Xiaoming revised and finalized the manuscript. All authors approved the final version.

Conflict of Interest: The authors declare no conflict of interest.

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Note: Figure translations are in progress. See original paper for figures.