

Postprint: Trends and Forecast Analysis of Premature Mortality Probability for Four Categories of Chronic Diseases in Baise City, 2015-2021

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Abstract

Background Chronic non-communicable diseases (chronic diseases) among Chinese residents pose a considerable disease burden and have become a significant factor limiting improvements in population health life expectancy. Objective To investigate the premature mortality status of four major chronic diseases (malignant tumors, cardiovascular and cerebrovascular diseases, diabetes, and chronic respiratory diseases) in Baise City from 2015 to 2021 and assess progress toward the “Healthy China 2030” goals, thereby providing reference for developing chronic disease prevention and control strategies in impoverished western regions. Methods Death data from 2015 to 2021 registered in the cause-of-death surveillance system of Baise City Center for Disease Control and Prevention were collected. Mortality rates, premature mortality probability, and other indicators were calculated. Joinpoint 24.0 software was utilized to describe trends using average annual percent change (AAPC) and rate change patterns. Results From 2015 to 2021, the crude mortality rate of the four chronic diseases in Baise City was 549.06/100,000 (AAPC=0.13%), and the standardized mortality rate was 302.92/100,000 (AAPC=-5.66%); neither trend was statistically significant ($P>0.05$). The standardized mortality rate of the four chronic diseases among females exhibited a decreasing trend (AAPC=-1.66%, $P=0.046$). The crude mortality rate of cardiovascular and cerebrovascular diseases showed an increasing trend in the total population, males, and females (AAPC=2.74%, $P=0.004$; AAPC=2.43%, $P=0.013$; AAPC=3.17%, $P=0.011$). The standardized mortality rate of chronic respiratory diseases demonstrated a decreasing trend in both males and females (AAPC=-8.66%, $P=0.023$; AAPC=-8.17%, $P=0.027$). The premature mortality probabilities of the four chronic diseases were 15.77% for the total population, 26.03% for males, and 10.42% for females. The premature mortality probability of chronic respiratory diseases declined across all groups (AAPC=-6.89%, $P=0.012$; AAPC=-7.18%, $P=0.007$; AAPC=-6.94%,

P=0.020). The premature mortality probability of the four chronic diseases among males was approximately 2.5 times that of females. Based on the average growth rate of premature mortality probability from 2015-2021, the projected premature mortality probability for the four chronic diseases in Baise City for 2030 is 14.62%, while the 2030 target value is 13.69%. Only the target values for females, malignant tumors, and chronic respiratory diseases exceed the projected values. To achieve the 2030 premature mortality probability target, the average annual decline rate during 2021-2030 must be increased to 2.63%, with the decline rate for males needing to reach 2.70%. The premature mortality probability of diabetes warrants particular attention, as its projected value is substantially lower than the target value, requiring the decline rate to be increased to 6.76%. Conclusion From 2015 to 2021, the crude mortality rate of cardiovascular and cerebrovascular diseases among the total population, males, and females in Baise City showed an increasing trend, while the mortality rate and premature mortality probability of chronic respiratory diseases showed a decreasing trend. Based on current average growth rate projections, Baise City still faces a gap in achieving the “Healthy China 2030” target values. Males should be the key focus population, with diabetes and cardiovascular/cerebrovascular diseases as priority intervention targets. The average annual growth rate during 2021-2030 must reach -2.63% to achieve the “Healthy China 2030” goals.

Full Text

Trend and Forecast Analysis of Premature Mortality Probability from Four Major Chronic Diseases in Baise City, 2015–2021

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Abstract

Background: The disease burden of chronic non-communicable diseases (NCDs) among Chinese residents is severe and has become a critical factor limiting improvements in healthy life expectancy. **Objective:** To examine premature mortality from four major NCDs (malignant tumors, cardiovascular and cerebrovascular diseases, diabetes, and chronic respiratory diseases) in Baise from 2015–2021 and assess progress toward the “Healthy China 2030” goals, providing evidence for NCD prevention and control strategies in impoverished western regions. **Methods:** Mortality data from 2015–2021 were collected from the Baise CDC cause-of-death surveillance system. Mortality

rates and premature mortality probabilities were calculated, and Joinpoint 24.0 software was used to analyze trends via average annual percentage change (AAPC). **Results:** From 2015–2021, the crude mortality rate for the four major NCDs was 549.06/100,000 (AAPC=0.13%) and the age-standardized mortality rate was 302.92/100,000 (AAPC=-5.66%), with neither trend reaching statistical significance ($P>0.05$). Age-standardized mortality in women showed a significant decline (AAPC=-1.66%, $P=0.046$). Crude mortality from cardiovascular disease increased significantly in the total population, men, and women (AAPC=2.74%, $P=0.004$; AAPC=2.43%, $P=0.013$; AAPC=3.17%, $P=0.011$), while age-standardized mortality from chronic respiratory disease decreased significantly in both men and women (AAPC=-8.66%, $P=0.023$; AAPC=-8.17%, $P=0.027$). The probability of premature mortality from the four NCDs was 15.77% for the total population, 26.03% for men, and 10.42% for women, with chronic respiratory disease showing declining trends in all groups (AAPC=-6.89%, $P=0.012$; AAPC=-7.18%, $P=0.007$; AAPC=-6.94%, $P=0.020$). Men's premature mortality probability was approximately 2.5 times that of women. Based on the average growth rate from 2015–2021, the projected premature mortality probability for 2030 is 14.62%, compared to the target of 13.69%. Only women, malignant tumors, and chronic respiratory diseases have target values above projected values. To achieve the 2030 target, the average annual decline rate from 2021–2030 must increase to 2.63% overall, and to 2.70% for men. Diabetes requires particular attention, as its predicted value is substantially below the target, requiring an accelerated decline rate of 6.76%. **Conclusion:** Cardiovascular disease crude mortality increased while chronic respiratory disease mortality and premature mortality probability decreased. Current trends suggest Baise will fall short of “Healthy China 2030” targets. Priority should be given to men as the key population and to diabetes and cardiovascular diseases for intervention, requiring an average annual decline rate of -2.63% from 2021–2030 to achieve the 2030 goals.

Keywords: Neoplasms; Diabetes mellitus; Cardiovascular and cerebrovascular diseases; Chronic respiratory disease; Probability of premature mortality; Joinpoint regression analysis; Trend analysis; Baise

Introduction

As mortality from infectious diseases declines, the risk of death from chronic non-communicable diseases (NCDs) has increased. According to 2022 WHO data, NCDs account for 73.6% of global deaths, with the four major NCDs comprising 70% of all-cause mortality. In China, 82.98% of deaths are attributed to these four NCDs, with cardiovascular/cerebrovascular diseases and malignant tumors ranking as the top two causes—significantly higher than the global average. WHO uses premature mortality probability from four NCDs as a key indicator to evaluate regional NCD prevention and control effectiveness. Both the “Healthy China 2030” Planning Outline and China's Medium- and Long-term

Plan for NCD Prevention and Control (2017–2025) have set specific targets for reducing premature NCD mortality. However, Zeng et al. predicted that at previous decline rates, nearly two-thirds of provinces—particularly economically disadvantaged ones—would fail to meet the 2030 targets, indicating the formidable challenge ahead.

Baise City, located in western Guangxi on the border, faces slow economic development and scarce medical resources. Since establishing its first NCD comprehensive prevention and control demonstration zone in 2019, no studies have examined premature mortality from the four major NCDs. Understanding Baise’s situation can inform policy development for impoverished border regions. Therefore, this study uses Joinpoint regression to analyze trends in premature mortality from 2015–2021, assessing prevention effectiveness and providing evidence for targeted interventions.

Methods

1.1 Data Sources Mortality data from 2015–2021 were obtained from the Baise CDC cause-of-death surveillance system covering four surveillance points (Youjiang District, Tianyang District, Tiandong County, and Lingyun County). Population data comprised registered permanent residents of all age groups from the Baise CDC information system. The four NCDs were classified according to ICD-10: malignant tumors (C00-C97), cardiovascular/cerebrovascular diseases (I00-I99), diabetes (E10-E14), and chronic respiratory diseases (J30-J98).

1.2 Indicators and Calculations (1) **Premature mortality probability** is a statistical indicator calculating the probability of dying from the four NCDs between ages 30–69. Calculation steps: (5-year) age group mortality rate $5M_x$ = difference in deaths between age groups x and $(x+5)$ / population in that interval; death probability $5q_x = 5M_x \times 5 / (1 + 5M_x \times 2.5)$; premature mortality probability $40q_{30} = [1 - (1 - 5q_x)] \times 100\%$ for $x = 30$ to 65.

(2) **Average Annual Percentage Change (AAPC)** is the primary Joinpoint regression model indicator for assessing overall trends across multiple segments. With $P < 0.05$, $AAPC > 0$ indicates an increasing trend while $AAPC < 0$ indicates a decreasing trend. $AAPC = (e^{\sum w_i \beta_i / w_i} - 1) \times 100\%$; parameter details are described by Li Huizhang et al.

(3) **Average growth rate** = $(a_n/a_0) - 1$, where a_0 is Baise’s 2015 premature mortality probability and a_n represents target or predicted values.

(4) **Target values:** The 2020 target = 2015 probability \times 90%; the 2030 target = 2015 probability \times 70%.

(5) **Predicted values:** Year n predicted probability = 2015 probability \times $(1 + \text{average growth rate from 2015–2021})^{(n-2015)}$.

1.3 Statistical Methods Cause-of-death surveillance data were compiled using Excel 2019. Joinpoint 24.0 software analyzed trends in composition ratios, crude mortality, standardized mortality, and premature mortality probability, with age standardization using 2010 national census data. AAPC described trends, with $P < 0.05$ considered statistically significant.

Results

2.1 Chronic Disease Mortality Proportion and Trends From 2015–2021, Baise recorded 56,849 chronic disease deaths, accounting for 91.16% of total deaths with an increasing trend (AAPC=0.53%, $P=0.013$). The four major NCDs caused 49,852 deaths (79.94% of total deaths), with 18,889 deaths (30.29%) occurring in the 30–69 age group; neither trend was statistically significant (AAPC=0.31%, $P=0.279$; AAPC=-0.89%, $P=0.370$).

2.2 Mortality Rates and Trends for Four Major NCDs From 2015–2021, the crude mortality rate for the four NCDs was 549.06/100,000 and the age-standardized rate was 302.92/100,000, with no significant trends (both $P > 0.05$). Cardiovascular disease crude mortality was 319.42/100,000, showing a significant increase (AAPC=2.74%, $P=0.004$). Chronic respiratory disease crude mortality was 94.31/100,000, showing a significant decrease (AAPC=-6.73%, $P=0.019$).

Men's crude and age-standardized mortality rates were 613.99/100,000 and 657.63/100,000 respectively, compared to women's 474.14/100,000 and 385.62/100,000. Women's age-standardized mortality showed a significant decline (AAPC=-1.66%, $P=0.046$). Both men and women showed increasing cardiovascular disease crude mortality (AAPC=2.43%, $P=0.013$; AAPC=3.17%, $P=0.011$) and decreasing chronic respiratory disease age-standardized mortality (AAPC=-8.66%, $P=0.023$; AAPC=-8.17%, $P=0.027$). Men's crude mortality was 1.3 times women's (613.99/474.14), and men's standardized rate was 1.7 times women's (657.63/385.62) [TABLE:3, TABLE:4].

2.3 Mortality Rates and Trends Among Elderly (≥ 60 Years) From 2015–2021, the proportion of elderly residents aged ≥ 60 years ranged from 11.68% to 16.18%. Among this group, 39,588 deaths from the four NCDs accounted for 79.41% of all NCD deaths. The crude mortality rate was 3,001.2/100,000 and the standardized rate was 3,011.13/100,000, with no significant trends (both $P > 0.05$). Both crude and standardized mortality rates for malignant tumors and chronic respiratory diseases showed significant declines (AAPC=-3.42%, $P=0.023$; AAPC=-3.08%, $P=0.030$; AAPC=-8.65%, $P=0.012$; AAPC=-8.34%, $P=0.035$).

2.4 Premature Mortality Probability and Trends From 2015–2021, premature mortality probabilities for the four NCDs were 15.77% for the total population, 26.03% for men, and 10.42% for women, with stable trends (all $P > 0.05$).

Chronic respiratory disease premature mortality probability decreased significantly across all groups (AAPC=-6.89%, P=0.012; AAPC=-7.18%, P=0.007; AAPC=-6.94%, P=0.020). Men's malignant tumor premature mortality probability also decreased significantly (AAPC=-4.79%, P=0.017). Men's overall premature mortality probability was approximately 2.5 times that of women (26.03/10.42) .

2.5 Target Achievement Analysis Baise achieved the 2020 target of reducing premature mortality probability by 10% from 2015 levels, as specified in both “Healthy China 2030” and the Medium- and Long-term Plan. However, based on the -1.92% average annual decline rate, the projected 2030 probability is 14.62%, higher than the 13.69% target. Only women, malignant tumors, and chronic respiratory diseases have target values exceeding projections. To achieve the 2030 target, the average annual decline rate from 2021–2030 must accelerate to 2.63% overall, and to 2.70% for men. Diabetes requires particular attention, as its predicted value falls substantially short of the target, necessitating an accelerated decline rate of 6.76% .

Discussion

From 2015–2021, chronic diseases accounted for 91.16% of deaths in Baise, approaching the 2015 national average (79.40%) but exceeding Guangxi's rate (77.80%). The four NCDs' crude mortality rate (549.06/100,000) was lower than the 2021 national average (588.97/100,000) but higher than economically developed regions like Beijing's Daxing District (502.44/100,000). The lack of significant trends in overall mortality rates indicates that while Baise's NCD mortality burden remains high and stable, recent prevention efforts have shown some effectiveness, though continued strengthening is needed as absolute death numbers continue rising.

Cardiovascular disease, with the highest mortality rate (319.42/100,000), increased at 2.74% annually. Chronic respiratory disease was the only condition showing a decreasing mortality trend (-6.73% annually). Men's crude and age-standardized mortality rates exceeded women's, consistent with Qingdao findings, while women's standardized mortality declined significantly (-1.66% annually), indicating higher NCD death risks for men.

China's population aged ≥ 60 years reached 18.70% in 2020, making it the world's most elderly nation, with two-thirds experiencing NCD comorbidities. In Baise, this proportion rose from 11.68% (2015) to 16.18% (2021), with the four NCDs accounting for 79.41% of deaths among the elderly. Elderly crude mortality (3,001.20/100,000) and standardized mortality (3,011.13/100,000) significantly exceeded the general population. Baise's severe aging trend, limited medical resources, transportation difficulties, high out-migration rate (7.09% from 2010–2020, ranking second nationally), and slow population growth (0.86%) contribute to a relatively stable mortality pattern. The “longevity town” reputation, with many elderly residents, also slows chronic disease death growth.

Guangxi ranks among China's top five provinces for highest premature mortality probability and slowest decline rates. Baise's 2015–2021 premature mortality probability (15.77%) was lower than the 2019 national average (16.50%) but higher than Guangzhou (10.50%). The 2019 cardiovascular disease premature mortality probability (9.73%) was lower than the national range (8.74%–14.54%) but higher than Shenzhen (3.12%–4.29%). Cardiovascular disease had the highest premature mortality probability among the four NCDs, consistent with national patterns. Low hypertension awareness and control rates in Baise necessitate enhanced health education, early risk factor detection, and integration of blood pressure, glucose, and lipid screening into public health examinations. Stroke and chest pain center systems should be improved to combine prevention and treatment.

Malignant tumor premature mortality probability (7.16%) was lower than national averages (8.85%–12.57%) but higher than Guangzhou (6.38%–7.40%). Liver, lung, gastric, and nasopharyngeal cancers are most common, with breast and cervical cancers also prominent among women. Interagency collaboration should improve environmental sanitation, control smoking, air pollution, and unhealthy diets, and establish screening systems for respiratory and digestive cancers using CT and *Helicobacter pylori* testing to improve early detection and 5-year survival rates.

Chronic respiratory disease premature mortality probability (1.56%) was lower than national ranges (1.63%–6.72%) and the only declining NCD (–6.89% annually), though slower than Guangxi's decline (–7.23%). This suggests effective screening and pulmonary function testing, but risks remain high nationally. Continued smoking cessation advocacy, air pollution control, pulmonary function testing in health check-ups, influenza vaccination access, and COPD management are needed.

Diabetes premature mortality probability (0.74%) exceeded national (0.45%–0.66%) and Shanghai Pudong New Area (0.47%–0.61%) levels. Despite being the lowest among the four NCDs, it showed a non-significant increasing trend (AAPC=1.19%, $P>0.05$), likely related to low awareness and control rates. Notably, diabetes comorbidity increases cardiovascular disease premature mortality risk. Enhanced diabetes education, screening for complications, and risk factor control are essential to improve self-management and reverse the rising trend.

Based on the –1.92% annual decline rate, Baise achieved the 2020 “Healthy China 2030” milestone but remains off-track for 2021–2030 targets, particularly for men, diabetes, and cardiovascular disease. To achieve gender- and disease-specific targets, men's decline rate must accelerate from –1.83% to –2.70%, diabetes from 4.66% to –6.76%, and cardiovascular disease from –1.75% to –2.75%.

This study's mortality data lacked detailed case information, precluding multivariate regression analysis. Few Joinpoint inflection points were observed, requiring additional years of surveillance data for greater precision. Without

urban/rural or ethnic stratification, policy recommendations cannot be tailored to specific economic levels, ethnicities, or lifestyles.

Conclusion

From 2015–2021, Baise showed increasing cardiovascular disease crude mortality and decreasing chronic respiratory disease mortality and premature mortality probability. Men’s mortality and premature mortality rates exceeded women’s, though their decline rate was slower. At the current -1.92% annual decline rate, only women, malignant tumors, and chronic respiratory diseases would achieve “Healthy China 2030” targets. Following demonstration zone establishment, chronic respiratory disease prevention has proven effective, but substantial NCD mortality and premature mortality risks persist. Government-led, multi-sectoral efforts must prioritize men, strengthen tertiary prevention and treatment of cardiovascular disease and malignant tumors, and adopt integrated prevention-treatment approaches. Vigilance against diabetes and chronic respiratory diseases must be maintained. Under the guidance of “Healthy China 2030” and Baise’s 14th Five-Year Plan, accelerating the four NCDs’ premature mortality decline rate to 2.63% from 2021–2030 is essential for achieving the 2030 target.

Author Contributions: ZHANG Shengnan conceptualized and drafted the manuscript; XU Shihua provided quality control; HUANG Rongchao, CHEN Jian, and ZHAO Chunru collected and analyzed data; MENG Minglyu calculated and verified indicators; MA Yingjiao revised the final manuscript and takes responsibility for the work.

Conflicts of Interest: None declared.

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