Cancer death and potential years of life lost in Feicheng City, China
Trends from 2013 to 2018

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Abstract
This study aimed to evaluate the impact of cancer-related mortality on life expectancy in Feicheng City.

We extracted the death records and population data of Feicheng City from 2013 to 2018 through the Feicheng Center for Disease Control and Prevention. The mortality, premature mortality, cause-eliminated life expectancy, potential years of life lost (PYLL), average potential years of life lost (APYLL), annual change percentage (APC), and other indicators of cancer were calculated. The age-standardized rates were calculated using the sixth national census (2010).

From 2013 to 2018, the mortality rate of cancer in Feicheng City was 221.55/100,000, and the standardized mortality rate was 166.37/100,000. The standardized mortality rate increased from 2013 to 2014 and then decreased annually. The premature mortality of cancer was 8.98% and showed a downward trend (APC = −2.47%, t = −3.10, P = .04). From 2013 to 2018, the average life expectancy of residents in Feicheng City was 78.63 years. Eliminating the impact of cancer, life expectancy could increase by 3.72 years. The rate of life loss caused by cancer in men was higher than that in women. The total life loss caused by cancer deaths was 126,870.50 person-years, the potential life loss rate was 22.51‰, and the average potential life loss was 13.30 years. The standardized potential years of life lost showed a downward trend (APC = −2.96%, t = −3.72, P = .02), and APYLL decreased by 1.98% annually (t = −5.44, P = .01). The top 5 malignant tumors in APYLL were leukemia, breast cancer, brain tumor, liver cancer, and ovarian cancer.

Lung cancer, esophageal cancer, female breast cancer, and childhood leukemia have a great impact on the life expectancy of residents in Feicheng City. Effective measures need to be taken to reduce the disease burden of malignant tumors.

Abbreviations: APC = annual change percentage, APYLL = average potential years of life lost, PYLL = potential years of life lost, PYLLR = standardized years of potential loss of life, SPYLL = standardized rate of potential life loss.

Keywords: cancer, cause eliminated life expectancy, potential years of life lost, premature mortality

1. Introduction
With the accelerated process of population aging, industrialization, and urbanization in China, cancer has become one of the main serious threats to human health. According to GLOBO-CAN 2018, 9.56 million people died of cancer worldwide, and China accounted for approximately 30% of this figure. In 2015, 2.338 million people died of cancer in China, and the mortality rate from cancer was 170.05/100,000. Cancer is the leading cause of disease-related deaths. In the past 10 years, the incidence and mortality of cancer have been on the rise and the circumstances of malignant tumor prevention and control are severe.

In 2014, the WHO defined death before the age of 70 years as “premature death” and recommended “premature death” as a significant indicator for evaluating the prevention and control of chronic noncommunicable diseases in various countries. Premature mortality is a probability indicator that is similar to a healthy life expectancy. It is not affected by age composition and can be compared between different times and regions. In 2016, the “Healthy China 2030” plan emphasized that the premature mortality of major chronic diseases in 2030 will be 30% lower than in 2015. Our study evaluated the effectiveness of malignant tumor prevention by continuously monitoring the premature mortality of malignant tumors.

Life expectancy refers to the average number of years that a group of people born in the same period can survive for,
according to the current age-specific mortality rate.\[5\] It is a comprehensive indicator that reflects the country’s socioeconomic level, cultural education level, residents’ health status, and health care level.\[6-8\] It was not until the beginning of the 20th century that people began to use cause-elimination life tables to assess the impact of specific diseases on population health and life expectancy.\[9\] The cause-eliminated life expectancy is based on the assumption that the life span will be extended if the cause of death is eliminated. The greater the risk of death caused by a particular disease, the greater the loss of life, and the greater the life expectancy after the cause is eliminated. One of the important goals in the “Healthy China 2030” Plan was that the average life expectancy per capita reaches 79.0 years by 2030.\[4\] The Statistical Bulletin on the average life expectancy of countries published by the World Health Organization in 2019, China’s average life expectancy was 77.3 years in 2019. Among the average life expectancy of countries published by the World Health Organization in 2019, China’s average life expectancy was 76.1 years (men, 77.6 years; women, 74.6 years). China also needs to continue to control related factors that affect life expectancy. Based on the local cancer death database, we performed the current study to evaluate the impact of cancer-related mortality on life expectancy in Feicheng City.

2. Methods

2.1. Data source

Feicheng is a county-level city in eastern China, with a population of 1,000,000. At the beginning of this century, Feicheng City was included in the World Health Organization’s tumor incidence and death registration and established a complete tumor incidence and death reporting system. We extracted the death records (name, sex, certificate number, date of birth, date of death, cause of disease) and population data (distribution characteristics of the entire population) of Feicheng from 2013 to 2018 through the Feicheng Center for Disease Control and Prevention and the Local Public Security Bureau. The subjects of the study were individuals who died of malignant tumors among the residents of Feicheng City from 2013 to 2018. The study was approved by the Ethics Committee of the Feicheng Center for Disease Control and Prevention.

2.2. Quality control

The All Causes of Death Network Reporting System covered the total population of Feicheng City and adopted the “National Causes of Death Registration Report Information System” for direct network reporting. The completion rate of the entered death medical certificate was over 95%, and the error rate was less than 5%. According to the tenth edition of the International Classification of Diseases (ICD-10), the work commissioner coded the leading fatal diseases, and the proportion of coding errors did not exceed 5%. The underreporting rate of deaths was less than 5%, and quality control indicators met the requirements. The Feicheng Center for Disease Control and Prevention conducted an underreporting investigation of the cause of death at least once a year and filled in with the cancellation of household registration and abnormal death data from the public security department. Before data analysis, we performed data cleaning, duplicate checking, and logical verification.

2.3. Statistical analysis

Mortality, premature mortality, cause-eliminated life expectancy, years of potential life loss (PYLL), standardized years of potential loss of life (SPYLL), potential life loss rate (PYLLR), standardized rate of potential life loss (SPYLLR), average years of potential life lost (APYLL), and annual change percentage (APC) were calculated using Excel 2010 (Microsoft, Inc., Simonyi, USA) and SAS 9.2 software (SAS Institute, Inc., Cary, North Carolina). The age-standardized rates were calculated using the sixth national census (2010). Life expectancy and the cause of eliminated life expectancy were calculated using the life table. The calculation formulas for the leading indicators are as follows:

Premature mortality
$$\text{P}\text{M} = 1 - \prod_{x}^{M_5}(1 - q_5)$$

Mortality rate in the xth age group
$$q_i = \left( \frac{M_i \times 5}{1 + M_i \times 5 \times 2.5} \right)$$

The age-standardized rates were calculated using the sixth national census (2010). Life expectancy and the cause of eliminated life expectancy were calculated using the life table. The calculation formulas for the leading indicators are as follows:

Mortality rate in the xth age group
$$q_i = \left( \frac{M_i \times 5}{1 + M_i \times 5 \times 2.5} \right)$$

Where e is the life expectancy (years), i is the age group, and di is the number of deaths in the ith age group. To eliminate the impact of the 0-year-old group and the high-age group on life loss, this study stipulates that life expectancy is 75 years. n is the total number of people in the ith age group, $\overline{N}$ is the population composition ratio of the ith age group in the sixth national census, and $\overline{n}$ is the actual population composition ratio of the ith age group.

$$\text{APC} = 100 \times (e^\beta - 1)$$

The log-linear regression method was used to calculate the regression coefficient $\beta$. $\gamma = \alpha + \beta x + \epsilon$, where $\gamma$ represents the dependent variable, that is, the natural logarithm of the research index. $\alpha$ represents the constant; $x$ represents the independent variable, that is, the year; and $\epsilon$ represents the random error. The t-test was performed on the regression coefficient, and $P < .05$ indicates that the difference is statistically significant.\[10\]

3. Results

3.1. Mortality of cancer

From 2013 to 2018, 13,155 people died of cancer in Feicheng City. The mortality rate of cancer was 221.55/100,000 (men, 293.42/100,000; women, 148.70/100,000), and the standardized mortality rate was 166.37/100,000 (men, 228.90/100,000; women, 109.57/100,000). The mortality rate of male cancer patients was higher than that of females. The standardized mortality rate of cancer increased from 2013 to 2014 and then decreased year by year (APC = -2.27%, $t = -2.59$, $P = .06$). The standardized mortality rate of male cancer changed steadily (APC = -2.27%, $t = -2.56$, $P = .06$), and the standardized mortality rate of women showed a decreasing trend (APC = -2.47%, $t = -2.93$, $P = .04$) (Table 1).
3.2. Death order of leading cancers

In the death order of leading cancers, the top 5 malignant tumors were lung cancer, esophageal cancer, gastric cancer, liver cancer, and female breast cancer. Esophageal cancer ranked first among male cancers, and the fifth was colorectal cancer. The death order of female cancers was the same as that of the entire population. Among the top 5 malignant tumors, except for breast cancer, the mortality rate of the other 4 malignant tumors in men was higher than that in women (Tables 2, 3 and 4).

3.3. Trends in mortality of the leading cancer

From 2013 to 2018, the mortality rate of lung cancer in Feicheng City increased by 4.92% annually ($t = 4.92, P = .01$), but the standardized mortality rate of esophageal cancer decreased by 6.85% annually ($t = -3.55, P = .02$). The standardized mortality rates of gastric cancer ($APC = -5.73\%, t = -2.90, P = .04$) and liver cancer ($APC = -6.39\%, t = -3.31, P = .03$) showed a decreasing trend. The mortality rate of male colorectal cancer was on the rise ($APC = 7.90\%, t = -3.55, P = .02$), and the mortality rate of female breast cancer has increased since 2013, declined in 2016, and then increased year by year ($APC = 3.05\%, t = 1.02, P = .37$) (Tables 2–4).

3.4. Premature mortality of cancer

From 2013 to 2018, 7610 people aged 30 to 70 years (not including 70) died of cancer in Feicheng City. The premature mortality rate was 8.98% (men, 12.72%; women, 5.24%), and the premature mortality rate for men was higher than that for women. From 2013 to 2018, the premature mortality of cancer showed a decreasing trend, from 9.28% to 8.41% ($APC = -2.47\%, t = -3.10, P = .04$). The premature mortality of cancer in men increased from 2013 to 2014 and then decreased annually ($APC = -2.18\%, t = -2.03, P = .11$). The premature mortality of cancer among women decreased year by year until it rebounded slightly in 2018 ($APC = -3.05\%, t = -2.29, P = .08$) (Fig. 1).

3.5. Trends in premature mortality of cancer

From 2013 to 2018, the premature mortality of esophageal cancer decreased from 2.26% to 1.64% ($APC = 6.67\%, t = -3.01, P = .04$). The premature mortality of liver cancer gradually declined until a slight rebound in 2018 ($APC = -6.11\%, t = -2.29, P = .08$). The premature mortality of male esophageal cancer decreased year by year ($APC = -5.82\%, t = -2.97, P = .04$), and the premature mortality of colorectal cancer changed steadily, fluctuating between 0.23% and 0.49% ($APC = 9.86\%, t = 1.65, P = .17$). The premature mortality of female breast cancer fluctuated between 0.44% and 0.67% ($APC = -4.26\%, t = -0.41, P = .70$) (Figs. 2–4).

3.6. Life expectancy and cause-eliminated life expectancy

From 2013 to 2018, the average life expectancy of residents in Feicheng was 78.63 years. Eliminating the impact of malignant

### Table 1

| Years | Mortality | Standardized mortality | Mortality | Standardized mortality | Mortality | Standardized mortality |
|-------|-----------|------------------------|-----------|------------------------|-----------|------------------------|
| 2013  | 206.69    | 169.38                 | 271.75    | 232.20                 | 140.87    | 112.34                 |
| 2014  | 220.48    | 174.92                 | 288.94    | 240.63                 | 151.01    | 116.24                 |
| 2015  | 229.80    | 174.56                 | 303.57    | 239.46                 | 162.88    | 115.06                 |
| 2016  | 232.42    | 170.99                 | 310.08    | 234.28                 | 153.70    | 112.32                 |
| 2017  | 216.80    | 156.16                 | 289.19    | 215.01                 | 143.60    | 102.98                 |
| 2018  | 223.99    | 154.47                 | 296.88    | 213.05                 | 150.29    | 101.56                 |

### Table 2

| Years | Mortality | Standardized mortality | Mortality | Standardized mortality | Mortality | Standardized mortality |
|-------|-----------|------------------------|-----------|------------------------|-----------|------------------------|
| 2013  | 45.66     | 37.61                  | 52.66     | 42.89                  | 31.15     | 25.27                  |
| 2014  | 49.76     | 39.06                  | 54.97     | 46.56                  | 29.45     | 23.40                  |
| 2015  | 55.66     | 42.74                  | 54.72     | 40.24                  | 34.14     | 26.03                  |
| 2016  | 54.08     | 39.26                  | 58.19     | 41.83                  | 32.43     | 24.17                  |
| 2017  | 55.76     | 39.63                  | 50.72     | 35.61                  | 28.03     | 19.85                  |
| 2018  | 59.86     | 40.37                  | 45.40     | 30.37                  | 26.90     | 18.72                  |

### Table 3

| Years | Mortality | Standardized mortality | Mortality | Standardized mortality | Mortality | Standardized mortality |
|-------|-----------|------------------------|-----------|------------------------|-----------|------------------------|
| 2013  | 28.72     | 22.18                  | 25.78     | 20.56                  | 26.29     | 19.48                  |
| 2014  | 27.51     | 21.56                  | 25.86     | 20.59                  | 26.39     | 19.67                  |
| 2015  | 25.86     | 20.99                  | 23.87     | 17.69                  | 28.29     | 21.24                  |
| 2016  | 23.87     | 17.69                  | 21.58     | 15.67                  | 26.29     | 19.48                  |
| 2017  | 21.58     | 15.67                  | 21.58     | 15.67                  | 26.29     | 19.48                  |
| 2018  | 20.72     | 15.06                  | 20.72     | 15.06                  | 26.29     | 19.48                  |

### Table 4

| Years | Mortality | Standardized mortality | Mortality | Standardized mortality | Mortality | Standardized mortality |
|-------|-----------|------------------------|-----------|------------------------|-----------|------------------------|
| 2013  | 10.22     | 7.96                   | 10.22     | 7.96                   | 10.22     | 7.96                   |
| 2014  | 10.39     | 8.49                   | 10.39     | 8.49                   | 10.39     | 8.49                   |
| 2015  | 11.20     | 9.21                   | 11.20     | 9.21                   | 11.20     | 9.21                   |
| 2016  | 8.72      | 6.29                   | 8.72      | 6.29                   | 8.72      | 6.29                   |
| 2017  | 3.05      | 2.84                   | 3.05      | 2.84                   | 3.05      | 2.84                   |
| 2018  | 1.02      | 0.68                   | 1.02      | 0.68                   | 1.02      | 0.68                   |

APC = annual change percentage.
tumors, life expectancy could increase by 3.72 years. The average life expectancy of men was 75.53 years, which increased by 4.45 years after eliminating the impact of cancer. The average life expectancy of women was 81.85 years, and it increased by 2.73 years after eliminating the impact of cancer. From 2013 to 2018, the life expectancy of residents in Feicheng City fluctuated between 77.87 years and 79.38 years (APC = 0.89, P = .08). The change in loss of years due to cancer was not statistically significant (APC = 2.22%, t = 0.58, P = .59). The life expectancy of men increased by 0.40% per year (t = 3.77, P = .02). The change in the loss of years due to cancer was not statistically significant (APC = −2.96%, t = −1.09, P = .34). Women’s life expectancy changed steadily (APC = 0.10%, t = 0.89, P = .43) (Table 5).

3.7. Trends in life loss rate caused by cancer

According to the analysis of the life loss rate caused by cancer of different ages in Feicheng from 2013 to 2018, the results showed that the life loss rate caused by cancer gradually increased with age, reaching a peak around 70 years of age. The rate of life loss in men was higher than that in women (Fig. 5). From 2013 to 2018, the rate of life loss due to liver cancer showed a decreasing trend (APC = −5.82%, t = −3.30, P = .03). Among men, life expectancy showed an upward trend after eliminating the cause of death from esophageal, lung, gastric, and colorectal cancers. APC were 0.40% (t = 3.10, P = .04), 0.50% (t = 3.46, P = .03), 0.40% (t = 3.46, P = .03), and 0.40% (t = 3.69, P = .02), respectively. The rate of life loss due to liver cancer among women showed a downward trend (APC = −9.79%, t = −3.94, P = .02) (Tables 6, 7 and 8).

3.8. Analysis of potential years of life lost from cancer

The total life loss caused by cancer deaths in Feicheng City from 2013 to 2018 was 126,870.50 person-years, and the potential life loss rate was 22.51‰ and the average potential life loss was 13.30 years. Men’s PYLLR was higher than that of women, while the opposite was true for APYLL. From 2013 to 2018, SPYLLR showed a downward trend (APC = −2.96%, t = −3.72, P = .02) and APYLL decreased by 1.98% annually (t = −5.44, P = .01) (Table 9). From 2013 to 2018, the PYLLR of lung cancer showed an upward trend (APC = 0.40%, t = 3.58, P = .02), and the PYLLR of esophageal cancer showed a downward trend (APC = −5.64%, t = −3.65, P = .02). The PYLL of men with gastric cancer decreased by 8.06% annually (t = −2.94, P = .04) (Table 10). The top 5 cancers in APYLL were leukemia, breast cancer, brain tumor, liver cancer, and ovarian cancer. The APYLL of liver cancer decreased year by year (APC = −3.44%, t = −9.32, P < .01), and the APYLL of leukemia changed steadily (APC = −0.60, t = 0.27, P = .80). The APYLL of liver cancer in men decreased each year (APC = −2.96%, t = −3.42, P = .03) (Table 11).
4. Discussion

Our results showed that the mortality rate of cancer in Feicheng City from 2013 to 2018 was 221.55/100,000, and the standardized mortality rate was 166.37/100,000. The mortality rate of cancer in men is higher than that in women, and the results are consistent with those of related studies.\[11,12\] This may be attributed to unhealthy habits, such as smoking and drinking or greater pressure in the workplace, life, and society.\[13,14\] Tobacco smoking accounts for approximately 23% to 25% of all cancer-related deaths in China.\[15,16\] In 2010, more than half of Chinese adult men were currently smoking,\[17\] and smoking rates among adolescents and young adults were still rising.\[18\] A meta-analysis of alcohol and cancer mortality showed that all cancer mortality rates in men had a J-shaped relationship with alcohol consumption, but those in women did not.\[19\] Endocrine biology is known to affect cancer epidemiology and possibly cause female predominance in some cancers. However, these environmental and hormonal factors associated with sex-specific differences in cancer could interact with EXITS loci or their gene products to modulate cancer risk. A study from the Broad Institute of Harvard and MIT showed that biallelic expression of EXITS genes in women explained a portion of the reduced cancer incidence compared to men across many tumor types.\[20\] The standardized mortality rate of cancer increased from 2013 to 2014 and then decreased annually. However, a study in Hebei Province found that from 1973 to 2013, the mortality rate from cancer increased by 51.57\%.\[21\] Another age-period cohort study showed that the cancer mortality rates of men (APC=0.9%, 95% CI: 0.8–1.0) and women (APC=0.8%, 95% CI: 0.7–0.9) showed an increasing trend from 1991 to 2009 in Serbia.\[22\] In this study, the top 5 leading cancers in the order of death were lung cancer, esophageal cancer, gastric cancer, liver cancer, and female breast cancer.
cancer. According to GLOBOCAN2018, lung cancer was ranked first, followed by colorectal cancer. Due to the regional characteristics of Feicheng City, the incidence of esophageal cancer was relatively high, ranking second only to lung cancer. Since 2006, Feicheng People’s Hospital has screened high-risk groups of 40 to 69 years old for upper gastrointestinal cancer, advocated early diagnosis and treatment, became more effective at screening.

From 2013 to 2018, the standardized mortality rates of gastric cancer and liver cancer in Feicheng City decreased annually. Reducing the consumption of corn contaminated with aflatoxins and improving the quality of drinking water by removing cyanotoxins from water sources may lead to a decrease in liver cancer mortality. The main risk factors for liver cancer include HBV infection, aflatoxin contamination, and HCV infection. Gastric cancer is mainly associated with Helicobacter pylori infection. With the widespread inoculation of HBV and the improvement of residents’ awareness of dietary hygiene, the incidence of these 2 cancers has decreased. Although both mortality rates showed a downward trend, they were still the leading cause of death of malignant tumors in Feicheng residents. From 2013 to 2018, the mortality rate of male colorectal cancer in Feicheng City showed an upward trend, but the standardized rate changed steadily, which indicated that the increase in mortality of colorectal cancer was mainly due to population aging. The incidence of colorectal cancer is closely related to the increasing westernization of lifestyle, lack of exercise, rising prevalence of obesity, family genetic history, and diet. There are differences in cancer mortality among different populations, which may be due to factors such as race, geographic region, economic development, and education level. Many differences are mainly due to the lack of resources related to treatment and prevention, which can be remedied through education and publicity, healthy lifestyle interventions, vaccination, and cancer screening.

In this study, the premature mortality of cancer in Feicheng from 2013 to 2018 was 8.98% and showed a downward trend year by year (APC = –2.47%, t = –3.10, P < .05). However, a study in Sri Lanka found that the premature mortality of cancer increased from 3.5% to 5.0% from 2001 to 2010. In this study, female breast cancer premature mortality fluctuated between 0.44% and 0.67%, ranking third among all the studied cancers. The incidence and mortality of breast cancer in women are relatively high, which is consistent with the conclusions of other studies.

In 2020, there were 2.26 million new breast cancer cases worldwide, and breast cancer replaced lung cancer as the world’s first cancer. Among female malignant tumors, breast cancer is the leading cause of premature death. In the future, it will be necessary to strengthen women’s health knowledge education, improve the quality of medical and health services, actively carry out women’s cancer investigation and treatment, and control the impact of breast cancer on women’s health.

The life expectancy of the Chinese people in 2015 was 76.34 years, but it was still lower than the expectancy in some developed countries. In this study, the average life expectancy of residents in Feicheng City from 2013 to 2018 was 78.63 years. Eliminating the impact of cancer, life expectancy could increase by 3.72 years. The life expectancy increased by 0.80 years after eliminating the cause of death from lung cancer, and 0.79 years after eliminating the impact of esophageal cancer. A study in Tianjin showed that after eliminating the impact of lung cancer, the life expectancy of residents increased the most, with men and women increased by 1.25 years and 0.97 years, respectively. A study of gastric cancer showed that early detection of gastric adenocarcinoma could increase life expectancy. These results indicate that malignant tumors seriously

### Table 5

|         | Male                        | Both                       | Female                       |
|---------|-----------------------------|----------------------------|-------------------------------|
|         | Life expectancy            | Cause eliminated life expectancy | Loss rate (%) | Life expectancy | Cause eliminated life expectancy | Loss rate (%) | Life expectancy | Cause eliminated life expectancy | Loss rate (%) |
| Years   |                             |                            |                               |                 |                              |                    |                               |                              |                    |
| 2013    | 74.65                       | 78.93                      | 4.28                          | 5.73             | 81.23                        | 83.91              | 2.67             | 3.29             | 77.87                        | 81.49              |
| 2014    | 74.94                       | 80.56                      | 5.62                          | 7.59             | 81.54                        | 84.45              | 2.91             | 3.57             | 78.21                        | 82.03              |
| 2015    | 75.58                       | 80.48                      | 4.90                          | 6.48             | 82.42                        | 85.49              | 3.07             | 3.73             | 78.93                        | 83.07              |
| 2016    | 75.36                       | 80.11                      | 4.76                          | 6.31             | 81.96                        | 84.76              | 2.79             | 3.41             | 78.57                        | 82.43              |
| 2017    | 76.52                       | 80.89                      | 4.36                          | 5.70             | 82.28                        | 84.90              | 2.62             | 3.18             | 79.38                        | 82.99              |
| 2018    | 76.02                       | 80.09                      | 4.07                          | 5.35             | 81.58                        | 84.01              | 2.43             | 2.98             | 78.76                        | 82.11              |
| APC (%) | 0.02                        | 0.40                       | –2.96                         | –3.34            | 0.10                         | 0.00               | –2.47            | –2.66            | 0.30                          | 0.20               |
| t       | 3.77                        | 1.17                       | –1.09                         | –1.24            | 0.89                         | 0.21               | –1.39            | –1.57            | 2.35                          | 1.07               |
| P       | .02                         | .31                        | .34                           | .28              | .43                          | .85                | .24              | .19              | .08                          | .34                |
| Total   | 75.53                       | 79.97                      | 4.45                          | 5.89             | 81.85                        | 84.58              | 2.73             | 3.34             | 78.63                        | 82.35              |

*APC = annual change percentage.*

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**Figure 5.** The trend of life expectancy loss caused by cancer in Feicheng, 2013 to 2018. Black line: Both. Black square marked line: male. Black circle marked line: female.
# Table 6

| Years | Cause eliminated life expectancy | Loss year | Loss rate (%) | Cause eliminated life expectancy | Loss year | Loss rate (%) | Cause eliminated life expectancy | Loss year | Loss rate (%) | Cause eliminated life expectancy | Loss year | Loss rate (%) | Cause eliminated life expectancy | Loss year | Loss rate (%) |
|-------|---------------------------------|-----------|---------------|---------------------------------|-----------|---------------|---------------------------------|-----------|---------------|---------------------------------|-----------|---------------|---------------------------------|-----------|---------------|
| 2013  | 78.59                           | 0.72      | 0.93          | 78.69                           | 0.82      | 1.06          | 78.35                           | 0.48      | 0.62          | 78.33                           | 0.46      | 0.59          | 81.41                           | 0.18      | 0.22          |
| 2014  | 78.97                           | 0.76      | 0.97          | 79.12                           | 0.91      | 1.17          | 78.66                           | 0.45      | 0.57          | 79.34                           | 0.41      | 0.53          | 82.63                           | 0.21      | 0.26          |
| 2015  | 79.83                           | 0.91      | 1.15          | 79.78                           | 0.86      | 1.09          | 79.46                           | 0.54      | 0.68          | 79.03                           | 0.36      | 0.46          | 82.11                           | 0.15      | 0.18          |
| 2016  | 79.35                           | 0.78      | 1.00          | 79.41                           | 0.85      | 1.08          | 79.05                           | 0.48      | 0.62          | 79.71                           | 0.32      | 0.41          | 82.50                           | 0.22      | 0.27          |
| 2017  | 80.20                           | 0.82      | 1.03          | 80.12                           | 0.74      | 0.93          | 79.79                           | 0.41      | 0.52          | 79.13                           | 0.37      | 0.47          | 81.80                           | 0.22      | 0.27          |
| 2018  | 79.55                           | 0.79      | 1.00          | 79.36                           | 0.60      | 0.76          | 79.12                           | 0.36      | 0.46          | 79.13                           | 0.37      | 0.47          | 81.80                           | 0.22      | 0.27          |

APC = annual change percentage.

# Table 7

| Years | Cause eliminated life expectancy | Loss year | Loss rate (%) | Cause eliminated life expectancy | Loss year | Loss rate (%) | Cause eliminated life expectancy | Loss year | Loss rate (%) | Cause eliminated life expectancy | Loss year | Loss rate (%) | Cause eliminated life expectancy | Loss year | Loss rate (%) |
|-------|---------------------------------|-----------|---------------|---------------------------------|-----------|---------------|---------------------------------|-----------|---------------|---------------------------------|-----------|---------------|---------------------------------|-----------|---------------|
| 2013  | 75.66                           | 1.00      | 1.34          | 75.52                           | 0.87      | 1.17          | 75.23                           | 0.58      | 0.77          | 75.23                           | 0.58      | 0.77          | 74.79                           | 0.14      | 0.18          |
| 2014  | 75.97                           | 1.03      | 1.38          | 75.82                           | 0.88      | 1.17          | 75.54                           | 0.59      | 0.79          | 75.49                           | 0.54      | 0.73          | 75.06                           | 0.12      | 0.16          |
| 2015  | 76.62                           | 1.04      | 1.37          | 76.65                           | 1.07      | 1.41          | 76.25                           | 0.67      | 0.88          | 76.12                           | 0.54      | 0.71          | 75.72                           | 0.14      | 0.19          |
| 2016  | 76.42                           | 1.07      | 1.42          | 76.34                           | 0.98      | 1.30          | 76.00                           | 0.64      | 0.85          | 75.82                           | 0.46      | 0.61          | 75.48                           | 0.13      | 0.17          |
| 2017  | 77.44                           | 0.92      | 1.20          | 77.56                           | 1.04      | 1.36          | 77.04                           | 0.52      | 0.68          | 76.97                           | 0.45      | 0.59          | 76.70                           | 0.18      | 0.23          |
| 2018  | 76.79                           | 0.77      | 1.01          | 76.96                           | 0.94      | 1.24          | 76.50                           | 0.48      | 0.63          | 76.52                           | 0.50      | 0.66          | 76.18                           | 0.16      | 0.21          |

APC = annual change percentage.

# Table 8

| Years | Cause eliminated life expectancy | Loss year | Loss rate (%) | Cause eliminated life expectancy | Loss year | Loss rate (%) | Cause eliminated life expectancy | Loss year | Loss rate (%) | Cause eliminated life expectancy | Loss year | Loss rate (%) | Cause eliminated life expectancy | Loss year | Loss rate (%) |
|-------|---------------------------------|-----------|---------------|---------------------------------|-----------|---------------|---------------------------------|-----------|---------------|---------------------------------|-----------|---------------|---------------------------------|-----------|---------------|
| 2013  | 81.72                           | 0.48      | 0.60          | 81.77                           | 0.54      | 0.66          | 81.56                           | 0.33      | 0.40          | 81.52                           | 0.28      | 0.35          | 81.41                           | 0.18      | 0.22          |
| 2014  | 82.06                           | 0.52      | 0.63          | 82.20                           | 0.66      | 0.81          | 81.74                           | 0.20      | 0.24          | 81.77                           | 0.23      | 0.28          | 81.72                           | 0.18      | 0.22          |
| 2015  | 83.07                           | 0.65      | 0.79          | 82.99                           | 0.57      | 0.70          | 82.76                           | 0.34      | 0.42          | 82.66                           | 0.24      | 0.29          | 82.63                           | 0.21      | 0.26          |
| 2016  | 82.49                           | 0.53      | 0.64          | 82.51                           | 0.54      | 0.66          | 82.24                           | 0.28      | 0.34          | 82.18                           | 0.21      | 0.26          | 82.11                           | 0.15      | 0.18          |
| 2017  | 82.79                           | 0.51      | 0.62          | 82.77                           | 0.49      | 0.60          | 82.54                           | 0.26      | 0.31          | 82.44                           | 0.16      | 0.19          | 82.50                           | 0.22      | 0.27          |
| 2018  | 82.15                           | 0.57      | 0.70          | 81.93                           | 0.35      | 0.43          | 81.77                           | 0.19      | 0.23          | 81.76                           | 0.18      | 0.22          | 81.80                           | 0.22      | 0.27          |

APC = annual change percentage.
endanger human health and cause life loss, especially lung cancer, esophageal cancer, liver cancer, and gastric cancer.

The PYLL focus on the absolute number of years of survival lost by each cause of death. This indicator helps to understand the impact of the cause of death on the survival and working hours of the entire population.[44,45] The total life loss caused by cancer deaths in Feicheng from 2013 to 2018 was 126,870.50 person-years; the potential life loss rate was 22.51‰, and the average potential life loss was 13.30 years. Both SPYLLR (APC = −2.96‰, $t = −3.72$, $P = 0.02$) and APYLL showed a downward trend (APC = −1.98‰, $t = −5.44$, $P = 0.01$). In 2015, people aged 16 to 84 in the United States lost 8,739,939 person-years due to cancer deaths, which means a loss of $94.4 billion (95% CI: 91.7–97.3). Moreover, premature death of cancer can lead to productivity losses. In 2012, the total cost of lost productivity due to cancer mortality in the 5 BRICS countries was $46.3 billion, accounting for 0.33% of the total gross domestic product. The YPLL of China was the largest, reaching 5.9 million years, and

### Table 9

The potential years of life lost from cancer in Feicheng, 2013–2018.

| Years | Both | Male | Female |
|-------|------|------|--------|
| PYLL  | (person year) | SPYLL  | (person year) | PYLLR  | (person year) | SPYLLR  | (person year) | APYLL  | (person year) | PYLL  | (person year) | SPYLL  | (person year) | PYLLR  | (person year) | SPYLLR  | (person year) | APYLL  | (person year) |
| 2013  | 21434.00 | 17372.34 | 22.85 | 15.22 | 14.10 | 14890.00 | 11996.12 | 31.25 | 25.17 | 14.23 | 9377.50 | 7617.87 | 20.33 | 16.51 | 19.78 |
| 2014  | 21497.00 | 16904.03 | 22.87 | 18.08 | 13.56 | 14654.00 | 11330.68 | 30.64 | 23.67 | 13.37 | 9776.50 | 8022.34 | 21.17 | 17.34 | 20.09 |
| 2015  | 21906.50 | 17206.50 | 23.23 | 18.25 | 13.27 | 15230.00 | 11711.26 | 31.76 | 24.43 | 13.10 | 9526.50 | 7985.98 | 20.56 | 16.82 | 19.92 |
| 2016  | 21957.00 | 17051.47 | 23.37 | 18.15 | 13.33 | 15152.00 | 11363.29 | 31.74 | 23.80 | 12.98 | 6805.00 | 5720.02 | 14.72 | 12.38 | 14.18 |
| 2017  | 20171.00 | 15432.30 | 21.46 | 16.46 | 13.12 | 13792.50 | 10244.90 | 29.00 | 21.53 | 12.58 | 6252.50 | 5226.53 | 13.54 | 11.32 | 13.41 |
| 2018  | 19986.50 | 14864.98 | 21.29 | 15.85 | 12.46 | 13205.00 | 9661.25 | 27.75 | 20.30 | 12.02 | 6681.50 | 5224.82 | 14.47 | 11.32 | 13.28 |

APC = annual change percentage, APYLL = average potential years of life lost, PYLL = potential years of life lost, PYLLR = potential life loss rate, SPYLL = standardized years of potential loss of life, SPYLLR = standardized rate of potential life loss.

### Table 10

PYLLR of leading cancers in Feicheng, 2013–2018 (%).

| Years | Both | Male | Female |
|-------|------|------|--------|
| Lung  | 4.67 | 3.80 | 2.68 |
| Esophageal | 4.67 | 3.80 | 2.68 |
| Liver  | 4.67 | 3.80 | 2.68 |
| Gastric | 4.67 | 3.80 | 2.68 |
| Breast (Female) | 4.67 | 3.80 | 2.68 |

APC = annual change percentage, PYLLR = potential life loss rate.
the total productivity loss was $28 billion.\[47\] In this study, the PYLL of lung cancer ranked first among leading cancers, and it has been increasing yearly (APC=0.40%, t=3.58, P=0.02). A study in Guangzhou showed that tobacco smoking and environmental pollution from industrial emissions were the leading risk factors for lung cancer.\[48\] We should strengthen the prevention and control of air pollution, implement a total ban on smoking in indoor public places, reduce industrial waste gas emissions, and use more energy-efficient kitchen range hoods to reduce the incidence of lung cancer. In the ranking of APYLL, leukemia was ranked first. The larger the APYLL, the earlier the death from the disease. Leukemia tends to occur in children and is the main malignant tumor that causes death in the younger age group.\[49\] A study in Colombia showed that, from 1997 to 2012, the PYLL of male cancer increased by 25.1% and that of female cancer increased by 31.1%. In childhood cancers, 48% to 50% of the years of life lost are caused by leukemia.\[50\] Cervical cancer increased by 31.1%. In childhood cancers, 48% to 50% of the years of life lost are caused by cervical cancer.\[51,52\]

Despite our meaningful results, there are several limitations to our study. First, this study was limited to cancer-related deaths in Feicheng City. There are differences in different regions of China, so we must be cautious when making inferences across the country. Second, this study only obtained mortality information by age and sex but failed to determine the difference in mortality between urban and rural areas and could not analyze the impact of socioeconomic status, education level, and lifestyle factors on cancer mortality. Third, the leading cause of death of the selected subjects in this study was cancer, and deaths from complications were not considered. However, this issue requires further research. The last question was the misclassification of the diseases. Although we used a strict quality control strategy, there were still some uncertainties regarding the cause of death and misclassification.

In conclusion, residents in Feicheng City have lost 3.72 years of life due to malignant tumor deaths. Lung, esophageal, stomach, and liver cancers have a greater impact on the life expectancy of residents in Feicheng City. The mortality and PYLL of lung cancer are on the rise. It is a cancer with the most severe disease burden in Feicheng City. The standardized mortality of esophageal cancer and gastric cancer declined, but the life years lost due to the 2 still accounted for 33.34% of all cancers. In women, the prevention of breast cancer should be paid more attention. In children, leukemia severely reduces their lifespan. We should focus on prevention, expand the screening coverage of leading cancers, increase the rate of early diagnosis, and reduce the disease burden of cancer.

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