Int J Clin Exp Pathol 2015;8(10):13323-13330
www.ijcep.com /ISSN:1936-2625/IJCEP0011953

*Original Article*

# Cancer burden in China from 2006 to 2010

Xuefei Zhang[1*], Yizhong Yan[1*], Shugang Li[1], Feng Li[2], Zhenzhen Wan[1], Lijuan Pang[2], Shuxia Guo[1], Qiang Niu[1], Shangzhi Xu[1], Honglian Xiang[1], Rong Ma[1], Jinpo Zheng[1], Jiangyan Xian[1]

*Departments of [1]Public Health, [2]Pathology, Key Laboratory of Xinjiang Endemic and Ethnic Diseases (Ministry of Education), Shihezi University School of Medicine, Shihezi 832002, Xinjiang, China. [*]Equal contributors and co-first authors.*

Received June 26, 2015; Accepted September 4, 2015; Epub October 1, 2015; Published October 15, 2015

**Abstract:** Objective: To investigate the incidence, mortality, and disease burden of cancer in China to provide a reference for cancer prevention and control. Methods: Cancer registry data (2006-2010) were collected from the Chinese Cancer Registry Annual Report by the National Center for Cancer Registries. Cancer incidence and mortality, potential years of life lost (PYLL), and disability-adjusted life years (DALYs) were calculated. Results: The cancer incidence rate was 267.13/100,000 overall, 299.13/100,000 in men, and 234.06/100,000 in women (1.2 times higher in men than in women). The cancer mortality rate was 176.32/100,000 overall, 220.54/100,000 in men, and 130.60/100,000 in women (1.6 times higher in men than in women). The incidence rate was higher in urban areas (285.97/100,000) than in rural areas (250.91/100,000), whereas the mortality rate was higher in rural areas (179.25/100,000) than in urban areas (172.91/100,000). The rural: urban incidence ratio decreased from 0.89 in 2006 to 0.69 in 2010, and the rural: urban mortality ratio decreased from 1.10 to 0.91 in the same years. PYLL rates and DALY rates were higher in men (16.45 and 22.19, respectively) than in women (11.22 and 13.87, respectively) and in rural areas (17.6 and 22.17, respectively) than in urban areas (12.6 and 17.09, respectively). The male: female ratios for PYLL and DALY rates were 1.46 and 1.6, respectively. The rural: urban ratios for PYLL and DALY rates decreased from 1.63 in 2006 to 1.22 in 2010 and from 1.51 in 2006 to 1.08 in 2010, respectively. Conclusion: The disease burden of cancer in China in 2006-2010 was substantial, particularly for men and residents of rural districts.

**Keywords:** Incidence, mortality, cancer, burden of disease, China

## Introduction

Cancer is a major cause of death worldwide. As estimated by GLOBOCAN 2008, there were approximately 12.7 million new cancer cases and 7.6 million cancer deaths in 2008, mainly in less developed countries [1]. Owing to an increase in the elderly population, environmental pollution, and infection, cancer has become one of the main public health problems in China [2-4]. Its incidence and mortality rates have increased in the past decade in China, as is the case in other developing countries [5]. In 2009, there were 3.06 million new cases of cancer and 2.21 million deaths due to cancer in China; this translates to 6 new cases and 4 deaths per minute [6]. Cancer has been the leading cause of death in urban areas and the second leading cause of death in rural areas [5].

It is important to study the burden of cancer in terms of years lived with disease and years of life lost. The global burden of disease [6-8], first studied by the World Bank and Harvard University in 1990, provided a new metric-the "disability adjusted-life year" (DALY)-for quantifying disease burden. The DALY index comprehensively reflects and can be used to calculate the years of life lost because of premature death and the years lived with disability.

We used various indicators to assess cancer burden in terms of disease frequency and its severity. Incidence, mortality, potential years of life lost (PYLL), and DALYs were calculated from population data. The results of this study will be useful for formulating health policies and establishing priorities in health intervention program planning and will guide health and biomedical

**Table 1.** The incidence of cancer in China in 2006-2010

| Year | All areas | | | Urban areas | | | Rural areas | | |
|---|---|---|---|---|---|---|---|---|---|
| | Men | Women | Both | Men | Women | Both | Men | Women | Both |
| 2006 | 303.84 | 243.01 | 273.66 | 304.09 | 255.48 | 280.17 | 302.95 | 197.43 | 250.35 |
| 2007 | 305.22 | 246.46 | 276.16 | 305.76 | 263.2 | 284.71 | 303.65 | 197.41 | 251.07 |
| 2008 | 267.56 | 330.16 | 299.12 | 332.20 | 281.52 | 307.04 | 322.58 | 215.18 | 269.57 |
| 2009 | 317.97 | 253.09 | 285.91 | 330.19 | 276.15 | 303.39 | 293.10 | 205.25 | 249.98 |
| 2010 | 268.65 | 200.21 | 235.23 | 287.56 | 223.74 | 256.41 | 213.71 | 249.42 | 176.29 |
| Total | 299.13 | 234.06 | 267.13# | 311.61 | 259.44 | 285.97* | 288.37 | 212.19 | 250.91* |

Note: *Comparison between men and women. $\chi^2 = 174.3$, $P < 0.001$. #Comparison between rural and urban areas. $\chi^2 = 7174.3$, $P < 0.001$. Data are expressed as the number of people with cancer per 100,000 people.

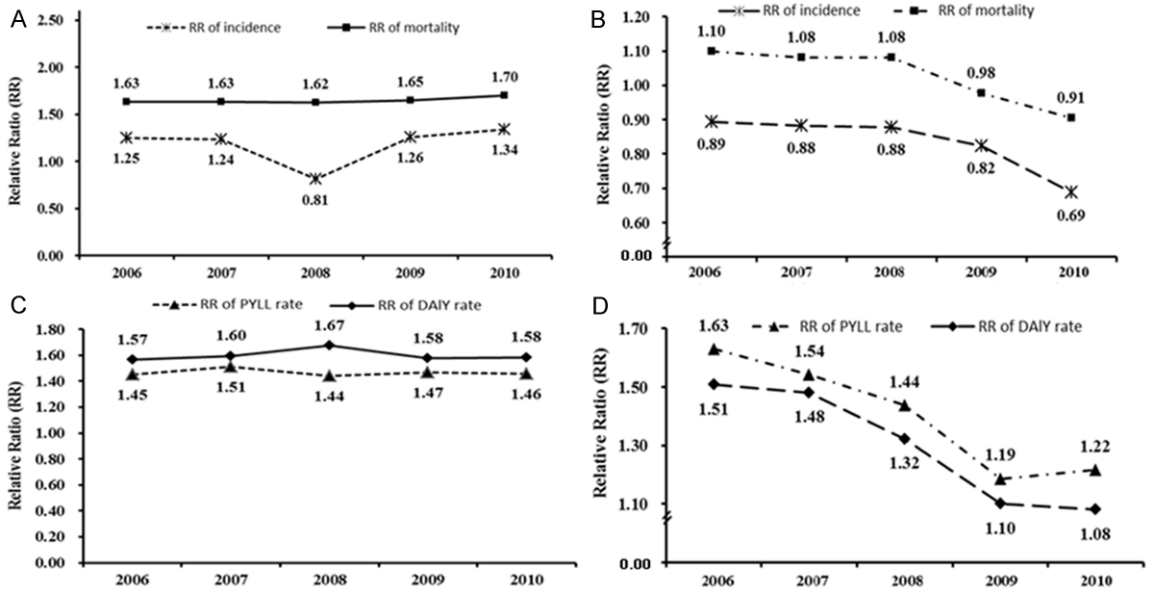


**Figure 1.** Relative Ratio of cancer burden in china by sex and districts. A. Male: female ratios for incidence and mortality. B. Rural: urban ratios for incidence and mortality. C. Male: female ratios for PYLL and DALY rates. D. Rural:urban ratios for PYLL and DALY rates. RR, relative ratio.

research and resource generation and expansion.

## Materials and methods

Two aspects of the population burden of cancer were examined: disease frequency (how often the disease occurs [incidence and mortality]) and severity (how serious the disease burden is [PYLL and DALY]). Burden was examined for all cancers according to sex and area (urban or rural).

### *Data collection*

The data collected and their sources were as follows: 1) mortality rates (2006-2010) for deaths due to all causes in China, the China Health Statistics Annuals [9-13]; 2) abridged life tables for 2010, the 2010 Chinese population census [14]; 3) 2006-2010 incidence and mortality rates for cancer, the 2008-2012 Chinese Cancer Registry Annual Report by the National Center for Cancer Registries [15-19]; and 4) 2007-2011 population data, the China Population and Employment Statistics Yearbook [14, 20-22].

### *Analytical indices*

PYLL is an estimate of the average years a person would have lived if he or she had not died prematurely [23]. It is, therefore, a measure of

**Table 2.** Cancer mortality in China in 2006-2010

| Year | All areas | | | Urban areas | | | Rural areas | | |
|---|---|---|---|---|---|---|---|---|---|
| | Men | Women | Both | Men | Women | Both | Men | Women | Both |
| 2006 | 217.48 | 133.27 | 175.70 | 210.94 | 132.28 | 171.97 | 241.04 | 136.79 | 189.07 |
| 2007 | 219.15 | 134.1 | 177.09 | 212.02 | 134.21 | 173.55 | 240.1 | 133.80 | 187.49 |
| 2008 | 228.14 | 140.48 | 184.67 | 222.53 | 139.97 | 181.54 | 248.94 | 142.36 | 196.34 |
| 2009 | 224.2 | 135.85 | 180.54 | 223.45 | 139.57 | 181.86 | 225.73 | 128.14 | 177.83 |
| 2010 | 186.37 | 109.42 | 148.81 | 192.55 | 117.97 | 156.14 | 180.09 | 100.74 | 141.35 |
| Total | 220.54 | 130.60 | 176.32# | 211.93 | 132.55 | 172.91* | 227.96 | 128.92 | 179.25* |

Note: *Comparison of mortality rates between men and women. $\chi^2 = 46599.7$, $P < 0.001$. #Comparison of mortality rates between rural and urban areas. $\chi^2 = 7.336$. $P < 0.001$. Data are expressed as the numbers of deaths due to cancer per 100,000 people.

premature mortality and was calculated as follows:

$$PYLL\ (years) = \sum_{x=1}^{74.8} dx\ (L - X) \quad (1)$$

where L is life expectancy, X is the median age, and dx is the number of deaths. For life expectancy, we used 74.8 years (72.4 years for men and 77.4 years for women); these values were obtained from the China Health Statistics Annuals for 2011 [14].

The PYLL rate is the number of potential years of life lost per thousand people and was calculated as follows:

$$PYLL\ rate = PYLL \div N \times 1000 \quad (2)$$

where N is the minimum number of premature deaths.

DALY is the sum of years of life lost (YLL) and years lost due to disability (YLD) [21] and was calculated as follows:

$$DALY\ (years) = YLL + YLD \quad (3)$$

YLL is the number of cancer deaths in a given group (age or place of residence in our study) multiplied by the remaining life expectancy (in years) of healthy individuals. The formula is as follows [24]:

$$YLL = Number\ of\ deaths \times life\ espectancy\ at\ the\ age\ of\ death \quad (4)$$

YLD is the number of cancer cases at each non-fatal disease phase multiplied by the mean duration of each phase. The product is multiplied by the disability weight [25] of the life-years to account for the severity of each event. The formula is as follows [26]:

$$YLD = Number\ of\ cases \times time\ until\ remission\ or\ death \times disability\ weight \quad (5)$$

The DALY rate was calculated as follows:

$$\text{DALY rate} = \frac{DALY}{N} \times 1000‰ \quad (6)$$

The relative ratio of cancer burden stratified by age and place of residence was calculated as follows:

$$Relative\ ratio = \frac{Incidence\ in\ men\ (rural\ areas)}{Incidencce\ in\ women\ (urban\ areas)} \quad (7)$$

Using this formula, we calculated the relative ratios for the incidence, mortality, and rates of PYLL and DALY in men versus women and in rural versus urban areas.

*Analytical tools*

DISMOD2 software (www.who.int/healthinfo/global_burden_disease/tools_software/en/) was used to calculate the average age of onset and duration of cancer. The template provided by the World Health Organization (available from http://www.who.int/entity/healthinfo/bodreferencedalycalculationtemplate.xls) was used to calculate DALYs.

*Statistical methods*

The chi-square test was used to compare incidence and mortality rates in men versus women and in rural versus urban areas. The Wilcoxon test was used to compare PYLLs and DALYs in men versus women and in urban versus rural areas. The data were analyzed using SPSS software for Windows, version 20.0 (SPSS Inc., Chicago, IL, USA), and a *P* value < 0.05 was considered to be statistically significant.

**Table 3.** PYLL and PYLL rates in China in 2006-2010

| | Year | All areas | | | Urban areas | | | Rural areas | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Men | Women | Both | Men | Women | Both | Men | Women | Both |
| PYLL | 2006 | 13782404 | 6816147 | 20598551 | 3951467 | 2729708 | 6681175 | 8684078 | 5233298 | 13917376 |
| | 2007 | 13368331 | 6747020 | 20115351 | 4168013 | 2793735 | 6961748 | 8391833 | 4761770 | 13153603 |
| | 2008 | 12905048 | 6977292 | 19882340 | 4345821 | 2993323 | 7339144 | 7771354 | 4771842 | 12543196 |
| | 2009 | 11162345 | 7032291 | 18194636 | 4627070 | 3078102 | 7705172 | 6719227 | 3770237 | 10489464 |
| | 2010 | 10300125 | 6646623 | 16946748 | 4587640 | 3096543 | 7684183 | 5702523 | 3560042 | 9262565 |
| | Total | 61518253 | 34219373 | 95737626* | 21680011 | 14691411 | 36371422 | 37269015 | 22097189 | 59366204 |
| PYLL rate | 2006 | 16.27 | 11.21 | 13.79 | 14.28 | 10.23 | 12.29 | 24.56 | 15.35 | 20.04 |
| | 2007 | 16.77 | 11.08 | 13.98 | 14.67 | 10.21 | 12.48 | 24.1 | 14.2 | 19.24 |
| | 2008 | 16.45 | 11.43 | 13.99 | 14.97 | 10.73 | 12.89 | 22.51 | 14.39 | 18.53 |
| | 2009 | 16.86 | 11.48 | 14.22 | 15.57 | 10.78 | 13.22 | 19.72 | 11.52 | 15.7 |
| | 2010 | 15.91 | 10.91 | 13.48 | 14.13 | 10.11 | 12.18 | 17.75 | 11.75 | 14.84 |
| | Total | 16.45 | 11.22 | 13.89* | 14.72 | 10.41 | 12.61# | 21.73 | 13.44 | 17.67# |

*Comparison of PYLL rates (per 1000) between men and women. Wilcoxon W=15.000, P<0.001. #Comparison of PYLL rates (per 1000) between rural and urban districts. Wilcoxon W=15.000, P<0.001. PYLL data are expressed in people-years. PYLL rates are expressed as percentages.

## Results

### *Cancer incidence*

The incidence rate of all cancers in the registration areas ranged from 303.84/100,000 in 2006 to 268.65/100,000 in 2010 for men and from 243.01/100,000 to 200.21/100,000 for women (**Table 1**). Incidence was approximately 1.2 times higher in men than in women (**Figure 1A**). The incidence rate was 285.97/100,000 in urban areas and 250.91/100,000 in rural areas (**Table 1**). The rural: urban incidence ratio decreased from 0.89 in 2006 to 0.69 in 2010 (**Figure 1B**).

### *Cancer mortality*

The average mortality rate for all cancers in 2006-2010 was 176.32/100,000; the rates for men and women were 220.54/100,000 and 130.60/100,000, respectively (**Table 2**). The male: female mortality ratio was 1.6 (**Figure 1A**). The cancer mortality rate in rural areas (179.25/100,000) was higher than that in urban areas (172.91/100,000) ($P < 0.001$), even though the incidence rate was lower in rural areas. The rural: urban ratio showed a tendency to decrease between 2006 (1.10) and 2010 (0.91).

### *PYLL and PYLL rates*

In 2006-2010, the total PYLL owing to cancer was 95,737,626 person-years (**Table 3**). The number of years lost was greater for men (61,518,253, person-years) than for women (34,219,373 person-years) ($P < 0.001$). Although men have a lower life expectancy than do women (72.4 and 77.4 years, respectively), they lost more potential years of life than did women. PYLL rates were 16.45 and 11.22 for men and women, respectively ($P < 0.001$). The rate of premature cancer-related death was 1.46 times higher in men than in women in 2006-2010 (**Figure 1C**). Cancer patients in rural areas lost 1.4 times more person-years than those in urban areas in 2006-2010 ($P < 0.001$). The relative rural: urban ratio significantly decreased from 1.63 in 2006 to 1.22 in 2010.

### *DALY and DALY rates*

Cancer caused an estimated loss of 131.44 million years of healthy life in 2006-2010 (86.20 million years for men and 45.23 million years for women) (**Table 4**). DALYs were greater for men than for women ($P < 0.001$). Patients in rural areas lost more years of healthy life (78.97 million years) than those in urban areas (52.46 million years) ($P < 0.001$). The DALY rate was 18.10. It was 1.6 times higher for men (22.19) than for women (13.87) in 2006-2010 (**Figure 1A**). The DALY rate was 1.3 times higher in rural areas (22.17) than in urban areas (17.09) in 2006-2010. The rural: urban ratio of DALY rates showed a tendency to decrease from 2006 (1.51) to 2010 (1.08).

## Discussion

Cancer has been a major cause of mortality in China for many years [9-13]. Cancer burden studies provide information that guides health-related decisions, cancer control programs, and cancer treatment [24]. Our study shows that the incidence of cancer in China is lower

**Table 4.** DALYs and DALY rates in China in 2006-2010

| | Year | All areas | | | Urban areas | | | Rural areas | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Men | Women | Both | Men | Women | Both | Men | Women | Both |
| DALY | 2006 | 18231328 | 8965604 | 27196932 | 5615067 | 3679868 | 9294934 | 11595548 | 6306450 | 17901998 |
| | 2007 | 18084228 | 9029203 | 27113431 | 5829778 | 3805344 | 9635121 | 11385042 | 6093268 | 17478310 |
| | 2008 | 19314589 | 9274281 | 28588870 | 6749605 | 4367689 | 11117294 | 11426166 | 6045410 | 17471576 |
| | 2009 | 16041957 | 9415107 | 25457064 | 6672188 | 4585431 | 11257619 | 9345999 | 4853447 | 14199445 |
| | 2010 | 14531502 | 8548864 | 23080366 | 7058493 | 4099065 | 11157558 | 7515882 | 4406926 | 11922808 |
| | Total | 86203604 | 45233059 | 131436663* | 31925131 | 20537397 | 52462526# | 51268637 | 27705501 | 78974137# |
| DALY rate | 2006 | 21.67 | 13.82 | 17.8 | 19.2 | 12.92 | 16.1 | 31.02 | 17.33 | 24.27 |
| | 2007 | 22.13 | 13.87 | 18.06 | 19.37 | 13 | 16.23 | 30.88 | 17 | 24.03 |
| | 2008 | 23.75 | 14.18 | 19.04 | 21.9 | 14.62 | 18.32 | 31.18 | 17.01 | 24.21 |
| | 2009 | 22.59 | 14.34 | 18.53 | 21.12 | 14.99 | 18.11 | 25.81 | 13.84 | 19.92 |
| | 2010 | 20.82 | 13.14 | 17.07 | 20.58 | 12.54 | 16.65 | 22.15 | 13.62 | 17.99 |
| | Total | 22.19 | 13.87 | 18.10* | 20.43 | 13.61 | 17.08 | 28.21 | 15.76 | 22.08 |

*Comparison of DALY rates between men and women. Wilcoxon W=15.000, P<0.001. #Comparison of DALY rates between rural and urban districts. Wilcoxon W=15.000, P<0.001. DALYs are expressed as years of healthy life. DALY rates are expressed as percentages.

than that in developed countries but higher than that in other developing countries [27]. The cancer mortality rate in China was higher than the worldwide rate and the rate in developing countries, but lower than the rate in developed countries [27]. According to a previous study, the worldwide average mortality rate for all tumor types was 112.10/100,000 in 2008 for both men and women, with crude rates of 124.0/100,000 and 99.0/10,000, respectively [25]. The mortality rate for individuals with malignant neoplasms was 223.1/100,000 (254.9/100,000 for men and 193.2/100,000 for women) in the developed world and 87.3/100,000 (96.1/100,000 for men and 78.2/100,000 for women) in the developing world [25]. Many global cancer studies had results similar to ours [28-31].

Factors responsible for the severe cancer burden in China include increased longevity, population aging, pollution, smoking, and unhealthy lifestyles [32-34]. Life expectancy in China has risen from 73 years (71 and 74 years for men and women, respectively) in 2005 to 74.8 years (72.4 and 77.4 years for men and women, respectively) in 2010 [9]. Aging is the main risk factor for cancer [35-37]. According to the China Population and Employment Statistics Yearbook 2007-2011, the percentage of elderly people (60 years of age and older) increased from 13.3% to 14.5%. Environmental pollution has also increased [14, 20-22, 38], and a previous study suggests that particulate matter with a diameter of 2.5 m (PM2.5) is the primary cause of lung cancer [39]. In China, the concentration of PM2.5 is rising owing to increased automobile exhaust, industrial pollution, and smoking in indoor establishments [40, 41].

The PYLL and DALY indices were used to evaluate the severity of disease burden. PYLL is a quantitative indicator that assesses how cancer impairs public health based on the death toll and life expectancy [23, 42]. DALY is a new comprehensive measurement of population health developed for the Global Burden of Disease study [6, 43, 44]. The loss of healthy life-years per 1000 people owing to malignant tumors is lower in China (18.10) than in developed countries such as Japan (48.27), South Korea (38.67), and Australia (38.03), but higher than in India (15.58) and the Arab nations (13.53) [45]. The number of cancer patients increases as the population ages [46]. Two-thirds of all cancers in China are associated with poor survival, which increases the cancer burden in this country [47].

Tumors were differentially distributed between urban and rural areas. Incidence was higher in urban areas, whereas mortality and PYLL and DALY rates were higher in rural areas in 2006-2010 in China. This may be explained by the greater exposure of urban residents to tumor risk factors such as air pollution. Urban residents are less physically active and have more social and mental pressures and more westernized lifestyles than rural residents, all of which may increase cancer incidence [48-51]. Higher mortality in rural areas may reflect limited medical care and poor economic levels [50]. Rural doctors in China are less educated and experienced than their urban counterparts,

with a lower proportion of the former receiving formal medical education and training. Zeng et al. [47] found that rural areas often lack the medical resources required for prompt cancer diagnosis and treatment and that rural residents pay less attention to their health; as a result, cancers are detected at later stages, which increases mortality.

In our study, the rural: urban ratios for incidence, mortality, PYLL rate, and DALY rate all decreased from 2006 to 2010. The decrease in the rural: urban incidence ratio was statistically significant, suggesting that incidence will increase in urban areas. However, the rural: urban ratios for mortality, PYLL rate, and DALY rate decreased almost to 1, indicating that the cancer burden in rural and urban areas may become equal. This may reflect the trend toward urbanization and less healthy lifestyles (e.g., replacement of traditional foods with low-volume foods high in fat and low in fiber) [52]. However, further research is needed.

Tumor incidence, mortality rate, PYLL rates, and DALY rates ware all higher in men than in women in 2006-2010 in China. This may be explained by the unhealthy habits of men [53], such as smoking and drinking, and the more stressful lives of men. Because of their jobs, men may also have more exposure to carcinogenic factors than women [54].

In conclusion, the cancer burden in 2006-2010 in China was substantial, particularly for men and residents of rural areas. Early detection and early treatment of tumors should be a priority. Prompt, accurate screening of malignant tumors will help alleviate the tumor burden in China. Additional means of reducing the cancer burden include timely intervention in individuals at risk, comprehensive health education programs for Chinese residents, and development of effective strategies for preventing and controlling cancer. These steps should be implemented in China in the future.

## Acknowledgements

This work was supported by a Xinjiang Production and Construction Corps major public health special project (2100409) and a Xinjiang Production and Construction Corps grant (2014BA039).

## Disclosure of conflict of interest

None.

**Address correspondence to:** Feng Li, Department of Pathology and Key Laboratory of Xinjiang Endemic and Ethnic Diseases (Ministry of Education), Shihezi University School of Medicine, Shihezi 832002, Xinjiang, China. Tel: +86-993-205-7153; E-mail: lifeng7855@126.com; Shugang Li, Department of Public Health and Key Laboratory of Xinjiang Endemic and Ethnic Diseases (Ministry of Education), Shihezi University School of Medicine, Shihezi 832002, xinjiang, China. Tel: +86-993-205-7153; E-mail: lishugang@ymail.com

## References

[1] Ferlay J, Shin HR, Bray F, Forman D, Mathers CD, Parkin D. GLOBOCAN 2008, Cancer Incidence and Mortality Worldwide: IARC CancerBase No. 10. Lyon, France: International Agency for Research on Cancer; Year. Available at: http://globocan.iarc.fr. 2015. Last accessed 5/17/2015.

[2] Chen WQ, Zhang SW, Zou XN and Zhao P. Cancer incidence and mortality in china, 2006. Chin J Cancer Res 2011; 23: 3-9.

[3] Chen WQ, Zeng HM, Zheng RS, Zhang SW and He J. Cancer incidence and mortality in china, 2007. Chin J Cancer Res 2012; 24: 1-8.

[4] Chen W, Zheng R, Zhang S, Zhao P, Li G, Wu L and He J. Report of cancer incidence and mortality in China, 2010. Chin J Cancer Res 2014; 23: 1-10.

[5] Chen W, Zheng R, Zeng H and Zhang S. [Trend analysis of the changes of male/female, urban/rural incidences and average age of cancer patients in China 1989-2008]. Zhonghua Zhong Liu Za Zhi 2014; 36: 796-800.

[6] Murray CJ and Lopez AD. Evidence-based health policy--lessons from the Global Burden of Disease Study. Science 1996; 274: 740-3.

[7] Murray CJ, Ezzati M, Flaxman AD, Lim S, Lozano R, Michaud C, Naghavi M, Salomon JA, Shibuya K, Vos T, Wikler D and Lopez AD. GBD 2010: design, definitions, and metrics. Lancet 2012; 380: 2063-6.

[8] Van der Weyden MB. The burden of disease and injury in Australia: time for action. Med J Aust 1999; 171: 581-2.

[9] Press PUMC. China Health Statistics Annuals, 2011. Beijing: National Bureau of population and employment statistics; 2011.

[10] Press PUMC. China Health Statistics Annuals, 2010. Beijing: National Bureau of population and employment statistics; 2010.

[11] Press PUMC. China Health Statistics Annuals, 2009. Beijing: National Bureau of population and employment statistics; 2009.
[12] Press PUMC. China Health Statistics Annuals, 2008. Beijing: National Bureau of population and employment statistics; 2008.
[13] Press PUMC. China Health Statistics Annuals, 2007. Beijing: National Bureau of population and employment statistics; 2007.
[14] Press CS. China Population and Employment Statistics Yearbook, 2011. Beijing: National Bureau of population and employment statistics; 2012.
[15] Chen W, Zheng R, Zhang S, Zhao P, Zeng H, Zou X and He J. Annual report on status of cancer in China, 2012. Chin J Cancer Res 2014; 26: 48-58.
[16] Chen W, Zheng R, Zhang S, Zhao P, Zeng H, Zou X and He J. Annual report on status of cancer in China, 2011. Chin J Cancer Res 2015; 25: 2-12.
[17] Chen W, Zheng R, Zhang S, Zhao P, Zeng H, Zou X and He J. Annual report on status of cancer in China, 2010. Chin J Cancer Res 2014; 24: 48-58.
[18] Chen W, Zheng R, Zhang S, Zhao P, Zeng H, Zou X and He J. Annual report on status of cancer in China, 2009. Chin J Cancer Res 2011; 23: 43-53.
[19] Chen W, Zheng R, Zhang S, Zhao P, Zeng H, Zou X and He J. Annual report on status of cancer in China, 2008. Chin J Cancer Res 2010; 22: 42-52.
[20] Press CS. China Population and Employment Statistics Yearbook, 2010. Beijing: National Bureau of population and employment statistics; 2011.
[21] Press CS. China Population and Employment Statistics Yearbook, 2009. Beijing: National Bureau of population and employment statistics; 2010.
[22] Press CS. China Population and Employment Statistics Yearbook, 2007. Beijing: National Bureau of population and employment statistics; 2008.
[23] Gardner JW and Sanborn JS. Years of potential life lost (YPLL)--what does it measure? Epidemiology 1990; 1: 322-9.
[24] Soerjomataram I, Lortet-Tieulent J, Parkin DM, Ferlay J, Mathers C, Forman D and Bray F. Global burden of cancer in 2008: a systematic analysis of disability-adjusted life-years in 12 world regions. Lancet 2012; 380: 1840-50.
[25] Gibney KB, O'Toole J, Sinclair M and Leder K. Disease burden of selected gastrointestinal pathogens in Australia, 2010. Int J Infect Dis 2014; 28: 176-85.
[26] Devleesschauwer B, Havelaar AH, Maertens de Noordhout C, Haagsma JA, Praet N, Dorny P, Duchateau L, Torgerson PR, Van Oyen H and Speybroeck N. DALY calculation in practice: a stepwise approach. Int J Public Health 2014; 59: 571-4.
[27] Jemal A, Bray F, Center MM, Ferlay J, Ward E and Forman D. Global cancer statistics. CA Cancer J Clin 2011; 61: 69-90.
[28] Shibuya K, Mathers CD, Boschi-Pinto C, Lopez AD and Murray CJ. Global and regional estimates of cancer mortality and incidence by site: II. Results for the global burden of disease 2000. BMC Cancer 2002; 2: 37-8.
[29] Mettlin C. Global breast cancer mortality statistics. CA Cancer J Clin 1999; 49: 138-44.
[30] Mathers CD, Shibuya K, Boschi-Pinto C, Lopez AD and Murray CJ. Global and regional estimates of cancer mortality and incidence by site: I. Application of regional cancer survival model to estimate cancer mortality distribution by site. BMC Cancer 2002; 2: 36-7.
[31] Guo P, Huang ZL, Yu P and Li K. Trends in cancer mortality in China: an update. Ann Oncol 2012; 23: 2755-62.
[32] Li Y, Dai M, Chen Y, Zhang S, Chen W, Dai Z and Zou X. [Estimates of lung cancer mortality at the province level in China]. Zhongguo Fei Ai Za Zhi 2011; 14: 120-6.
[33] Chen W, Armstrong BK, Zheng R, Zhang S, Yu X and Clements M. Cancer burden in China: a Bayesian approach. BMC Cancer 2013; 13: 458-60. PMID: 24093796.
[34] Chen W. Cancer statistics: updated cancer burden in China. Chin J Cancer Res 2015; 27: 1.
[35] Zhang NJ, Guo M and Zheng X. China: awakening giant developing solutions to population aging. Gerontologist 2012; 52: 589-96.
[36] Berut M, Mik M, Kedzia-Berut R, Kujawski R, Trzcinski R, Dziki L and Dziki A. Colorectal cancer in young and elderly patients. Pol Przegl Chir 2013; 85: 446-51.
[37] Wang Zhibao ST, Li Guoping. Regional Differences and Evolutions of Population Aging in China. Population Research 2013; 37: 66-77.
[38] Press CS. China Population and Employment Statistics Yearbook, 2008. Beijing: National Bureau of population and employment statistics; 2008.
[39] Vinikoor-Imler LC, Davis JA and Luben TJ. An ecologic analysis of county-level PM2.5 concentrations and lung cancer incidence and mortality. Int J Environ Res Public Health 2011; 8: 1865-71.
[40] Hung LJ, Chan TF, Wu CH, Chiu HF and Yang CY. Traffic air pollution and risk of death from ovarian cancer in Taiwan: fine particulate matter (PM2.5) as a proxy marker. J Toxicol Environ Health A 2012; 75: 174-82.
[41] Hu W, Downward GS, Reiss B, Xu J, Bassig BA, Hosgood HD 3rd, Zhang L, Seow WJ, Wu G,

Chapman RS, Tian L, Wei F, Vermeulen R and Lan Q. Personal and indoor PM2.5 exposure from burning solid fuels in vented and unvented stoves in a rural region of China with a high incidence of lung cancer. Environ Sci Technol 2014; 48: 8456-64.

[42] Wiesner G and Bittner EK. [Life expectancy, potential years of life lost (PYLL), and avoidable mortality in an East/West comparison]. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 2004; 47: 266-78.

[43] Murray CJ, Frenk J, Piot P and Mundel T. GBD 2.0: a continuously updated global resource. Lancet 2013; 382: 9-11.

[44] Murray CJ, Ezzati M, Flaxman AD, Lim S, Lozano R, Michaud C, Naghavi M, Salomon JA, Shibuya K, Vos T and Lopez AD. GBD 2010: a multi-investigator collaboration for global comparative descriptive epidemiology. Lancet 2012; 380: 2055-8.

[45] Brennan DS and Spencer AJ. Disability weights for the burden of oral disease in South Australia. Popul Health Metr 2004; 2: 7-11.

[46] Leng SX, Tian XP, Durso S, Lazarus G, Lu C, Park E, Xie H, Kang L, Li D, Shen T and Fried LP. The aging population and development of geriatrics in China. J Am Geriatr Soc 2008; 56: 571-3.

[47] Zeng H, Zheng R, Guo Y, Zhang S, Zou X, Wang N, Zhang L, Tang J, Chen J, Wei K, Huang S, Wang J, Yu L, Zhao D, Song G, Chen J, Shen Y, Yang X, Gu X, Jin F, Li Q, Li Y, Ge H, Zhu F, Dong J, Guo G, Wu M, Du L, Sun X, He Y, Coleman MP, Baade P, Chen W and Yu XQ. Cancer survival in China, 2003-2005: A population-based study. Int J Cancer 2015; 136: 1921-30.

[48] Zhang Y, Bu Y and Gao H. Rural-urban disparities of breast cancer patients in China. Med Oncol 2013; 30: 387-92.

[49] Gao J, Xie L, Chen WQ, Zhang SW, Wu QJ, Yang Y, Yang WS, Tan YT and Xiang YB. Rural-urban, sex variations, and time trend of primary liver cancer incidence in China, 1988-2005. Eur J Cancer Prev 2013; 22: 448-54.

[50] Fei X, Wu J, Kong Z and Christakos G. Urban-rural disparity of breast cancer and socioeconomic risk factors in China. PLoS One 2015; 10: 1-15.

[51] Guo B and Huang ZL. Esophageal cancer mortality trends in rural and urban China between 1987 and 2009. Asian Pac J Cancer Prev 2011; 12: 2105-10.

[52] Bray F, Jemal A, Grey N, Ferlay J and Forman D. Global cancer transitions according to the Human Development Index (2008-2030): a population-based study. Lancet Oncol 2012; 13: 790-801.

[53] Yang L and Colditz GA. An active lifestyle for cancer prevention. J Natl Cancer Inst 2014; 106: 10-9.

[54] Kubo T. [Cancer and lifestyle-related diseases risk among shifts workers]. Nihon Rinsho 2013; 71: 2206-12.