Exploring Patterns and Trends with Selected Cancer Rates Reported by China National Cancer Registry: Alternative Perspectives and Findings

Ting Zhao¹, Jing Cheng¹,², Jing Chai¹, Rui Feng³, Debin Wang¹* and Yehuan Sun²

¹School of Health Services Management, Anhui Medical University, 81 Meishan Road, Hefei 230032, Anhui, China.
²Department of Epidemiology and Statistics, School of Public Health, Anhui Medical University, 81 Meishan Road, Hefei 230032, China.
³Library Department of Literature Retrieval and Analysis, Anhui Medical University, 81 Meishan Road, Hefei, China.

Authors’ contributions

This work was carried out in collaboration between all authors. Author TZ performed the data analysis and wrote the first draft of the manuscript. Authors Jing Cheng and Jing Chai managed the literature review and revised the manuscript. Author RF extracted the data and designed the figures. Authors DW and YS conceived the study and finalized the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJMMR/2015/17163

Received 28th February 2015
Accepted 2nd May 2015
Published 30th May 2015

Original Research Article

ABSTRACT

Background: National cancer registration reports provide huge potential for identifying patterns and trends of policy, research, prevention and treatment significance. Yet given the range of factors involved in cancer onset, case identification, progression and reporting, pin-pointing this complexity requires systematic thinking and varied strategies of data analysis.

Methods: The study extracts data about incidence rates (IRs) and mortality rates (MRs) of lung, stomach, colorectal and liver cancers for 2004, 2006 and 2009 from relevant China National
Cancer Registry (CNCR) reports and analyzes the data using line-graphs, ratios and logistic growth modeling.

**Results:** The study shows that: a) all line graphs of age-specific IRs and MRs of the 4 cancers characterized typical S-shape with substantial differences in terms of smoothness, height and proximity; b) MR lines mimicked and located below the corresponding (of the same cancer, population group and year of reporting) IR lines for almost all the age groups except 1 to 2 oldest ones; c) colorectal cancer witnessed the lowest MR/IR ratios on average followed by gastric and lung cancers and all such ratios featured an increasing trend along the age spectrum; d) urban vs. rural ratios in IRs or MRs showed an increasing trend along the age axis for 3 out of the 4 cancers but a typical v-shaped curves for stomach cancer; e) the lines of recent vs. early ratios in cumulative IRs or MRs for urban areas located apparently closer than that for rural areas; f) all the age-specific IRs and MRs fitted very well with logistic growth models (goodness of fit > 0.91) and the integrations and ages when the models reached 5%, 50% or 95% of their highest values yielded interesting features.

**Conclusion:** The study provides useful perspectives for analyzing age-specific IRs and MRs and reveals a number of interesting patterns and trends with cancer counts reported by CNCR.

**Keywords:** Cancer; registry; incidence; mortality; urban; rural.

### 1. INTRODUCTION

Cancer registry (CR) is gaining recognition worldwide [1,2]. Many countries, including China, have established large scale long-term operating CR systems [2-4]. These systems have accumulated large amount data about incidence rates (IRs) and mortality rates (MRs) of combined and specific cancers and thus a huge potential for identifying patterns and trends of policy, research, prevention and treatment significance [4-8]. However, most CR data are published in raw dataset with primitive groupings or summary reports (usually at an annual base) falling far short from exploring their full potential. Up to date, CR data have been used mainly in describing cancer distribution among different groups, assessing or predicting cancer burdens, and modeling age, cohort and time (APC) effects on cancers [9-12]. In addition to these, CR data may be used in many other ways. In a previous paper [13], we tried to identify some of the patterns and trends with the IRs/MRs of all cancers behind available reports published by China National Cancer Registry (CNCR). The paper addressed several features with age-specific IRs/MRs reported by CNCR and possible contributing factors. These included: S-shaped age-specific IRs/MRs; identical patterns between MRs and IRs along the age spectrum; positive differences in age-specific IRs and MRs (i.e., IR minus MR ) for almost all the age groups but the oldest couple ones (i.e., 80-84 and 85 years plus); big discrepancies between the secondary peaks of age-specific MR/IR ratios for urban and rural females; U-shaped urban versus rural ratios of age-specific IRs and MRs; mixed trends in the IRs and MRs between different years etc. These provide useful perspectives and examples for exploring the mounting data from CR and other relevant initiatives.

Cancers of different types or locations are heterogeneous in terms of causes, progression, symptoms, diagnosis, treatment and prognosis [14-17]. Collective characteristics observable with all cancers combined together may differ substantially from that of specific cancers. Therefore, this paper examines patterns and trends with incidence and mortality rates of specific cancers from similar perspectives as we adopted in our previous work and others and compares the findings between these specific cancers and that of all types of cancer as a whole. Given that the CNCR annual reports provide aggregate data on 46 specific cancers, it is impossible for us to address each of these cancers within a single paper. Instead, we had to be selective and focused on only four leading (lung, stomach, colorectal and liver) cancers. Leading cancers also mean most serious health threats and thus worth top attention for any kind of studies; while four was the largest number of cancers to be fitted into manageable figures (like Fig. 1) and tables (like Table 1).

### 2. MATERIALS AND METHODS

#### 2.1 Data Source

The study used CNCR annual reports as source data. It extracted incidence and mortality rates in 2004, 2006 and 2009 from CNCR Annual
Reports 2004, 2009 and 2012, respectively. CNCR Annual Report 2004 is the earliest available report of the kind; while CNCR Annual Report 2012, the latest one. All of the reports provide incidence and mortality counts by type of cancer, age, gender, registry site and region (urban vs. rural) etc. Due to space limit, this study extracted and analyzed only data about lung, gastric, colorectal and liver cancers (further referred to as 4-cancers) (see Appendix A). They are the four most common types of cancers in China according to CNCR Annual Report 2012.

2.2 Data Analysis

The study adopted mainly descriptive analysis. It calculated 4 kinds of indicators and portrayed their patterns and trends in line or histograms graphs using Microsoft Excel 2010. These indicators include: a) age-specific IRs and MRs by gender, region (urban or rural) and year of reporting; b) age-specific MR/IR ratios by gender, region and year of reporting; c) urban versus rural ratios in terms of age-specific IR and MR by gender and year of reporting; and d) age-,gender- and region-specific ratios between accumulative IR (or MR) reported in a later year (e.g., 2009) and that reported in an earlier year (e.g., 2006). Here, an IR or MR for a given cancer and group equals the number of the cancer incidence cases registered for the group divided by the total number of people within the group; while an MR/IR ratio, the IR in a certain year divided by the MR in the same year; an IR (or MR) ratio between urban and rural areas, the IR (or MR) of urban areas in a certain year divided by the IR (or MR) of rural areas in the same year; a accumulative IR (or MR) reported in a later year (e.g., 2009) and that reported in an earlier year (e.g., 2006). Here, an IR or MR for a given cancer and group equals the number of the cancer incidence cases registered for the group divided by the total number of people within the group; while an MR/IR ratio, the IR in a certain year divided by the MR in the same year; an IR (or MR) ratio between urban and rural areas, the IR (or MR) of urban areas in a certain year divided by the IR (or MR) of rural areas in the same year; a accumulative IR (or MR) for a given age (say age X), sum of all IRs (or MRs) from age 0 up to age X reported in a given year. Reported IRs and MRs for some age groups (e.g., age 0 through to 25) were extremely low. This made ratios generated using these IRs or MRs vary substantially and misleading. In order to prevent such problems, the calculation of part of the indicators excluded these ages.

The study also performed a series of modeling which used SPSS version 16 as calculation tool and reported age-specific IRs or MRs as observed data and produced 3-parameter logistic growth equations using formula $P_x = \frac{p_{max}}{1 + e^{-k(x-b)}}$. Where x stands for age; and $P_x$, cancer incidence rate for a given age x; $p_{max}$, the biggest cancer incidence rate for all ages; k, growth rate; while b serves as a baseline growth rate that determines the location of "the rapidly growing phase" of the growth or S-curve along the age spectrum.

In addition, the study calculated integrations of all the logistic growth equations derived via the above process, $A_{0.5MIR}$ (the age when the IR of a given cancer reached 50% of its max values), time lags between $A_{0.5MIR}$ and $A_{0.5MMR}$ (the age when the MR of a given cancer reached 50% of its max) and between $A_{0.95MIR}$ and $A_{0.05MIR}$ and MR vs. IR integrations ratios (a MR vs. IR integration ratio equals the integration of an IR model for a specific subgroup divided by the integration of the MR model for the same subgroup).

3. RESULTS

3.1 Simple Line-graphs

Figs. 1a-p depicts, in line-graphs, the age-specific IRs and MRs of the 4-cancers by gender (males, females), region (urban, rural) and year of reporting (2004, 2006 and 2009) respectively (see Appendix B for detailed data). All these lines characterized atypical S-shaped curves consisting of a relatively low and stable phase from age 0 to around age 35, a rapidly growing phase from around age group 35 to 75, and a final phase with slowing down increase, even slight decrease. These lines showed substantial differences in terms of smoothness, height and proximity. The lines representing IRs or MRs of lung cancer for urban males located the highest; followed by IR or MR lines of stomach cancer for rural males; and IR or MR lines of lung cancer of rural males. The IR and MR lines for rural areas witnessed greater sub-trend variations than that for urban areas. The IR and MR lines of lung and liver cancers located much closer to each other compared with that of colorectal and stomach cancers. All of the MR lines located below the corresponding (of the same cancer and year) IR lines for almost all the age groups except 1 to 2 oldest ones (i.e., 80-84 and 85 years plus).

3.2 MR vs IR Ratios

Figs. 2a-p shows, in lines again, the age-specific IR/IR ratios of the 4-cancers by gender (males, females), region (urban, rural) and year of reporting (2004, 2006 and 2009) respectively (see Appendix B for detailed data). All these lines characterized atypical S-shaped curves consisting of a relatively low and stable phase from age 0 to around age 35, a rapidly growing phase from around age group 35 to 75, and a final phase with slowing down increase, even slight decrease. These lines showed substantial differences in terms of smoothness, height and proximity. The lines representing IRs or MRs of lung cancer for urban males located the highest; followed by IR or MR lines of stomach cancer for rural males; and IR or MR lines of lung cancer of rural males. The IR and MR lines for rural areas witnessed greater sub-trend variations than that for urban areas. The IR and MR lines of lung and liver cancers located much closer to each other compared with that of colorectal and stomach cancers. All of the MR lines located below the corresponding (of the same cancer and year) IR lines for almost all the age groups except 1 to 2 oldest ones (i.e., 80-84 and 85 years plus).
cancers respectively. Colorectal cancer witnessed the lowest MR/IR ratios on average followed by gastric and lung cancers. All the lines showed an increasing trend from younger to older age and the pace of increase remained relatively slow until some age around 60 and then began to grow faster and faster. Greater sub-trend variations or fluctuations in the lines appeared for rural than urban areas and for females than males. For any given cancer and subgroup, the 3 colored (blue, red and green) lines displayed similar trend and intertwined together without apparent difference; yet the lines for year 2009 appeared to be somewhat smoother than the other two.

### 3.3 Urban vs. Rural Ratios

Figs. 3a-p presents the characteristics and trends of age-specific IRs or MR ratios for people of 35+ between urban and rural areas. These ratios varied from 0.64 to 2.57 (mean=1.26), from 0.25 to 1.04 (mean=0.54), from 0.70 to 3.15 (mean=1.75), and from 0.27 to 1.59 (mean=0.66) for lung, gastric, colorectal, and liver cancer respectively. Three out of the four cancers witnessed increasing trend in the lines (Figs. 3a-d, i-p); yet stomach cancer, atypical v-shaped curves (Figs. 3e-h). Most part of the lines for lung and colorectal cancers plotted above 1; while the main part for stomach and liver cancer lines, below 1. Greater similarities in terms of the patterns (ups and downs) and absolute values of the lines between year 2004 and 2006 than that between 2004 (or 2006) and 2009 were observable with stomach and liver cancers for all subgroups. The lines representing the most recent (year 2009) ratios located higher over that of the remaining years in stomach cancer for almost all the age and gender subgroups (Figs. 3e-h) and in liver cancer for both genders (Figs. 3m-p) and age groups under 75-79 (Figs. 3m-p). Lung cancer presented some extent of increasing gap, from younger to older age groups, between the ratio lines for different years.

### 3.4 Recent vs. Early Ratios

Figs. 4a-p displays the ratios of cumulative IRs reported in year 2009 vs. 2006 (blue lines) and 2006 vs. 2004 (red lines) and the ratios of cumulative MRs reported in year 2009 vs. 2006 (green lines) and 2006 vs. 2004 (purple lines). They displayed a number of interesting features: a) all the lines ended within an ratio range from 0.62 to 1.43; b) all of the red and 13 out of the purple lines ended above 1 but only half of the blue and 6 out of the green lines did so; c) the four kinds of colored lines consisting the gender specific figure components for urban areas (Fig. 4, columns 1-2) located apparently closer than that for rural areas (Fig. 4, columns 3-4) and, for both gender subgroups in rural areas, most part of the blue and red lines located below 1, while green and purple lines, above 1; d) only a small part of lines demonstrated some extent of decreases from age group 35 to 85+, e.g., the blue lines of lung, stomach and colorectal cancers among rural males (Figs. 4c, g, k) and of stomach cancer among rural females (Fig. 4h), and the green lines of lung cancer among rural males (Fig. 4c) and of liver cancer among urban males and females (Figs. 4m, n).

### 3.5 Logistic Growth Models

Table 1 provides parametric estimates of the logistic growth models of the age-specific IRs and MRs of the 4-cancers. Goodness of fit for all subgroups was estimated as high as over 0.91. Yet, the 3 parameters defining the models showed substantial variations: $P_{\text{max}}$ (the highest IR or MR) ranged from 56.211 (for colorectal cancer) to 772.583 (for lung cancer); b, from 6.046 (for liver cancer) to 16.532 (for lung cancer); and k, from 0.386 (for liver cancer) to 1.173 (for lung cancer). As shown in Fig. 5 and Appendix C, integrations of the IR and MR models ranged from 381.84 to 3018.49 and from 245.10 to 2852.02 respectively; while $A_{0.5\text{MIR}}$, from 43.81 to 66.86. If examined on cancer by cancer base, the IR and MR integrations witnessed greater values in males than females for all the 4-cancers and in urban than rural areas for lung and colorectal cancers; while $A_{0.5\text{MIR}}$, moderate yet consistent urban over rural difference. The time lag between $A_{0.5\text{MIR}}$ and $A_{0.5\text{MMR}}$ presented substantial variations (from -0.40 to 15.05) with longer lags for colorectal and stomach cancers over lung and liver cancers and for urban areas over rural areas. Time lag between $A_{0.95\text{MIR}}$ and $A_{0.05\text{MIR}}$ differed from 25.10 for lung cancer to 67.53 for liver cancer. The MR vs. IR integrations ratios were the highest (115.43%) for liver cancer and the lowest (59.94%) for colorectal cancer. And 8 out of these 48 ratios valued even greater than 100%.
Fig. 1. Age-specific IRs and MRs by gender, region and year of reporting.
| Indicators          | Lung cancer | Stomach cancer | Colorectal cancer | Liver cancer |
|---------------------|-------------|----------------|-------------------|--------------|
|                     | P<sub>max</sub> | b   | k   | R   | P<sub>max</sub> | b   | k   | R   | P<sub>max</sub> | b   | k   | R   |
| Incidence rate      |             |     |     |     |             |     |     |     |             |     |     |     |
| Urban male 2009     | 649.37      | 11.59| 0.77| 0.99| 277.10      | 10.47| 0.73| 0.99| 320.93      | 10.01| 0.66| 0.99|
| Urban male 2006     | 575.18      | 12.63| 0.85| 0.98| 285.95      | 11.28| 0.78| 0.97| 279.22      | 12.09| 0.82| 0.98|
| Urban male 2004     | 551.71      | 13.20| 0.90| 0.99| 260.97      | 10.40| 0.72| 0.97| 235.79      | 11.71| 0.80| 0.99|
| Urban female 2009   | 277.99      | 13.14| 0.89| 0.98| 123.58      | 9.99 | 0.67| 0.98| 210.59      | 10.08| 0.68| 0.99|
| Urban female 2006   | 233.73      | 13.49| 0.93| 0.98| 113.30      | 9.80 | 0.68| 0.94| 177.44      | 11.08| 0.78| 0.97|
| Urban female 2004   | 229.95      | 13.45| 0.93| 0.98| 102.14      | 9.01 | 0.63| 0.95| 159.46      | 11.37| 0.81| 0.97|
| Rural male 2009     | 418.84      | 12.54| 0.88| 0.97| 385.44      | 13.21| 1.00| 0.97| 124.68      | 9.13  | 0.64| 0.98|
| Rural male 2006     | 475.30      | 14.65| 1.03| 0.94| 477.92      | 12.82| 0.97| 0.96| 148.45      | 9.81  | 0.67| 0.98|
| Rural male 2004     | 301.95      | 15.76| 1.17| 0.95| 380.81      | 14.90| 1.16| 0.95| 99.46       | 8.78  | 0.62| 0.99|
| Rural female 2009   | 185.96      | 10.20| 0.72| 0.97| 171.58      | 10.79| 0.78| 0.97| 81.74       | 9.64  | 0.70| 0.97|
| Rural female 2006   | 164.03      | 9.42 | 0.67| 0.99| 194.54      | 12.97| 0.98| 0.96| 85.29       | 9.76  | 0.71| 0.97|
| Rural female 2004   | 112.26      | 11.87| 0.88| 0.95| 171.52      | 13.93| 1.05| 0.95| 61.67       | 9.86  | 0.74| 0.99|
| Mortality rate      |             |     |     |     |             |     |     |     |             |     |     |     |
| Urban male 2009     | 772.58      | 12.39| 0.78| 1.00| 410.91      | 10.09| 0.60| 1.00| 440.44      | 11.07| 0.62| 1.00|
| Urban male 2006     | 681.88      | 14.88| 0.96| 0.99| 361.67      | 12.81| 0.80| 1.00| 285.35      | 12.94| 0.77| 1.00|
| Urban male 2004     | 645.87      | 15.00| 0.98| 0.99| 314.68      | 13.96| 0.88| 0.98| 293.52      | 12.33| 0.72| 1.00|
| Urban female 2009   | 312.00      | 16.36| 1.05| 0.99| 222.36      | 11.04| 0.64| 1.00| 268.28      | 12.40| 0.71| 1.00|
| Urban female 2006   | 270.40      | 16.53| 1.08| 0.99| 161.63      | 12.49| 0.77| 0.99| 216.06      | 10.72| 0.62| 1.00|
| Urban female 2004   | 257.93      | 16.40| 1.09| 0.99| 139.41      | 12.79| 0.79| 0.98| 170.34      | 13.22| 0.81| 1.00|
| Rural male 2009     | 449.58      | 13.62| 0.92| 0.98| 458.80      | 12.35| 0.83| 0.99| 128.85      | 12.04| 0.74| 0.99|
| Rural male 2006     | 495.89      | 15.82| 1.07| 0.96| 514.37      | 14.68| 1.09| 0.98| 88.00       | 13.16| 0.85| 0.97|
| Rural male 2004     | 292.86      | 15.66| 1.13| 0.97| 361.36      | 14.95| 1.09| 0.96| 140.45      | 13.08| 0.81| 0.96|
| Rural female 2009   | 187.09      | 11.70| 0.78| 0.97| 225.36      | 12.51| 0.81| 0.98| 93.84       | 12.38| 0.76| 0.99|
| Rural female 2006   | 142.52      | 11.16| 0.79| 0.97| 229.85      | 11.72| 0.80| 0.98| 86.89       | 10.48| 0.66| 0.98|
| Rural female 2004   | 118.46      | 13.38| 0.95| 0.98| 192.81      | 12.71| 0.89| 0.97| 56.21       | 12.98| 0.86| 0.97|

Note: Source data came from age-specific incidence rates of top ten and all cancers from China cancer registry report 2012; \( P_{\text{max}}, b \) and \( k \) represents the parameters in the logistic equation, \( y_t = \frac{P_{\text{max}}}{1 + e^{b-kt}} \), where \( t \) stands for age and \( y \), incidence rate for age \( t \); \( R \) stands for goodness of fit between predicted and observed age-specific cancer incidence rates; NA stands for not applicable.
Fig. 2. MR/IR ratios by age, gender, region and year of reporting
Fig. 3. Urban vs. rural ratios in IRs or MRs by age, gender and year of reporting
Fig. 4. Recent vs. early ratios in cumulative IRs or MRs by gender, age, and type of cancers
Fig. 5. Selected statistics of logistic growth modeling of the age-specific IRs and MRs
4. DISCUSSION

As more and more long-term operating cancer registry systems are being established, there is a growing need to explore the mounting data produced by these systems and inform policy-making and interventions against the epidemic. Given the range of factors involved in cancer onset, identification, progression and reporting [18-20], pin-pointing this complexity in the path to the cancer incidence and mortality rates generated via cancer registries requires systematic thinking of all the determinants and varied strategies of data analysis. By transforming the IRs and MRs reported in the CNCR Annual Reports into four kinds of secondary indicators (i.e., patterns of age-specific IRs or MRs, ratios of MRs vs. IRs, ratios of urban IRs or MRs vs. rural IRs or MRs, and ratios of accumulative IRs vs., accumulative MRs), this study provides useful new perspectives for analyzing cancer epidemics.

Plotting age-specific IRs and MRs for different cancers, population groups and years together provides an easy yet unique comparison of the similarities and differences between: a) IRs and MRs of same cancer and year; b) IRs (or MRs) of same cancer for different years; c) IRs (or MRs) of different cancers for a given year. All the MR lines mimicked the general trend of the corresponding (of the same cancer and same population group) IR lines. This may because there is no radical cure for cancers and one incidence case occurred at age 1 generally follows one mortality case some years later (i.e., at age 1 plus years of survival of the individual under concern). The reasons why MR lines located below the corresponding IR lines may be attributed to: a) onset of cancer proceeded death due to cancer; b) IR increased as age grows; c) part of the individuals diagnosed with cancer died to non-cancer diseases and thus did not enter into cancer death registry. The drops, from age group 81-84 to age group 85+, in all the IRs and part of the MRs may be explained by reduction, due to high age, in: a) risk behaviors (e.g., smoking, exposing to poison in work); b) exposure to environmental carcinogenesis factors; c) uptake of cancer screening, diagnosis and treatment services; and d) cancer case or death reporting. Male vs. female differences in the IRs and MRs (e.g., higher IRs and MRs of lung cancer, stomach cancer, colorectal cancer, and liver cancer in males than females) may be associated with gender-related variations in genetics, physiology, psychology, lifestyles, exposure to environmental cancer genesis factors, and responses to cancer symptoms and prevention and treatment services that lead to uneven cancer registration [21-23]; while regional discrepancies (e.g., higher urban vs. rural IRs and MRs of lung cancer and colorectal cancer), different lifestyles and physical and service environments between these areas [24,25].

Ratios enable quantitative comparisons between the two indicators under concern. An age-specific MR to IR ratio is co-determined by: a) slope of trend (increase or decrease) in IRs along the age spectrum; b) survival time of the cancer under concern; c) quality of IRs and MRs reported. Therefore, the increasing age-specific ratios for all the subgroups (Fig. 2) may due largely to accelerating increases, along the age span, in all the corresponding IRs. And survival time may be a major reason for the relatively lower MR/IR ratios of colorectal cancer followed by stomach, lung and liver cancers. The finding that most of the lines in Fig. 2 increased from below to over 1 in the latest 2 to 3 age groups may not necessarily mean greater real MRs than IRs for these groups. In general, the MR of a given cancer and group should be no-higher than the IR of the same cancer and group. So the phenomenon may due mainly to reduced service utilization by and thus under diagnosis for the elderly [13].

Similarly, urban vs. rural ratios reflect the combined effects of: physical factors (i.e., heretics, immunity), environmental risks (e.g., smoking, air pollution, and sedentary work), service seeking, and case reporting (i.e., accuracy and completeness of cases and deaths reported). Differences in environment risks may be the main reasons for higher IR and MR of stomach and liver cancers and lower IR and MR of lung and colorectal cancers in urban than rural areas. Improving nutrition, drinking water hygiene and case reporting for rural residents may have played an important role in the narrowing urban vs. rural gaps in IRs and MRs of stomach and liver cancers as manifested by that the blue lines located higher over the red and green lines (Figs. 3e-h and 3m-p) [26-28]; while the decreasing discrepancies in IRs and MRs, for residents aged 70+ or so, as displayed by the apparently higher green lines over the blue or red lines in Figs. 3a-d suggest worsening relative air quality for rural residents due to escalating air pollution in rural areas and rapidly growing numbers of farmers seeking temporary jobs in cities.
Regarding ratios depicted in Fig. 4, they reflect recent vs. early (e.g., year 2009 vs. 2006) changes in accumulated burden of the 4 cancers by given age groups under concern and the ending point of each of the lines represents the relative overall burden of a given cancer among a specific subgroup. For urban areas, most of the lines representing the ratios ended above 1, suggesting a consistent increase in the overall cumulative indicators of the 4 cancers from 2004 to 2009. For rural areas, the direction of the changes seemed to be inconsistent, i.e., the cumulative IRs and MRs increased (as shown by the green and purple lines above 1) from 2004 to 2006 but decreased (as shown by the blue and red lines located below 1) from 2006 to 2009. Besides, looser lines for rural than urban areas suggest greater changes in IRs or MRs in the former 3-year period compared with that in the latter. These may be attributed to a variety of reasons. First, China started its new wave of nationwide health reforms in 2009 and began to implement the New Cooperative Medical Systems in rural areas throughout the country. Second, the CNCR Annual Report 2004 utilized data provided by 38 out of all the then 43 national cancer registries; while the 2006 report, 34 out 49 registries; and the 2009 report, 72 out of 104 registries. Third, China cancer registry system made fundamental changes in 2006 and shifted from the original 5-year reporting into annual reporting.

One point worth particular noting relates to the atypical S-shaped lines of reported IRs and MRs and their high goodness of fit with logistic growth curves for all the cancers and population subgroups. It indicates that cancer epidemic may follow logistic law. One possible hypotheses underlying this phenomenon may be: a) onset of clinically detectable cancers results from counteraction between cancer cell occurrence (determined by a threshold of multiple damages due to exposures to risk factors) and removal (determined by body immunity) [29,30]; b) as age grows, body cells get damaged for more and more times, and their chances to reach the threshold increase exponentially; c) level of life spectrum exposure to cancer risk factors starts relatively low at birth, increases during childhood and adolescence (due initiation of unhealthy or unprotected behaviors), remains the highest in adulthood and begins to decrease gradually in late lifetime (due to reduced smoking, drinking etc.) [31-33] and cancer immunity manifests similar lifetime trend [34,35]. Given these, the early low and relatively stable phase of the S-curved age-specific cancer rates may reflect the combined effects of low cancer cell occurrence vs. high immunity; while the rapidly growing part, exponentially increasing occurrence vs. high and stable immunity; and the late high and relatively stable stage, diminishing occurrence due to reduced risk exposure vs. downward immunity.

Logistic growth models may help explore age-specific cancer rates in various ways. First, description of cancer incidence or mortality rates along the whole age span using logistic growth equations becomes estimating the parameters in the equations rather than uncovering rates for all of the ages. Such a shift of focus may result in great resource reduction, since logistic equations generally involve only a few parameters and estimation of these requires much less data than what have usually been collected. Second, if there are sufficient evidences to believe that certain age-specific cancer rates follow logistic growth law, then the goodness of fit estimations can be viewed as a quality indicator of the cancer counts reported. Of the goodness of fit (i.e., R values) of the 48 IR models listed in Table 1, only 7 of them were estimated as higher than that of the corresponding MR models (e.g., the model of IRs of lung cancer among urban males in year 2009 vs. the models of MRs of the same cancer in the same subgroup and year); poorer goodness of fit was also observed with models for rural subgroups compared with that of urban ones. These suggest that the quality of cancer counts reported by rural areas and about IRs were not as good as data from urban registry system and about MRs. Third, mathematical integration of the logistic growth equations may be used to measure overall burden of cancers. As shown in Figs. 5a-b, urban males were the hardest hit (by lung cancer) followed by followed by rural males (by stomach cancer). Fourth, the ages when the age-specific IR or MR of a cancer model reaches 5% (A_{0.05}), 50% (A_{0.50}) and 95% (A_{0.95}) of its highest value (P_{max}) may serve as indicator ages to inform data analysis and intervention planning. For example, A_{0.05} may be used to define the starting age for some targeted interventions (e.g., screening); while the age range between A_{0.05} and A_{0.95} of a cancer may be viewed as critical ages for stemming the epidemic.

The study suffers from several limitations. First, reported cancer incidence and mortality rates reflect not only actual prevalence of cancers but also performances of registry systems and readers are fully cautioned about potential biases.
due defects with cancer registration e.g., under reporting, misclassification. Second, the time interval between the earliest (2004) cancer rates and the latest (2009) ones was only 5 years. So our findings in terms between different years may not necessarily represent long-term trends. Third, CNCRs provide similar data about 58 types of most common cancers in China. Yet our study included only four types of cancers due to space limit. Fourth, it used aggregate data extracted from published reports which did allow for more detailed analysis. For example, the study did not mention differences between sub-regions of China, e.g., differences between south and north or east and west China.

5. CONCLUSION
The study provides useful perspectives for analyzing age-specific IRs and MRs and reveals a number of interesting patterns and trends with cancer counts reported by CNCR.

CONSENT
It is not applicable.

ETHICAL APPROVAL
It is not applicable.

COMPETING INTERESTS
Authors have declared that no competing interests exist.

REFERENCES
1. Parkin DM. The evolution of the population-based cancer registry. Nat Rev Cancer. 2006;6(8):603-12.
2. Available: http://www.encr.eu/index.php/who-we-are/about-us
3. Wei KR, Chen WQ, Zhang SW, Liang ZH, Zheng RS, Ou ZX. Cancer registration in the People's Republic of China. Asian Pac J Cancer Prev. 2012;13:4209-4214.
4. Hannah K, Weir, Michael J. Thun, Benjamin F. Hankey, Lynn A. G. Ries, Holly L. Howe, Phyllis A. Wingo, et al. Annual Report to the Nation on the Status of Cancer, 1975-2000, Featuring the Uses of Surveillance Data for Cancer Prevention and Control, JNCI J Natl Cancer Inst. 2003; 95(17):1276-1299.
5. Rebecca Siegel, Deepa Naishadham, Ahmedin Jemal. Cancer statistics. Cancer J Clin. 2013;1-20.
6. Wangqing Chen, Rongshou Zheng, Siwei Zhang, Ping Zhao, Guanglin Li, Lingyou Wu, et al. Report of incidence and mortality in China cancer registries, 2009. Chin J Cancer Res. 2013;25(1):10-21.
7. Park HC, Jung KW, Kim BW, et al. Characteristics and survival of Korean anal cancer from the Korea central cancer registry data. Ann Coloproctol. 2013; 29(5):182-5. DOI: 10.3393/ac.2013.29.5.182
8. Brecht IB, Bremensdorfer C, Schneider DT, Frühwald MC, Offenmüller S, Mertens R, et al. Rare malignant pediatric tumors registered in the German Childhood Cancer Registry 2001-2010, Pediatr Blood Cancer. 2014;61(7):1202-9. DOI: 10.1002/pbc.24997
9. Zheng ZX, Zheng RS, Zhang SW, Chen WQ. Colorectal cancer incidence and mortality in China, 2010. Asian Pac J Cancer Prev. 2014;15(19):8455-60.
10. Li R, Cancer burden in China and the role of the cancer registries. Ann Transl Med. 2014;2(7):69. DOI: 10.3978/j.issn.2305-5839.2014.06.12
11. [11] Wang P, Xu C, Yu C, Age-period-cohort analysis on the cancer mortality in rural China: 1990-2010. Int J Equity Health. 2014;13:1. DOI: 10.1186/1475-9276-13-1
12. Meira KC, Silva GA, Silva CM, Valente JG, Age-period-cohort effect on mortality from cervical cancer. Rev Saude Publica. 2013;47(2):274-82. DOI: 10.1590/S0034-8910.2013047004253
13. Chen PL, Zhao T, Feng R, Chai J, Tong GX, Wang DB, Patterns and trends with cancer incidence and mortality rates reported by the China National Cancer Registry. Asian Pac J Cancer Prev. 2014;15(15):6327-32.
14. Xu X, Yang H, Qiao L, Tan Z, Jin J, Yin Y, et al. Clinical characteristic and outcomes of lung cancer patients with venous thromboembolism. Zhonghua Yi Xue Za Zhi. 2014;94(26):2045-9.
15. Zilberman Y, Sonkusale SR, Microfluidic optoelectronic sensor for salivary diagnostics of stomach cancer. Biosens Bioelectron. 2014;50:366-72.
16. Attié R, Chinen LT, Yoshioka EM, Silva MC, de Lima VC. Acute bacterial infection negatively impacts cancer specific survival of colorectal cancer patients. World J Gastroenterol. 2014;20(38):13930-5. DOI: 10.3748/wjg.v20.i38.13930
17. Lai GY, Weinstein SJ, Albanes D, Taylor PR, Virtamo J, McGlynn KA, et al.
Association of serum α-tocopherol, β-carotene, and retinol with liver cancer incidence and chronic liver disease mortality. Br J Cancer; 2014. DOI: 10.1038/bjc.2014.365

18. Perdue DG, Haverkamp D, Perkins C, Daley CM, Provost E, Geographic variation in colorectal cancer incidence and mortality, age of onset, and stage at diagnosis among american Indian and alaska native people, 1990-2009. Am J Public Health 2014;104(3):S404-14. DOI: 10.2105/AJPH.2013.301654

19. Kharazmi E, Chen T, Narod S, Sundquist K, Hemminki K. Effect of multiplicity, laterality, and age at onset of breast cancer on familial risk of breast cancer: A nationwide prospective cohort study. Breast Cancer Res Treat. 2014;144(1):185-92. DOI: 10.1007/s10549-014-2848-3.

20. Barayan GA, Brimo F, Bégin LR, Hanley JA, Liu Z, Kassouf W, et al. Factors influencing disease progression of prostate cancer under active surveillance: A McGill University Health Center Cohort. BJU Int; 2014. DOI: 10.1111/bju.12754

21. Kim HM, Kim HS, Gender-specific colorectal cancer: Epidemiologic difference and role of estrogen. Korean J Gastroenterol. 2014;63(4):201-8.

22. Kovalchik SA, De Matteis S, Landi MT, Caporaso NE, Varadhan R, Consonni D, et al. A regression model for risk difference estimation in population-based case-control studies clarifies gender differences in lung cancer risk of smokers and never smokers. BMC Med Res Methodol. 2013;13:143. DOI: 10.1186/1471-2288-13-143

23. Serke M, Stanzel F, Westhoff M. Gender-specific difference in lung cancer. Pneumologie. 2013;67(5):270-9. DOI: 10.1055/s-0033-1343149

24. Tajima K, Hirose K, Nakagawa N, Kuroishi T, Tominaga S. Urban-rural difference in the trend of colorectal cancer mortality with special reference to the subsites of colon cancer in Japan. Jpn J Cancer Res. 1985;76(8):717-28.

25. Xia Z, Duan X, Tao S, Qiu W, Liu D, Wang Y, et al. Pollution level, inhalation exposure and lung cancer risk of ambient atmospheric polycyclic aromatic hydrocarbons (PAHs) in Taiyuan, China. Environ Pollut. 2013;173:150-6. DOI: 10.1016/j.envpol.2012.10.009

26. Sun Xiudi, Mu Ren, Zhou Youshang, Dai Xudong, Zhang Siwei, Huang Fu Xiaomei, et al. Analysis of mortality rate of stomach cancer and its trend in twenty years in China. Chin J On Col. 2004;26(1):4-9.

27. Zheng Rongshou, Zhang Siwei, Wu Liangyou, Li Guanglin, Zhao Ping, Hao Jie, et al. Report of Incidence and Mortality from China Cancer Registries in 2008. China Cancer. 2012;21(1):1-12.

28. Li Xudong, Yao Hongyan, Kan Jianli. A meta-analysis on source of drinking water and primary liver cancer in China. China Cancer. 2009;18(7):545-547.

29. Umar A. Cancer Immunoprevention: A new approach to Intercept Cancer Early. Cancer Prev Res (Phila); 2014. pii: canprevres.0213.2014.

30. Steinman L. Conflicting consequences of immunity to cancer versus autoimmunity to neurons: Insights from paraneoplastic disease. Eur J Immunol; 2014. DOI: 10.1002/eji.201445191

31. Cai Min, Qian Jun-cheng, Xu Ling, Rao Ke-qin. Smoking trends from 1993 to 2008 and factors associated with smoking in rural area. Chinese Rural Health Service Administration. 2010;30(5):364-367.

32. Maziak W, Taleb ZB, Bahelah R, Islam F, Jaber R, Auf R, et al. The global epidemiology of waterpipe smoking, Tob Control; 2014. pii: tobaccocontrol-2014-051903. DOI: 10.1136/tobaccocontrol-2014-051903.

33. Yang Xu-bing, Liu Xiao-qiang, Wang De-bin, Xue Cheng-bing, Cheng Jing, Chai Jing. Analysis of the influencing factor and epidemic trend of urban and rural residents frequency of drinking in Jiangsu Province. Chin J Dis Control Prev. 2011;15(6):503-506.

34. Bertoletti A, Hong M. Age-dependent immune events during HBV infection from birth to adulthood: An alternative interpretation. Front Immunol. 2014;5:441. DOI: 10.3389/fimmu.2014.00441.

35. Djukic M, Nau R, Sieber C. The ageing immune system. Dtsch Med Wochenschr. 2014;139(40):1987-90. DOI: 10.1055/s-0034-1370283

36. Sun Xiudi, Mu Ren, Zhou Youshang, Dai Xudong, Zhang Siwei, Huang Fu Xiaomei, et al. Analysis of mortality rate of stomach cancer and its trend in twenty years in China. Chin J On Col. 2004;26(1):4-9.
### APPENDICES

#### Appendix A. Incidence and mortality cases by age groups, cancer types and year reporting extracted from China Cancer Registry Annual reports

| Incidence cases, mortality cases year, gender, region | Total | 0-4 | 5-9 | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
|-----------------------------------------------------|-------|-----|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|
| **Lung cancer**                                      |       |     |     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |     |
| Incidence case 2009, male, urban                     | 22360 | 0   | 0   | 1    | 1    | 14    | 23    | 35    | 165   | 408   | 897   | 1838  | 2541  | 2579  | 2872  | 3735  | 3862  | 2305  | 1084 |
| Incidence case 2006, male, urban                     | 16433 | 2   | 2   | 1    | 1    | 5     | 5     | 21    | 43    | 160   | 356   | 715   | 1423  | 1602  | 1744  | 2320  | 3265  | 2781  | 1415  | 572  |
| Mortality case 2009, male, urban                     | 19452 | 0   | 0   | 0    | 1    | 0     | 10    | 10    | 31    | 96    | 295   | 661   | 1347  | 1798  | 1871  | 2358  | 3398  | 3820  | 2444  | 1312 |
| Mortality case 2006, male, urban                     | 14901 | 0   | 0   | 0    | 3    | 4     | 3     | 13    | 36    | 90    | 253   | 551   | 1018  | 1168  | 1362  | 1997  | 3048  | 3017  | 1637  | 701  |
| Incidence case 2009, female, urban                   | 11449 | 0   | 0   | 1    | 0    | 3     | 5     | 19    | 44    | 138   | 276   | 529   | 882   | 1094  | 1123  | 1284  | 2110  | 1962  | 1292  | 687  |
| Incidence case 2006, female, urban                   | 8166  | 2   | 5   | 2    | 1    | 3     | 5     | 20    | 43    | 100   | 248   | 391   | 683   | 726   | 1165  | 1645  | 1342  | 757   | 409   |
| Mortality case 2009, female, urban                   | 9474  | 0   | 0   | 0    | 0    | 3     | 4     | 8     | 25    | 81    | 148   | 309   | 505   | 639   | 757   | 957   | 1863  | 1949  | 1399  | 827  |
| Mortality case 2006, female, urban                   | 7115  | 0   | 0   | 0    | 1    | 3     | 6     | 8     | 21    | 56    | 154   | 240   | 407   | 395   | 529   | 979   | 1510  | 1437  | 871   | 498  |
| Incidence case 2009, male, rural                     | 8075  | 1   | 1   | 0    | 1    | 0     | 8     | 13    | 36    | 70    | 213   | 345   | 640   | 1025  | 1169  | 1185  | 1370  | 1183  | 582   | 233  |
| Incidence case 2006, male, rural                     | 3487  | 0   | 0   | 0    | 0    | 1     | 6     | 14    | 36    | 93    | 147   | 294   | 375   | 461   | 561   | 666   | 506   | 251   | 76    |
| Mortality case 2009, male, rural                     | 6921  | 0   | 0   | 1    | 1    | 1     | 4     | 14    | 27    | 47    | 163   | 257   | 486   | 715   | 917   | 1011  | 1252  | 1133  | 631   | 262  |
| Mortality case 2006, male, rural                     | 3014  | 0   | 0   | 1    | 0    | 0     | 1     | 5     | 12    | 34    | 68    | 95    | 226   | 301   | 361   | 460   | 622   | 484   | 255   | 89    |
| Incidence case 2009, female, rural                   | 3900  | 0   | 0   | 0    | 1    | 2     | 4     | 9     | 14    | 45    | 169   | 202   | 339   | 473   | 486   | 500   | 591   | 520   | 375   | 170  |
| Incidence case 2006, female, rural                   | 1518  | 0   | 0   | 0    | 0    | 0     | 2     | 7     | 10    | 30    | 65    | 86    | 143   | 179   | 163   | 205   | 229   | 199   | 127   | 73    |
| Mortality case 2009, female, rural                   | 3099  | 0   | 0   | 0    | 0    | 1     | 2     | 10    | 12    | 39    | 94    | 117   | 236   | 325   | 362   | 350   | 526   | 486   | 363   | 176  |
| Mortality case 2006, female, rural                   | 1270  | 1   | 0   | 0    | 0    | 0     | 0     | 3     | 4     | 21    | 41    | 64    | 116   | 143   | 130   | 161   | 225   | 188   | 114   | 59    |
## Appendix A. Incidence and mortality cases by age groups, cancer types and year reporting extracted from China Cancer Registry Annual Reports (continued)

| Incidence cases, mortality cases year, gender, region | Total | 0   | 1–4 | 5–9 | 10–19 | 20–24 | 25–29 | 30–34 | 35–39 | 40–44 | 45–49 | 50–54 | 55–59 | 60–64 | 65–69 | 70–74 | 75–79 | 80–84 | 85+ |
|-----------------------------------------------|-------|-----|-----|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|
| **Stomach cancer** | | | | | | | | | | | | | | | | | | | | |
| Incidence case 2009, male, urban | 11863 | 0   | 0   | 2   | 4    | 4     | 6     | 33    | 63    | 119   | 301   | 633   | 1198  | 1513  | 1445  | 1439  | 1894  | 1774  | 966  | 469   |
| Incidence case 2006, male, urban | 9442  | 3   | 4   | 0   | 1    | 2     | 9     | 19    | 34    | 115   | 288   | 546   | 885   | 989   | 1119  | 1288  | 1704  | 1430  | 738  | 268   |
| Mortality case 2009, male, urban | 8079  | 0   | 0   | 0   | 2    | 3     | 6     | 24    | 53    | 131   | 289   | 615   | 793   | 786   | 974   | 1338  | 1456  | 995  | 614   |
| Mortality case 2006, male, urban | 6847  | 0   | 0   | 0   | 2    | 4     | 7     | 11    | 52    | 148   | 286   | 447   | 548   | 631   | 855   | 1414  | 1288  | 780  | 374   |
| Incidence case 2009, female, urban | 5496  | 0   | 0   | 0   | 2    | 15    | 41    | 70    | 133   | 206   | 349   | 499   | 589   | 496   | 581   | 852   | 815   | 552  | 296   |
| Incidence case 2006, female, urban | 4461  | 2   | 1   | 0   | 3    | 17    | 38    | 67    | 109   | 212   | 299   | 420   | 416   | 424   | 505   | 747   | 663   | 350  | 188   |
| Mortality case 2009, female, urban | 4080  | 0   | 1   | 1   | 0    | 6     | 17    | 36    | 76    | 102   | 172   | 259   | 292   | 330   | 356   | 620   | 721   | 618  | 473   |
| Mortality case 2006, female, urban | 3315  | 0   | 0   | 0   | 2    | 7     | 15    | 44    | 57    | 91    | 161   | 233   | 209   | 213   | 390   | 563   | 613   | 436  | 281   |
| Incidence case 2009, male, rural | 9584  | 0   | 0   | 1   | 4    | 6     | 13    | 34    | 80    | 218   | 417   | 922   | 1387  | 1641  | 1513  | 1491  | 1081  | 572  | 204   |
| Incidence case 2006, male, rural | 4751  | 0   | 0   | 0   | 1    | 4     | 5     | 17    | 47    | 104   | 240   | 525   | 715   | 712   | 782   | 785   | 485   | 248  | 81    |
| Mortality case 2009, male, rural | 6897  | 0   | 0   | 0   | 1    | 3     | 3     | 11    | 14    | 41    | 120   | 220   | 461   | 787   | 963   | 1073  | 1220  | 1070 | 634   |
| Mortality case 2006, male, rural | 3603  | 0   | 0   | 0   | 1    | 0     | 0     | 1     | 9     | 33    | 77    | 125   | 322   | 424   | 509   | 590   | 674   | 486   | 253  | 99    |
| Incidence case 2009, female, rural | 4006  | 0   | 0   | 0   | 1    | 6     | 15    | 32    | 64    | 155   | 202   | 314   | 492   | 596   | 508   | 577   | 553   | 331  | 160   |
| Incidence case 2006, female, rural | 2206  | 0   | 0   | 0   | 0    | 4     | 6     | 14    | 50    | 75    | 94    | 214   | 254   | 284   | 344   | 346   | 282   | 167  | 72    |
| Mortality case 2009, female, rural | 3064  | 0   | 0   | 0   | 0    | 2     | 11    | 13    | 39    | 63    | 95    | 182   | 274   | 355   | 372   | 475   | 548   | 418  | 217   |
| Mortality case 2006, female, rural | 1770  | 0   | 0   | 0   | 0    | 5     | 5     | 7     | 29    | 41    | 57    | 141   | 162   | 207   | 236   | 323   | 270   | 186  | 101   |
## Apependix A. Incidence and mortality cases by age groups, cancer types and year reporting extracted from China Cancer Registratry Annual Reports (continued)

| Incidence cases, mortality cases year, gender, region | Total | 0  | 1–4 | 5–9 | 10–14 | 15–19 | 20–24 | 25–29 | 30–34 | 35–39 | 40–44 | 45–49 | 50–54 | 55–59 | 60–64 | 65–69 | 70–74 | 75–79 | 80–84 | 85+ |
|------------------------------------------------------|-------|----|-----|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|
| **Colorectal cancer**                                 |       |    |     |     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |     |     |
| Incidence case 2009, male, urban                      | 11407 | 0  | 0   | 0   | 3     | 18    | 40    | 80    | 160   | 322   | 606   | 1093  | 1307  | 1309  | 1290  | 1805  | 1788  | 1048  | 538  |
| Mortality case 2009, male, urban                       | 5490  | 0  | 0   | 0   | 2     | 6     | 14    | 34    | 46    | 94    | 168   | 366   | 428   | 493   | 520   | 902   | 1053  | 814   | 550  |
| Incidence case 2006, male, urban                       | 3787  | 0  | 0   | 0   | 1     | 4     | 10    | 14    | 34    | 80    | 163   | 198   | 285   | 273   | 449   | 755   | 723   | 524   | 274  |
| Mortality case 2006, male, urban                       | 9163  | 0  | 0   | 1   | 2     | 1     | 17    | 47    | 74    | 161   | 264   | 457   | 837   | 1031  | 964   | 1016  | 1428  | 1423  | 916   | 524  |
| Incidence case 2006, female, urban                     | 6968  | 0  | 3   | 1   | 2     | 7     | 7     | 26    | 46    | 152   | 222   | 421   | 647   | 673   | 661   | 945   | 1185  | 1117  | 561   | 293  |
| Mortality case 2009, female, urban                     | 4337  | 0  | 0   | 0   | 0     | 3     | 5     | 25    | 45    | 79    | 129   | 240   | 310   | 311   | 370   | 671   | 815   | 751   | 583   |
| Incidence case 2006, female, urban                     | 3148  | 0  | 0   | 0   | 0     | 1     | 1     | 8     | 13    | 37    | 65    | 133   | 160   | 237   | 223   | 364   | 554   | 606   | 417   | 329  |
| Mortality case 2009, female, urban                     | 2593  | 0  | 0   | 0   | 1     | 2     | 8     | 8     | 24    | 75    | 114   | 148   | 269   | 358   | 331   | 350   | 373   | 285   | 175   | 72   |
| Incidence case 2006, male, rural                       | 1084  | 0  | 0   | 0   | 0     | 2     | 1     | 6     | 14    | 32    | 52    | 58    | 113   | 141   | 124   | 139   | 177   | 132   | 63    | 30   |
| Mortality case 2009, male, rural                       | 1310  | 0  | 0   | 0   | 0     | 3     | 5     | 14    | 33    | 33    | 55    | 75    | 139   | 133   | 171   | 202   | 225   | 146   | 76    |
| Incidence case 2006, male, rural                       | 561   | 0  | 0   | 0   | 0     | 1     | 0     | 1     | 5     | 10    | 21    | 19    | 56    | 70    | 53    | 58    | 79    | 110   | 49    | 29   |
| Mortality case 2009, female, rural                     | 1996  | 0  | 0   | 0   | 0     | 1     | 10    | 10    | 14    | 56    | 83    | 113   | 192   | 250   | 259   | 250   | 273   | 249   | 161   | 75   |
| Incidence case 2006, female, rural                     | 892   | 0  | 1   | 0   | 1     | 1     | 0     | 7     | 11    | 34    | 37    | 46    | 94    | 99    | 97    | 115   | 130   | 113   | 72    | 34   |
| Mortality case 2009, female, rural                     | 1024  | 0  | 0   | 0   | 0     | 0     | 5     | 4     | 7     | 20    | 36    | 45    | 77    | 79    | 88    | 97    | 151   | 182   | 140   | 93   |
| Incidence case 2006, female, rural                     | 483   | 0  | 0   | 0   | 0     | 0     | 7     | 2     | 12    | 17    | 24    | 38    | 30    | 51    | 55    | 76    | 73    | 62    | 36   |
### Apendix A. Incidence and mortality cases by age groups, cancer types and year reporting extracted from China Cancer Registratry Annual Reports (continued)

| Incidence cases, mortality cases year, gender, region | Total | 0  | 1-4 | 5-9 | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
|------------------------------------------------------|-------|----|-----|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|
| Liver cancer                                         |       |    |     |     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |      |     |
| Incidence case 2009, male, urban                      | 11425 | 4  | 8   | 2   | 3     | 10    | 21    | 56    | 168   | 404   | 734   | 1203  | 1691  | 1644  | 1279  | 1052  | 1118  | 1057  | 652  | 319 |
| Incidence case 2006, male, urban                      | 8510  | 6  | 5   | 4   | 3     | 1     | 17    | 52    | 139   | 287   | 631   | 953   | 1183  | 1018  | 834   | 946   | 981   | 793   | 463  | 194 |
| Mortality case 2009, male, urban                      | 10268 | 2  | 6   | 1   | 1     | 5     | 18    | 33    | 98    | 309   | 554   | 1045  | 1449  | 1400  | 1092  | 957   | 1110  | 1105  | 729  | 354 |
| Mortality case 2006, male, urban                      | 8070  | 1  | 1   | 1   | 2     | 6     | 13    | 31    | 79    | 223   | 540   | 834   | 1020  | 891   | 788   | 874   | 1057  | 917   | 531  | 261 |
| Incidence case 2009, female, urban                    | 3882  | 1  | 3   | 1   | 3     | 0     | 11    | 11    | 35    | 61    | 126   | 202   | 334   | 404   | 420   | 423   | 599   | 585   | 402  | 261 |
| Incidence case 2006, female, urban                    | 2833  | 2  | 3   | 0   | 3     | 3     | 5     | 14    | 21    | 45    | 81    | 166   | 230   | 294   | 277   | 363   | 504   | 413   | 260  | 149 |
| Mortality case 2009, female, urban                    | 3617  | 1  | 2   | 0   | 0     | 0     | 8     | 11    | 17    | 57    | 97    | 160   | 275   | 321   | 353   | 398   | 585   | 606   | 424  | 302 |
| Mortality case 2006, female, urban                    | 3032  | 0  | 1   | 1   | 2     | 0     | 6     | 13    | 18    | 39    | 94    | 124   | 203   | 253   | 249   | 396   | 545   | 530   | 373  | 185 |
| Incidence case 2009, male, rural                      | 6730  | 1  | 0   | 1   | 1     | 6     | 12    | 42    | 113   | 327   | 586   | 684   | 990   | 975   | 804   | 696   | 643   | 480   | 255  | 114 |
| Incidence case 2006, male, rural                      | 3303  | 0  | 0   | 0   | 2     | 9     | 14    | 25    | 66    | 193   | 305   | 360   | 487   | 466   | 371   | 325   | 329   | 211   | 97   | 43  |
| Mortality case 2009, male, rural                      | 6141  | 0  | 0   | 1   | 0     | 6     | 10    | 27    | 85    | 240   | 508   | 608   | 841   | 862   | 774   | 666   | 605   | 506   | 266  | 136 |
| Mortality case 2006, male, rural                      | 3136  | 0  | 0   | 2   | 1     | 8     | 11    | 20    | 50    | 174   | 298   | 320   | 505   | 423   | 346   | 326   | 305   | 204   | 106  | 37  |
| Incidence case 2009, female, rural                    | 2499  | 1  | 1   | 1   | 1     | 1     | 10    | 2     | 28    | 52    | 124   | 177   | 271   | 304   | 302   | 315   | 310   | 294   | 194  | 111 |
| Incidence case 2006, female, rural                    | 1201  | 0  | 0   | 2   | 2     | 0     | 1     | 8     | 13    | 45    | 71    | 91    | 143   | 161   | 120   | 134   | 163   | 126   | 78   | 43  |
| Mortality case 2009, female, rural                    | 2229  | 0  | 2   | 1   | 1     | 2     | 6     | 3     | 17    | 39    | 92    | 135   | 222   | 248   | 267   | 286   | 307   | 273   | 198  | 130 |
| Mortality case 2006, female, rural                    | 1147  | 0  | 1   | 2   | 3     | 0     | 1     | 3     | 14    | 39    | 60    | 78    | 119   | 122   | 141   | 132   | 157   | 128   | 89   | 58  |
### Appendix B. Incidence rates (IRs) and mortality rates (MRs) extracted from China Cancer Registry Annual Reports (1/100000)

| IR, MR, year, gender, region | Age groups | Lung cancer |
|-----------------------------|------------|-------------|
|                             |            | IR 2009, male, urban | 0.0 0.0 0.0 0.1 0.1 0.5 0.9 1.6 6.7 16.8 34.5 76.2 132.2 194.7 300.1 424.7 569.9 639.4 565.3 |
|                             |            | IR 2006, male, urban | 1.6 0.3 0.1 0.1 0.3 0.2 1.1 2.3 7.7 15.6 34.0 75.1 123.0 187.6 272.4 419.6 562.5 582.4 487.6 |
|                             |            | IR 2004, male, urban | 2.8 1.9 0.1 0.2 0.2 0.8 1.2 2.9 6.6 13.5 32.9 66.1 112.9 184.4 264.4 423.1 537.4 562.2 472.6 |
|                             |            | MR 2009, male, urban | 0.0 0.0 0.0 0.1 0.0 0.4 0.4 1.4 3.9 12.2 25.4 55.8 93.5 141.2 246.4 386.4 563.7 677.9 684.2 |
|                             |            | MR 2006, male, urban | 0.0 0.0 0.0 0.2 0.2 0.1 0.7 1.9 4.3 11.1 26.2 53.8 89.7 146.5 234.5 391.7 610.2 673.7 597.5 |
|                             |            | MR 2004, male, urban | 1.1 0.0 0.0 0.0 0.4 0.2 0.9 2.6 4.4 11.1 27.6 52.5 138.8 241.9 417.1 578.2 624.7 588.9 |
|                             |            | IR 2009, female, urban | 0.0 0.0 0.1 0.0 0.2 0.2 0.8 2.1 5.7 11.6 21.5 37.5 56.3 83.1 127.4 191.1 259.7 291.4 232.5 |
|                             |            | IR 2006, female, urban | 1.7 0.9 0.2 0.1 0.2 0.3 1.1 2.3 4.9 11.5 19.4 33.3 53.0 75.1 127.4 194.9 236.7 202.1 |
|                             |            | IR 2004, female, urban | 0.0 0.0 0.0 0.3 0.1 0.4 0.7 2.7 4.7 9.5 16.4 33.8 51.7 81.3 130.7 191.3 232.2 193.0 |
|                             |            | MR 2009, female, urban | 0.0 0.0 0.0 0.0 0.2 0.2 0.3 1.2 3.3 6.2 12.4 21.5 32.9 50.6 95.0 191.4 258.0 315.5 279.9 |
|                             |            | MR 2006, female, urban | 0.0 0.0 0.0 0.0 0.2 0.3 0.5 1.1 2.7 7.1 11.9 21.9 30.7 54.7 107.0 178.9 253.4 267.4 246.1 |
|                             |            | MR 2004, female, urban | 0.0 0.2 0.0 0.1 0.1 0.1 0.7 1.3 4.1 6.2 12.8 20.8 36.0 62.0 114.8 185.8 254.7 260.0 228.9 |
|                             |            | IR 2009, male, rural | 0.8 0.2 0.0 0.1 0.0 0.7 1.2 3.0 5.7 17.6 30.1 66.9 123.3 186.3 236.4 363.3 461.7 428.5 335.5 |
|                             |            | IR 2006, male, rural | 0.0 0.0 0.0 0.0 0.2 0.2 1.2 2.4 6.2 17.7 30.1 69.1 123.0 191.6 271.5 437.3 530.8 537.8 330.2 |
|                             |            | IR 2004, male, rural | 0.0 0.0 0.0 0.0 0.0 1.0 0.7 2.8 6.7 12.4 26.4 61.9 114.8 176.3 245.1 370.1 341.6 285.8 219.6 |
|                             |            | MR 2009, male, rural | 0.0 0.0 0.0 0.1 0.1 0.4 1.2 2.3 3.8 13.5 22.5 50.8 86.2 144.1 201.7 332.0 442.2 484.6 377.2 |
|                             |            | MR 2006, male, rural | 0.0 0.0 0.0 0.0 0.2 0.2 1.0 2.0 5.9 12.9 19.4 53.1 98.7 150.1 222.7 408.4 507.7 546.4 386.7 |
|                             |            | MR 2004, male, rural | 0.0 0.0 0.0 0.0 0.2 0.6 0.4 2.2 4.9 9.9 20.4 46.6 91.0 136.4 216.2 307.4 332.2 289.7 229.0 |
|                             |            | IR 2009, female, rural | 0.0 0.0 0.0 0.1 0.2 0.4 0.8 1.2 3.7 14.3 18.1 37.9 59.9 80.6 103.1 150.2 175.9 206.1 144.9 |
|                             |            | IR 2006, female, rural | 0.0 0.0 0.0 0.0 0.0 0.4 1.3 1.6 5.1 12.5 17.7 33.6 58.9 70.2 97.2 129.4 153.4 163.8 141.6 |
|                             |            | IR 2004, female, rural | 0.0 0.0 0.0 0.0 0.4 0.4 0.9 1.8 5.2 7.9 17.2 28.1 47.0 56.2 83.7 122.8 124.5 116.7 80.3 |
|                             |            | MR 2009, female, rural | 0.0 0.0 0.0 0.0 0.1 0.2 0.9 1.0 3.2 8.0 10.5 25.8 41.2 60.1 72.2 133.6 164.4 199.5 150.1 |
|                             |            | MR 2006, female, rural | 1.6 0.0 0.0 0.0 0.0 0.0 0.6 0.7 3.6 7.9 13.2 27.3 47.8 56.0 76.3 127.1 144.9 147.0 114.5 |
|                             |            | MR 2004, female, rural | 0.0 0.0 0.0 0.0 0.2 0.2 0.5 1.4 4.2 6.1 13.7 19.6 33.3 48.3 76.5 114.5 122.6 122.3 96.6 |
## Appendix B. Incidence rates (IRs) and mortality rates (MRs) extracted from China Cancer Registratry Annual Reports (1/100000, continued)

| IR, MR, year, gender, region | Age groups | 0  | 1~4  | 5~9 | 10~14 | 15~19 | 20~24 | 25~29 | 30~34 | 35~39 | 40~44 | 45~49 | 50~54 | 55~59 | 60~64 | 65~69 | 70~74 | 75~78 | 80~84 | 85+  |
|-----------------------------|------------|----|------|-----|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| **Stomach cancer**          |            |    |      |     |      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |     |
| IR 2009, male, urban        |            | 0.0| 0.0  | 0.2 | 0.3  | 0.2   | 0.2   | 1.3   | 2.9   | 4.9   | 12.4  | 24.4  | 49.6  | 78.7  | 109.1 | 150.4 | 215.4 | 261.8 | 267.9 | 244.6 |
| IR 2006, male, urban        |            | 2.3| 0.7  | 0.0  | 0.1  | 0.4   | 1.0   | 1.8   | 5.5   | 12.6  | 25.9  | 46.7  | 76.0  | 120.4 | 151.2 | 219.0 | 289.2 | 303.7 | 228.4 |
| MR 2009, male, urban        |            | 0.0| 1.3  | 0.0  | 0.1  | 0.4   | 1.0   | 3.4   | 6.2   | 11.8  | 26.3  | 50.7  | 72.4  | 105.9 | 134.5 | 197.8 | 250.5 | 280.1 | 205.7 |
| MR 2006, male, urban        |            | 0.0| 0.0  | 0.0  | 0.1  | 0.1   | 0.2   | 1.1   | 2.2   | 5.4   | 11.1  | 25.5  | 41.3  | 59.3  | 101.8 | 152.2 | 214.8 | 276.0 | 320.2 |
| MR 2004, male, urban        |            | 0.0| 0.0  | 0.0  | 0.1  | 0.2   | 0.4   | 0.6   | 2.5   | 6.5   | 13.6  | 23.6  | 42.1  | 67.9  | 100.4 | 152.2 | 214.8 | 276.0 | 320.2 |
| IR 2009, female, urban      |            | 1.7| 0.2  | 0.0  | 0.2  | 0.9   | 2.1   | 3.6   | 5.3   | 9.8   | 14.8  | 22.6  | 32.3  | 43.9  | 55.2  | 88.5  | 116.9 | 107.5 | 92.9  |
| IR 2006, female, urban      |            | 0.0| 0.0  | 0.0  | 0.0  | 0.1   | 0.6   | 1.7   | 3.3   | 5.5   | 8.7   | 14.0  | 21.2  | 30.3  | 36.7  | 57.6  | 78.5  | 107.9 | 124.5 |
| IR 2004, female, urban      |            | 0.0| 0.0  | 0.0  | 0.0  | 0.1   | 0.6   | 1.7   | 3.3   | 5.5   | 8.7   | 14.0  | 21.2  | 30.3  | 36.7  | 57.6  | 78.5  | 107.9 | 124.5 |
| MR 2009, female, urban      |            | 0.0| 0.0  | 0.0  | 0.0  | 0.0   | 0.2   | 0.4   | 1.0   | 2.2   | 5.4   | 11.1  | 25.5  | 41.3  | 59.3  | 101.8 | 152.2 | 214.8 | 276.0 |
| MR 2006, female, urban      |            | 0.0| 0.0  | 0.0  | 0.0  | 0.0   | 0.2   | 0.4   | 1.0   | 2.2   | 5.4   | 11.1  | 25.5  | 41.3  | 59.3  | 101.8 | 152.2 | 214.8 | 276.0 |
| MR 2004, female, urban      |            | 0.0| 0.0  | 0.0  | 0.0  | 0.0   | 0.2   | 0.4   | 1.0   | 2.2   | 5.4   | 11.1  | 25.5  | 41.3  | 59.3  | 101.8 | 152.2 | 214.8 | 276.0 |
| IR 2009, female, urban      |            | 0.0| 0.0  | 0.0  | 0.0  | 0.0   | 0.1   | 0.6   | 1.7   | 3.3   | 5.5   | 8.7   | 14.0  | 21.2  | 30.3  | 36.7  | 57.6  | 78.5  | 107.9 |
| IR 2006, female, rural      |            | 0.0| 0.0  | 0.0  | 0.0  | 0.0   | 0.1   | 0.6   | 1.7   | 3.3   | 5.5   | 8.7   | 14.0  | 21.2  | 30.3  | 36.7  | 57.6  | 78.5  | 107.9 |
| IR 2004, female, rural      |            | 0.0| 0.0  | 0.0  | 0.0  | 0.0   | 0.1   | 0.6   | 1.7   | 3.3   | 5.5   | 8.7   | 14.0  | 21.2  | 30.3  | 36.7  | 57.6  | 78.5  | 107.9 |
| MR 2009, female, rural      |            | 0.0| 0.0  | 0.0  | 0.0  | 0.0   | 0.1   | 0.6   | 1.7   | 3.3   | 5.5   | 8.7   | 14.0  | 21.2  | 30.3  | 36.7  | 57.6  | 78.5  | 107.9 |
| MR 2006, female, rural      |            | 0.0| 0.0  | 0.0  | 0.0  | 0.0   | 0.1   | 0.6   | 1.7   | 3.3   | 5.5   | 8.7   | 14.0  | 21.2  | 30.3  | 36.7  | 57.6  | 78.5  | 107.9 |
| MR 2004, female, rural      |            | 0.0| 0.0  | 0.0  | 0.0  | 0.0   | 0.1   | 0.6   | 1.7   | 3.3   | 5.5   | 8.7   | 14.0  | 21.2  | 30.3  | 36.7  | 57.6  | 78.5  | 107.9 |

Zhao et al.; BJMMR, 8(11): 896-918, 2015; Article no.BJMMR.2015.521
## Appendix B. Incidence rates (IRs) and mortality rates (MRs) extracted from China Cancer Registry Annual Reports (1/100000, continued)

| Age groups | IR, 2009, male, urban | IR, 2006, male, urban | IR, 2004, male, urban | MR, 2009, male, urban | MR, 2006, male, urban | MR, 2004, male, urban | IR, 2009, female, urban | IR, 2006, female, urban | IR, 2004, female, urban | MR, 2009, female, urban | MR, 2006, female, urban | MR, 2004, female, urban | IR, 2009, male, rural | IR, 2006, male, rural | IR, 2004, male, rural | MR, 2009, male, rural | MR, 2006, male, rural | MR, 2004, male, rural | IR, 2009, female, rural | IR, 2006, female, rural | IR, 2004, female, rural | MR, 2009, female, rural | MR, 2006, female, rural | MR, 2004, female, rural |
|-------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| 0-4         | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 5-9         | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 10-14       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 15-19       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 20-24       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 25-29       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 30-34       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 35-39       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 40-44       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 45-49       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 50-54       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 55-59       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 60-64       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 65-69       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 70-74       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 75-79       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 80-84       | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
| 85+         | 0.1                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  | 0.0                  |
## Appendix B. Incidence rates (IRs) and mortality rates (MRs) extracted from China Cancer Registry Annual Reports (1/100000, continued)

| Liver cancer | IR, MR, year, gender, region | Age groups | 0 | 1-4 | 5-9 | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
|--------------|------------------------------|------------|---|-----|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|
| IR 2009, male, urban | 2.0 | 0.9 | 0.2 | 0.2 | 0.6 | 0.8 | 2.2 | 7.8 | 16.5 | 30.3 | 46.3 | 70.1 | 85.5 | 96.5 | 109.9 | 127.1 | 156.0 | 180.9 | 166.4 |
| MR 2006, male, urban | 1.0 | 0.7 | 0.1 | 0.1 | 0.3 | 0.7 | 1.3 | 4.5 | 12.6 | 22.9 | 40.2 | 60.0 | 72.8 | 82.4 | 100.0 | 126.2 | 163.1 | 202.2 | 194.6 |
| MR 2009, male, urban | 0.8 | 0.2 | 0.1 | 0.2 | 0.4 | 0.6 | 1.7 | 4.2 | 10.7 | 23.7 | 39.6 | 53.9 | 68.4 | 84.8 | 102.6 | 135.8 | 185.5 | 218.5 | 222.5 |
| MR 2004, male, urban | 0.0 | 0.2 | 0.1 | 0.3 | 0.3 | 0.4 | 2.1 | 5.6 | 10.8 | 22.7 | 39.7 | 54.2 | 69.0 | 77.1 | 94.2 | 131.4 | 165.3 | 187.8 | 204.7 |
| IR 2009, female, urban | 0.6 | 0.4 | 0.1 | 0.2 | 0.0 | 0.4 | 0.5 | 1.7 | 2.5 | 5.3 | 8.1 | 14.2 | 20.8 | 31.1 | 40.0 | 61.5 | 75.7 | 90.7 | 88.3 |
| MR 2004, female, urban | 0.1 | 0.2 | 0.0 | 0.3 | 0.2 | 0.3 | 0.8 | 1.1 | 2.2 | 3.7 | 8.2 | 12.4 | 22.8 | 28.7 | 39.7 | 59.7 | 72.8 | 79.8 | 73.6 |
| MR 2009, female, urban | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.5 | 0.9 | 1.8 | 3.0 | 4.9 | 7.7 | 12.5 | 23.8 | 38.8 | 57.6 | 70.5 | 67.8 |
| MR 2006, female, urban | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.3 | 0.5 | 0.8 | 2.4 | 4.1 | 6.4 | 11.7 | 16.5 | 26.1 | 39.5 | 60.1 | 80.2 | 95.6 | 102.2 |
| MR 2004, female, urban | 0.0 | 0.2 | 0.1 | 0.2 | 0.0 | 0.3 | 0.7 | 1.0 | 1.9 | 4.3 | 6.1 | 10.9 | 19.6 | 25.8 | 43.3 | 64.6 | 93.5 | 114.5 | 91.4 |
| MR 2009, female, urban | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.3 | 1.0 | 1.2 | 1.9 | 4.5 | 5.9 | 12.3 | 18.2 | 26.2 | 38.5 | 62.6 | 79.0 | 105.1 | 98.4 |
| MR 2006, female, urban | 0.8 | 0.0 | 0.1 | 0.1 | 0.6 | 1.1 | 3.7 | 9.5 | 26.4 | 48.4 | 59.8 | 103.5 | 117.6 | 126.3 | 138.9 | 170.5 | 187.4 | 187.8 | 164.1 |
| MR 2004, female, urban | 0.0 | 0.0 | 0.0 | 0.4 | 1.7 | 3.1 | 4.8 | 11.1 | 33.3 | 57.9 | 73.6 | 114.5 | 152.8 | 154.2 | 157.3 | 216.0 | 221.3 | 207.9 | 186.8 |
| MR 2009, male, rural | 1.0 | 0.0 | 0.0 | 0.3 | 1.2 | 2.5 | 5.5 | 16.7 | 39.0 | 66.6 | 95.8 | 119.4 | 141.5 | 156.1 | 166.8 | 183.7 | 196.6 | 170.0 | 140.0 |
| MR 2006, male, rural | 0.0 | 0.0 | 0.0 | 0.6 | 0.9 | 2.4 | 7.1 | 19.4 | 41.9 | 53.1 | 87.9 | 104.0 | 121.6 | 132.9 | 160.4 | 170.5 | 195.7 | 195.9 | 195.8 |
| MR 2004, male, rural | 0.0 | 0.3 | 0.2 | 1.5 | 2.4 | 3.8 | 8.4 | 30.1 | 56.6 | 65.4 | 118.7 | 138.7 | 143.8 | 157.8 | 200.3 | 214.0 | 227.1 | 160.8 |
| MR 2009, female, rural | 0.9 | 0.2 | 0.1 | 0.1 | 0.9 | 0.2 | 2.4 | 4.3 | 10.5 | 15.9 | 29.6 | 36.5 | 50.1 | 65.0 | 78.8 | 99.5 | 106.6 | 94.6 |
| MR 2006, female, rural | 0.0 | 0.5 | 0.4 | 0.0 | 0.2 | 1.5 | 2.1 | 7.7 | 13.7 | 18.8 | 33.6 | 53.8 | 51.7 | 63.5 | 92.1 | 97.1 | 100.6 | 83.4 |
| MR 2004, female, rural | 0.0 | 0.0 | 0.2 | 0.2 | 0.6 | 0.9 | 3.9 | 7.9 | 14.2 | 21.4 | 29.4 | 43.8 | 44.0 | 65.3 | 82.4 | 97.0 | 84.9 | 83.8 |
| MR 2009, female, rural | 0.0 | 0.4 | 0.1 | 0.2 | 0.6 | 0.3 | 3.2 | 7.8 | 12.1 | 24.2 | 31.4 | 44.3 | 59.0 | 78.0 | 92.4 | 108.8 | 110.8 |
| MR 2006, female, rural | 0.0 | 0.4 | 0.5 | 0.6 | 0.0 | 0.2 | 0.6 | 2.3 | 6.6 | 11.5 | 16.1 | 28.0 | 40.8 | 60.8 | 82.6 | 88.7 | 96.7 | 112.5 |
| MR 2004, female, rural | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.4 | 0.4 | 2.6 | 6.4 | 12.4 | 16.1 | 28.3 | 40.3 | 42.3 | 69.8 | 85.1 | 94.1 | 86.0 | 77.3 |
## Appendix C. Integrations and indicative ages dirived from logistic growth equations

| Indicators          | Lung cancer | Stomach cancer | Colorectal cancer | Liver cancer |
|---------------------|-------------|----------------|-------------------|--------------|
|                     | A0.05       | A0.50          | A0.95             | A0.05        | A0.50 | A0.95 |
| Integration         | A0.05       | A0.50          | A0.95             |               |       |       |
| Urban male 2009     | 45.98       | 65.05          | 84.12             | 2941.49      | 41.84 | 62.11 |
|                     | 41.84       | 62.11          | 82.39             | 1417.13      | 43.41 | 65.68 |
| Urban male 2006     | 46.68       | 63.92          | 81.16             | 2723.77      | 43.17 | 61.95 |
|                     | 43.17       | 61.95          | 80.73             | 1467.51      | 43.81 | 63.91 |
| Urban female 2009   | 47.45       | 64.05          | 80.65             | 1308.63      | 42.30 | 64.21 |
|                     | 42.30       | 64.21          | 80.68             | 582.43       | 42.31 | 63.89 |
| Urban female 2006   | 46.87       | 62.76          | 78.64             | 1159.12      | 40.40 | 62.05 |
|                     | 40.40       | 62.05          | 83.70             | 581.72       | 42.30 | 61.23 |
| Urban female 2004   | 46.47       | 62.30          | 78.13             | 1161.08      | 38.27 | 61.71 |
|                     | 38.27       | 61.71          | 85.15             | 532.92       | 42.22 | 60.46 |
| Rural male 2009     | 44.27       | 60.93          | 77.58             | 2230.06      | 41.47 | 56.23 |
|                     | 41.47       | 56.23          | 71.00             | 2410.98      | 38.37 | 61.11 |
| Rural male 2006     | 47.00       | 61.33          | 75.67             | 2489.41      | 40.78 | 55.93 |
|                     | 40.78       | 55.93          | 71.08             | 3018.49      | 41.15 | 63.09 |
| Rural male 2004     | 46.61       | 57.16          | 69.71             | 1832.62      | 41.44 | 54.10 |
|                     | 41.44       | 54.10          | 66.77             | 2543.58      | 36.86 | 60.49 |
| Rural female 2009   | 40.53       | 61.03          | 81.54             | 990.03       | 40.04 | 58.81 |
|                     | 40.04       | 58.81          | 77.59             | 986.74       | 37.65 | 58.59 |
| Rural female 2006   | 38.57       | 60.64          | 82.72             | 887.61       | 41.17 | 56.19 |
|                     | 41.17       | 56.19          | 71.21             | 1218.67      | 38.03 | 58.79 |
| Rural female 2004   | 40.51       | 57.19          | 73.68             | 681.20       | 42.43 | 56.47 |
|                     | 42.43       | 56.47          | 70.52             | 1064.54      | 36.71 | 56.81 |

### Mortality rate

| Indicators          | Urban male 2009 | Urban male 2006 | Urban male 2004 | Urban female 2009 | Urban female 2006 | Urban female 2004 | Rural male 2009 | Rural male 2006 | Rural male 2004 | Rural female 2009 | Rural female 2006 | Rural female 2004 |
|---------------------|-----------------|-----------------|-----------------|------------------|------------------|------------------|----------------|----------------|----------------|-----------------|-----------------|------------------|
| A0.05               | 50.53           | 52.05           | 51.62           | 53.81             | 52.73             | 51.73             | 48.20           | 50.11           | 51.10           | 46.07           | 46.22           | 44.93           |
| A0.50               | 69.40           | 67.35           | 66.68           | 67.82             | 66.33             | 65.24             | 64.26           | 63.86           | 65.36           | 64.92           | 64.92           | 60.43           |
| A0.95               | 88.28           | 82.65           | 81.73           | 81.82             | 79.92             | 75.24             | 80.31           | 77.61           | 81.55           | 80.37           | 72.26           | 75.93           |
| Integration         | 2852.02         | 2762.06         | 2700.54         | 1232.76           | 1147.55           | 1150.15           | 2096.40         | 2347.26         | 1655.68         | 1655.68         | 726.06          | 851.78          |

**Note:** Source data came from age-specific incidence rates of top ten and all cancers from China cancer registry report 2012; A0.05, A0.50 and A0.95 stands for the age when the logistic growth equation reaches 5%, 50% and 95% of its highest value respectively.

© 2015 Zhao et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history: The peer review history for this paper can be accessed here: http://www.sciencedomain.org/review-history.php?id=1123&aid=12&aid=9508