British Medical Bulletin, 2017, **121**:83–94
doi: 10.1093/bmb/ldw050
Advance Access Publication Date: 2 December 2016

Invited Review

Cancer burden with ageing population in urban regions in China: projection on cancer registry data from World Health Organization

Kelvin K. F. Tsoi[†,‡,*], Hoyee W. Hirai[‡], Felix C. H. Chan[‡], Sian Griffiths[†,§], and Joseph J. Y. Sung[**]

[†]Jockey Club School of Public Health and Primary Care, Prince of Wales Hospital, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong, [‡]Stanley Ho Big Data Decision Analytics Research Centre, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong, [§]Institute of Global Health Innovation, Imperial College, London, UK, and [**]Department of Medicine and Therapeutics, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong

*Correspondence address. Jockey Club School of Public Health and Primary Care, Prince of Wales Hospital, The Chinese University of Hong Kong, 4/F, Shatin, Hong Kong. E-mail: kelvintsoi@cuhk.edu.hk

Editorial Decision 19 October 2016; Accepted 7 November 2016

Abstract

Background: China is facing the challenges of an expanding ageing population and the impact of rapid urbanization, cancer rates are subsequently increasing. This study focuses on the changes of the ageing population and projects the incidence of common ageing-related cancers in the urban regions in China up to 2030.

Sources of data: Cancer incidence data and population statistics in China were extracted from the International Agency for Research on Cancer.

Areas of agreement: Due to improving longevity in China, continuous and remarkable increasing trends for the lung, colorectal and prostate cancers are expected.

Growing points: The rate of expanding ageing population was taken into account when predicting the trend of cancer incidence; the estimations of ageing-related cancers were more factual and significant than using the conventional approach of age standardization.

Areas timely for developing research: The incidence rates of lung, colorectal and prostate cancers will continue to rise in the future decades due to the rise of ageing population. Lifestyle modification such as cutting tobacco smoking rates and promoting healthier diets as well as cancer screening programs should be a health system priority in order to decrease the growing burden of cancer-related mortality and morbidity.

Key words: ageing population, lung cancer, colorectal cancer, stomach cancer, prostate cancer

Introduction

China has been ranked as the most populous country in the world with a population of 1.36 billion, 18% of the world's population.[1] Like other countries, China is seeing an expanding ageing population. Although the overall population growth rate decreased from 1.8% in 1960 to 0.5% in 2015, the growth for the population aged over 65 had increased from 4% in 1960 to 10% in 2015.[1] The one-child family policy, introduced in 1979, has further contributed to the problem of the uneven ageing structure.[2] Thus, with improving life expectancy, China is facing a huge healthcare burden with ageing-related diseases such as cancer or cardiovascular disease.

Urbanization has further aggravated the healthcare burden. The number of urban cities in China had increased at least 3-fold between 1978 and 2007.[3] The Western diet, change of occupational pattern and air pollution are associated with the rise of cancer in China.[4] The incidence rate of cancer increased from 215.8 per 100 000 in 2003 to 250.3 per 100 000 in 2011.[5,6] According to the Chinese National Office for Cancer Prevention and Control and the National Central Cancer Registry estimation, there were ~4.3 million cancers diagnosed in China in 2015. Although population growth and change of population demographical structure are the driving forces to increase cancer incidences, many studies have made projections of cancer trends[7–9] using only age-standardized rates without considering the rate of population growth.[10]

This paper focuses on the change of population structure among the ageing population (i.e. the proportional change of population with age 65+ along the years) and makes projections for the common ageing-related cancers in urban regions in China. Our expectation is that the growth of the ageing population will make differential impacts on the burdens of different cancers, and this information will be important for prioritizing the limited healthcare resources of the future health system.

Methods

Data extraction

The database from the International Agency for Research on Cancer (IARC) World Health Organization[11] provided incidences of 27 cancers and population statistics from 102 cancer registries in 39 countries worldwide; the year of coverage was varied by registries. All cancer registries in China were included since the earliest common reported year; so data from each cancer registry could be combined.

Cancer selection

The cancers ranked as the top-10 were separately selected for both sexes then combined as the total cancer incidences. As this study focuses on the cancer projection for ageing populations, cancers were not included if: (i) ageing is not a major risk factor for the cancer or (ii) the cancer incidences were shifting to the younger generation. If the cancer incidence rate in those aged 65+ was less than double of those in other age groups, we assumed that ageing was not the major risk factor for the future cancer burden. If the incidence rates in those aged 65+ were decreasing over the years, whereas the rates in any other age group were increasing, we assumed that the cancer incidences were shifting to the younger generations.

Statistical analysis

Projection models were constructed to estimate the cancer trends up to 2030. Cancer incidences and sizes of population were independently projected by sex and age groups and then combined as the overall incidence. Auto-Regressive Integrated Moving Average (ARIMA) models were constructed to project cancer incidence and populations with the historical cancer incidence rates; cancer incidences and population sizes were the projection parameters. The Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test and Akaike Information Criterion (AIC) value were used to determine the model validity and goodness-of-fit. When the *P*-value of KPSS >0.05 represented that data fulfilled the assumption of trend stationary[12] and the model with minimum AIC value was selected as the best-fit model. Otherwise, linear regression using least squares method was applied, i.e. ARIMA model without auto-regressive and moving average functions. Age-standardized incidence rates and incidence rates for age 65+ were combined in each projected year and plotted against time. As the projection parameters were presented in 5-year intervals in IARC, local polynomial regression was used to smooth the projected line across the intervals.[13] The trends of incidence rates of age 65+ were further weighted by the increased elderly population (i.e. a ratio of increased 65+ population with reference to the year of 1993), and this incidence rate was defined as an 'ageing-adjusted incidence rate' for comparison. The conceptual framework for ageing-adjusted incidence rate was also presented (Appendix 1). The same methodology was also applied in our previous work for global comparison on colorectal cancer trends.[14] All incidence rates were calculated as cases per 100 000 persons and plotted up to 2030 using statistical software R (Version 3.2.1). Chi-square test was used to compare the increasing or decreasing trends of incidence rates, and statistical significance was obtained at $P < 0.05$.

Results

Demographic details

Cancer data from three urban regions in China were available from IARC, including Hong Kong, Shanghai and Jiashan. The registries reported data from 1988 to 2007 in Hong Kong and in Shanghai, and from 1993 to 2007 in Jiashan. Therefore, 15-year historical cancer incidence data from 1993 was used to develop projection models in this study. Hong Kong is a city on the southern part of China with a land mass of around 1104 km^2. The reported population growth was 17%, increasing from 5.9 million in 1993 to 6.9 million in 2007 (Table 1). Shanghai is a city on the eastern part of China covering ~7037 km^2. The reported population size decreased by 9% from 6.8 million in 1993 to 6.2 million in 2007. Jiashan is a region next to Shanghai with land size ~506 km^2. The reported population were increased by 2% from 0.37 million in 1993 to 0.38 million in 2007. Male to female ratios were around 1:1 in all areas with a slightly increasing female population. The total population of those 65+ in the three regions was 13 044 738

Table 1 Demographics of the three selected region

Land size	Hong Kong		Shanghai		Jiashan		Total	
	1104 km^2		7037 km^2		506 km^2		7952.1 km^2	
Year	1993	2007	1993	2007	1993	2007	1993	2007
Population (dataset)	5 901 000	6 916 300	6 769 861	6 152 359	373 877	381 010	13 044 738	13 449 669
Proportion of age 65 + (%)	9.25	12.61	12.08	15.34	8.43	12.89	10.70	13.87
M:F	1:0.98	1:1.11	1:0.96	1: 0.99	1:0.98	1: 1.01	1:0.97	1:1.05
Population (official)	5 998 000	6 916 300	13 810 000	13 588 600	373 900	380 700	20 181 900	20 885 600
Average annual salary (USD)	13 324	17 427	678	4710	817	3072	309*	1823*
GDP (USD)	12 billion	59 billion	18 billion	170 billion	203 000	2.5 billion	428 billion*	3573 billion*

*Data of whole China.

(10.7% of the total population) in 1993, and increased to 13 449 669 (13.9% of the total population) in 2007 thus the proportions of age 65+ increased almost 30% in the 15-year period.

Selection for the cancers

A total of 15 cancers were selected from the top-10 ranked cancers by sex (Appendix 2). Incidence rates of each cancer were plotted against the years between 1993 and 2007 by age groups. Seven cancers were ageing related with no incidence shift to young generation (Table 2), including lung, stomach, liver, colorectal, esophagus, prostate and pancreatic cancer. Although there were certain numbers of patients with liver or breast cancer, these cancers were common in younger generations; and therefore, they were finally excluded in this study.

Trends of colorectal cancer with or without ageing effect in China

To distinguish the difference among the age-standardized incidence rates, the incidence rates of age 65+ and the ageing-adjusted incidence rates of age 65+, the figures on colorectal cancer are presented as a demonstration (Fig. 1). The age-standardized incidence rates gradually increased from 27.5/100 000 in 1993 to 33.8/100 000 in 2007 (black line). When we only focus on the population of age 65+, the colorectal cancer incidence rates were 176/100 000 in 1993 and 260/100 000 in 2007 (blue line). When the relative ratio of 65+ was fitted into the incidence rates, the ageing-adjusted incidence rate showed an increasing trend and was raised to 337/100 000 in 2007 (dotted-blue line). These incidence rates were further projected to 2030, and the ageing-adjusted incidence rate was then expected to be 502/100 000.

Trends of other cancers in China

For lung cancer, the age-standardized incidence rates showed a gradual decrease from 45.6/100 000 in 1993 to 33.8/100 000 in 2030, but the ageing-adjusted incidence rates for age 65+ showed an increasing trend from 344/100 000 in 1993 to 511/

Table 2 Cancer selection for the model projection with adjustment on ageing population (incidence rates across the age groups shown in Appendix 4)

Cancer	Incidence rates dominated* in age 65+	Incidences shifting† to young generation	Selected‡ for projection modeling
Lung	Yes	No	Yes
Stomach	Yes	No	Yes
Esophagus	Yes	No	Yes
Liver	No	No	No
Colorectal	Yes	No	Yes
Breast	No	No	No
Brain and CNS	No	No	No
Cervix uteri	No	Yes	No
Pancreas	Yes	No	Yes
Thyroid	No	No	No
Lymphoma	No	No	No
Bladder	Yes	No	Yes
Corpus uteri	No	No	No
Prostate	Yes	No	Yes
Ovary	No	No	No

CNS, central nervous system.

*The incidence rate in age 65+ is more than double of those in other age groups.

†The incidence rate in age 65+ is decreasing over the years, whereas the rate in any other age group is increasing.

‡Cancer is selected if its incidence rate dominated in age 65+, and the incidences were not shifted to young generation.

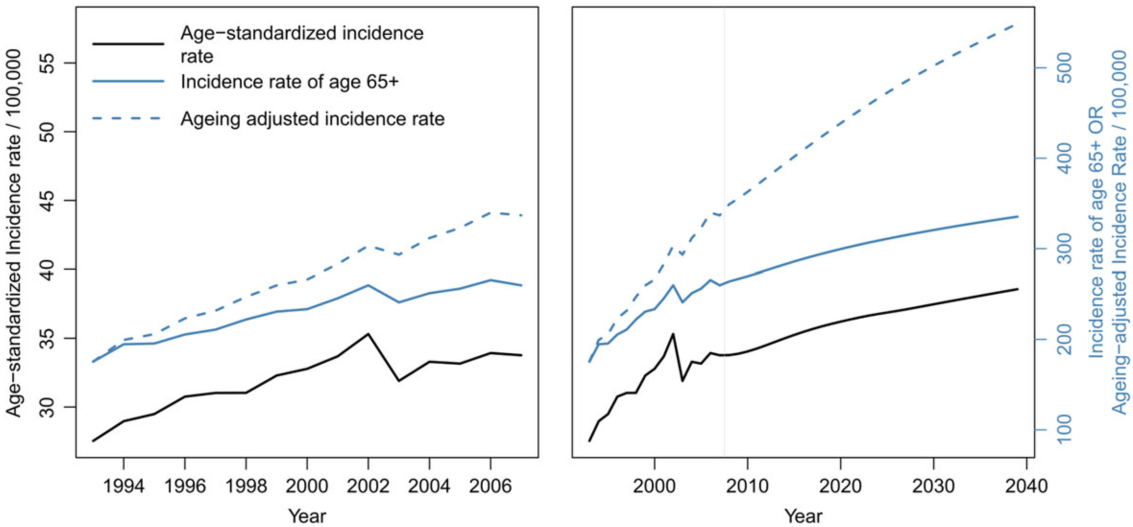


Fig. 1 Comparison among age-standardized incidence rates, incidence rate of age 65+ and ageing-adjusted incidence rate of age 65+ with increasing elderly population in all regions.

100 000 in 2030 (Fig. 2). For stomach cancer, although the age-standardized incidence rates showed a decreasing trend, the ageing-adjusted incidence rates showed a stable trend. There were much lower incidence rates in esophagus, bladder, prostate and pancreas cancers in 1993 (Table 3), but only prostate cancer showed both increasing age-standardized incidence rate and ageing-adjusted incidence rate of age 65+ (Fig. 2). The ageing-adjusted incidence rate for prostate cancer was expected to be even higher than that for stomach cancer in 2030.

Subgroup analyses by sex

For male, colorectal, lung, prostate and pancreas cancers showed increasing trends of ageing-adjusted incidence rates. Colorectal cancer had the greatest increment of the ageing-adjusted incidence rate of from 197.1/100 000 in 1993 to 658.5/100 000 in 2030 (Appendix 3). For female, colorectal and pancreas cancers showed increasing trends of ageing-adjusted incidence rates. The ageing-adjusted incidence rate of colorectal cancer increased from 157.9/100 000 in 1993 to 386.3/100 000 in 2030. Colorectal cancer would be much affected by the ageing of both Chinese male and female population.

Comparison across cancer ranking

Among the cancers included in this study, lung cancer started with the highest incidence rates in 1993. However, with the projected incidence related to change in ageing structure, colorectal cancer will have comparable ageing-adjusted incidence rates (i.e. 511/100 000 for lung and 502/100 000 for colorectal cancer). The incidences of prostate cancer will continuously increase and overtake the rank of stomach cancer by 2030, whereas cancers of esophagus, bladder and pancreas would remain at the low incidence rates, even if growth of the ageing population was considered.

Discussion

This study compared the trends on colorectal, lung, stomach, esophagus, pancreas, bladder and prostate cancers with adjustment for the ageing population in China. The incidence of colorectal cancer and lung cancer is projected to increase over time due to advanced ageing and population growth. Although the current incidence rates of prostate cancer are not alarming, this study shows that the trend of prostate cancer will rise with the ageing of the population, and will become more common than

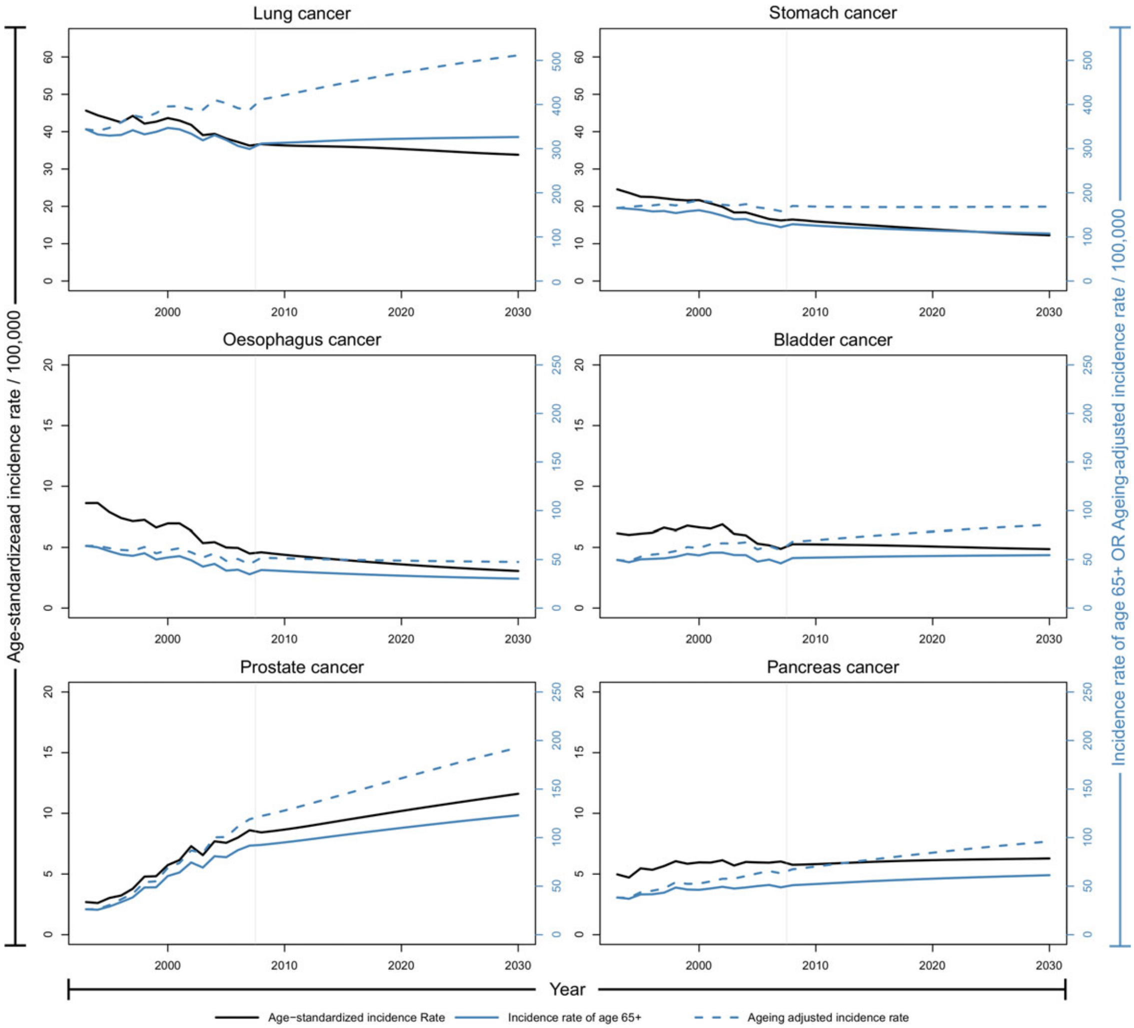


Fig. 2 Projected cancer incidence over the period until 2030 in China.

stomach cancer by 2030. Other cancers will remain at the low incidence rates even though the ageing population is expanding.

Epidemiologic studies indicate that environment and lifestyle are the major determinants of the geographical distribution of cancer.[15–17] Some regions in China have developed at a faster pace than others as a result of urbanization and economic growth which have introduced the rural–urban health differential.[18] Although studies have reported that esophagus and stomach were the major sites for cancer in China's rural areas,[7,19,20] increasing trends for these cancers were not observed in this study because we focused on three urban areas and cancer registry data from rural areas were not included. While it would be interesting to consider the cancer trends in rural areas, the data from the WHO are limited. Breast cancer is a common cancer among Chinese women; the ageing effect on breast cancer was not significant (Appendix 4). As the current projection model focuses on the rate of expanding population age 65 or above, the ageing-related projection model would not be applicable in this case. Brey *et al.* have forecasted the global cancer mortality and reported that the number one cancer-caused of death in China in 2030 will be lung cancer for both male and female.[21] Our study showed similar results that lung cancer will be the

Table 3 Projected cancer incidence rates to 2030 in the selected urban regions in China

Cancer	Year	Age-standardized incidence rate/100 000	Incidence rate of age 65 +/100 000 (a)	Population of 65+/overall population (%)	Relatively increased in the ratio of age 65+ (b)	Ageing-adjusted incidence rate of age 65+/100 000 (c) = (a) × (b)
Colorectal	1993	27.5	175.5	10.70	1.00	175.5
	2007	33.8	259.9	13.87	1.30	336.8
	2015	35.2	285.8	15.04	1.41	401.6
	2030	37.5	320.5	16.76	1.57	502.3
Lung	1993	45.6	343.8	10.70	1.00	343.8
	2007	36.3	299.2	13.87	1.30	387.7
	2015	36.0	318.8	15.04	1.41	448.1
	2030	33.8	326.4	16.76	1.57	511.4
Stomach	1993	24.5	165.5	10.70	1.00	165.5
	2007	16.2	122.1	13.87	1.30	158.3
	2015	14.9	119.3	15.04	1.41	167.7
	2030	12.3	107.6	16.76	1.57	168.6
Esophagus	1993	8.6	64.1	10.70	1.00	64.1
	2007	4.5	34.9	13.87	1.30	45.2
	2015	4.0	35.5	15.04	1.41	49.9
	2030	3.1	30.3	16.76	1.57	47.5
Bladder	1993	6.2	49.6	10.70	1.00	49.6
	2007	4.9	46.1	13.87	1.30	59.8
	2015	5.2	53.0	15.04	1.41	74.4
	2030	4.9	54.5	16.76	1.57	85.5
Prostate	1993	2.7	26.2	10.70	1.00	26.2
	2007	8.6	91.7	13.87	1.30	118.9
	2015	9.4	102.7	15.04	1.41	144.3
	2030	11.6	122.9	16.76	1.57	192.6
Pancreas	1993	5.0	38.3	10.70	1.00	38.3
	2007	6.0	48.8	13.87	1.30	63.2
	2015	6.0	55.3	15.04	1.41	77.7
	2030	6.3	61.3	16.76	1.57	96.1

most common cancer in China by that time. The high level of lung cancer may be associated with tobacco smoking and environmental pollution. In 2010, there were an estimated 301 million smokers in China, 52.9% and 2.4% of the male and female populations, respectively, making this country the largest consumer of tobacco in the world.[22] The IARC has discussed the causal effect of air pollution to lung cancer and stated that exposure to ambient fine particles (PM 2.5) was estimated to have contributed 223 000 deaths from lung cancer. More than half of the lung cancer deaths attributable to ambient PM 2.5 were estimated to have been in China and other East Asian countries.[23,24] Although Chinese women had a relatively low prevalence of tobacco smoking rate, a meta-analysis has reported that cooking smoke was a major risk factor for lung cancer in Chinese women.[25] If smoking and solid-fuel use remain at current levels, Lin HH projected that there will be 18 million lung cancer deaths in China in 2033.[26]

Colorectal cancer is the second most common cancer; however, the ageing-adjusted incidence rates of lung and colorectal cancer are very similar but there is a steep incline in colorectal cancer. The epidemic of colorectal cancer may be strongly influenced by tobacco use and the Western dietary pattern resulting from urbanization.[4,27] Colorectal cancer is a preventable cancer; the incidence can be reduced by screening and removal of precancerous polyp, which can also improve the survival rate of colorectal cancer by the early detection and treatment at early-stage.[28] However, population-based colorectal cancer screening program is not available in China. For the generation whose rates continue to rise, early detection as well as health system provision need to be considered by policy makers. For future generations, facing greater longevity, efforts to prevent cancer from occurring need to continue to be prioritized.

The strength of this study is the projection on the cancer trends with adjustment on the future change of ageing proportions. However, there are several limitations. First, only secondary data from IARC were analyzed; the data quality and completeness cannot be guaranteed. For example, the cancer data from Shanghai only included 9 out of 16 towns representing half of the total population of the city. Second, the cancer incidences were reported until 2007 at the time of analysis. The accuracy of projected results may be affected by the length of historical data; it will be worth updating the result when the WHO releases more updated figures. Third, although the incidence rates are adjusted for age and sex, the future cancer incidences will still be affected by many other factors, such as smoking cessation rates, development and acceptance of cancer screening programs, and changes of lifestyle. Fourth, the three included urban regions are economically developed ones and probably approaching the highest degree of aging in China. As China is developing rapidly, we assume that the overall development level of China in 2030 will be comparable with the three included regions in order to make this study result extrapolate the general population in all urban regions of China.

In conclusion, our data suggest that due to the changes of ageing population the incidence rates of colorectal, lung and prostate cancers will continue to rise in future decades, whereas stomach, esophagus, pancreas and bladder cancers will remain at current lower incidence rates in the urban regions in China. This increased burden of disease among those over 65 needs to be addressed through primary prevention at younger age groups and through appropriate service provision for detection and treatment for older groups in the population.

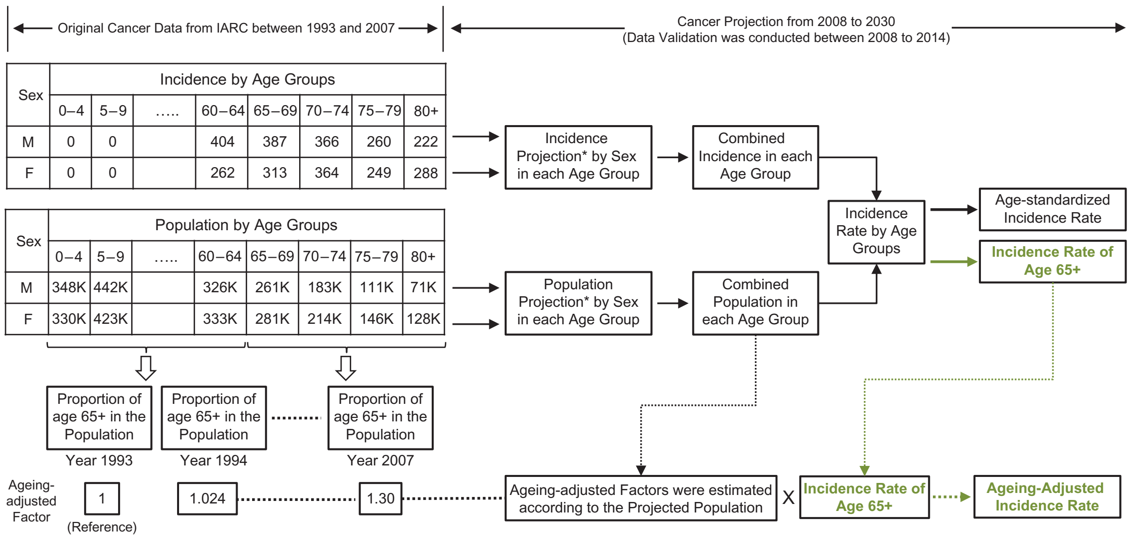
Conflict of interest statement

Prof S. Griffiths is a commissioning editor for BMB.There is no other conflict of interest to be declared.

Funding

This is a self-initiated study. No funding was received.

Appendixes



* Time-series (ARMIA) model was used in the projection.

Appendix 1 Conceptual framework.

Appendix 2 The top-10 cancer in China in 2015 (in thousands).

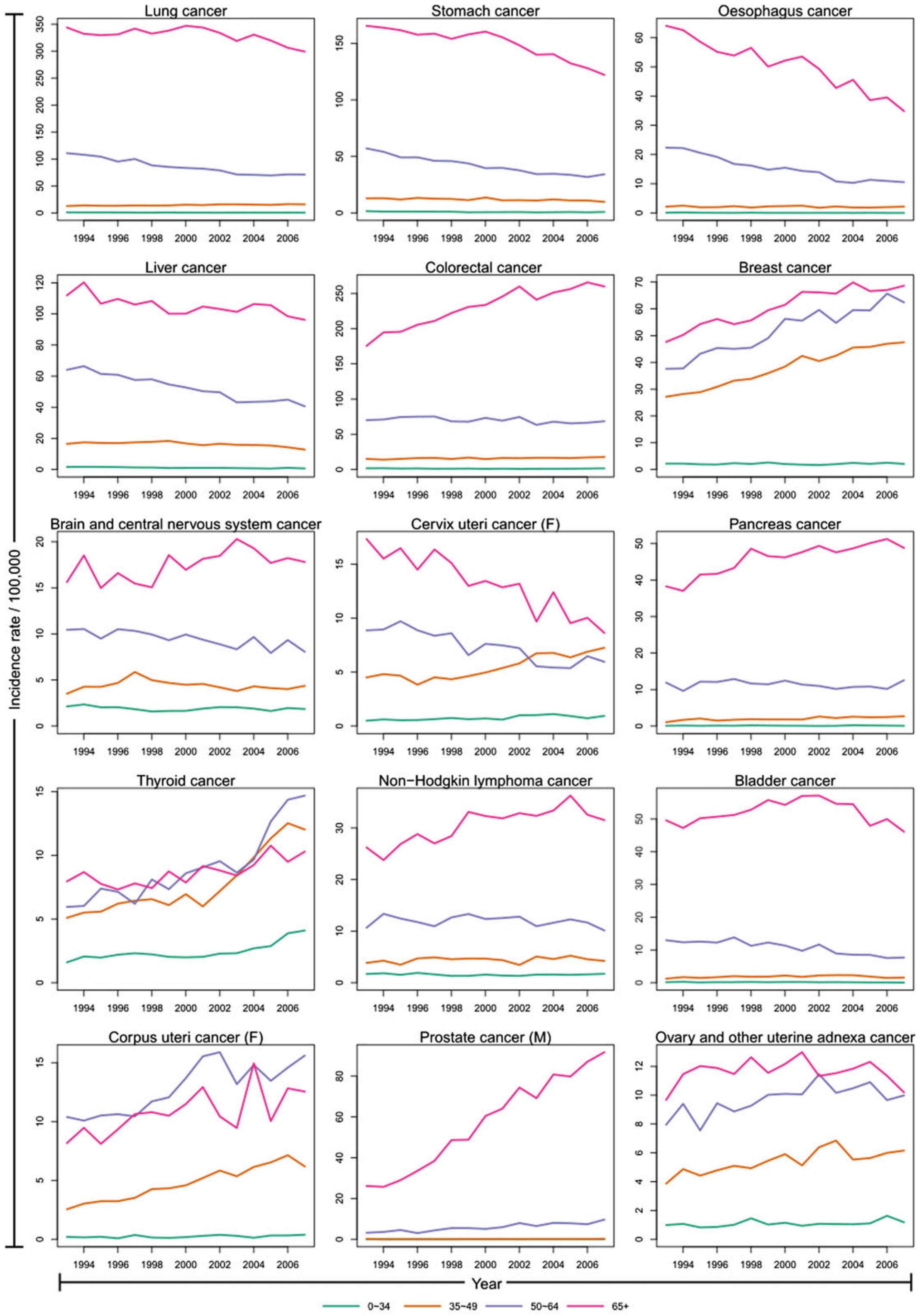
Cancer		Total		Male		Female	
Position	ICD-10	Incidence ('000)	Rank	Incidence ('000)	Rank	Incidence ('000)	Rank
Lung	C33–C34	733.3	1st	509.3	1st	224	2nd
Stomach	C16	679.1	2nd	477.7	2nd	201.4	3rd
Esophagus	C15	477.9	3rd	320.8	4th	157.2	5th
Liver	C22	466.1	4th	343.7	3rd	122.3	6th
Colorectal	C18–C21	376.3	5th	215.7	5th	160.6	4th
Breast	C50	272.4	6th	3.8	22nd	268.6	1st
Brain and CNS	C70–C72	101.6	7th	52.3	9th	49.3	11th
Cervix	C53	98.9	8th	–	–	98.9	7th
Pancreas	C25	90.1	9th	52.2	10th	37.9	12th
Thyroid	C73	90.0	10th	22.2	17th	67.9	8th
Lymphoma	C81–C85, C88, C90, C96	88.2	11th	53.0	8th	35.2	13th
Bladder	C67	80.5	12th	62.1	6th	18.4	17th
Corpus uteri	C54–C55	63.4	15th	–	–	63.4	9th
Prostate	C61	60.3	17th	60.3	7th	–	–
Ovary	C56	52.1	19th	–	–	52.1	10th

Ref. Chen *et al.*[7]

Appendix 3 Subgroup analyses by sex for the projected cancer incidence rates to 2030.

Cancer	Year	Ageing-adjusted incidence rate of age 65+/100 000		
		Male	Female	Overall
Colorectal	1993	197.1	157.9	175.5
	2007	423.5	268.8	336.8
	2015	515.3	315.1	401.6
	2030	658.5	386.3	502.3
Lung	1993	515.6	203.8	343.8
	2007	591.0	231.5	387.7
	2015	709.9	255.0	448.1
	2030	830.9	282.5	511.4
Stomach	1993	236.5	107.7	165.5
	2007	225.1	106.6	158.3
	2015	247.5	108.5	167.7
	2030	247.8	111.1	168.6
Esophagus	1993	99.3	35.4	64.1
	2007	68.8	27.0	45.2
	2015	81.0	27.0	49.9
	2030	77.0	26.4	47.5
Bladder	1993	79.0	25.6	49.6
	2007	103.7	26.2	59.8
	2015	132.8	31.7	74.4
	2030	156.2	35.2	85.5
Prostate	1993	58.2	NA	26.2
	2007	275.5	NA	118.9
	2015	343.6	NA	144.3
	2030	467.1	NA	192.6
Pancreas	1993	44.0	33.6	38.3
	2007	76.3	52.9	63.2
	2015	93.0	65.7	77.7
	2030	117.5	79.7	96.1

NA, not applicable.



Remarks: Incidence data were from International Agency for Research on Cancer, World Health Organization

Appendix 4 Cancer incidences across the age groups.

References

1. World Bank Data. The World Bank Group. Washington, DC. http://data.worldbank.org/country/china, (31 July 2015, date last accessed)
2. Hesketh T, Lu L, Xing ZW. The effect of China's one-child family policy after 25 years. *N Engl J Med* 2005; 353:1171–76.
3. Yeh A, Xu J, Liu K. *China's Post-Reform Urbanization: Retrospect, Policies and Trends*. New York: United Nations Population Fund (UNFPA) and the International Institute for Environment and Development (IIED), 2011.
4. Gong P, Liang S, Carlton E, et al. Urbanisation and health in China. *Lancet* 2012;379:843–52.
5. Zhang S, Chen W, Kong L, Li K, Zhao P. An annual report: cancer incidence in 35 cancer registries in China, 2003. *China Cancer*. 2007;16:494–507.
6. Chen W, Zheng R, Zeng H, Zhang S. Annual report on status of cancer in China, 2011. *Chin J Cancer Res*. 2015;27:2–12.
7. Chen W, Zheng R, Baade PD, et al. Cancer statistics in China, 2015. *CA Cancer J Clin*. 2016;66:115–32.
8. Shi JF, Canfell K, Lew JB, Qiao YL. The burden of cervical cancer in China: synthesis of the evidence. *Int J Cancer*. 2012;130:641–54.
9. Yang L, Parkin DM, Li LD, Chen YD, Bray F. Estimation and projection of the national profile of cancer mortality in China: 1991–2005. *British J Cancer*. 2004;90:2157–66.
10. Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJ, Lozano R, Inoue M. *Age Standardization of Rates: A New WHO Standard*. World Health Organization 2001. GPE Discussion Paper Series: No.31. http://www.who.int/healthinfo/paper31.pdf, (31 July 2016, date last accessed)
11. Ferlay J, Bray F, Steliarova-Foucher E, Forman D. *Cancer Incidence in Five Continents, CI5plus*. IARC CancerBase No. 9. Lyon: International Agency for Research on Cancer; 2014. http://ci5.iarc.fr, (28 July 2016, date last accessed).
12. Kwiatkowski D, Phillips P, Schmidt P, Shin Y. Testing the null hypothesis of stationarity against the alternative of a unit root. *J Econom*. 1992;54:159–178.
13. Fan J, Gijbels I. *Local Polynomial Modelling and its Applications*. London: Chapman and Hall, 1996.
14. Tsoi KK, Hirai HW, Chan FC, Griffiths S, Sung JJ. Colorectal cancer burden in the ageing world: a global comparison between developed and developing regions. *Clin Gastroenterol Hepatol*. 2016;(in press).
15. Danaei G, Hoorn SV, Lopez AD, Murray CJL, Ezzati M. The Comparative Risk Assessment collaborating group. Causes of cancer in the world: comparative risk assessment of nine behavioural and environmental risk factors. *Lancet*. 2005;366:19–25.
16. Raaschou-Nielsen O, Andersen ZJ, Beelen R, et al. Air pollution and lung cancer incidence in 17 European cohorts: prospective analyses from the European Study of Cohorts for Air Pollution Effects (ESCAPE). *Lancet Oncol*. 2013;14:813–22.
17. Hosgood HD, Wei H, Sapkota A, et al. Household coal use and lung cancer: systematic review and meta-analysis of case–control studies, with an emphasis on geographic variation. *Int J Epidemiol*. 2011;40:719–28.
18. Miller MK, Stokes CS, Clifford WB. A comparison of the rural-urban mortality differential for deaths from all causes, cardiovascular disease and cancer. *J Rural Health*. 1987;3:23–34.
19. Chen W, Zheng R, Zhang S, et al. Esophageal cancer incidence and mortality in China, 2010. *Thorac Cancer*. 2014;5:343–8.
20. Yang L. Incidence and mortality of gastric cancer in China. *World J Gastroenterol*. 2006;12:17–20.
21. Bray F, Jernal A, Grey N, Ferlay J, Forman D. Global cancer transitions according to the HumanDevelopment Index (2008–2030): a population-based study. *Lancet*. 2012;13:790–801.
22. Li Q, HJHsia J, Yang G. Prevalence of smoking in China in 2010. *N Engl J Med*. 2012;364:2469–70.
23. Lim SS, Vos T, Flaxman AD, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380:2224–2260.
24. World Health Organization. *Air Pollution and Cancer*. Geneva: World Health Organization; 2013. http://www.iarc.fr/en/publications/books/sp161/, (17 October 2016, date last accessed).
25. Wang DM, Chen BJ, Li WM, Li Jiang CWB. Risk factors on lung cancer: a meta-analysis [in Chinese]. *Chin J Evid-Based Med*. 2010;10:1446–9.
26. Lin HH, Murray M, Cohen T, Colijn C, Ezzati M. Effects of smoking and solid-fuel use on COPD, lung cancer, and tuberculosis in China: a time-based, multiple risk factor, modelling study. *Lancet*. 2008;372: 1473–83.
27. Tsoi KKF, Pau CYY, Wu WKK, Chan FKL, Griffiths S, Sung JJY. Cigarette smoking and the risk of colorectal cancer: a meta-analysis of prospective cohort studies. *Clin Gastroenterol Hepatol*. 2009;7:682–88.
28. Labianca R, Nordlinger B, Beretta GD, et al. Early colon cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Ann Oncol*. 2013; 24:64–7.