National and subnational trends in cancer burden in China, 2005–20: an analysis of national mortality surveillance data

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Summary

Background Cancer has been the leading cause of death since 2010 in China, with increasing incidence, mortality, and burden. We aimed to assess national and subnational changes in the cancer burden from 2005 to 2020 in China using data from the National Mortality Surveillance System.

Methods We extracted data on cancer-related deaths from the National Mortality Surveillance System, which accounts for 24·3% of the country's population with national and provincial representativeness. Data for the surveillance population stratified by age and sex were extracted from the National Bureau of Statistics of China. We estimated mortality and years of life lost (YLLs) for all cancers and for 23 cancer groups by age and sex, nationally, and for 31 provinces in China between 2005 and 2020. We calculated age-standardised mortality and YLL rates using the China 2020 census as the reference population. Average annual percent changes in age-standardised rates for mortality and YLLs were calculated to assess trends over the study period. Decomposition analysis was used to assess the drivers of changes in cancer-related death due to three explanatory components: population growth, population ageing, and age-specific mortality rates in China.

Findings The total number of cancer-related deaths increased by 21·6% to 2 397 772 and YLLs increased by 5·0% to 56 598 975 between 2005 and 2020. The three leading fatal cancer types remained stable for both sexes over the study period: tracheal, bronchus, and lung cancer; liver cancer; and stomach cancer. The fourth and fifth leading cancers also remained stable among males (oesophageal, and colon and rectum), while colon and rectum cancer replaced oesophageal cancer as the fourth and breast cancer replaced colon and rectum cancer as the fifth leading cause of cancer-related death among females. Age-standardised mortality rates and age-standardised YLL rates for almost all cancer types (except for prostate for male and multiple myeloma for female) decreased significantly in both sexes in urban areas. Age-standardised YLL rates increased for about half of all cancers for both sexes in rural areas. Leading fatal types were leukaemia and brain and nervous system cancer in younger groups (aged 0–19 years); liver, tracheal, bronchus, and lung, or breast cancers in middle-aged groups (aged 40–59 years); and tracheal, bronchus, and lung, liver, or stomach cancers in older adults (aged ≥60 years) in 2020. The leading causes of cancer-related mortality varied for each province, with tracheal, bronchus, and lung or liver cancer at the top in 30 provinces.

Interpretation The cancer burden in China appeared to be shifting towards that in high-income countries from 2005 to 2020. Adjustments to existing health plans and actions are needed to reduce the burdens of tracheal, bronchus, and lung cancer or other leading and emerging cancers.

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Introduction

Cancer is a major public health problem and a crucial contributor to disease burden worldwide.[1–3] On the basis of the 2020 WHO estimates, cancer is the first or second leading cause of death in most countries before the age of 70 years.[1,4] Cancer has been the leading cause of death since 2010 in China, with increasing incidence, mortality, and burden.[5–7] Global annual deaths from cancer were estimated at almost 10 million based on the Global Cancer Observatory (GLOBOCAN) 2020 database.[1] Moreover, China accounted for 30·15% of all cancer-related deaths worldwide.[1] Given ageing populations, cancer-related deaths are projected to continue rising, both globally and in China, creating a huge public health burden.[5,8]

China has made considerable efforts in cancer control and prevention in the past two decades.[6,9–12] Furthermore, China has recently proposed new heath plans and specific actions, such as the Cancer Prevention and Control Implementation Plan 2019–22 in 2019,[13] the Action Plan to Improve the Quality of Oncology Diagnosis and Treatment in 2021,[14] and the Action Plan to Accelerate the Elimination of Cervical Cancer by 2030 in 2023,[15] to cope with the increasing cancer burden during the country's economic growth. Guided by the UN framework of the 2030 Agenda for Sustainable Development,[16] the State Council of China released a series of health plans between 2015 and 2020, including the Medium-to-Long-Term Plan for Prevention and

Research in context

Evidence before this study

We searched PubMed using the search terms "cancer burden", "national trends" and "cancer mortality" on Feb 1, 2023, for papers published between Jan 1, 2000, and Feb 1, 2023, with no language restrictions. We found that cancer is a critical public health issue worldwide. We identified 1019 references that address the cancer burden, but there is a gap in the empirical evidence in China across all cancer types, by sex and by urban versus rural area. Cancer has been the leading cause of death since 2010 in China. The absolute numbers of deaths, mortality rate, and burden of cancer are projected to continue growing globally and in China. The transition of the cancer spectrum can be determined using high-quality national data, since there are substantial developments in social, economic, and medical aspects in China. China has made considerable efforts in cancer control and prevention in the past two decades and has recently proposed new health plans and specific actions to cope with the cancer transition during the country's development.

Added value of this study

We assessed changes in the cancer burden between 2005 and 2020 in China using data from the National Mortality Surveillance System, focusing mainly on the patterns across sex, age, urban versus rural areas, and provinces. We observed a remarkable increase in the total number of cancer-related deaths and years of life lost (YLLs) and substantial discrepancies by sex in cancer mortality and leading causes of cancer mortality. Mortality and YLLs due to gastrointestinal neoplasms declined significantly for both sexes, including for liver, stomach, and oesophageal cancers. By contrast, mortality and YLLs continued to increase for most other cancers, including colon and rectum cancers, pancreatic cancer, multiple myeloma, and lymphoma for both sexes, prostate cancer in males, and ovarian cancer in females. Age-standardised rates for mortality and YLLs of almost all cancer types (except for prostate for males and multiple myeloma for females) decreased significantly in both sexes in urban areas, whereas age-standardised YLL rates increased for about half of all cancers for both sexes in rural areas. Leading fatal cancer types were typically rapidly progressing cancers in younger groups (ie, those aged 0–19 years) and cancers related to chronic diseases in middle-aged groups (ie, those aged 40–59 years) and older adults (ie, those aged ≥60 years). Tracheal, bronchus, and lung and liver cancer ranked highest in terms of mortality in most provinces, while deaths from colon and rectum cancer and pancreatic cancer increased in higher-income provinces.

Implications of all the available evidence

Cancer-related deaths and YLLs continued to rise in China between 2005 and 2020. The cancer burden in China shifted towards that in high-income countries. Prioritising the development of a cancer control policy and incorporating it into all stages of policy making will be helpful. Adjustments to existing health plans and actions are needed to reduce the burdens of tracheal, bronchus, and lung or other leading and emerging cancers.

Control of Chronic Diseases in China (2017–25)[17] and Healthy China 2030.[18] In addition, China has set a key target to improve the overall cancer 5-year survival rate by 10% in 2025,[17] and to reduce the number of premature deaths from non-communicable diseases (including cancer) by 30% by 2030.[18] Therefore, timely and reliable information on the development and change in the cancer burden is essential for governments to precisely guide the implementation of targeted prevention and control measures.

In this study, we used data from the National Mortality Surveillance System with under-reporting adjustment and garbage code redistribution to estimate the number of cancer-related deaths and years of life lost (YLLs) for 23 cancer groups in China and its 31 provinces between 2005 and 2020.

Methods

Data sources

Cancer mortality data were derived from the National Mortality Surveillance System, a system that collects death records from surveillance locations to understand death patterns in China. The National Mortality Surveillance System covers 605 surveillance points in 31 provincial-level administrative divisions in mainland China, accounting for 24·3% of the country's population with national and provincial representativeness[19] (a detailed description of the National Mortality Surveillance System is provided in the appendix p 1). Under-reporting was adjusted based on under-reporting field surveys during 2006–17.[20] Data quality and control, the under-reporting rate, garbage code redistribution method, and the garbage code proportion in this study are detailed in the appendix (pp 1–2, 4, 24). Strict quality control measures were implemented regularly in the National Mortality Surveillance System for both completeness and accuracy of cause of death identification by different administrative levels of the Center for Disease Control and Prevention network across China. The existence of garbage codes could influence the accuracy of the cause of death statistics. We grouped garbage codes and assigned a target code for each group according to the characteristics of disease and rules for inferring cause of death. Data for the surveillance population, stratified by age and sex and socioeconomic covariates, were sourced from the National Bureau of Statistics of China.[21] Socioeconomic covariates including urbanisation rate, average years of education attainment, and per capita gross domestic product were used to calculate the mortality rate.[21] Population by age group in the China

See Online for appendix

For more on the **National Bureau of Statistics of China** see http://data.stats.gov.cn

	Both sexes				Males				Females			
	Deaths (thousands)	Mortality rate (per 100 000)	YLLs (thousands)	YLL rate (per 100 000)	Deaths (thousands)	Mortality rate (per 100 000)	YLLs (thousands)	YLL rate (per 100 000)	Deaths (thousands)	Mortality rate (per 100 000)	YLLs (thousands)	YLL rate (per 100 000)
All sites	2397·77	170·80 (170·58–171·02)	56 598·98	4031·72 (4030·64–4032·79)	1565·70	218·31 (217·97–218·66)	37 240·09	5192·56 (5190·85–5194·27)	832·07	121·18 (120·92–121·44)	19 358·89	2819·27 (2818·00–2820·55)
Tracheal, bronchus, and lung	766·14	54·57 (54·45–54·70)	16 836·39	1199·31 (1198·73–1199·88)	538·24	75·05 (74·85–75·25)	12 048·42	1679·97 (1679·01–1680·93)	227·90	33·19 (33·05–33·33)	4787·97	697·28 (696·66–697·91)
Liver	367·72	26·19 (26·11–26·28)	9972·86	710·40 (709·95–710·84)	274·76	38·31 (38·17–38·46)	7821·93	1090·65 (1089·88–1091·42)	92·96	13·54 (13·45–13·63)	2150·93	313·24 (312·83–313·66)
Stomach	291·20	20·74 (20·67–20·82)	6300·29	448·79 (448·44–449·14)	199·66	27·84 (27·72–27·96)	4378·38	610·50 (609·93–611·07)	91·53	13·33 (13·24–13·42)	1921·91	279·89 (279·49–280·29)
Colon and rectum	182·43	13·00 (12·94–13·05)	3884·25	276·69 (276·41–276·96)	104·91	14·63 (14·54–14·72)	2277·35	317·54 (317·13–317·96)	77·52	11·29 (11·21–11·37)	1606·90	234·02 (233·65–234·38)
Oesophageal	173·29	12·34 (12·29–12·40)	3616·28	257·60 (257·33–257·86)	130·35	18·18 (18·08–18·27)	2880·62	401·66 (401·19–402·12)	42·94	6·25 (6·19–6·31)	735·66	107·14 (106·89–107·38)
Pancreatic	100·43	7·15 (7·11–7·20)	2166·35	154·32 (154·11–154·52)	63·10	8·80 (8·73–8·87)	1391·33	194·00 (193·68–194·32)	37·32	5·44 (5·38–5·49)	775·02	112·87 (112·62–113·12)
Breast	57·06	4·06 (4·03–4·10)	1758·27	125·25 (125·06–125·43)	0·66	0·09 (0·09–0·10)	12·30	1·72 (1·69–1·75)	56·40	8·21 (8·15–8·28)	1745·97	254·27 (253·89–254·65)
Leukaemia	54·86	3·91 (3·88–3·94)	2048·87	145·95 (145·75–146·15)	31·79	4·43 (4·38–4·48)	1153·21	160·80 (160·50–161·09)	23·08	3·36 (3·32–3·40)	895·66	130·44 (130·17–130·71)
Brain and nervous system	54·22	3·86 (3·83–3·89)	1710·90	121·87 (121·69–122·06)	30·68	4·28 (4·23–4·33)	1008·41	140·61 (140·33–140·88)	23·53	3·43 (3·38–3·47)	702·49	102·30 (102·07–102·54)
Cervical	44·75	3·19 (3·16–3·22)	1356·05	96·60 (96·43–96·76)	..	..	..	..	44·75	6·52 (6·46–6·58)	1356·05	197·48 (197·15–197·82)
Lymphoma	39·59	2·82 (2·79–2·85)	1005·80	71·65 (71·51–71·79)	26·25	3·66 (3·62–3·70)	680·13	94·83 (94·61–95·06)	13·34	1·94 (1·91–1·98)	325·67	47·43 (47·27–47·59)
Prostate	30·81	2·19 (2·17–2·22)	483·93	34·47 (34·37–34·57)	30·81	4·30 (4·25–4·34)	483·93	67·48 (67·29–67·67)	..	..	..	..
Bladder	29·73	2·12 (2·09–2·14)	492·86	35·11 (35·01–35·21)	24·03	3·35 (3·31–3·39)	405·95	56·60 (56·43–56·78)	5·70	0·83 (0·81–0·85)	86·91	12·66 (12·57–12·74)
Gallbladder and biliary tract	28·14	2·00 (1·98–2·03)	553·01	39·39 (39·29–39·50)	13·47	1·88 (1·85–1·91)	275·71	38·44 (38·30–38·59)	14·67	2·14 (2·10–2·17)	277·30	40·38 (40·23–40·53)
Nasopharynx	24·54	1·75 (1·73–1·77)	677·83	48·28 (48·17–48·40)	18·40	2·56 (2·53–2·60)	517·44	72·15 (71·95–72·35)	6·14	0·89 (0·87–0·92)	160·38	23·36 (23·24–23·47)
Ovarian	20·88	1·49 (1·47–1·51)	595·59	42·43 (42·32–42·53)	..	..	..	..	20·88	3·04 (3·00–3·08)	595·59	86·74 (86·52–86·96)
Larynx	16·34	1·16 (1·15–1·18)	359·28	25·59 (25·51–25·68)	14·19	1·98 (1·95–2·01)	321·75	44·86 (44·71–45·02)	2·15	0·31 (0·30–0·33)	37·53	5·47 (5·41–5·52)

(Table 1 continues on next page)

	Both sexes				Males				Females			
	Deaths (thousands)	Mortality rate (per 100 000)	YLLs (thousands)	YLL rate (per 100 000)	Deaths (thousands)	Mortality rate (per 100 000)	YLLs (thousands)	YLL rate (per 100 000)	Deaths (thousands)	Mortality rate (per 100 000)	YLLs (thousands)	YLL rate (per 100 000)
(Continued from previous page)												
Kidney	14·75	1·05 (1·03–1·07)	304·51	21·69 (21·61–21·77)	9·09	1·27 (1·24–1·29)	199·61	27·83 (27·71–27·95)	5·66	0·82 (0·80–0·85)	104·91	15·28 (15·19–15·37)
Lip and oral cavity	10·62	0·76 (0·74–0·77)	234·72	16·72 (16·65–16·79)	7·48	1·04 (1·02–1·07)	175·64	24·49 (24·38–24·60)	3·14	0·46 (0·44–0·47)	59·08	8·60 (8·53–8·67)
Skin	10·08	0·72 (0·70–0·73)	173·62	12·37 (12·31–12·43)	5·25	0·73 (0·71–0·75)	97·48	13·59 (13·51–13·68)	4·82	0·70 (0·68–0·72)	76·14	11·09 (11·01–11·17)
Multiple myeloma	8·12	0·58 (0·57–0·59)	176·61	12·58 (12·52–12·64)	5·01	0·70 (0·68–0·72)	109·17	15·22 (15·13–15·31)	3·11	0·45 (0·44–0·47)	67·44	9·82 (9·75–9·90)
Thyroid	3·92	0·28 (0·27–0·29)	73·66	5·25 (5·21–5·28)	1·54	0·21 (0·20–0·23)	30·46	4·25 (4·20–4·29)	2·38	0·35 (0·33–0·36)	43·20	6·29 (6·23–6·35)
Other neoplasms	68·17	4·86 (4·82–4·89)	1817·05	129·43 (129·25–129·62)	36·02	5·02 (4·97–5·07)	970·88	135·37 (135·10–135·64)	32·15	4·68 (4·63–4·73)	846·17	123·23 (122·97–123·49)

YLLs=years of life lost.

***Table 1:* Mortality and YLLs for 23 cancer types in China by sex, 2020**

2020 census was used as the reference population to calculate age-standardised mortality rates and YLLs.

Outcomes

Overall cancer mortality rates and mortality rates for each of 23 cancer groups (lip and oral cavity cancer, nasopharynx cancer, oesophageal cancer, stomach cancer, colon and rectum cancer, liver cancer, gallbladder and biliary tract cancer, pancreatic cancer, larynx cancer, tracheal, bronchus, and lung cancer, skin cancer, breast cancer, cervical cancer, ovarian cancer, prostate cancer, kidney cancer, bladder cancer, brain and nervous system cancer, thyroid cancer, lymphoma, multiple myeloma, leukaemia, and other neoplasms) by age and sex, nationally, and for 31 provinces in mainland China between 2005 and 2020 were estimated according to the following procedures: first we calculated the under-reporting rate annually for each age-sex stratum by capture-mark-recapture method[22] and then we calculated the adjusted cancer mortality rate using the formula: crude mortality rate / (1 – under-reporting rate).[19]

We conducted garbage code redistribution, the proportion of cause of death calculations, and cancer-related death estimations as reported previously.[23] Briefly, we grouped garbage code and assigned a target code for each group according to the characteristics of disease and rules for inferring cause of death. We redistributed garbage codes based on the proportion of the target code, known coefficients from previous studies, and coefficients from the National Mortality Surveillance System (appendix p 1). The proportion of cause of death for each cancer by province-age-sex was calculated by the number of cancer cases after redistribution divided by the total number of deaths. Mortality rate of cancer by each year, province, sex, and age group was then calculated by multiplying all-cause mortality rate by proportion of cancer in all deaths. The definition of cancer-related death was based on the International Classification of Diseases 10th Revision (appendix p 5).

YLLs is a measure of premature death, and is computed by multiplying the number of estimated deaths by the life table's life expectancy at age of death.[23] We summed the YLLs for each age group by cause of death, sex, and province. YLL computations were based on theoretical minimum risk reference life tables of all cancer subcategories by 2020.[23]

Statistical analysis

Age-standardised mortality rates and YLL rates were calculated using data from the China 2020 census using a direct standardisation method, which is the most common standardisation method.[24] All relevant metrics were estimated separately for the two sexes and various age groups (ie, 0–19 years, 20–39 years, 40–59 years, 60–79 years, and ≥80 years) from 2005 to 2020. Age-standardised mortality rates and YLL rates were analysed in 31 province-level administrative units in mainland

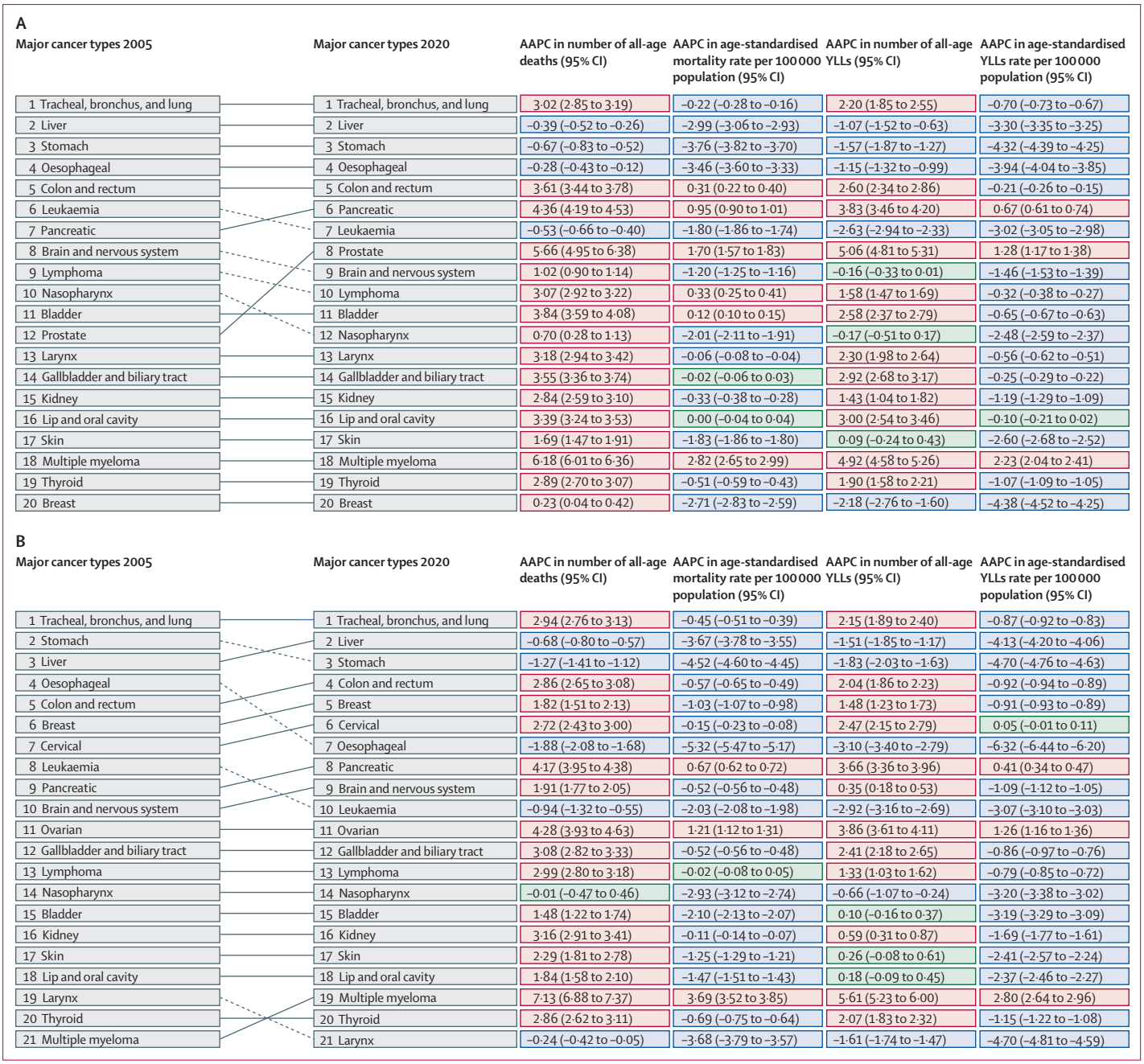

Figure 1: **Cancer group rankings by absolute deaths for males (A) and females (B) in China, 2005–20**
Rankings represent absolute deaths, excluding other neoplasms. Cancers were ranked in 2020, with lines connecting to their rank in 2005. The colours refer to the AAPC in cancer types from 2005 to 2020: red is an increase in AAPC, green is no change, and blue is a decrease. AAPC=average annual percent change. YLLs=years of life lost.

China. We estimated 95% CIs for mortality rate, age-standardised mortality rate, YLL rate, and age-standardised YLL rate. We used average annual percent change with 95% CIs to describe trends in cancer mortality and YLLs from 2005 to 2020. All statistical tests were two-sided. We also calculated the proportion of all cancer-related deaths accounted for by each cancer group and compared rankings by absolute numbers of deaths and YLLs between 2005 and 2020. We conducted a decomposition analysis of changes in cancer-related deaths using the methods developed by Gupta[25] to understand the drivers of changes in cancer-related death due to three explanatory components: population growth, population ageing, and age-specific mortality rates in China.[25] Briefly, based on counterfactual approach, we estimated the expected number of deaths in 2020 by

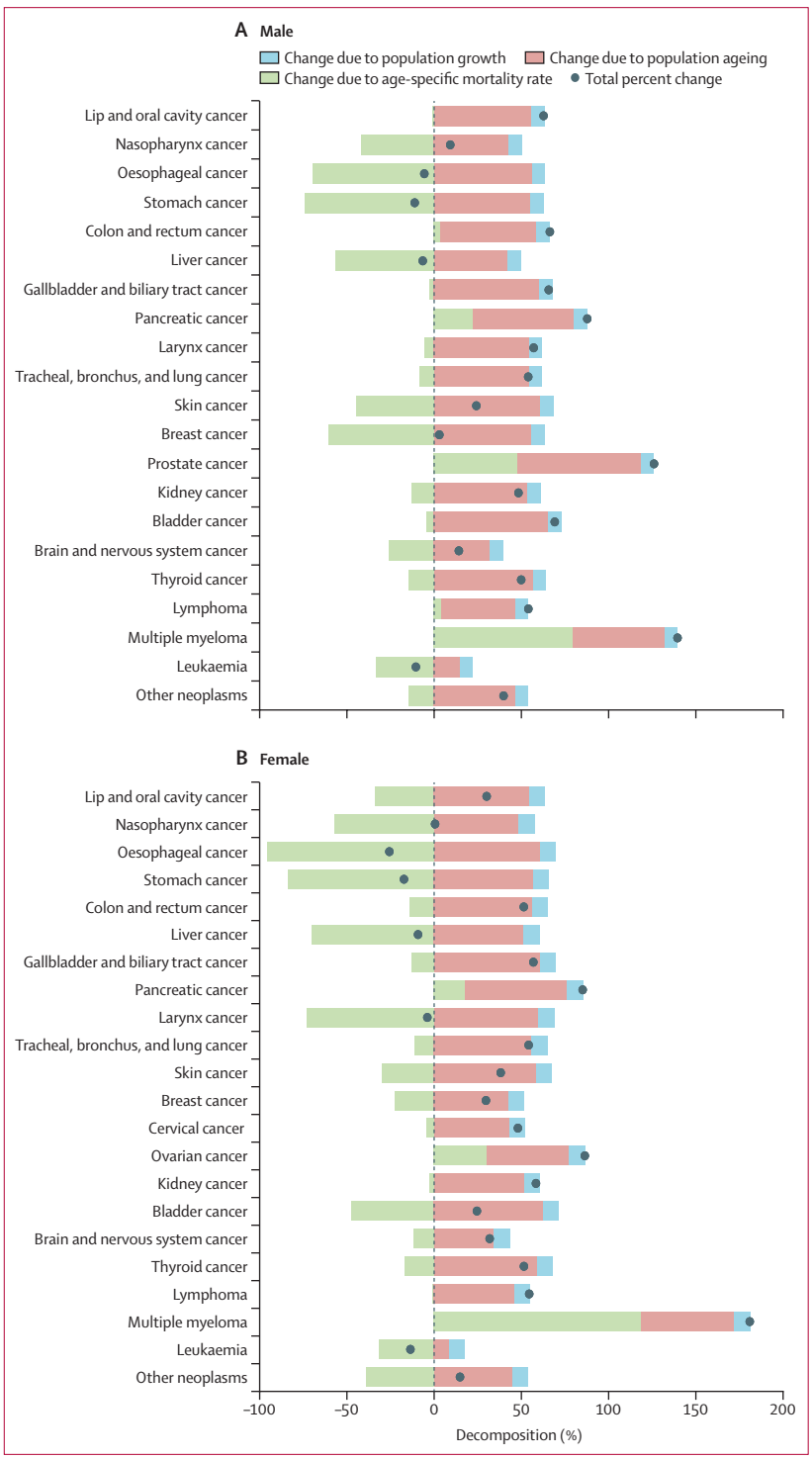

Figure 2: **Decomposition of changes in deaths due to different cancer types attributable to population growth, population ageing, and age-specific mortality rates in China, 2005–20**

multiplying the number of population in 2020, age-specific mortality rate in 2005, and the age structure in 2005 (scenario one) and 2020 (scenario two). We then estimated the change due to population growth by subtracting 2005 actual deaths from scenario one, the change due to population ageing by calculating the differences between scenario two and scenario one, and the change due to age-specific mortality rate by subtracting scenario two from 2020 actual deaths.[21] All analyses were performed using SAS (version 9.4), Joinpoint Regression Program (version 5.0.2), and R (version 4.0.4).

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

In 2020, there were 2 397 772 cancer-related deaths (mortality rate 170·80 per 100 000; 95% CI 170·58–171·02) and 56 598 975 YLLs due to cancer in China (table 1). In total, cancer-related deaths increased by 21·6% and YLLs increased by 5·0% between 2005 and 2020 (appendix p 6).

For males, in 2020, the five leading cancers by mortality rate were tracheal, bronchus, and lung cancer (75·05 per 100 000; 95% CI 74·85–75·25), liver cancer (38·31; 38·17–38·46), stomach cancer (27·84; 27·72–27·96), oesophageal cancer (18·18; 18·08–18·27), and colon and rectum cancer (14·63; 14·54–14·72). For females, the five leading cancers by mortality rate in 2020 were tracheal, bronchus, and lung (33·19 per 100 000; 95% CI 33·05–33·33), liver cancer (13·54; 13·45–13·63), stomach cancer (13·33; 13·24–13·42), colon and rectum cancer (11·29; 11·21–11·37), and breast cancer (8·21; 8·15–8·28). Rankings by YLLs were consistent with those by mortality (table 1).

There were significant reductions in age-standardised mortality rates between 2005 and 2020 for most cancers, with an increased number of all-age deaths due to cancer since 2005 (figure 1). Tracheal, bronchus, and lung cancer remained the leading cause of cancer-related deaths in both sexes between 2005 and 2020, despite a mild decrease in age-standardised mortality rate (figure 1; appendix p 8). However, the absolute numbers of deaths (figure 1) and proportions of tracheal, bronchus, and lung cancer-related deaths among all cancer-related deaths (appendix p 10) increased between 2005 and 2020 (appendix pp 25–26), primarily attributable to population growth and population ageing (figure 2). The second to fifth leading cancers by mortality rate remained unchanged in males between 2005 and 2020, with the proportion of these four cancers among all cancer types decreasing from 55·8% in 2005 to 45·3% in 2020. In females, the second to the fifth leading cancers by mortality rate showed evident changes between 2005 and 2020, with liver cancer moving from third to second position, colon and rectum cancers moving from fifth to fourth position, and breast cancer moving from sixth to

fifth position (figure 1); the proportion of all cancer-related deaths accounted for by the second to the fifth leading causes of cancer-related mortality decreased from 46·6% to 38·3% between 2005 and 2020 (appendix pp 10, 26). For males, we identified an increased age-standardised mortality rate from 2005 to 2020 for multiple myeloma, lymphoma, and prostate, pancreatic, colon and rectum, and bladder cancers, with average annual percent changes ranging from 0·12% to 2·82%. Among these cancers, pancreatic cancer rose in the ranking from seventh to sixth position and prostate cancer rose from twelfth to eighth position between 2005 and 2020 (figure 1). In females, we identified an increased age-standardised mortality rate for multiple myeloma, ovarian cancer, and pancreatic cancer, with average annual percent changes ranging from 0·67% to 3·69%, with pancreatic cancer rising in the ranking from ninth to eighth position and multiple myeloma rising from 21st to 19th position between 2005 and 2020 (figure 1).

The mortality and YLL rates due to cancer were higher in rural areas than in urban areas for both sexes (appendix p 11). Age-standardised mortality rate and age-standardised YLL rates for almost all cancer types (except for prostate for male and multiple myeloma for female)

A Urban male

Major cancer types 2005	Major cancer types 2020	AAPC in number of all-age YLLs (95% CI)	AAPC in age-standardised YLLs rate per 100 000 population (95% CI)
1 Tracheal, bronchus, and lung	1 Tracheal, bronchus, and lung	0·77 (0·00 to 1·55)	−2·90 (−3·40 to −2·39)
2 Liver	2 Liver	−1·62 (−2·33 to −0·90)	−4·79 (−5·45 to −4·12)
3 Stomach	3 Stomach	−1·65 (−2·63 to −0·67)	−5·63 (−6·16 to −5·10)
4 Oesophageal	4 Colon and rectum	1·57 (0·48 to 2·67)	−2·18 (−2·97 to −1·38)
5 Colon and rectum	5 Oesophageal	−0·47 (−0·76 to −0·19)	−4·18 (−4·82 to −3·53)
6 Pancreatic	6 Pancreatic	2·02 (0·47 to 3·60)	−1·95 (−3·71 to −0·16)
7 Leukaemia	7 Prostate	4·67 (3·22 to 6·14)	0·26 (−1·88 to 2·45)
8 Brain and nervous system	8 Leukaemia	−4·33 (−5·82 to −2·82)	−5·51 (−6·67 to −4·33)
9 Lymphoma	9 Brain and nervous system	−0·35 (−1·37 to 0·67)	−2·98 (−3·77 to −2·19)
10 Bladder	10 Lymphoma	−0·94 (−2·53 to 0·68)	−3·57 (−5·23 to −1·87)
11 Nasopharynx	11 Bladder	0·65 (−1·09 to 2·42)	−3·43 (−4·33 to −2·53)
12 Prostate	12 Nasopharynx	−1·47 (−3·17 to 0·27)	−4·94 (−5·96 to −3·91)
13 Gallbladder and biliary tract	13 Gallbladder and biliary tract	0·92 (−0·35 to 2·21)	−3·10 (−4·25 to −1·94)
14 Larynx	14 Larynx	0·72 (−0·19 to 1·65)	−3·04 (−3·69 to −2·39)
15 Kidney	15 Kidney	−0·42 (−1·18 to 0·34)	−3·73 (−4·70 to −2·75)
16 Lip and oral cavity	16 Lip and oral cavity	1·51 (0·42 to 2·62)	−2·43 (−3·92 to −0·91)
17 Skin	17 Multiple myeloma	1·70 (−0·43 to 3·87)	−1·84 (−3·58 to −0·07)
18 Multiple myeloma	18 Skin	−1·38 (−2·62 to −0·14)	−4·48 (−6·77 to −2·14)
19 Thyroid	19 Thyroid	−1·79 (−3·05 to −0·51)	−5·47 (−6·67 to −4·25)
20 Breast	20 Breast	−1·54 (−2·45 to −0·62)	−4·56 (−5·32 to −3·80)

B Rural male

Major cancer types 2005	Major cancer types 2020	AAPC in number of all-age YLLs (95% CI)	AAPC in age-standardised YLLs rate per 100 000 population (95% CI)
1 Liver	1 Tracheal, bronchus, and lung	3·24 (2·31 to 4·19)	1·04 (0·65 to 1·43)
2 Tracheal, bronchus, and lung	2 Liver	−0·82 (−1·22 to −0·42)	−2·28 (−2·92 to −1·64)
3 Stomach	3 Stomach	−1·41 (−1·74 to −1·07)	−3·63 (−4·38 to −2·89)
4 Oesophageal	4 Oesophageal	−1·21 (−1·91 to −0·50)	−3·51 (−3·98 to −3·05)
5 Colon and rectum	5 Colon and rectum	3·66 (2·64 to 4·69)	1·47 (−0·02 to 2·99)
6 Leukaemia	6 Pancreatic	5·70 (4·24 to 7·19)	3·26 (1·42 to 5·13)
7 Brain and nervous system	7 Leukaemia	−1·08 (−2·05 to −0·10)	−0·93 (−1·69 to −0·16)
8 Pancreatic	8 Brain and nervous system	0·06 (−0·69 to 0·82)	−0·69 (−1·26 to −0·11)
9 Nasopharynx	9 Prostate	5·45 (3·75 to 7·18)	1·96 (−0·60 to 4·58)
10 Lymphoma	10 Lymphoma	4·36 (2·69 to 6·06)	3·05 (1·68 to 4·44)
11 Prostate	11 Bladder	4·59 (3·04 to 6·15)	1·92 (1·32 to 2·53)
12 Bladder	12 Nasopharynx	0·38 (−0·91 to 1·69)	−1·17 (−1·90 to −0·43)
13 Larynx	13 Larynx	3·32 (2·96 to 3·68)	1·23 (0·77 to 1·68)
14 Gallbladder and biliary tract	14 Gallbladder and biliary tract	5·32 (3·14 to 7·56)	2·74 (1·85 to 3·64)
15 Skin	15 Kidney	3·74 (2·14 to 5·36)	1·81 (0·76 to 2·87)
16 Kidney	16 Lip and oral cavity	4·79 (4·14 to 5·44)	1·99 (0·65 to 3·35)
17 Lip and oral cavity	17 Skin	0·70 (−0·46 to 1·87)	−1·28 (−2·63 to 0·09)
18 Multiple myeloma	18 Multiple myeloma	9·81 (6·69 to 13·03)	7·86 (5·44 to 10·35)
19 Breast	19 Thyroid	5·60 (4·32 to 6·89)	3·26 (1·92 to 4·63)
20 Thyroid	20 Breast	−3·01 (−3·52 to −2·49)	−4·47 (−4·95 to −3·98)

(Figure 3 continues on next page)

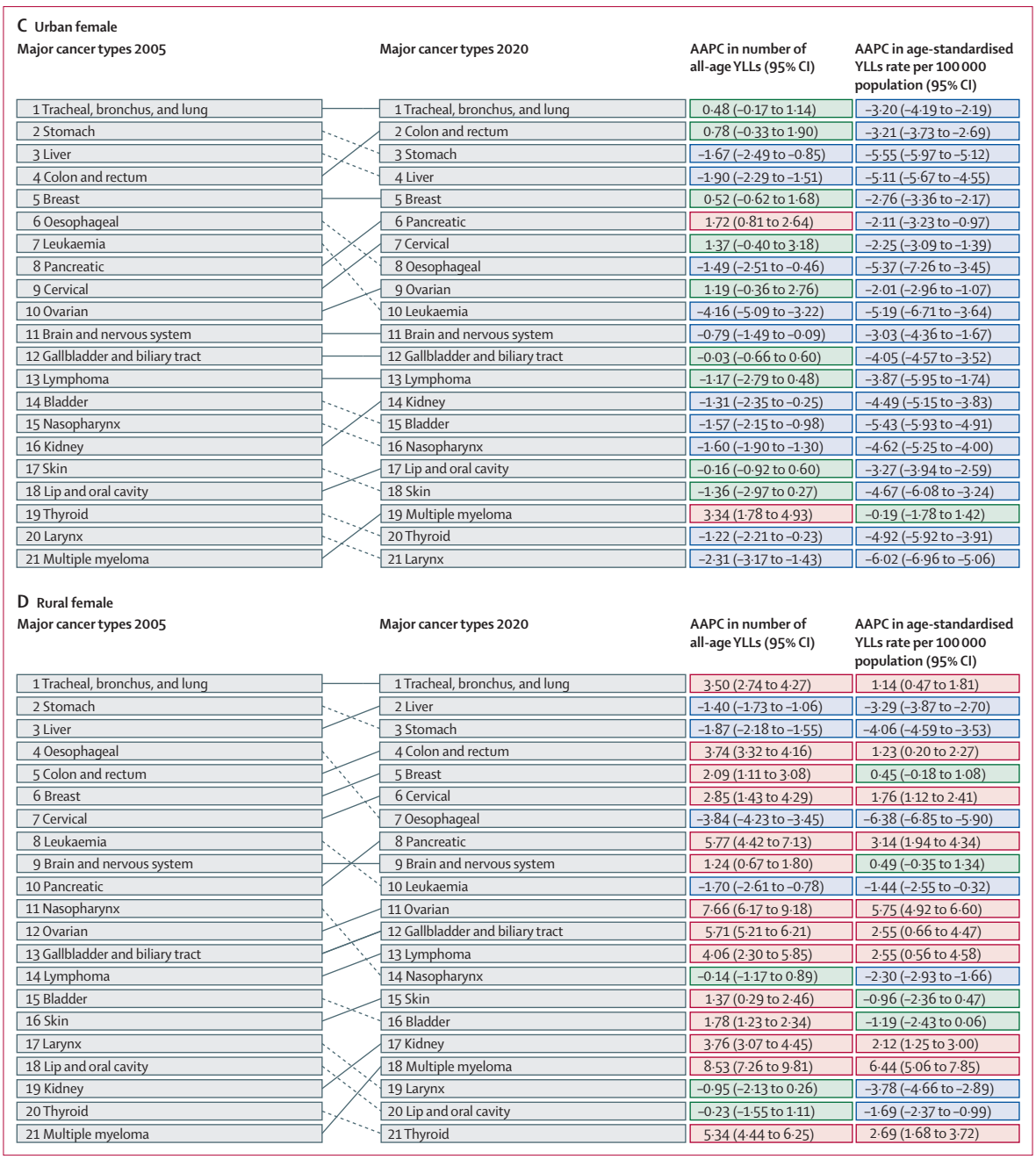

Figure 3: **Cancer group rankings by absolute YLLs in urban versus rural areas in China, 2005–20**
Rankings represent absolute YLLs, excluding other neoplasms. Cancers were ranked in 2020, with lines connecting to their rank in 2005. The colours refer to the AAPC in cancer types from 2005 to 2020: red is an increase in AAPC, green is no change, and blue is a decrease. AAPC=average annual percent change. YLLs=years of life lost.

decreased significantly in both sexes in urban areas. A decomposition analysis showed that in about three-quarters of cancer types, the number of deaths increased, which was primarily attributable to population ageing, followed by population growth, from 2005 to 2020 (appendix p 27). In rural areas, we identified an increased age-standardised YLL rate for 11 of 20 cancer types in males and for ten of 21 cancer types in females (figure 3; appendix p 16), and four out of five cancer types in numbers of deaths were increased, which was primarily attributable to increase in the age-specific mortality rate and an ageing population (appendix p 28). In urban males, YLLs due to pancreatic cancer (average annual percent change in YLLs 2·02%; 0·47–3·60), and lip and oral cavity cancer (1·51%; 0·42–2·62) had statistically increased, although ranks of these cancers stayed the

same. In urban females, we observed an upward trend in rankings in colon and rectum cancer, which ranked fourth in terms of YLLs in 2005 and second in 2020 (figure 3; appendix p 14). For rural males, tracheal, bronchus, and lung cancer moved from the second leading cancer in terms of YLLs in 2005 to the leading cause of YLLs due to cancer in 2020, with an average annual percent change of 3·24% (95% CI 2·31–4·19). From 2005 to 2020, pancreatic cancer, prostate cancer, bladder cancer, kidney cancer, lip and oral cavity cancer, and thyroid cancer moved upwards in rankings among rural males, while colon and rectum cancer, lymphoma, larynx cancer, gallbladder and biliary tract cancer, and multiple myeloma remained in the same place; liver cancer, leukaemia, brain and nervous system cancer, nasopharynx cancer, skin cancer, and breast cancer dropped in the rankings. For females in rural areas, YLLs due to bladder cancer and thyroid cancer increased but these cancers moved downwards in the ranking during the study period (figure 3; appendix p 16).

The top ten leading causes of cancer-related deaths varied considerably across age groups, with much lower mortality rates in younger and middle-aged adults than among older adults (tables 2 and 3). Among individuals aged 0–19 years, the three leading fatal cancer types were leukaemia, brain and nervous system cancers, and liver cancers. Tracheal, bronchus, and lung cancer replaced brain and nervous system cancer as the third leading cause of cancer-related death among males aged 20–39 years, while in females in this age group, breast cancer rose in the ranking from third to the top position and cervical cancer rose from sixth to third position between 2005 and 2020. In individuals aged 40–59 years, the three leading fatal cancer types in males were liver, tracheal, bronchus, and lung, and stomach cancer, while those in females were tracheal, bronchus, and lung, breast, and cervical cancer. We observed increasing mortality rates due to pancreatic cancer for both sexes and due to cervical and ovarian cancer for females in the 40–59 years and 60–79 years age groups. Among individuals aged 80 years or older, the three leading causes of cancer-related mortality in males were tracheal, bronchus, and lung, stomach, and liver cancer, while tracheal, bronchus, and lung, stomach, and colon and rectum cancer replaced liver cancer as the third position were the three leading causes of cancer-related mortality among females in this age group. Stomach, liver, and oesophageal cancer for both sexes and breast and cervical cancer for females showed decreasing mortality rates between 2005 and 2020, while other cancer types showed increases in mortality in those aged 80 years or older (table 2).

Total cancer mortality rates in 11 provinces were higher than the average in China (appendix p 18). Provincial differences in age-standardised mortality rates and age-standardised YLL rates in 2020 are shown in the appendix (pp 29–30). All cancer types had decreasing mortality rates, age-standardised mortality rates, YLL rates, and age-standardised YLL rates (appendix pp 31–34) in Guangxi, Hebei, Xinjiang, Henan, and Qinghai in males (appendix p 20) and in Jiangsu, Henan, Guangxi, Xinjiang, and Shanghai in females (appendix p 22). Rankings of each cancer type by age-standardised mortality rate and age-standardised YLL rate in China and its 31 provinces in 2020 are shown in the appendix (pp 35–36). Tracheal, bronchus, and lung cancer remained the leading cancer type by age-standardised mortality rate in most provinces. The main cancer types by age-standardised mortality rate and age-standardised YLL rate by province are mapped to visualise provincial differences in the appendix (pp 39–56). Gastrointestinal cancers, such as liver, stomach, and oesophageal cancers, remained the most common cause of death across the country (appendix p 37), with a remarkable reduction in mortality rates and age-standardised mortality rates in

	Mortality rate (per 100 000 population)	Average annual percent change in mortality rate (95% CI)
0–19 years		
All sites	4·89 (4·78 to 5·00)	–3·59 (–3·67 to –3·51)*
1 Leukaemia	2·03 (1·96 to 2·09)	–5·00 (–5·21 to –4·79)*
2 Brain and nervous system	1·51 (1·45 to 1·57)	–1·17 (–1·41 to –0·92)*
3 Liver	0·31 (0·29 to 0·34)	–4·01 (–4·12 to –3·90)*
4 Kidney	0·03 (0·02 to 0·04)	–7·27 (–8·65 to –5·88)*
5 Tracheal, bronchus, and lung	0·02 (0·02 to 0·03)	–13·71 (–14·49 to –12·92)*
6 Colon and rectum	0·01 (0·00 to 0·01)	–17·46 (–18·59 to –16·32)*
20–39 years		
All sites	14·49 (14·32 to 14·65)	–3·72 (–3·82 to –3·62)*
1 Liver	5·73 (5·63 to 5·83)	–4·34 (–4·51 to –4·16)*
2 Leukaemia	2·25 (2·18 to 2·31)	–3·51 (–3·61 to –3·42)*
3 Tracheal, bronchus, and lung	1·89 (1·83 to 1·95)	–4·03 (–4·14 to –3·91)*
4 Brain and nervous system	1·03 (0·99 to 1·08)	–1·53 (–1·60 to –1·46)*
5 Stomach	0·80 (0·76 to 0·84)	–4·68 (–4·89 to –4·48)*
6 Colon and rectum	0·71 (0·67 to 0·75)	–2·90 (–3·01 to –2·80)*
7 Pancreatic	0·18 (0·16 to 0·20)	–1·50 (–1·63 to –1·37)*
8 Oesophageal	0·08 (0·07 to 0·09)	–9·62 (–9·93 to –9·31)*
9 Gallbladder and biliary tract	..	..
10 Prostate	..	..
40–59 years		
All sites	125·26 (124·80 to 125·73)	–2·94 (–3·06 to –2·81)*
1 Liver	40·31 (40·05 to 40·58)	–3·34 (–3·47 to –3·21)*
2 Tracheal, bronchus, and lung	35·27 (35·02 to 35·52)	–1·68 (–1·79 to –1·57)*
3 Stomach	11·91 (11·76 to 12·05)	–5·89 (–6·08 to –5·70)*
4 Oesophageal	8·44 (8·32 to 8·56)	–5·23 (–5·43 to –5·02)*
5 Colon and rectum	6·76 (6·65 to 6·87)	–0·33 (–0·40 to –0·26)*
6 Pancreatic	4·08 (4·00 to 4·17)	0·65 (0·59 to 0·71)*
7 Brain and nervous system	3·57 (3·49 to 3·65)	–1·77 (–1·86 to –1·67)*
8 Leukaemia	2·89 (2·82 to 2·96)	–3·04 (–3·12 to –2·97)*
9 Gallbladder and biliary tract	0·65 (0·62 to 0·68)	0·10 (–0·02 to 0·22)
10 Kidney	0·64 (0·61 to 0·68)	–1·50 (–1·62 to –1·39)*

(Table 2 continues on next page)

	Mortality rate (per 100 000 population)	Average annual percent change in mortality rate (95% CI)
(Continued from previous page)		
60–79 years		
All sites	801·07 (799·39 to 802·75)	−1·57 (−1·82 to −1·32)*
1 Tracheal, bronchus, and lung	298·41 (297·39 to 299·44)	−0·15 (−0·43 to 0·13)
2 Liver	121·62 (120·97 to 122·27)	−2·83 (−2·94 to −2·73)*
3 Stomach	109·62 (109·00 to 110·24)	−3·94 (−4·16 to −3·73)*
4 Oesophageal	73·29 (72·78 to 73·80)	−3·35 (−3·54 to −3·17)*
5 Colon and rectum	50·62 (50·20 to 51·04)	−0·19 (−0·49 to 0·10)
6 Pancreatic	34·41 (34·06 to 34·76)	0·81 (0·52 to 1·10)*
7 Brain and nervous system	12·30 (12·09 to 12·51)	−1·35 (−1·53 to −1·17)*
8 Leukaemia	11·72 (11·52 to 11·93)	−0·62 (−0·84 to −0·40)*
9 Prostate	11·42 (11·22 to 11·62)	0·55 (0·14 to 0·97)*
10 Bladder	9·42 (9·24 to 9·60)	−1·46 (−1·88 to −1·03)*
≥80 years		
All sites	2897·02 (2887·58 to 2906·47)	−0·18 (−0·25 to −0·11)*
1 Tracheal, bronchus, and lung	1004·91 (999·41 to 1010·43)	0·88 (0·85 to 0·91)*
2 Stomach	400·80 (397·33 to 404·27)	−2·33 (−2·36 to −2·29)*
3 Liver	309·75 (306·71 to 312·80)	−1·81 (−1·84 to −1·79)*
4 Colon and rectum	256·76 (253·99 to 259·54)	1·64 (1·55 to 1·72)*
5 Oesophageal	242·66 (239·96 to 245·36)	−2·39 (−2·43 to −2·34)*
6 Prostate	138·74 (136·70 to 140·78)	2·52 (2·39 to 2·66)*
7 Pancreatic	124·35 (122·42 to 126·28)	1·69 (1·61 to 1·77)*
8 Bladder	98·56 (96·85 to 100·28)	1·81 (1·72 to 1·90)*
9 Brain and nervous system	36·11 (35·07 to 37·15)	0·50 (0·43 to 0·57)*
10 Leukaemia	35·19 (34·16 to 36·22)	1·31 (1·16 to 1·47)*

Among those aged 0–19 years, there were only six fatal cancer types for males and females. *Indicates a significant increase or decrease.

Table 2: **Ten leading cancer types by mortality rate in 2020 and average annual percent change in mortality rate in males in China, 2005–20**

large parts of China (appendix pp 31–32). However, we observed a greater increase by age-standardised mortality rate in colon and rectum and pancreatic cancer in higher-income provinces (appendix p 31). We observed a nationwide decline in mortality due to leukaemia. Despite accounting for a low proportion of total cancer-related deaths, multiple myeloma and lymphoma showed a rapidly increasing trend in mortality in China as a whole, and in most provinces (appendix pp 31–32).

Discussion

In this study, we assessed changes in the cancer burden from 2005 to 2020 in China using data from the National Mortality Surveillance System, focusing on patterns across sex, age, urban versus rural areas, and provinces. We observed a remarkable increase in the total number of cancer-related deaths and YLLs and substantial discrepancies by sex and age in cancer mortality and leading causes of cancer-related mortality. The five leading causes of cancer-related mortality remained unchanged in males: tracheal, bronchus, and lung, liver, stomach, oesophageal, and colon and rectum cancers. However, the five leading causes of cancer-related mortality in females were tracheal, bronchus, and lung, stomach, liver, oesophageal, and colon and rectum cancer in 2005, which changed to tracheal, bronchus, and lung, liver, stomach, colon and rectum, and breast cancer in 2020. Deaths, mortality, and YLLs due to liver, stomach, and oesophageal cancer declined significantly for both sexes over the study period. Age-standardised mortality and age-standardised YLL rates for almost all cancer types (except for prostate for males and multiple myeloma for females) decreased significantly in both sexes in urban areas, whereas age-standardised YLL rates increased for about half of all cancers in rural areas. The mortality ranking and increased average annual percent change in age-standardised mortality rates for colon and rectum and pancreatic cancer in high-income provinces are noteworthy. Furthermore, population ageing played a substantial role in the increase in mortality and disease burden for many cancer types.

The incidence of cancer in China is similar to the world average and lower than that in high-income countries; however, the mortality rate is much higher than the global average[1] and that of high-income countries.[26] This difference can be largely explained by the lower 5-year survival for most of the major cancers in China.[27] The different distribution of cancer types could also play a role, with more lethal types in the Chinese population.[1,28] In this study, estimated cancer-related deaths were lower than the GLOBOCAN 2020[1] and estimates from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019;[7] however, China still ranks first in the world for number of cancer-related deaths due to China's large population base. These differences in estimates could be explained by the different data sources and methods used in the estimation process (eg, GLOBOCAN 2020 estimations were based on 90 cancer registries of China, and GBD 2019 used a combination of aggregated data from a variety of sources, including cancer registry data). Our results might be more accurate because they were based on national surveillance data. As China has a large population and the total number of cancer-related deaths and YLLs increased remarkably from 2005 to 2020, the burden of cancer in China is heavy and continues to rise, consistent with the findings of other studies.[7,8,26]

The higher mortality and YLL rates of cancer in rural versus urban areas were observed for both sexes. Although the five leading cancer types by mortality were consistent for both sexes in urban and rural areas, the trends were drastically different. For example, although all-age deaths due to tracheal, bronchus, and lung cancer increased for both sexes in urban areas, age-standardised mortality and YLL rates decreased. By contrast, age-standardised mortality and YLL rates for tracheal, bronchus, and lung cancer increased in rural areas. This phenomenon encompasses a series of influencing factors, such as remaining geographical differences in

5-year survival rates between urban and rural areas, which were higher in urban areas than in rural areas for both sexes.[27] Differences in risk factors could also play a role, such as higher smoking rates in rural areas than in urban areas.[29]

The substantial discrepancies observed in the burden of cancer between sexes (greater in males) could be associated with biological differences and environmental factors, including greater exposure to occupational risk, high social stress, and unhealthy lifestyles in males.[6,9] A previous study indicated that about 45·2% of all cancer deaths in China were attributable to 23 modifiable risk factors.[9] China has released a series of health plans to strengthen the primary control and prevention of cancer, including the Medium-to-Long-Term Plan for Prevention and Control of Chronic Diseases in China (2017–25) and Healthy China 2030, whose implementation would prompt changes in the age-standardised mortality rate and age-standardised YLL rate of major cancer-related deaths, especially in females.[6,10–12,17,18] For example, the decreasing trends in age-standardised mortality and YLL rates in breast cancer or cervical cancer could attribute to the "Two cancers" screening programme.[11,12] Our findings provide further evidence that the five leading causes of cancer-related mortality in females have changed, whereas those in males remained unchanged.

The observed trends in cancer mortality could be explained, at least in part, by a change in relevant risk factors and incidence rates. For example, the consistently high smoking prevalence among Chinese males is likely to have contributed to the high lung cancer mortality rate. Although there has been a slow decline in the prevalence of smoking (58·4% to 50·8% for males and 2·2% to 1·9% for females between 2007 and 2018) in China as a whole, there has been no significant decrease in the prevalence of smoking in rural areas in China.[29] In addition, levels of ambient particulate matter pollution increased significantly during the study period, with reductions only beginning in the past few years. Lower intake of fresh fruit and vegetables and insufficient physical activity during the study period could also play a role in the observed mortality trend.[6,9,30] Moreover, the relatively stable trend in age-standardised incidence for all cancers in males and a significant increase by 2·3% per year in females during 2000–16 could also have contributed to cancer mortality.[31]

The importance, necessity, and effectiveness of interventions such as cancer screening for early diagnosis and treatment and the promotion of hepatitis B and human papillomavirus vaccination[11,12,26,32] are evidenced by the decline in deaths, ranking, and age-standardised mortality rates for liver, stomach, and oesophageal cancers in both sexes, and the decrease in age-standardised mortality rates for breast and cervical cancers among females. The decline in the incidence of stomach and oesophageal cancers has been reported previously,[10] with continuous early diagnosis and treatment of the cancers in the Huai River Basin. Similar trends were reported in high-income countries.[27,33] The implementation of cancer screening in China needs to improve national coverage (only 25·7% of women aged 35–64 years were covered for breast cancer screening and only 31·4% were covered for cervical cancer screening in 2015)[11,12] and increase individual service uptake.

Colon and rectum cancer remained the fifth leading cause of cancer-related mortality in males and increased to the fourth leading cause in females between 2005 and 2020 (previously fifth). Colon and rectum cancer is usually considered one of the most visible signs of cancer transformation with economic development, as it is closely related to lifestyle.[23] Increased intake of foods of animal origin, obesity, and unhealthy habits such as smoking and alcohol consumption in higher-income areas are associated with colon and rectum cancer risk; these risk factors are also associated with pancreatic

	Mortality rate (per 100 000 population)	Average annual percent change in mortality rate (95% CI)
0–19 years		
All sites	4·18 (4·07 to 4·29)	−3·73 (−3·78 to −3·67)*
1 Leukaemia	2·26 (2·18 to 2·33)	−4·22 (−4·34 to −4·11)*
2 Brain and nervous system	1·10 (1·04 to 1·15)	−0·42 (−0·51 to −0·33)*
3 Liver	0·08 (0·06 to 0·09)	−5·79 (−6·70 to −4·88)*
4 Colon and rectum	0·01 (0·01 to 0·02)	−9·74 (−10·48 to −9·00)*
5 Ovarian	0·01 (0·00 to 0·01)	−16·29 (−17·54 to −15·02)*
6 Kidney	0·01 (0·01 to 0·02)	−13·23 (−13·77 to −12·67)*
20–39 years		
All sites	11·82 (11·67 to 11·98)	−2·34 (−2·40 to −2·29)*
1 Breast	2·12 (2·06 to 2·19)	0·34 (0·23 to 0·44)*
2 Leukaemia	1·96 (1·90 to 2·02)	−3·44 (−3·50 to −3·38)*
3 Cervical	1·29 (1·24 to 1·34)	0·28 (0·16 to 0·40)*
4 Liver	1·25 (1·20 to 1·30)	−5·35 (−5·44 to −5·26)*
5 Tracheal, bronchus, and lung	1·11 (1·07 to 1·16)	−2·53 (−2·57 to −2·49)*
6 Stomach	1·02 (0·97 to 1·06)	−2·49 (−2·58 to −2·39)*
7 Colon and rectum	0·77 (0·73 to 0·81)	−1·03 (−1·23 to −0·84)*
8 Brain and nervous system	0·77 (0·73 to 0·80)	−2·43 (−2·51 to −2·34)*
9 Ovarian	0·39 (0·37 to 0·42)	2·65 (2·58 to 2·72)*
10 Pancreatic	0·09 (0·08 to 0·11)	−2·57 (−2·89 to −2·26)*
40–59 years		
All sites	69·01 (68·66 to 69·36)	−2·11 (−2·20 to −2·02)*
1 Tracheal, bronchus, and lung	14·95 (14·79 to 15·12)	−1·29 (−1·36 to −1·21)*
2 Breast	10·50 (10·36 to 10·64)	−0·79 (−0·85 to −0·72)*
3 Cervical	8·30 (8·18 to 8·42)	0·59 (0·53 to 0·65)*
4 Liver	7·67 (7·55 to 7·79)	−4·67 (−4·83 to −4·52)*
5 Stomach	5·70 (5·60 to 5·80)	−4·68 (−4·80 to −4·55)*
6 Colon and rectum	4·72 (4·63 to 4·81)	−0·89 (−0·93 to −0·84)*
7 Ovarian	3·44 (3·37 to 3·52)	1·82 (1·69 to 1·96)*
8 Pancreatic	2·26 (2·20 to 2·33)	0·25 (0·18 to 0·32)*
9 Brain and nervous system	2·24 (2·18 to 2·30)	−1·61 (−1·69 to −1·54)*
10 Leukaemia	2·21 (2·14 to 2·27)	−3·09 (−3·21 to −2·97)*

(Table 3 continues on next page)

	Mortality rate (per 100 000 population)	Average annual percent change in mortality rate (95% CI)
(Continued from previous page)		
60–79 years		
All sites	329·12 (328·07 to 330·18)	−2·14 (−2·36 to −1·92)*
1 Tracheal, bronchus, and lung	94·99 (94·42 to 95·55)	−0·87 (−1·13 to −0·62)*
2 Liver	39·41 (39·04 to 39·77)	−3·61 (−3·80 to −3·42)*
3 Stomach	35·61 (35·26 to 35·95)	−5·18 (−5·60 to −4·77)*
4 Colon and rectum	29·47 (29·15 to 29·78)	−1·32 (−1·64 to −1·00)*
5 Breast	18·44 (18·19 to 18·69)	−0·49 (−0·53 to −0·45)*
6 Oesophageal	17·44 (17·19 to 17·68)	−6·37 (−6·85 to −5·90)*
7 Pancreatic	16·54 (16·31 to 16·78)	0·53 (0·26 to 0·79)*
8 Cervical	16·12 (15·88 to 16·35)	0·38 (0·24 to 0·52)*
9 Brain and nervous system	8·83 (8·65 to 9.00)	−0·26 (−0·39 to −0·12)*
10 Ovarian	8·36 (8·19 to 8·53)	1·58 (1·43 to 1·72)*
≥80 years		
All sites	1554·61 (1548·80 to 1560·43)	−1·15 (−1·19 to −1·11)*
1 Tracheal, bronchus, and lung	474·94 (471·74 to 478·14)	0·69 (0·62 to 0·76)*
2 Stomach	204·34 (202·25 to 206·44)	−3·82 (−3·92 to −3·72)*
3 Colon and rectum	179·66 (177·70 to 181·62)	0·56 (0·51 to 0·60)*
4 Liver	161·16 (159·30 to 163·02)	−2·93 (−2·99 to −2·88)*
5 Oesophageal	119·68 (118·08 to 121·29)	−3·39 (−3·48 to −3·30)*
6 Pancreatic	74·72 (73·46 to 75·99)	1·22 (1·09 to 1·34)*
7 Breast	47·63 (46·63 to 48·65)	−2·10 (−2·15 to −2·06)*
8 Gallbladder and biliary tract	35·84 (34·97 to 36·72)	0·29 (0·23 to 0·35)*
9 Cervical	33·02 (32·18 to 33·87)	−2·52 (−2·58 to −2·47)*
10 Brain and nervous system	31·07 (30·26 to 31·89)	1·36 (1·26 to 1·46)*

Among those aged 0–19 years, there were only six fatal cancer types for males and females. *Indicates a significant increase or decrease.

Table 3: **Ten leading cancer types by mortality rate in 2020 and average annual percent change in mortality rate in females in China, 2005–20**

cancer.[32] We observed increasing trends in deaths, age-standardised mortality rates, YLLs, and age-standardised YLL rates in people older than 40 years due to pancreatic cancer. Enhanced availability and accessibility of health-care resources for treatment and management and diagnostic services are needed for these cancers, especially in males as the average annual percent change in age-standardised mortality rate of colon and rectum and pancreatic cancer is higher in males than females.

We also identified an increased age-standardised mortality rate for genitourinary neoplasms, including prostate and bladder cancer in males and ovarian cancer in females, between 2005 and 2020 in China, possibly associated with changes in lifestyle and population ageing.[34] High-income countries have a higher incidence, mortality, and burden of these three cancers. However, the mortality associated with these cancers is decreasing due to better disease awareness, medical policies, and early screening.[26,34]

Several neoplasms that account for a low proportion of cancer-related mortality cannot be ignored. For example, the mortality rate and age-standardised mortality rate of multiple myeloma and lymphoma increased nationwide from 2005 to 2020. These increases could be associated with economic growth, population ageing, and increased diagnosis mentioned by previous studies.[35,36]

The Chinese Government regards cancer prevention and control as a major special action, targeting an overall 5-year survival rate of more than 46·6% by 2030.[18] Given population ageing and increasingly modern lifestyles, our findings suggest that special efforts are needed to control the increasing deaths from tracheal, bronchus, and lung, colon and rectum, and pancreatic cancer. The premature mortality of cancers in China could be reduced through the improvement of health insurance coverage and strengthening of the medical system and services for the aforementioned cancers.

This study has some limitations. First, the mortality of several types of cancer across provinces might be underestimated owing to under-reporting, and estimation from the 24% surveillance population. We reported adjusted mortality rates based on under-reporting surveys conducted periodically to minimise the under-reporting bias. The iterative method involving multistage stratification used by the National Mortality Surveillance System ensured the representativeness at the national and provincial level.[20] Second, the 95% CIs in this study do not consider measurement bias, selection bias, and model misspecification bias. Third, coding quality varies by province with relatively poor quality in the rural western areas, such as Tibet and Xinjiang, as indicated by the garbage code analysis. Considering the small population size in this region, we believe this will have had little effect on our results. Nevertheless, coding quality in these areas needs to be improved to reflect the local disease burden more accurately. We redistributed the garbage codes to maximise the accuracy and completeness of cause of cancer-related deaths data. Fourth, the absence of data on education level, and data regarding cancer stage prevents cross-regional differences in mortality and cancer burden from being adequately discussed and explained.

In conclusion, the cancer burden in China appeared to shift towards that of high-income countries between 2005 and 2020, with substantial discrepancies in sex, age, and urban versus rural areas observed in cancer mortality and leading causes of cancer-related mortality. The Chinese Government should make every effort to promote cost-effective cancer screening and immunisation programmes, implement strict tobacco control policies, and commit to raising awareness of healthy lifestyles through education. Adjustments to national cancer control programmes are needed to reduce the burden of tracheal, bronchus, and lung cancer and other emerging cancers across provinces.

Contributors

JQ, PY, LW, and MZ conceived the ideas for this research and provided overall guidance. JQ, PY, and MZ verified the data, and all authors had

full data access. All authors prepared the first draft of the manuscript and finalised it based on comments from each other. PY was responsible for the decision to submit the manuscript for publication. All other authors contributed to the analysis and approved the manuscript for publication.

Declaration of interests

We declare no competing interests.

Data sharing

Data included in this study are not publicly available. The National Center for Chronic and Non-communicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention provides conditional data access for qualified researchers with legitimate requests. Please contact yinpeng@ncncd.chinacdc.cn to seek approval for data access.

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