


eGastroenterology Burden of digestive system malignancies and its impact on life expectancy in China, 2004–2021

Ting Hu,¹ Shiyue Wang,¹ Yingying Wang,¹ Xinlong Wang,¹ Lin Shang,² Kaijuan Wang ^{1,3,4}

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¹College of Public Health, Zhengzhou University, Zhengzhou, Henan, China

²Department of Science and Technology of Henan Province, Zhengzhou, Henan, China

³Henan Key Laboratory of Tumor Epidemiology; Henan International Joint Laboratory of Tumor Biomarkers and Molecular Imaging, Zhengzhou University, Zhengzhou, Henan, China

⁴National Key Laboratory of Metabolism Disorder and Esophageal Cancer Prevention & Treatment, Zhengzhou University, Zhengzhou, Henan, China

Correspondence to

Professor Kaijuan Wang; kjwang@163.com

Digestive system malignant tumours (DSMTs) are prevalent, with oesophageal, gastric, colorectal, liver and pancreatic cancers being the most common types according to the fifth edition of the WHO's classification of DSMTs. Data from GLOBOCAN 2022 showed that oesophageal, gastric, colorectal, liver and pancreatic cancer accounted for approximately 4.6%, 6.8%, 9.3%, 7.8% and 4.8% of global cancer deaths and ranked seventh, fifth, second, third and sixth, respectively. Prior research has forecasted a substantial increase in new cases and mortality rates of digestive system malignancies by 2040, with a projected global increase of 58% in new cases and a more pronounced surge of 73% in deaths.¹ This alarming growth forecast underscores the impending massive public health burden associated with these diseases. In China, the cancer profile exhibits similarities with both developed and developing countries. Specifically, colorectal, gastric and liver cancers represent a larger proportion of total malignancies in China compared with the global average in 2020. Liver, gastric, oesophageal and colorectal cancers are among the most common malignancies in China, associated with poor prognoses and contributing greatly to the high cancer burden in the country. Life expectancy serves as a crucial metric that mirrors the social development level and health status of a population. Enhancing life expectancy stands as a key objective of the 'Healthy China 2030' initiative. Assessing the disease burden and life expectancy of DSMTs across China, alongside monitoring their evolving trends, is essential for appraising the efficacy of DSMTs prevention and treatment strategies across various regions, populations and time periods in recent years (online supplemental file 1).²

Between 2004 and 2021, the crude mortality rate (CMR) for DSMTs in the Chinese

population remained relatively stable, while the age-standardised mortality rate (ASMR) exhibited a downward trend (the average annual percentage change, AAPC=−3.12%, 95% CI: −4.37%, −1.85%). The CMR of oesophageal and gastric cancers exhibited significant decreasing trends, with AAPCs of −1.66% and −2.02%, respectively (both $p<0.05$). However, CMR for colorectal cancer increased, with an AAPC of 3.59% ($p<0.05$). The ASMR for oesophageal cancer, gastric cancer and liver cancer also demonstrated decreasing trends, with AAPCs of −4.30%, −4.14% and −2.58%, respectively (all $p<0.05$). Conversely, both the CMR and ASMR for pancreatic cancer exhibited increasing trends, with AAPCs of 5.72% and 2.71%, respectively ($p<0.05$) (table 1, online supplemental table A1).

From 2004 to 2021, the ASMR of oesophageal cancer, gastric cancer and liver cancer all showed a downward trend in both males and females (AAPCs are −3.94%, −4.11% and −2.53% in males, −5.55%, −4.54% and −2.86% in females, respectively, all $p<0.05$), whereas the ASMR of colorectal cancer and pancreatic cancer in males exhibited upward trends, with AAPCs of 0.53% and 2.59%, respectively ($p<0.05$). Notably, the ASMR of pancreatic cancer showed an increasing trend in females (AAPC=2.09%, $p<0.05$). Furthermore, from 2004 to 2021, the ASMR of oesophageal, gastric and liver cancers in urban and rural areas decreased (AAPCs are −3.38%, −5.09% and −3.21% in urban areas, −5.28%, −4.63% and −2.79% in rural areas, respectively, all $p<0.05$), while the ASMR of pancreatic cancer in rural areas increased by 4.62% per year ($p<0.05$). The ASMR of oesophageal, gastric and liver cancers in the eastern and central regions is decreasing (AAPCs are −4.38%, −4.31% and −3.64% in the eastern region, −5.64%, −4.96% and

Table 1 Crude mortality rate (/100 000), and average annual percentage change (AAPC, %) of five digestive system malignant tumours in China from 2004 to 2021

Year	Oesophageal cancer	Gastric cancer	Colorectal cancer	Liver cancer	Pancreatic cancer	Total
2004	15.46	25.23	7.31	26.44	2.60	77.05
2005	14.95	24.19	7.53	26.08	2.63	75.39
2006	12.81	18.87	7.17	21.39	2.88	63.12
2007	13.68	21.23	7.96	23.89	3.38	70.16
2008	13.20	20.64	8.07	25.52	3.37	70.81
2009	13.06	21.24	8.54	25.30	3.64	71.30
2010	12.05	20.39	8.27	24.79	3.69	69.19
2011	12.03	19.58	8.48	23.94	3.91	66.23
2012	11.84	20.01	8.81	24.40	4.08	69.14
2013	12.54	20.41	9.02	24.69	4.23	70.89
2014	12.84	21.10	9.65	26.22	4.43	74.24
2015	12.57	20.92	10.19	26.08	4.76	74.53
2016	12.51	20.51	10.47	25.53	5.06	74.09
2017	12.49	19.92	10.99	25.17	5.14	73.72
2018	12.36	19.69	11.58	24.66	5.57	73.88
2019	12.01	19.57	12.21	24.43	6.00	71.67
2020	11.79	18.40	12.71	25.05	6.24	74.20
2021	11.70	18.39	13.07	24.92	6.58	74.65
AAPC (%)	-1.66	-2.02	3.59	0.10	5.72	-0.24
95% CI	(-2.84, -0.46)	(-3.06, -0.98)	(3.11, 4.07)	(-0.38, 0.57)	(5.03, 6.57)	(-1.17, 0.69)
P value	0.007	<0.001	<0.001	0.670	<0.001	0.607

The AAPC value is the AAPC value of the optimal model selected by Joinpoint software.
AAPC, average annual percentage change.

-2.90% in the central region, respectively), and pancreatic cancer is increasing (AAPCs are 1.37% and 3.06%, respectively). In western China, oesophageal cancer and gastric cancer showed decreasing trends, with AAPCs of -3.34% and -4.50%, respectively. In contrast, colorectal cancer and pancreatic cancer demonstrated increasing trends, with AAPCs of 1.46% and 4.21%, respectively (all $p<0.05$) (figure 1).

Between 2004 and 2021, the average annual rate of premature death from DSMTs decreased by 3.32% (95% CI: -4.52%, -2.09%), significant downward trends were observed in oesophageal, gastric and liver cancers, with AAPCs of -5.44%, -5.10% and -2.93% (all $p<0.05$). The probability of premature death from DSMTs diminished considerably during the observed period, irrespective of gender (AAPC=-3.45%, -4.13%, respectively, both $p<0.05$). Additionally, the premature death probability of oesophageal cancer, gastric cancer and liver cancer decreased in both sexes (AAPCs are -4.56%, -5.33% and -3.05% in males, -7.34%, -6.29% and -3.75% in females, respectively, all $p<0.05$). The average annual increase in premature death probability of pancreatic cancer in males was 2.19% and in females was 2.66% (both $p<0.05$). The total premature death probability of DSMTs

significantly reduced in both urban and rural areas from 2004 to 2021, with AAPCs of -2.50% and -3.71%, respectively (both $p<0.05$). Similarly, the premature death probability of oesophageal cancer, gastric cancer and liver cancer diminished in both urban and rural settings (AAPCs are -3.83%, -5.56% and -2.67% in urban areas, -5.75%, -5.67% and -2.87% in rural areas, respectively, all $p<0.05$). Colorectal cancer showed a decreasing trend in urban areas (AAPC=-0.87%, $p<0.05$). The probability of premature death due to pancreatic cancer in rural areas has risen (AAPC=4.37%, $p<0.05$). The total premature death probability of DSMTs significantly decreased in the eastern, middle and western regions, with AAPCs of -2.79%, -3.90% and -2.29%, respectively (all $p<0.05$). The premature mortality rate for oesophageal, gastric and liver cancer fell substantially in the east and middle of China (AAPCs are -4.27%, -4.96% and -3.23% in eastern areas, -6.09%, -5.58% and -2.56% in middle areas, respectively, all $p<0.05$). In western China, both oesophageal and gastric cancer rates are dropping, with AAPCs of -4.68% and -6.15%, respectively (both $p<0.05$). However, it rose for pancreatic cancer in the centre and west, with AAPCs of 3.12% and 3.85%, respectively (both $p<0.05$) (figure 2 online supplemental table A2).

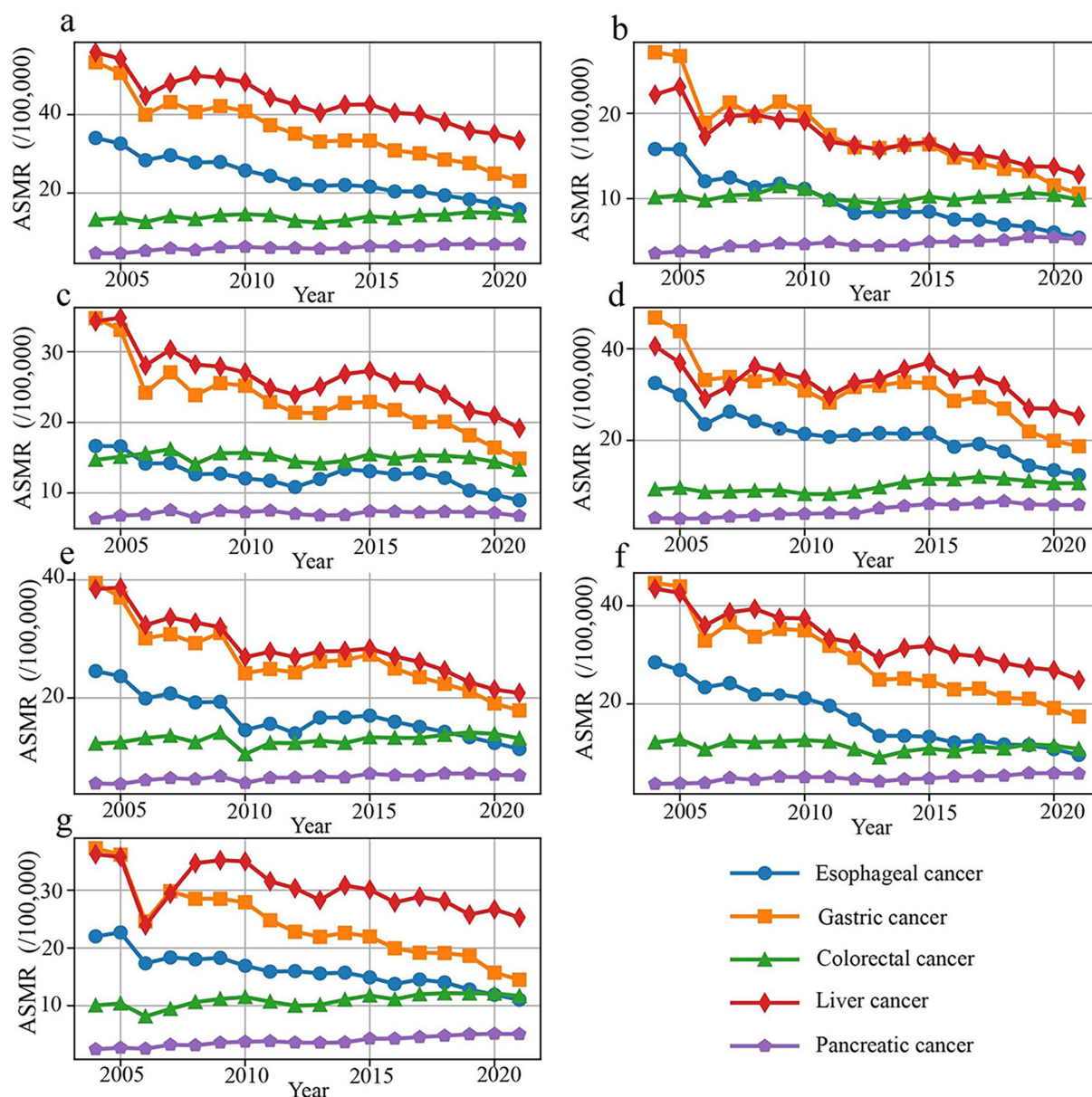


Figure 1 Trends of age-standardised mortality rates (ASMR) (/100 000) of digestive system tumours by sex, urban and rural areas, and regions from 2004 to 2021. (a) Male, (b) Female, (c) City, (d) Rural, (e) East, (f) Middle and (g) West. ASMRs: calculated based on the population size of China's seventh population census and the age composition ratio of the seventh population census.

From 2004 to 2021, the average life expectancy in China increased by 4.4 years (AAPC=0.35%, $p<0.05$), with the cause eliminated life expectancy (CELE) rising by 4.06 years ($p<0.05$). This improvement was seen across diverse demographic groups, including both men and women, urban and rural residents, and those living in the eastern and central regions (all $p<0.05$). Overall, for all five types of cancers examined, the increase in CELE was greater in men than in women, more pronounced in rural areas than in cities, and highest in the western region, followed by the middle and eastern regions (figure 3, online supplemental table A3).

The total number of potential years of life lost (PYLL) due to DSMTs-related deaths in the Chinese population from 2004 to 2021 amounted to 21 728 300 person-years.

This included 16 287 820 person-years for males and 5 440 480 person-years for females. Regionally, urban areas accounted for 6 620 200 person-years, while rural areas accounted for 15 108 100 person-years. The PYLL was 8 662 200 person-years in the east, 7 376 200 person-years in the centre and 5 689 900 person-years in the west. The average potential years of life lost (AYLL) over the entire 18-year period was 18.29 person-years, with 14.64 person-years for men and 13.52 person-years for women. In terms of urban–rural differences, urban areas had an AYLL of 13.53 person-years, while rural areas had a slightly higher value of 13.88 person-years. Geographically, the eastern, central and western regions showed values of 13.86, 14.30 and 15.24 person-years, respectively. Over the 18-year period, the overall PYLL rate

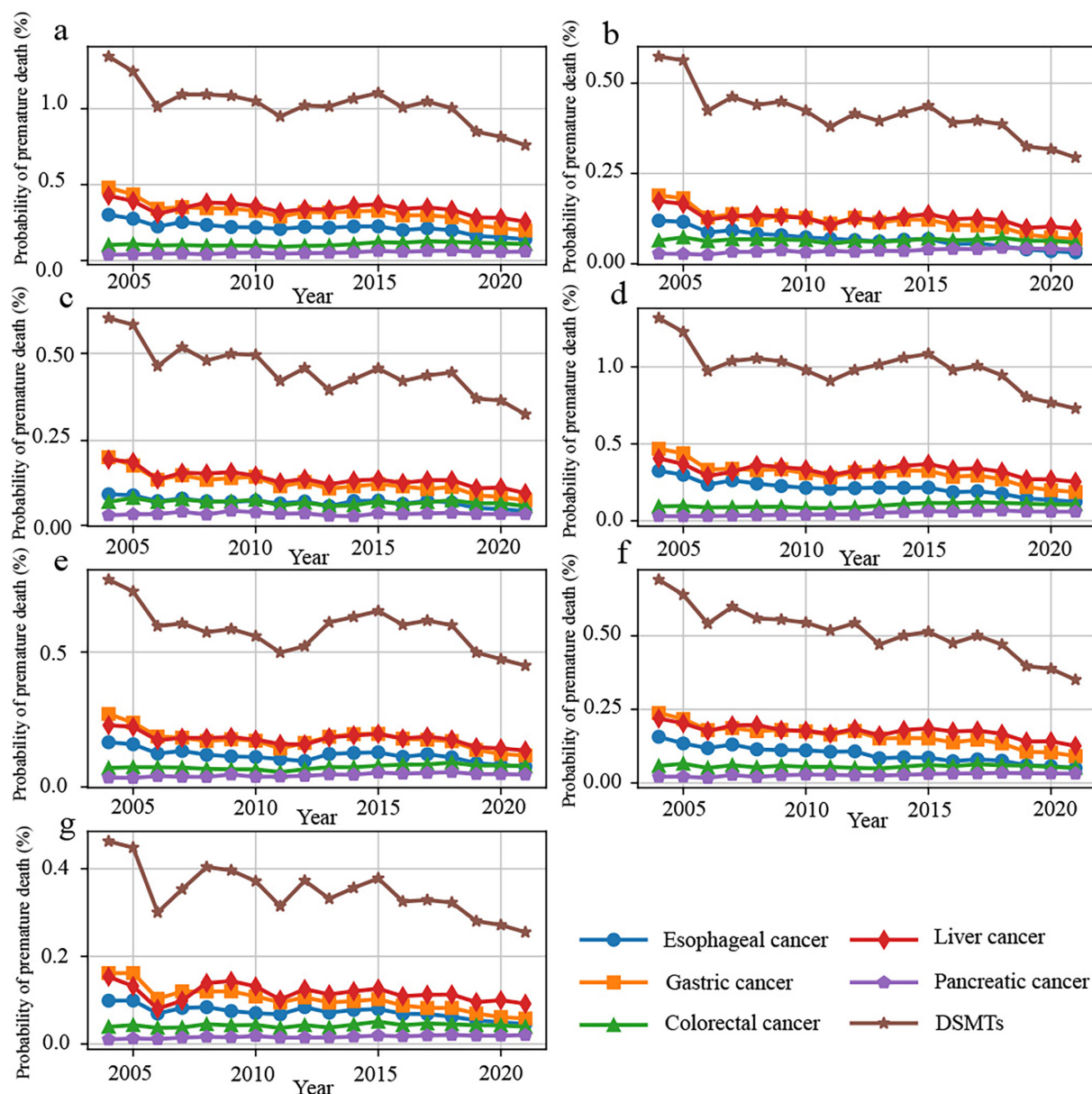


Figure 2 Trends in the probability of premature mortality of five digestive system malignant tumours in China by gender, urban and rural areas, and regions from 2004 to 2021. (a) Male, (b) Female, (c) City, (d) Rural, (e) East, (f) Middle and (g) West. DSMTs, digestive system malignant tumours.

(PYLLR) was 0.76%. Specifically, it was 1.05% for men, 0.37% for women, 0.68% in urban areas and 0.75% in rural areas. The eastern, central and western regions exhibited PYLLRs of 0.78%, 0.74% and 0.75%, respectively. A significant increasing trend was observed in the total PYLL (AAPC=6.34, $p<0.05$), while the AYLL showed a decreasing trend (AAPC=-1.58%, $p<0.05$). Males consistently had higher levels of PYLL, AYLL and PYLLR compared with females. Rural areas had higher PYLL, AYLL and PYLLR values than urban areas, in terms of regional differences, the eastern region has higher PYLL and PYLLR values, while the western region has a higher AYLL value. (online supplemental figure A1). Among the five digestive malignant tumours, liver cancer had the highest PYLL at 10 006 412 person-years over 18 years,

followed by gastric cancer with 5 036 817 person-years PYLL. Over the 18-year period, PYLL from five digestive system cancerall showed a significant upward trend, with AAPCs of 3.97%, 4.62%, 9.78%, 6.35% and 12.79% respectively (all $p<0.05$) (online supplemental table A4).

Our findings indicate that between 2004 and 2021, China observed a stable CMR for DSMTs, contrasting with a significant decline in the ASMR. This divergence in patterns could be attributed to the ageing demographic landscape of the nation, as evidenced by World Bank projections, which indicated a rise in the elderly population from 13.5% in 2020 to 14.9% in 2022, coupled with an escalating burden of chronic illnesses.³

The reduction in the prevalence of oesophageal, gastric and liver cancers may be linked to enhancements

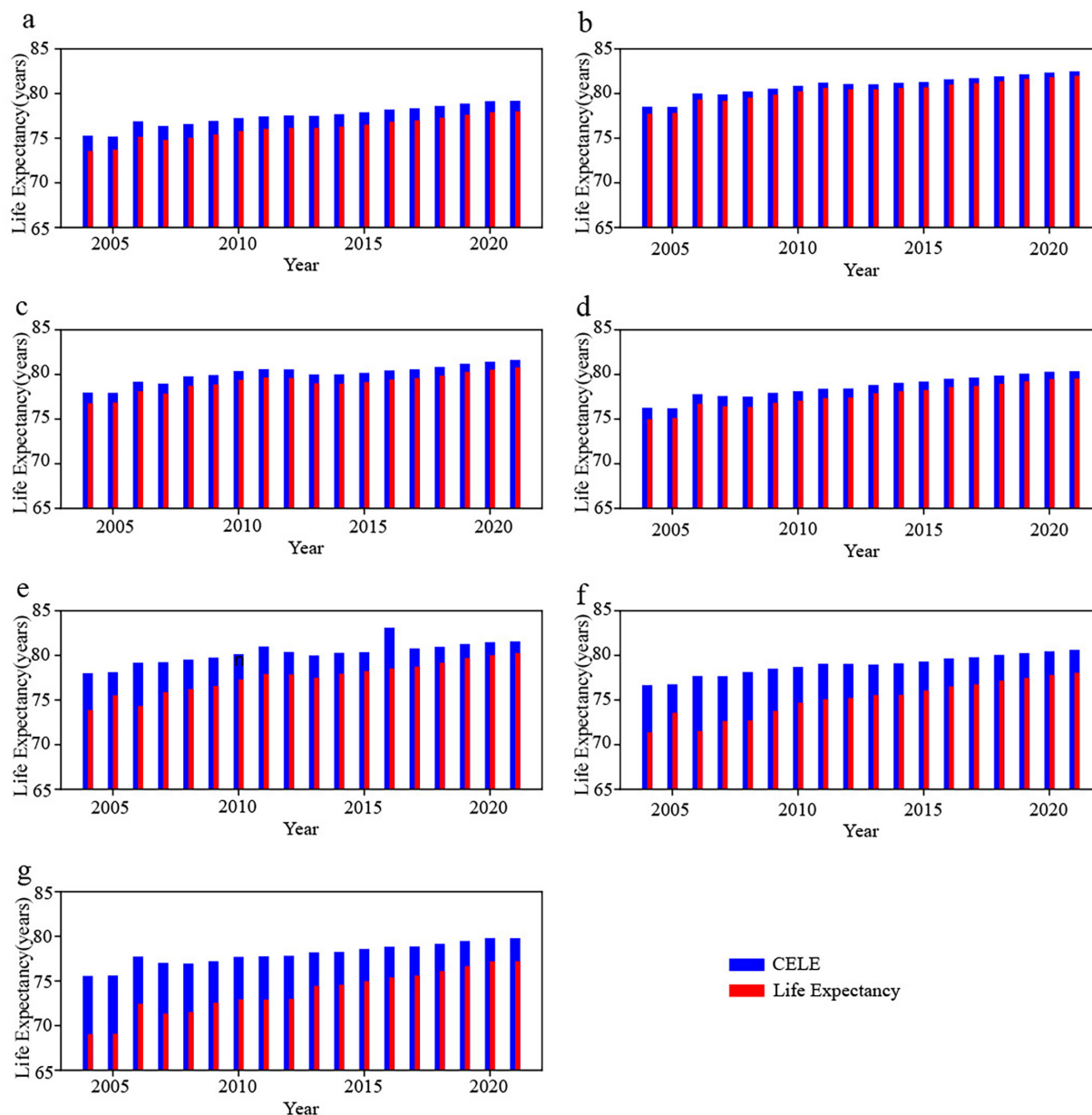


Figure 3 The levels and trends of life expectancy (years) in different genders and regions from 2004 to 2021 in China. (a) Male, (b) Female, (c) City, (d) Rural, (e) East, (f) Middle and (g) West. CELE, cause-eliminated life expectancy.

in dietary habits, lifestyle modifications and effective healthcare policies. Screening and early detection are vital for managing oesophageal, gastric and liver cancers. Since 2005, China has implemented cancer screening programmes targeting these malignancies, including early diagnosis and treatment in high-incidence rural areas, the Huaihe River Basin and urban regions. These initiatives have appreciably boosted early diagnosis rates. Additionally, numerous research projects, such as endoscopic screening cohorts in the Taihang Mountains, Anyang oesophageal cancer cohort study and prospective cohort studies, have effectively improved early diagnosis and treatment rates for oesophageal cancer.³ In addition, economic growth, better food storage and hygiene, and control of *Helicobacter pylori* have contributed to a notable decrease in the disease burden of gastric cancer. China's

incorporation of the hepatitis B vaccine into its national immunisation programme in 2002, coupled with advancements in medical technology, reduced hepatitis B viral infections and decreased aflatoxin exposure, resulting in a marked decline in liver cancer.

Lifestyle choices play an important role in the risk of colorectal and pancreatic cancers. As China's economy has expanded, there has been a rise in the consumption of dairy products, red and processed meats, alongside a decrease in the intake of grains and fibre. This dietary transition has led to higher incidence and mortality rates from these diseases, highlighting the need for public health interventions to promote healthier eating habits. Colorectal and pancreatic cancers are often diagnosed at advanced stages because of their subtle early symptoms, which greatly hinders treatment efficacy and contributes

to the difficulty in reducing mortality rates for these diseases.⁴ The faecal occult blood test serves as a sensitive, easily administered, and widely embraced screening tool for colorectal cancer in high-risk populations. Its significance lies in its ability to enable early detection, which is crucial for improving survival rates and reducing mortality from this disease.⁵ The ASMR of pancreatic cancer is escalating in rural areas, primarily due to the adoption of Westernised lifestyles characterised by smoking, excessive alcohol consumption, obesity and physical inactivity. Changing these detrimental habits is essential to curb mortality from this disease.⁶ Furthermore, previous studies have demonstrated that imaging modalities such as CT, MRI and nuclear magnetic resonance exhibit high sensitivity and specificity in diagnosing pancreatic cancer. These advanced imaging techniques play a crucial role in detecting early-stage pancreatic cancer and in facilitating the differential diagnosis of related conditions.⁷

From 2004 to 2021, life expectancy and CELE due to the five types of digestive system tumours have increased in China. The rate of life loss due to these tumours has decreased among men, thereby reducing their overall disease burden. However, men still experience higher PYLL and PYLLR than women. Rural and eastern regions exhibited more substantial impacts in comparison to urban and central/western areas, which was attributed to higher smoking, alcohol consumption and unhealthy lifestyles among males. Insufficient medical resources and uneven health resource distribution exacerbate cancer risks in rural areas, with regional economic disparities further complicating health inequalities.⁸ In recent years, however, inequalities between urban and rural areas as well as among the eastern and central regions have been narrowing. Consequently, variations in the burden of digestive system tumours between these areas are also progressively diminishing.⁹ The ASMR of pancreatic and colorectal cancer tends to be higher in the eastern region, possibly because of its elevated economic development, increased adoption of westernised diets, and a faster pace of life. To reduce loss of life from these tumours, effective health education programmes and interventions are necessary. Prevention measures should focus on colorectal and pancreatic cancers, particularly among men living in rural and western areas. Screening for specific digestive tumours is essential in high-risk populations and areas. However, this study has several limitations. First, the long time span may have caused differences in data comparability owing to changes in the cause-of-death surveillance system and data collection methods. Second, despite advancements in cause-of-death surveillance in China, regional and interinstitutional variations in data quality and completeness may have impacted the outcomes.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval All data used in this study were sourced from the publicly available database of the Chinese Centre for Disease Control and Prevention (CDC). This database is specifically designed to provide the public and researchers with updated data and information on disease control and public health. The data do not contain any private personal information and are summarised in a statistical manner. To ensure privacy protection, all data used in this study were anonymised and could not be traced back to any individual. Therefore, individual privacy is not compromised. Since the data are publicly accessible and do not involve direct investigation or experimentation, informed consent from individuals is not required.

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ORCID iD

Kaijuan Wang <http://orcid.org/0000-0002-3300-9453>

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