

BMJ Open Burden of brain and other central nervous system cancer in China, 1990–2019: a systematic analysis of observational data from the global burden of disease study 2019

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ABSTRACT

Objective To evaluate the trends in disease burden and the epidemiological features of central nervous system (CNS) cancer in China from 1990 to 2019.

Design A population-based observational study.

Setting The incidence, prevalence, death and disability-adjusted life years (DALYs) due to CNS cancer in China, stratified by sex, age and provincial region, were collected from the Global Burden of Disease Study 2019.

Participants Data were publicly available and individuals were not involved.

Results In 2019, the incident cases of CNS cancer in China were 347 992 (95% UI 262 084–388 896), and the age-standardised rate (ASR) of incidence was 5.69 (95% UI 4.36–6.78) per 100 000 person-years increased by 27.9% compared with that in 1990; meanwhile, CNS cancer caused 63 527 (95% UI 47 793–76 948) deaths in China in 2019, and the ASR of death was 3.5 (95% UI 2.62–4.21) per 100 000 person-years decreased by 9.6%. The ASRs of incidence and prevalence of CNS cancer in China increased more rapidly than the global average; meanwhile, the ASRs of DALYs owing to CNS cancer declined more rapidly. The burden of CNS cancer showed no significant differences between men and women, but was more pronounced in early childhood and old adulthood. The ASRs of incidence and prevalence were higher in high-income provinces, confirmed by the positive correlation with Sociodemographic Index (SDI), with correlation coefficient r of 0.322 and 0.767, respectively (both $p < 0.0001$). However, the ASRs of death and DALYs demonstrated a negative correlation with SDI, with r of -0.319 and -0.642 , respectively (both $p < 0.0001$).

Conclusions From a global perspective, China has been bearing a substantial burden of CNS cancer. More attention should be paid to children and elderly populations for CNS cancer. The disease burden varied significantly at the subnational level of China, which was associated with socioeconomic development.

INTRODUCTION

Primary malignant tumours in the central nervous system (CNS) mainly occur in the brain (accounting for more than 90%), with

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This is the first study in China that analyses the trend of the disease burden of CNS cancer for a long-term period of 30 years (1990–2019) at national and subnational levels.
- ⇒ From the Global Burden of Disease Study 2019, wide disparities were revealed in the burden of CNS cancer by sex, age and provincial region in China, which might be associated with socioeconomic development.
- ⇒ The main limitation is that the data were secondary estimated data rather than the original surveillance data, and hence it has all the limitations pertaining to the data, such as the inevitable report omission of some CNS cancer cases, the underestimation of years lived with disability due to the scanty follow-up survey of some patients with CNS cancer and the lack of the detailed information about histological subtypes of CNS cancer.

other anatomical regions also reported, such as the spinal cord, meninges and cranial nerves, and will be referred to as CNS cancer collectively subsequently. CNS cancer is a group of malignant tumours with high heterogeneity in molecular biology and histology,¹ accounting for nearly 30% of all primary CNS tumors.² The prognosis of CNS cancer is unsatisfactory, as the overall 5-year relative survival rate following diagnosis of a CNS cancer was 36.0% according to data from the USA.² CNS cancers, constituting 1.6%–1.9% of all cancer cases and causing 2.5%–2.6% of all cancer deaths,^{3 4} exhibit large variability in epidemiology across the world⁵; moreover, the diagnosis and treatment of CNS cancer usually require highly specialised and integrated multidisciplinary care, which varies significantly across the world and results in the discrepancies in clinical outcomes, less

satisfactory in low-income and middle-income regions.^{6 7} For the biggest developing country with the largest population, it is crucial to profile the disease burden imposed by CNS cancer in China, which is still inadequate.

The Global Burden of Diseases, Injuries and Risk Factors Study (GBD) provides constantly updated estimations of the incidence, prevalence, mortality, years of life lost (YLLs), years lived with disability (YLDs) and disability-adjusted life-years (DALYs) for a mutually exclusive and collectively exhaustive list of diseases and injuries, based on all available data from literature, survey data, surveillance data, inpatient admission records, outpatient visit records, health insurance claims, etc.^{8–12} By now, GBD 2019 has provided the most up-to-date assessment of the burden of 369 diseases and injuries for 204 countries and territories from 1990 to 2019.¹² Previously, GBD 2016 brain and other CNS cancer collaborators analysed the CNS cancer burden at the global scale,⁵ in which China had the highest number of incident cases, deaths and DALYs due to CNS cancer across the world.

Thus, in the present study, we analysed the current situation, the temporal trend from 1990 to 2019, the sex and age distribution, and the spatial pattern of the CNS cancer burden in China, intending to provide a reference for policymakers and peer researchers.

MATERIALS AND METHODS

Overview

In the present study, all analyses were performed with data from GBD 2019¹³ explored with the Global Health Data Exchange query tool (<http://ghdx.healthdata.org/gbd-results-tool>). CNS cancer was listed at level 3 (B.1.22) under neoplasms (B.1, level 2) and non-communicable diseases (B, level 1) in the GBD 2019 cause hierarchy, corresponding to C70–C72.9 in the International Classification of Diseases, 10th Revision, and 191–192.9 in the 9th revision.

The incidence, prevalence, mortality and DALYs, stratified by age, sex and region (mainly 33 province-level administrative units in China, namely, 31 provinces, municipalities, autonomous regions, and Hong Kong and Macao Special Administrative Regions, referred to as provinces subsequently, were adopted to depict the disease burden of CNS cancer in China. The comprehensive methods to calculate estimations of these metrics were reported previously^{5 13 14}; thus, a brief overview specific to CNS cancer is presented here.

Mortality, incidence, prevalence and DALYs estimation

Mortality was estimated with the Cause of Death Ensemble model, in which the combined data on CNS cancer mortality included observed vital registration deaths and deaths derived from registry incidence multiplied by mortality to incidence ratio was the data inputs. The main data sources in China included the Disease Surveillance Point system, the China Cancer Registry, the Chinese Center for Disease Control and Prevention cause-of-death

reporting system, medical certification of causes of death for Macao and Hong Kong, as well as surveys.¹⁵

Incidence was estimated by dividing the final mortality estimates by mortality to incidence ratios and DisMod-MR V.2.1, a Bayesian meta-regression modelling tool, was used to ensure consistency.

The CNS cancer prevalence was calculated by estimating 10-year survival based on mortality-to-incidence ratios for each incidence cohort and adjusting for expected background mortality.

YLLs were generated by multiplying the number of deaths with the corresponding standard life expectancy at the age of death. YLDs were the product of the prevalence of each phrase of CNS cancer multiplied by a distinct disability weight, quantifying the severity of a sequela. Moreover, DALYs were the sum of YLLs and YLDs.

The 95% UIs for each measure were supplied, of which lower and upper bounds were estimated by the 25th and 975th values of the ordered 1000 samples from the posterior distribution of each measure.

Patient and public involvement

Patients or the public were not involved in the design, conduct, reporting or dissemination plans of our research

Statistical analysis

The age-standardised incidence rates (ASRs) of incidence, prevalence, death and DALYs were employed to avoid the interference caused by population size and age distribution and were calculated by the formula $ASR = \frac{\sum_{i=1}^A a_i w_i}{\sum_{i=1}^A w_i} \times 100,000$, where a_i represents the age-specific rate, and w_i represents the number of people in age group i , and A represents the number of age groups in the reference standard population.

Joinpoint regression analysis¹⁶ was performed to evaluate the temporal trends of disease burden from 1990 to 2019, in which the annual percentage change (APC) and the average annual percentage change (AAPC), both with the 95% CI were calculated by Joinpoint Regression Program V.4.9.0.0 (March 2021, National Cancer Institute). In the segmented log-linear regression model for ASR data, $\ln(ASR) = \alpha + \beta_i \times (\text{calendar year}) + \varepsilon$, APC indicating the rate of change in specific segment of whole study period and APCC indicating the overall rate of change in the whole study period were calculated as follows:

$$APC = (e^{\beta_i} - 1) \times 100$$

$$AAPC = (e^{\sum w_i \beta_i / \sum w_i} - 1) \times 100$$

In the aforementioned formulas, β_i is the slope coefficients of each segment in the expected year range, and w_i is the year length of each segment in the year range.¹⁷

The ASRs of incidence, prevalence, death and DALYs due to CNS cancer in China in the next two decades were predicted by the autoregressive integrated moving average (ARIMA) model, which has been widely used to forecast the trend of epidemiological data.^{18 19} It was

performed on the open-source R program V.4.0.5 with forecast V.8.15 and tseries V.0.10–49 packages and the function `auto.arima()`, to determine the optimal value of p , d and q in the ARIMA (p , d , q) model.

Spearman's correlation test was performed between the disease burden metrics and Sociodemographic Index (SDI) of different provinces, a composite indicator of income per capita, years of schooling and total fertility rate. In addition, these provinces were also roughly classified into four regions: the east, the central, the west and the northeast, based on geographical, climatic, economic and cultural characteristics. Correlation analyses were performed with R software V.4.0.5, and a p value of less than 0.05 was considered statistically significant.

RESULTS

Overall incidence, prevalence, mortality and DALYs of CNS cancer worldwide and in China

In 2019, CNS cancer afflicted 347 992 (95% UI 262 084–388 896) incident cases across the world, with an ASR of 4.34 (95% UI 3.27–4.86) per 100 000 person-years increased by 13.8% from 1990 to 2019. Meanwhile, CNS cancer caused 246 253 (95% UI 185 642–270 930) deaths in 2019 globally, with an ASR of 3.05 (95% UI 2.29–3.36) per 100 000 person-years decreased by 1.2% from 1990 to 2019. Additionally, the global prevalent cases of CNS cancer were 1 065 294 (95% UI 800 441–1 199 906) in 2019, with an ASR of 13.48 (95% UI 10.09–15.19) per 100 000 person-years increased by 59.7% from 1990 to 2019; and the DALYs were 8 659 871 (95% UI 6 718 029–9 574 458) person-years in 2019, with an ASR of 109.04 (95% UI 84.57–120.92) per 100 000 person-years, decreased by 10.4% from 1990 to 2019 (table 1).

In China, CNS cancer afflicted 94 686 (95% UI 73 401–114 092) incident cases in 2019, accounting for more than a quarter of that in the world, with an ASR of 5.69 (95% UI 4.36–6.78) per 100 000 person-years (online supplemental figure S1), increased by 27.9% from 1990 to 2019. Moreover, CNS cancer caused 63 527 (95% UI 47 793–76 948) deaths in China in 2019, comprising 2.34% deaths in all neoplasms (ranked eighth) (online supplemental figure S2), which was the highest in the world (online supplemental figure S1), with an ASR of 3.5 (95% UI 2.62–4.21) per 100 000 person-years (online supplemental figure S1), decreased by 9.6% from 1990 to 2019. Additionally, the prevalent cases of CNS cancer in China in 2019 were 327 890 (95% UI 256 541–399 233), with an ASR of 22.58 (95% UI 17.42–27.22) per 100 000 person-years, increased by 177%, and the total DALYs due to CNS cancer were 2 053 424 (95% UI 1 584 338–2 524 972) person-years, comprising 3.23% DALYs in all neoplasms (ranked ninth) (online supplemental figure S2), with an ASR of 126.24 (95% UI 96.01–154.8) per 100 000 person-years, decreased by 21.7% from 1990 to 2019 (table 1).

Temporal trends of burden CNS cancer from 1990 to 2019 and the forecasts for the next two decades in China

The absolute values of incidence, prevalence, deaths and DALYs increased steadily in China from 1990 to 2019 (figure 1). After analysed by Joinpoint regression, stable increases in ASRs of incidence (AAPC 0.8%, 95% CI 0.6% to 1.1%) and prevalence (AAPC 3.6%, 95% CI 3.3% to 3.9%), and stable decreases in ASRs of deaths (AAPC –0.4%, 95% CI –0.4% to –0.3%) and DALYs (AAPC –0.8%, 95% CI –1% to –0.7%) were demonstrated (figure 1 and online supplemental table S1).

Additionally, DALYs due to CNS cancer were predominantly driven by YLLs, rather than YLDs (online supplemental figure S3), consistent with a previous study on a global scale.⁵

The disease burden of AA in China in the next two decades was predicted by the ARIMA model, which fitted well with GBD 2019 estimations from 1990 to 2019, and it could be expected that a continuous increase of ASRs of incidence and prevalence would be inevitable, while the ASRs of deaths and DALYs due to CNS cancer would remain stable by 2039 (figure 2).

Sex and age distribution of the burden of CNS cancer in China

For both absolute value and age-specific rate of incidence, prevalence, deaths and DALYs due to CNS cancer in China in 2019, no significant differences were observed in men and women. The number of incident cases peaked at the age of 60–69 years, and its ASR exhibited a small peak in early childhood (under 5 years of age), then kept steady until the sixth decade, followed by a steep rise. The number of deaths peaked at the age of 65–74 years, and its ASR showed a similar trend to that of incidence. The age distribution of prevalence and its age-specific rate showed a peak in the middle-aged group (30–49 years), besides the early childhood. The DALYs due to CNS cancer peaked at the age of 50–59 years, and its ASR showed a more representative curve with a minor peak at childhood, followed by a decline in middle age, then a major peak in senior age (figure 3 and online supplemental table S2).

Spatial pattern of the burden of CNS cancer in China

Substantial disparities of CNS cancer burden existed in the included 33 provinces in China. For the ASR of incidence, the top five provinces were Tianjin, Liaoning, Hubei, Shandong and Shanghai, located in circum-Bohai-Sea region and Yangtze River basin (figure 4 and online supplemental table S3). The distribution of prevalence was more characteristic, higher in high-income provinces located in the east coast, the south coast and Yangtze River basin, whereas the distribution of mortality and DALYs due to CNS cancer may be complicated by multiple factors, as they were also prominent in some low-income provinces (figure 4 and online supplemental table S3). Moreover, the dynamic changes of these metrics from 1990 to 2019, also visualised in the maps, reflected similar patterns (online supplemental figure S4).

Table 1 Counts and ASR of incidence, prevalence, death and DALYs due to CNS cancer and the percentage change of the ASRs in the world and in China

Measurement	World				China			
	1990	2019	Change (%)	1990	2019	Change (%)	1990	2019
Incidence counts (95% UI)	179 051 (152 530–237 072)	347 992 (262 084–388 896)	94.4	45 847 (35 181–61 348)	94 686 (73 401–114 092)	106.5	45 847 (35 181–61 348)	94 686 (73 401–114 092)
Incidence ASR (per 100 000 person-years, 95% UI)	3.82 (3.34–5.0)	4.34 (3.27–4.86)	13.8	4.45 (3.47–5.94)	5.69 (4.36–6.78)	27.9	4.45 (3.47–5.94)	5.69 (4.36–6.78)
Prevalence counts (95% UI)	423 569 (360 088–559 067)	1 065 294 (800 441–1 199 906)	151.5	92 193 (69 713–123 623)	327 890 (256 541–399 233)	255.7	92 193 (69 713–123 623)	327 890 (256 541–399 233)
Prevalence ASR (per 100 000 person-years, 95% UI)	8.44 (7.3–10.94)	13.48 (10.09–15.19)	59.7	8.15 (6.19–10.95)	22.58 (17.42–27.22)	177	8.15 (6.19–10.95)	22.58 (17.42–27.22)
Death counts (95% UI)	139 632 (119 905–182 291)	246 253 (185 642–270 930)	76.4	37 966 (29 102–50 213)	63 527 (47 793–76 948)	67.3	37 966 (29 102–50 213)	63 527 (47 793–76 948)
Death ASR (per 100 000 person-years, 95% UI)	3.08 (2.71–4.01)	3.05 (2.29–3.36)	–1.2	3.87 (3.04–5.1)	3.5 (2.62–4.21)	–9.6	3.87 (3.04–5.1)	3.5 (2.62–4.21)
DALYs counts (95% UI)	6 165 296 (4 958 436–8 491 433)	8 659 871 (6 718 029–9 574 458)	40.5	1 769 659 (1 286 809–2 432 375)	2 053 424 (1 584 338–2 524 972)	16	1 769 659 (1 286 809–2 432 375)	2 053 424 (1 584 338–2 524 972)
DALYs ASR (per 100 000 person-years, 95% UI)	121.67 (100.03–164.94)	109.04 (84.57–120.92)	–10.4	161.29 (118–220.25)	126.24 (96.01–154.8)	–21.7	161.29 (118–220.25)	126.24 (96.01–154.8)

ASR, age-standardised rate; DALY, disability-adjusted life-year; 95% UI, 95% uncertainty interval.

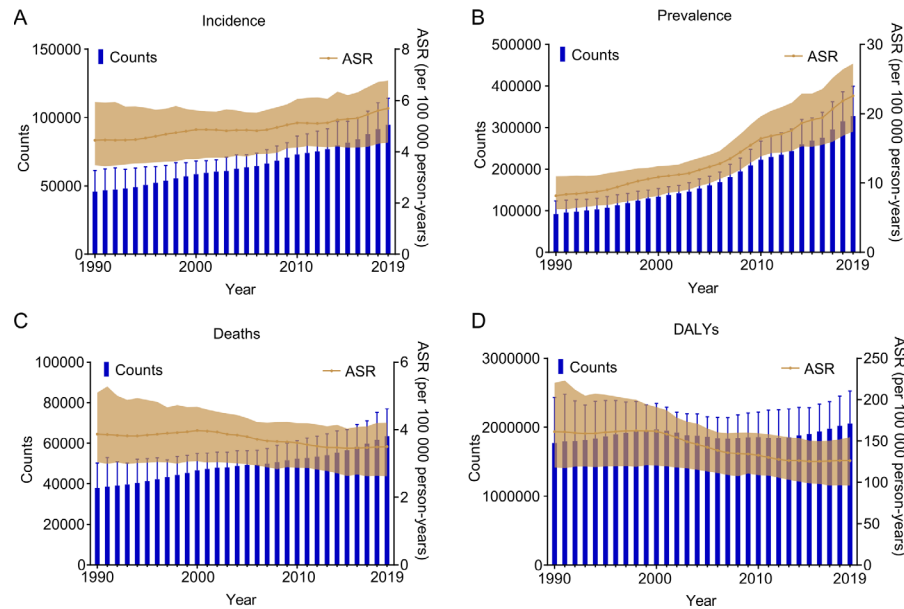


Figure 1 The temporal trend of the absolute counts and ASR of incidence (A), prevalence (B), deaths (C) and DALYs (D) due to CNS cancer in China from 1990 to 2019. Shaded areas show 95% uncertainty intervals. ASR, age-standardised rate; DALY, disability-adjusted life-year.

To explore the potential relationship between the burden of CNS cancer and sociodemographic development of different provinces, correlation analyses were performed on burden metrics with SDI. A positive correlation was demonstrated between the ASRs of incidence and prevalence with SDI; meanwhile, the ASRs of incidence and prevalence tended to rise with SDI growing in most provinces, especially when SDI was <0.7 (figure 5).

By contrast, a negative correlation was observed between the ASRs of death and DALYs with SDI; meanwhile, the ASRs of death and DALYs tended to decline with SDI growing (figure 5).

Furthermore, the correlation analysis was performed on mortality to incidence ratio with SDI and a more remarkable negative correlation was observed (online supplemental figure S5).

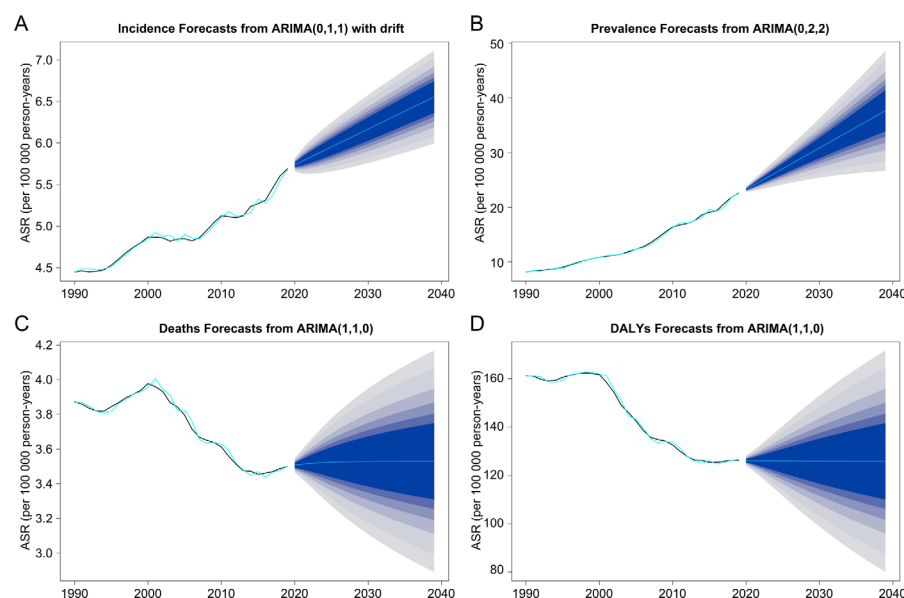


Figure 2 Forecasts of the disease burden of CNS cancer in the next two decades in terms of ASRs of incidence (A), prevalence (B), deaths (C) and DALYs (D) by the ARIMA model. The black lines represent estimates from GBD 2019; the cyan lines indicate fitted curves by the ARIMA model. The blue lines indicate forecasts in the next two decades, with shaded areas from inside to outside indicating confidence levels of 50%, 60%, 70%, 80%, 90% and 95%, respectively. ARIMA, autoregressive integrated moving average; ASR, age-standardised rate; CNS, central nervous system; DALY, disability-adjusted life-year.

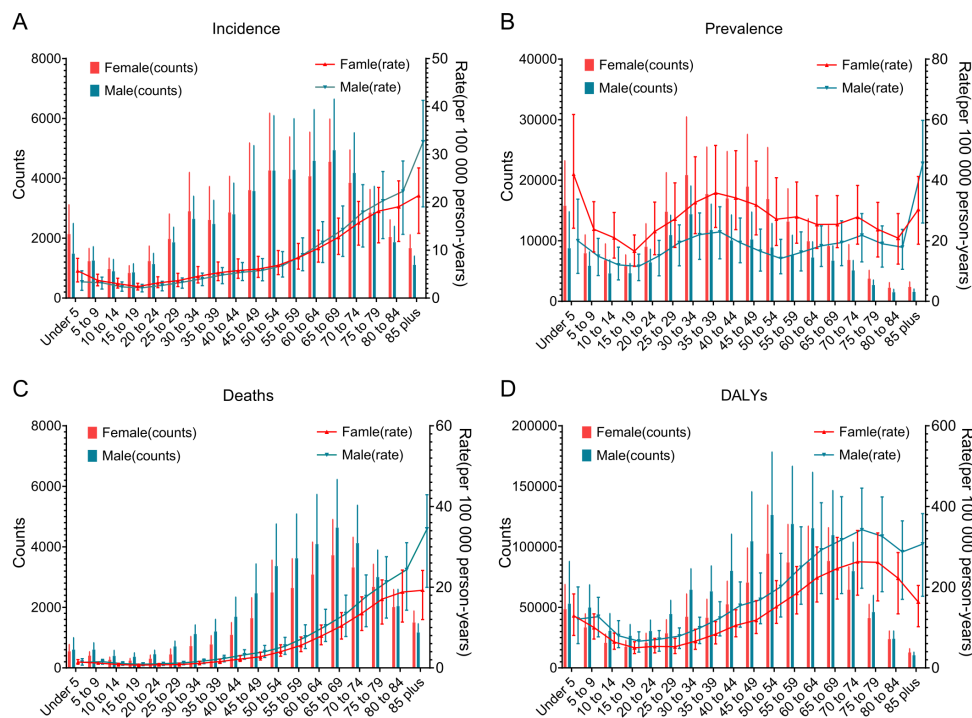


Figure 3 The age distribution of absolute counts and crude rates of incidence (A), prevalence (B), deaths (C) and DALYs (D) due to CNS cancer in China in 2019 stratified by sex. CNS, central nervous system; DALYs, disability-adjusted life-year.

DISCUSSION

As evidenced by GBD 2019, China has been bearing a substantial burden of CNS cancer, with the largest numbers

of CNS cancer incident cases, deaths and DALYs across the world; and the deaths and DALYs due to CNS cancer in China were both ranked in the top 10 among all cancers,

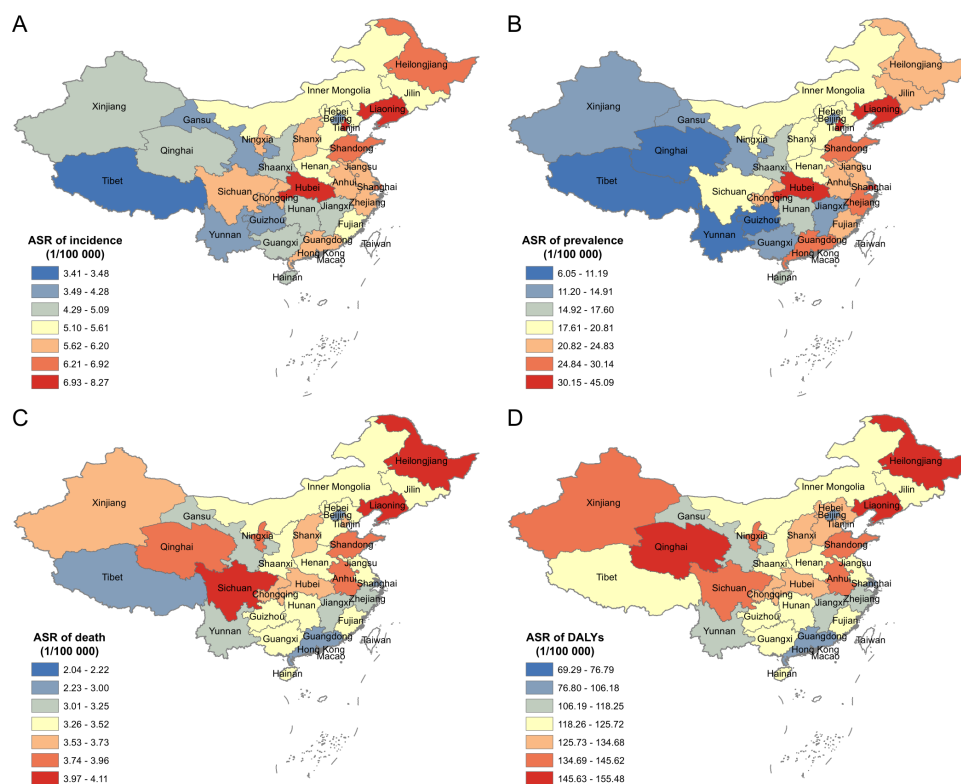


Figure 4 The geographic distribution of the ASR of incidence (A), prevalence (B), deaths (C) and DALYs (D) due to CNS cancer in included 33 provincial administrative units of China in 2019. ASR, age-standardised rate; CNS, central nervous system; DALY, disability-adjusted life-year.

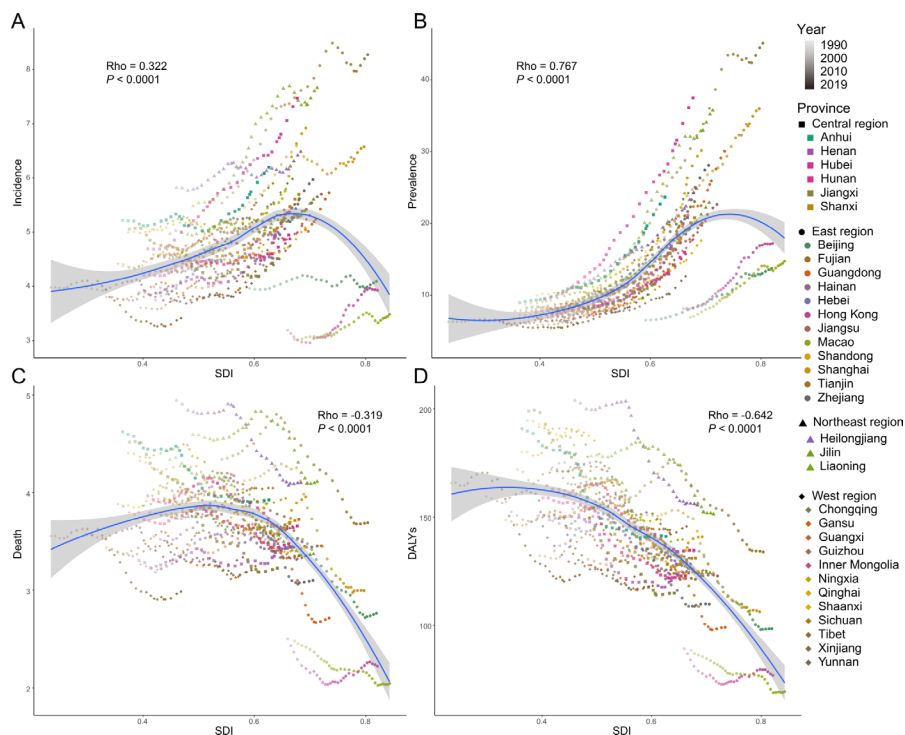


Figure 5 The correlation analysis of the age-standardised rate of incidence (A), prevalence (B), deaths (C) and DALYs (D) due to CNS cancer with SDI of included 33 provincial administrative units of China, classified into four regions, from 1990 to 2019. The solid blue smooth curve represents the expected value within the whole range of the SDI by a local polynomial regression fitting method. The Spearman r correlation coefficient and corresponding p value are also displayed. CNS, central nervous system; DALYs, disability-adjusted life-year; SDI, Sociodemographic Index.

consistent with previous researches.²⁰ From 1990 to 2019, the incidence and prevalence of CNS cancer kept rising steadily, while the ASRs of mortality and DALYs declined. The disease burden was similar in men and women, but more pronounced in children and elderly populations. The CNS cancer burden showed remarkable disparities at the subnational level in China; with social development, the incidence and prevalence tending to increase but the mortality and DALYs would decline.

The estimations by GBD 2019 were compatible with relevant researches; the incident cases and deaths in the present paper were a little higher than that from the International Agency for Research on Cancer, which reported 296 851 incident cases and 241 037 deaths due to CNS cancers in 2018 globally,³ and that from the National Central Cancer Registry of China, which reported 101 600 incident cases and 61 000 deaths due to CNS cancers in 2015 in China,²¹ both well explained by the temporal trend of the epidemiological parameters and differences in data collection and estimation modelling.

Substantial variations were reported in the incidence of CNS cancer, ranging from the lower rate of 2.81 per 100 000 person-years in Africa²² to the higher rate of 7.08 per 100 000 person-years in the USA.² Because of the large population base, the age-standardised incidence rate of CNS cancer in China was medium in the world, despite the large number of incident cases. Besides the differences in population genetics and oncogenic environmental exposures, lower life expectancies in low-income regions and the less

well-established diagnosis and registry reporting system in these regions may explain a large part of the low incidence in these regions.²² For the epidemiological data in China, it was reported that the overall prevalence of primary brain tumours, including malignant and benign, was 22.52 per 100 000 in 2006 according to a multicentre cross-sectional study, but more comprehensive and recent epidemiological surveys were scarce thereafter.

As for the clinical outcomes of CNS cancer, the 5-year net survival rates in China were inferior to that in high-income countries, especially in children with approximately 40% in China vs 70%–80% in European and American countries.⁶⁷

From 1990 to 2019, the absolute counts of incidence, prevalence, deaths and DALYs of CNS cancer had been rising steadily, but this should be attributed to the incremental population and prolonged life expectancy of people in China, in which the total population increased from 1 183 682 thousand in 1990 to 1 422 350 thousand in 2019 and the life expectancy at birth increased from 68.1 years in 1990 to 77.6 years in 2019.²³

The increase of age-standardised incidence rate of CNS cancer in China was more dramatic than the global average; meanwhile, the mortality due to CNS cancer in China declined more steeply than the global average. This should be explained mainly by the improvement of diagnostic ascertainment and surgical techniques in China, minimally invasive neurosurgery, for example,²⁴ as well as the ageing of the population²⁵ and environmental risk factor exposure in recent decades.



The present data did not show significant sex differences in the disease burden of CNS cancer, but this needs to be confirmed, because the incidence rate, for example, varies between men and women when referring to literature from different data sources.^{26–28} As reported, men had higher incidences of germ cell tumours, haematopoietic neoplasms and glioblastoma, while women had higher incidences among other neuroepithelial tumours and malignant meningioma.^{29,30} Thus, the current study with all histological subtypes combined could not detect the potential differences between men and women.

The general age distribution of the burden of CNS cancer in China was bimodal, with peaks in early childhood and old adulthood, in line with the global data.⁵ CNS cancers were the most common paediatric solid tumours and represented the leading burden in terms of morbidity and mortality in children.^{26,31,32} Meanwhile, like most neoplasms, the highest incidence and mortality of CNS cancer occurred in the elderly population.³³

Regarding the spatial distribution of CNS cancer burden in China, the ASRs of incidence, prevalence, mortality and DALYs showed distinct patterns. The higher ASRs of incidence and prevalence and the greater increase of them were mainly distributed in the high-income provinces located in circum-Bohai-Sea region, southeast coast, and Yangtze River basin. Meanwhile, the ASRs of incidence and prevalence showed a positive correlation with SDI and tended to rise as the SDI growing in most provinces, which implied that more CNS cancer cases would spring up with the sociodemographic development. This was consistent with the general global pattern,^{5,22} which could be explained by the differences in access to advanced imaging technology and surgical care necessary for case ascertainment. Moreover, it should also be noted that the failure of early diagnosis of CNS cancer in these low-income regions could also lead to more advanced cases at diagnosis, which means poor prognosis for patients. The relationship between incidence and risk factor exposure remains to be determined, since the only validated epidemiological risk factors for CNS cancers were ionising radiation, increasing risk in both adults and children, and atopic conditions, decreasing risk in adults.²⁶ The mortality and DALYs due to CNS cancer demonstrated a favourable negative correlation with SDI and tended to decline as the SDI growing in most provinces and the outcomes tended to be better as the SDI growing, which was probably caused by the improvement of the access to the highly integrated medical infrastructure for the treatment of CNS cancer.

To our knowledge, this is the first study systematically evaluating the disease burden of CNS cancer in China which could provide shreds of evidence for developing specific healthcare policy, such as to train sufficient competent neurological doctors for the upcoming CNS cancer incident case wave, especially paediatric neurosurgeons, to disseminate neuroimaging technology in western regions to achieve a timelier diagnosis and to enhance collaborations between neurosurgical centres in high-income and low-income regions to narrow the gaps of survival in different regions.

However, the limitations of the study should be noted. First, since CNS cancer is relatively uncommon and the diagnosis procedure is complicated and high demanding, the report omission was inevitable. Second, the scanty follow-up survey of patients with CNS cancer in China may lead to the underestimation of YLD. Third, due to the lack of risk factor exposure data, the explanation on the distribution of CNS cancer burden is somewhat speculative and the causality needs to be confirmed. Lastly but most significantly, CNS cancer is characterised by the heterogeneity of histological subtypes, but it was analysed together and some potential features could not be revealed. Therefore, separated and systematic analyses are definitely needed, and it is promising that the establishment of the National Brain Tumour Registry of China in January 2018 will provide more comprehensive and updated information on CNS cancer in China.³⁴

To conclude, China has been bearing a substantial burden of CNS cancer compared with the global average. Since 1990, the ASRs of incidence and prevalence of CNS cancer have kept rising steadily, while those of mortality and DALYs have declined. The variation of disease burden due to sex, age and region should be considered in evidence-based healthcare planning and resource allocation.

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Contributors MZhu and PY designed the study and provided guidance, both acting as guarantor. EW, ZS and FZ conceived the experiments. ZL and MZho extracted and evaluated the original data. XH analysed the data and drafted the manuscript. ZL and WL revised the manuscript.

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

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Competing interests None declared.

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

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement The global data and that of China in the present paper can be explored with the Global Health Data Exchange query tool (<http://ghdx.healthdata.org/gbd-results-tool>), and the subnational data of China were obtained from a third party and are not publicly available, but can be accessed from the corresponding author upon reasonable request.

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