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Characteristics and trend analysis of cancer mortality among residents of the Xizang autonomous region, 2014–2023

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Abstract

Background The Xizang Autonomous Region, located in China's southwestern frontier with an average elevation of 4000 m, faces socioeconomic development challenges influenced by its natural environment and regional disparities. Previous studies have indicated that cancer ranks as the fourth leading cause of death among permanent residents in Xizang. However, there is a paucity of research on the trends and characteristics of cancer mortality in this region. This study aims to analyze mortality data from Xizang between 2014 and 2023 to elucidate the characteristics and trends of cancer deaths and to provide a foundation for developing effective cancer prevention and treatment strategies.

Methods Mortality data for cancer patients from 2014 to 2023 were extracted from the Death Information Registration and Management System of the Chinese Center for Disease Control and Prevention (CDC). The population data for Xizang were obtained from the Basic Information System of the Chinese CDC. Crude and age-standardized mortality rates were computed via SPSS software, and joinpoint regression models were employed to estimate the average annual percent change (AAPC) in mortality trends.

Results Between 2014 and 2023, the crude mortality rate (CMR) for cancer increased from 31.38 per 100,000 to 49.37 per 100,000, whereas the age-standardized mortality rate (ASMR) rose from 50.15 per 100,000 to 66.42 per 100,000, with annual increases of 4.59% and 2.12%, respectively. The leading causes of cancer death are liver cancer, stomach cancer, lung cancer, esophageal cancer, and cervical cancer.

Conclusion Cancer mortality in Xizang is increasing, with higher rates in men than in women, although the rate of increase is faster in women. Mortality rates increase with age, predominantly affecting middle-aged and elderly populations. Liver and stomach cancers are the primary contributors to cancer mortality. Given the severe cancer control situation, comprehensive prevention strategies and early diagnosis and treatment for high-risk populations are crucial.

Keywords Cancer, Mortality, Tibet

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Background

According to the International Agency for Research on Cancer (IARC) data released in 2020, there were approximately 9.96 million new cancer deaths globally, with China contributing approximately 30.12% of this total [1]. The cancer mortality rate in China exceeds the global average, indicating a significant disease burden [2]. A 2022 study by the China Cancer Center highlighted that with China's societal advancement and accelerating aging population, age has emerged as a critical factor in cancer prevention and control. Owing to aging as a risk factor, the absolute number of cancer deaths in China continues to rise [3]. Additionally, research by the Chinese Center for Disease Control and Prevention (China CDC) in 2021 identified cancer as the second leading cause of death nationally, second in the eastern region, and third in the central and western regions [4]. The Tibet Autonomous Region (Tibet), situated on the southwestern border of China and characterized by high-altitude conditions averaging 4000 m above sea level, is characterized by complex climatic and socioeconomic factors that influence its relatively underdeveloped status. Previous studies have indicated that cancer is the fourth leading cause of death among Xizang's permanent residents [5, 6]. However, there is a paucity of research on cancer mortality trends and characteristics in this region. This study aims to analyze cancer death data from disease surveillance points (DSPs) in Xizang to elucidate the patterns and trends of cancer mortality, thereby providing a reference for cancer prevention strategies.

Data source

Cancer mortality data for Xizang from 2014 to 2023 were obtained from the death surveillance points (DSPs) within the Population Death Registration Management System of the China CDC. This system is known for its comprehensive representation at both the national and provincial levels [7]. The cancer cases were classified via the International Classification of Diseases (ICD-10), with codes ranging from C00 to C97. Resident population data were sourced from the Basic Information System of the China CDC. The quality control procedures adhered to the "Guidance Manual for Population Cause of Death Surveillance" issued by the China CDC [8].

Hospitals across all levels are responsible for completing medical death certificates, which are subsequently reviewed and subjected to quality control by county (district) CDCs. Autonomous regions and municipal CDCs perform regular spot checks to further ensure the accuracy of the data. To ensure data validity and consistency, annual training on a standardized protocol is conducted, which includes random checks for disease classification accuracy and duplications. China CDC organizes 1 to 2 sessions of standardized training annually and the Xizang CDC conducts 1 to 3 operational training sessions annually and performs annual supervision and inspection of grassroots CDCs and hospitals. The causes of death are determined using a standardized protocol by trained personnel based in local hospitals or CDC branches. Additionally, municipal CDCs carry out quarterly data comparisons with public security and civil affairs departments to maintain data accuracy.

Statistical analysis

The data were summarized via Excel (version Microsoft 365, Microsoft Corp., Washington, DC, USA). Cancer mortality rates, including the crude mortality rate (CMR) and age-standardized mortality rate (ASMR), were calculated via Excel. The death counts stratified by gender and age group were calculated using IBM SPSS Statistics 20.The joinpoint regression program (version 4.9.0.1, National Cancer Institute, Rockville, MD, USA) was employed to determine the average annual percent change (AAPC) and corresponding 95% confidence intervals (CIs) for both crude mortality and the ASMR. The Z test assessed the significance of the AAPC, and a two-tailed P of 0.05 was deemed statistically significant. An increasing trend is defined as when the AAPC and its lower 95% CI are both greater than zero. A decreasing trend is defined as when the AAPC and its upper 95% CI are both less than zero. The ASMR was computed through direct age standardization, using 2010 census data from China as the standard population.

Results

Trends in cancer mortality in Tibet from 2014 to 2023

Table 1 presents the trends in the crude cancer mortality rates (CMRs) and age-standardized mortality rates (ASMRs) in Xizang from 2014 to 2023 for both sexes. During the study period, a total of 3,786 cancer-related deaths were recorded across eight disease surveillance sites in Xizang, representing 11.79% of all deaths. The average annual CMR for cancer is 43.20 per 100,000 people, while the average ASMR is 64.34 per 100,000 people.

In 2014, the CMR was 31.38 per 100,000, which increased to 49.37 per 100,000 by 2023, reflecting a 57.33% increase. The ASMR also increased from 50.15 per 100,000 in 2014 to 66.42 per 100,000 in 2023, representing a 32.44% increase. The male-to-female mortality ratio was 1.65:1.

For males, the average annual CMR was 52.56 per 100,000, and the average annual ASMR was 81.70 per 100,000. The CMR for males increased from 38.63 per 100,000 in 2014 to 66.15 per 100,000 in 2023, a 71.24% increase. The ASMR for males rose from 64.80 per 100,000 in 2014 to 81.60 per 100,000 in 2023, a 25.93% increase.

Table 1 Trend Analysis of Cancer Mortality Rates by gender for residents of Xizang, 2014–2023

year	males			females			total		
	Number of deaths	CMR(1/100,000)	ASMR(1/100,000)	Number of deaths	CMR(1/100,000)	ASMR(1/100,000)	Number of deaths	CMR(1/100,000)	ASMR(1/100,000)
2014	154	38.63	64.80	90	23.49	36.06	244	31.38	50.15
2015	157	38.64	61.10	83	21.66	31.74	240	30.40	46.11
2016	192	47.47	75.59	103	25.84	37.97	295	36.74	57.35
2017	209	50.12	81.07	112	27.81	39.63	321	39.16	59.32
2018	224	53.54	93.36	130	31.81	46.65	354	42.81	68.00
2019	244	56.29	99.36	170	40.13	60.39	414	48.31	78.57
2020	261	57.54	89.56	171	39.49	52.37	432	48.72	69.67
2021	263	56.88	81.31	164	37.12	48.58	427	47.23	64.60
2022	325	58.28	85.47	215	45.56	59.00	540	51.37	72.08
2023	331	66.15	81.60	188	34.26	52.52	519	49.37	66.42
Total	2360	53.01	81.70	1426	33.07	47.32	3786	43.20	64.06
AAPC(95%CI)		6.05(3.06~9.13)	2.87(-0.28~6.13)		7.35(3.37~11.08)	6.31(3.04~9.70)		5.94(3.36~8.58)	4.01(0.30~7.84)
t value		4.02	1.78		4.78	4.51		4.59	2.12
P value		0.000	0.075		0.001	0.001		0.000	0.033

In females, the average annual CMR was 33.07 per 100,000, with an average annual ASMR of 47.32 per 100,000. The CMR for females increased from 23.49 per 100,000 in 2014 to 34.26 per 100,000 in 2023, reflecting a 10.77% increase. The ASMR for females increased from 36.06 per 100,000 in 2014 to 52.52 per 100,000 in 2023, which is a 45.65% increase.

The cancer CMR in Xizang significantly increased from 2014 to 2023, with annual average percent changes (AAPCs) of 6.05 (95% CI: 3.06–9.13) for males, 7.35 (95% CI: 3.37–11.08) for females, and 5.94 (95% CI: 3.36–8.58) overall. These changes were statistically significant ($P<0.05$). The ASMR also significantly increased, with AAPCs of 6.31 (95% CI: 3.04–9.70) for females and 4.01 (95% CI: 0.30–7.84) overall during the same period ($P<0.05$).

Figure 1 illustrates the distribution of cancer deaths by age from 2014 to 2023. The CMR for Tibetan residents is lowest in the 5–9 age group (1.6/100,000) and begins to rise significantly after age 35 (12.92/100,000), peaking in the 80–84 age group (522.00/100,000). For males, the CMR was lowest in the 5–9 year age group (1.41/100,000) and highest in the 80–84 year age group (700.99/100,000). For females, the CMR was lowest in the 1-year age group (1.40/100,000) and highest in the 75–79 years age group (418.60/100,000). Notably, female CMR exceeds male CMR only in the 5–9 and 10–14 age groups; otherwise, male CMR is greater across all other age groups. Cancer mortality is predominantly concentrated in the 50–79 years age group, accounting for 74.1% of deaths, with 75.8% of these deaths occurring in males and 71.2% in females within the same age group.

Figure 2 presents that in 2014, the top five cancers were liver, stomach, lung, leukemia, and brain cancers, whereas in 2023, they were liver, stomach, lung, cervical, and esophageal cancers, with the top three remaining unchanged. Table 2 highlights that from 2014 to 2023, the leading causes of cancer mortality among Tibetan residents were liver, stomach, lung, esophageal, and cervical cancers, collectively accounting for 76.10% of all cancer deaths. Among men, the predominant cancers were liver, stomach, lung, esophageal, and colorectal cancers, accounting for 84.03% of cancer deaths; for women, the leading cancers were liver, stomach, cervical, lung, and breast cancers, accounting for 68.51% of cancer deaths.

Table 3 shows that in the 0–14 year age group, the top five cancers causing death were leukemia and brain, liver, stomach, and lung cancers, accounting for 63.91% of the total cancer deaths. For the 15–49 year age group, the leading cancers were liver, stomach, leukemia, lung, and brain cancers, accounting for 71.04% of all cancer deaths. In the 50–69 year age group, the top five cancers were liver, stomach, lung, cervical, and esophageal cancers, although the percentage of total deaths was not specified.

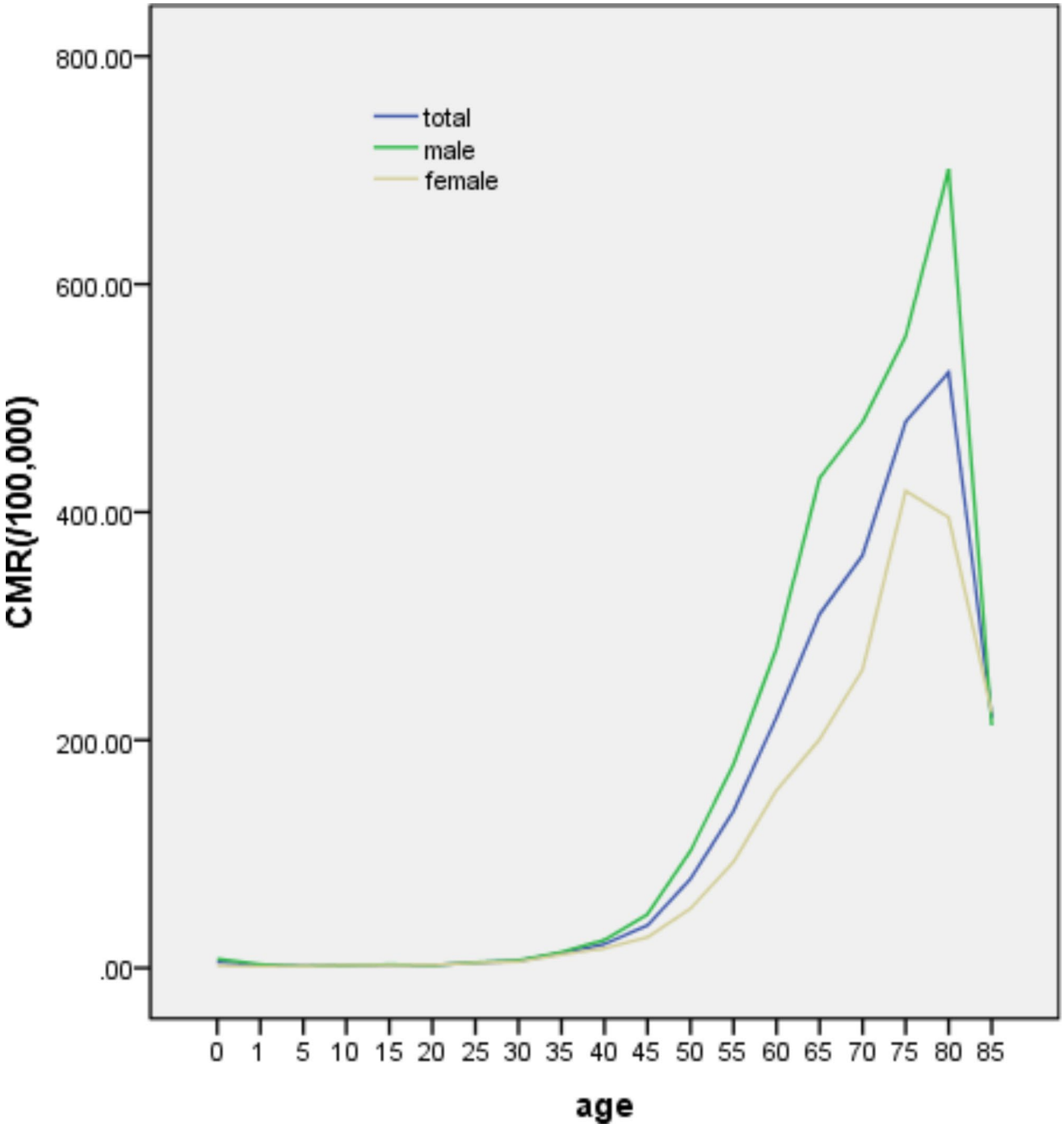

Fig. 1 Crude mortality rate (CMR) of cancer among residents of Xizang by sex and age from 2014 to 2023

For those aged 70 years and above, the leading cancers were liver, stomach, lung, esophageal, and colorectal cancers, with the percentage of total deaths also unspecified.

Discussion

This study represents the first comprehensive analysis of cancer mortality trends among Tibetan residents. Between 2014 and 2023, the average annual cancer mortality rate (CMR) among Tibetans was 43.20 per 100,000, whereas the age-standardized mortality rate (ASMR) was 64.06 per 100,000. Both figures are notably lower than the national averages reported for 2019, which were 190.66 per 100,000 for CMR and 140.66 per 100,000 for ASMR [2]. The lower cancer mortality rate in Xizang than the national average may be attributed to delays in case detection and reporting. This underscores the need for enhanced monitoring and dynamic surveillance to better understand and address these trends.

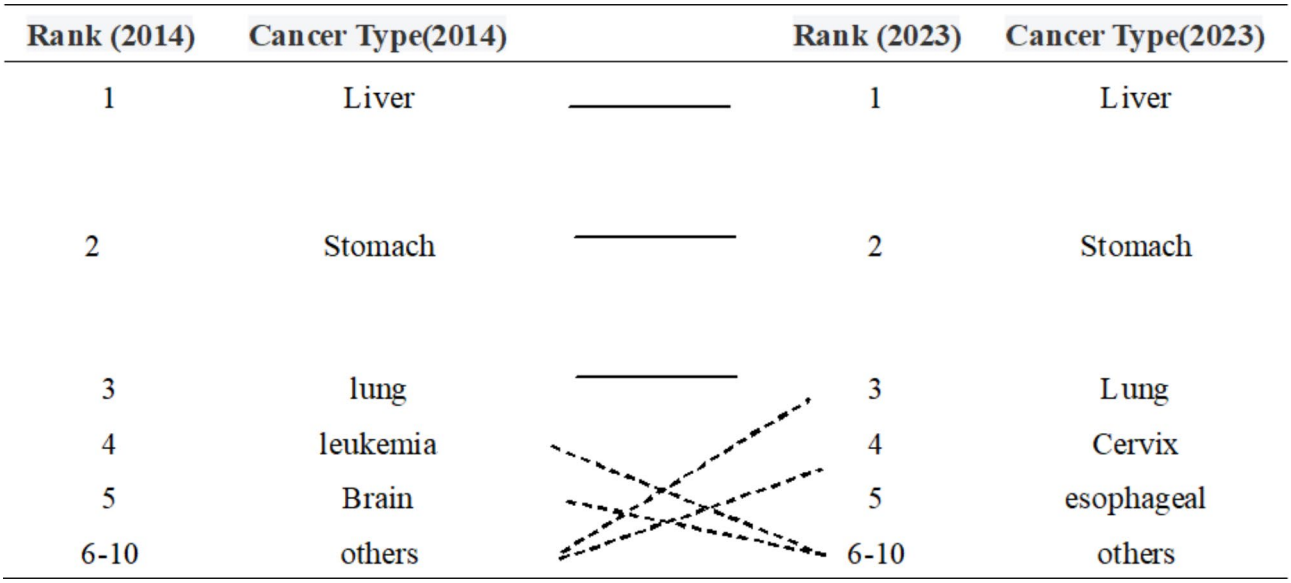

Fig. 2 Ranking of major cancer types among residents of Xizang in 2014 and 2023

From 2014 to 2023, both the CMR and ASMR for cancer among Tibetans demonstrated an increasing trend, aligning with the national rise in CMR but diverging from the national decline in the ASMR [2]. The leading causes of cancer mortality in Xizang are liver cancer, stomach cancer, lung cancer, esophageal cancer, and cervical cancer. This differs from the national pattern, where lung cancer is the predominant cause of death [2, 9–12]. The high mortality rate of liver cancer in Xizang may be attributed to the high prevalence and increasing incidence of hepatitis virus infections, poor lifestyle choices, and obesity, coupled with insufficient early detection and treatment [13].In 2002, China integrated HBV into its Expanded Program on Immunization (EPI), making the vaccine available at no cost to children aged 20 and a catch-u p vaccination programme was launched in 2009 [14]. In 2011, China launched a programme to prevent mother-to-child transmission of HBV in 1156 counties [15]. In 2015, the programme was rolled out nationally [16]. These efforts are expected to have driven the substantial decreases in HBV infection observed over time in China.However, HBV seroprevalence remains highly heterogeneous across the country, the highest prevalence in the latest study period was observed in Tibet [17]. Xizang was the only province where HBsAg seroprevalence increased between 1993 and 2005 (8.2%, 95% CI 5.3 to 12.5%) and 2006–2021 (8.8%, 95% CI 6.4 to 12.1%)" [18]. The imperative for Tibet is that of continuously expanding the coverage of HBV vaccine.

Gender-specific analyses revealed that both crude and standardized cancer mortality rates were higher in males than in females, which is consistent with national data and findings from other provinces [9–12, 19]. The age-standardized mortality rate for males (81.70 per 100,000) was approximately twice that for females (47.32 per 100,000), reflecting similar patterns observed nationally [2]. This disparity may be related to greater exposure to cancer risk factors among males, including elevated rates of cigarette smoking, alcohol consumption, and red meat intake [20, 21].

The cancer mortality rates for both genders have been increasing, with female CMR increasing more rapidly (AAPC = 7.35%,CI 3.37 to 11.08%) than male CMR (AAPC = 6.05%, CI 3.06 to 9.13%). This trend could be linked to socioeconomic factors such as limited health education and inadequate healthcare access in Xizang. Studies have suggested that lower human development index (HDI) levels are associated with higher cancer mortality in women [23].

Liver cancer and gastric cancer were the top two causes of cancer death for both sexes, together accounting for 60.17% of all cancer-related deaths. Gastric cancer in Xizang may also be influenced by dietary risk factors such as high salt consumption, preserved foods, and low intake of fruits and vegetables [13].

Lung, esophageal, and colorectal cancers rank third to fifth among men and are potentially linked to poor lifestyle and dietary habits [24–26]. Cervical and breast cancers, despite the Chinese government's efforts to promote screening programs, remain significant health concerns for women in Xizang. The contributing factors include low literacy levels, insufficient health awareness, economic pressures, and incomplete screening coverage [27, 28]. Numerous studies have shown that chronic HR-HPV infection in the reproductive tract increases the incidence of CIN and cervical cancers [29]. Cervical vaccination

Table 2 Trend analysis of Cancer mortality rates by gender among residents of the Xizang autonomous region, 2014–2023

Rank	Cancer Type (Males)	CMR per 100,000	Proportion (%)	Cancer Type (Females)	CMR per 100,000	Proportion (%)	Cancer Type (Total)	CMR per 100,000	Proportion (%)
1	Liver	23.63	44.58	Liver	8.07	24.40	Liver	15.97	36.98
2	Stomach	12.58	23.73	Stomach	7.37	22.30	Stomach	10.02	23.19
3	Lung	5.14	9.70	Cervical	2.94	8.91	Lung	3.70	8.56
4	Esophageal	1.98	3.73	Lung	2.20	6.66	Esophageal	1.61	3.72
5	Colorectal	1.21	2.29	Breast	2.06	6.24	Cervical	1.57	3.65

serves as the first line of defense against HPV infection and is the most effective strategy for reducing the disease burden of cervical cancer. In China, HPV vaccines have not yet been included in the national immunization program, with insufficient vaccine production capacity and vaccine hesitancy among the population hindering the coverage among eligible girls. Additionally, the high cost and substantial market demand make it difficult for girls in resource-poor regions to access vaccination. Regional HPV vaccination programs should be promoted, with targeted financial subsidies for impoverished areas [30]. Recent studies in Xizang indicate a rising proportion of female lung cancer patients, particularly nonsmokers, with the majority presenting at advanced stages [31]. This trend warrants further investigation to improve early detection and treatment strategies.

Age-specific analyses revealed that the CMR in Xizang increased with age, with a gradual increase starting at approximately age 35, a significant increase after 50 years, and a peak between 80 and 84 years. This pattern contrasts with other regions, where increases are observed from age 40 [9, 11], suggesting a younger age of cancer onset in Xizang that necessitates proactive prevention efforts. Cancer deaths in Xizang are predominantly concentrated in the 50–79 year age group, accounting for 74.1% of cases, with men accounting for 75.8% and women accounting for 71.2%, reflecting age as a significant risk factor for cancer [3]. Additionally, leukemia is the leading cause of death among children under 14 years of age in Tibet, a malignancy associated with environmental hazards such as house decoration materials, pesticides, electromagnetic radiation, viral infections, tobacco smoke, solvents, and traffic emissions [32], indicating potential risks in children's environments.

Limitations of this study include potential biases from recent improvements in death surveillance and underreporting due to insufficient policy support, which affects data quality. Future research should focus on enhancing surveillance systems and addressing reporting gaps.

In conclusion, cancer mortality rates in Xizang are increasing, with a higher prevalence in males than in females; however, the rate of increase is more pronounced among females. Liver and stomach cancers are the most common. The mortality begins to rise gradually from age 35 and accelerates with age, exhibiting distinct patterns across different sexes and age groups. Moving forward, it is crucial for the government to collaborate with various sectors to implement a comprehensive cancer prevention and control strategy. This should include timely identification of risk factors, actively expand the coverage of vaccination for cervical cancer vaccines, hepatitis B vaccines, and other related vaccines, enhancement of health education, and the promotion of targeted

Table 3 Cause-of-death rankings of major cancers by age in Xizang, 2014–2023

Rank	Age Group	Cancer Type	CMR per 100,000	Proportion (%)
1	0–14 years	Leukemia	0.15	36.11
		Brain	0.05	11.12
		Liver	0.02	5.56
		Stomach	0.02	5.56
		Lung	0.02	5.56
2	15–49 years	Liver	2.98	37.99
		Stomach	1.37	17.47
		Leukemia	0.47	5.97
		Lung	0.39	4.95
		Brain	0.37	4.66
3	50–69 years	Liver	9.47	41.48
		Stomach	5.18	22.69
		Lung	1.86	8.15
		Cervical	0.86	3.75
		Esophageal	0.83	3.65
4	≥ 70 years	Liver	3.50	28.91
		Stomach	3.45	28.44
		Lung	0.17	11.77
		Esophageal	0.64	5.27
		Colorectal	0.51	4.24

early diagnosis and treatment initiatives to reduce cancer mortality rates effectively.

Abbreviations

NMSS	National mortality surveillance system
ASMR	Age-standardized mortality rate
CMR	Crude mortality rate
AAPC	Average annual percent change
ICD	International classifcation of diseases

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Author contributions
Pingcuo zhuoma designed the study, analyzed the data, conducted visual processing on the data, as well as drafted and revised the manuscript. Pingcuo zhuoma is the first authorship.Gama Cangjue sorted and analyzed the data. Jinlei Qi provided demographic data and facilitated academic paper collaboration. Hui Wang critically revised the manuscript.

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Data availability
The datasets generated and/or analysed during the current study are not publicly available due for confidentianlity principles but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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