

# Cancer prevalence among the rural poverty-stricken population in Northeast China

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**Purpose:** The burden of cancer impacts many of the world's top concerns, but little information is published about the characteristics of cancer prevalence in the poor population.

**Materials and methods:** Data on cancer prevalence were obtained from the Health Poverty Alleviation Information System of Heilongjiang province. Prevalence was defined as all living cancer cases on October 1, 2018. Geographical area, cancer site, sex, age, educational level, and time since diagnosis were investigated.

**Results:** There were 10,529 cancer cases among 624,869 poor rural people in Heilongjiang up to October 1, 2018, and 77% of them did not have labor ability. Females accounted for 53.4%. The top five common cancers were lung, breast, colorectal, stomach, and liver cancer. There were distinct regional, sex, and age distribution differences in cancers. The prevalence rate for overall cancers was 1,685.0 per 100,000 people, which was much higher than that of the national level. Cancer prevalence peaked at an earlier age group (65–69 year). The 5-year cancer prevalence was 80.1% of the total cases.

**Conclusion:** Cancer imposes significant health and financial burdens in the rural poor. This study presents total and partial prevalence for the first time using actual dates from a large poor population in China, providing valuable information for tailored cancer prevention and control, quantifying the cancer burden and identifying priorities for poverty alleviation plans.

**Keywords:** cancer burden, prevalence, rural, poverty-stricken population

## Introduction

Cancer is a major life-threatening disease and the most important obstacle to the increase in life expectancy worldwide.<sup>1–4</sup> In China, approximately 4,292,000 cancer cases were newly diagnosed, and 2,814,000 patients died of cancer in 2015.<sup>3</sup> Cancer is the leading cause of death in China and is responsible for approximately one in four of total deaths.<sup>5</sup>

Cancer prevalence is a broad concept defined as all people alive at index-date who have a history of being diagnosed with cancer. Prevalence profiles can provide detailed descriptive information and evidence for cancer prevention and control strategies,<sup>6,7</sup> which also serve as a vital measure used to describe cancer patterns. Due to the complexity and variety of the types of cancer, and their extremely complicated biological characteristics, it is usually unrealistic to census the prevalence data of cancer in massive populations, let alone census for the information of vulnerable populations. Previous studies were usually based on incidence and survival data from cancer registries to predict the partial prevalence of cancer;<sup>6–11</sup> however, the quality of some registries is not sufficiently high for study and reporting.<sup>2,12,13</sup> Therefore, it might be difficult to provide a complete picture of

cancer features, and studies tended to focus on the burden of partial prevalence for cancer patients diagnosed within the first few years.<sup>14</sup>

Poverty and disease have an apparent interactive relationship;<sup>15,16</sup> economic level and condition strongly influence human health.<sup>17</sup> Previous studies have shown that socioeconomic status was significantly associated with cancer treatment and mortality.<sup>12,18,19</sup> As the health-care cost of cancer treatment is usually extremely high,<sup>10,20–22</sup> the economic burden from cancer has a greater impact on the vulnerable rural populations. A large proportion of cancer patients rely heavily on their family's financial and care support during cancer treatment, especially in the last stage of their life.<sup>20</sup> Many rural households experiencing financial catastrophes of cancer treatment are even falling into a vicious circle of disease and poverty.

Poverty reduction is a common goal of all countries in the world, and poverty is one of the most important issues world wide; however, the health situation of poverty-stricken people is a gravely understudied area. Cancer burden in poor populations is poorly documented, and there are very few publications concerning cancer characteristics in poverty-stricken populations. Attention to the health status of the poor can provide evidence and reference for the world's poverty reduction goals and healthy development. This study aimed to present a comprehensive overview on cancer prevalence in a poverty-stricken population in the northeast province of China, to provide reliable evidence for developing more targeted cancer control actions and policy for the poor population in the future.

## Materials and methods

### Date source

The data for this study were extracted from the Health Poverty Alleviation Information System (HPAIS) of Heilongjiang, which is a database used to dynamically record the basic demographic, disease, treatment and medical expenses information of the rural poor. HPAIS covers approximately 0.62 million rural people living below the poverty line in 9,598 villages of Heilongjiang province. Definitions and standards of poverty line differ widely all around the world. The international poverty line is currently set at \$1.90 in terms of 2011 purchasing power parity by the World Bank. The Chinese national rural poverty household standard was set at 2,300 yuan of per capita net income in 2010, which is dynamically adjusted according to price

index and living index by year. The standard was adjusted to 3,535 yuan in 2018. In addition to income, the standard for selecting candidate poverty-stricken rural households also takes into consideration the housing situation, children's attendance at school, sanitation facilities, health condition, and many other factors into comprehensive measurement for their poverty level in China.

### Ethics statement

This study was reviewed and approved by the Research Ethics Committee of Harbin Medical University. The database used in this study was anonymized and without any individual patient identifiers.

### Statistical analysis

Cancer was reported in this study for all cancers combined (International Statistical Classification of Diseases and Related Health Problems-10th Revision codes: C00–C97) and 26 types of cancers: lip, oral cavity, and pharynx (C00–10, C12–14); nasopharynx (C11); esophagus (C15); stomach (C16); colorectal (C18–21); liver (C22); gallbladder (C23–24); pancreas (C25); larynx (C32); lung (C33–34); other thoracic organs (C37–38); bone (C40–41); melanoma of the skin (C43); nervous system (C47); breast (C50); cervix (C53); uterus (C54–55); ovary (C56); prostate (C61); testis (C62); kidney (C64–66, C68); bladder (C67); brain and central nervous system (CNS) (C70–72); thyroid (C73); lymphoma (C81–85, 88, 90, 96); leukemia (C91–95).

Crude rate (CR) and age-standardized rate (ASR) were calculated per 100,000 individuals for prevalence, corresponding population stratified by area, sex and cancer type. The World Health Organization (2000–2025) Standard Population was applied for calculating age-standardized rates. Age-specific prevalence was presented by top five common cancers by age group (younger than 14 years, 15–34 years, 35–64 years, and 65 years or older). Cancer prevalence was further stratified by time since diagnosis (within 1 year, 3 years, 5 years, 10 years, 15 years, and more than 15 years).

### 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 article. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

## Results

### Characteristics of the poor population and cancer cases

As of October 1, 2018, there were a total of 624,869 rural poor people in Heilongjiang Province. The mean age was 53 years and 35.4% were 65 years or above. Males accounted for 52.7% of the total. Only 4.3% of adults ( $\geq 18$  years) had a senior school education or above, and 55.0% did not have the capacity to work. Of the total population, the number of cancer patients was 10,529. The mean age was 61 years and approximately 38.7% were 65 years old or above. Males comprised 46.6% of the cancer patients. Only 2.3% of adults with cancer had a senior school education or above, and up to 77.2% did not have the capacity to work. Among the total poor population, poverty caused by disease accounted for about 56% of the total reasons for poverty (Figure 1A). Regarding the poor who had been diagnosed with cancer, the burden from cancer accounted for 86% of all reasons for poverty (Figure 1B).

All rural poverty-stricken people recorded in HPAIS were covered by Basic Medical Insurance for Urban and Rural Resident with waived of premiums. Among them, about 31.1% who were extremely poor and/or seriously ill were also covered by the Insurance Scheme for Catastrophic Diseases (ISCD). Regarding the poor people with cancer, the coverage rate of ISCD was about 37.4%.

### Cancer prevalence by area

The cancer prevalence rates in the poor population were much higher in eastern areas than in other areas of Heilongjiang province (Figure 2). Of the 13 areas, breast cancer ranked first in eight areas and second in four areas; lung cancer ranked first in three areas, second in four

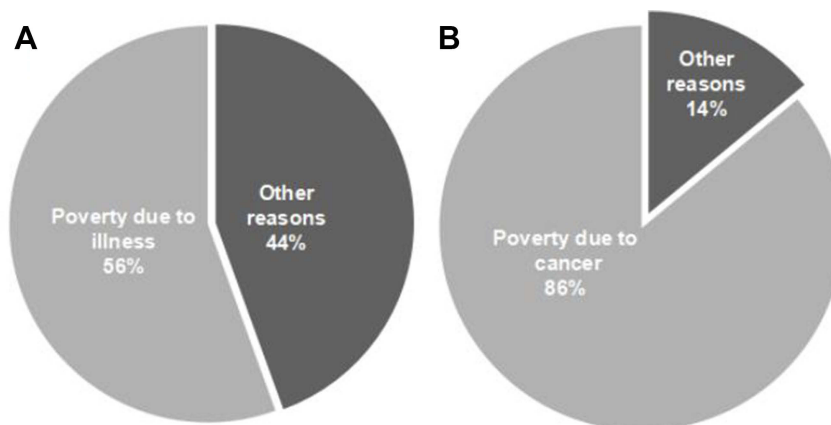
areas, and third in four areas; colorectal cancer ranked first in two areas, second in four areas, and third in five areas; stomach cancer ranked third in two areas, while leukemia and liver cancer ranked third in one area. In the northernmost area, Daxing'anling, where the population is sparse, the air quality is excellent, the weather is colder, and the pace of life is slow and easy, the two most common cancers were esophagus cancer and nervous system cancer, which is clearly different from other areas.

### Cancer prevalence by type and sex

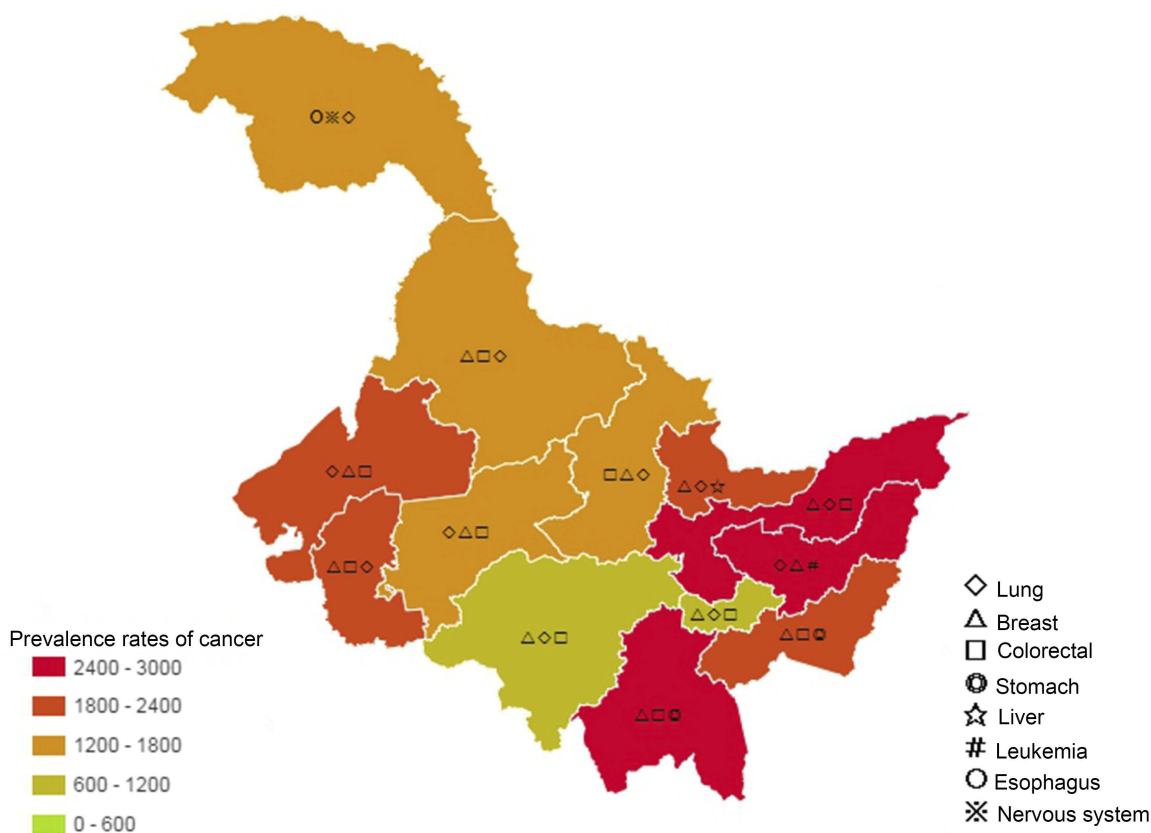
Among 10,529 cancer cases, the most frequent cancers were lung cancer (1,654 cases, 15.7%), followed by breast cancer (1,548 cases, 14.7%), colorectal cancer (1,121 cases, 10.6%), stomach cancer (664 cases, 6.3%), and liver cancer (643 cases, 6.1%) (Table 1). These five cancers accounted for 53.4% of the overall burden of cancers in rural poor people of Heilongjiang province. Among males, the most common cancers were lung (18.5%), colorectal (14.3%), stomach (10.5%), liver (10.1%), and bladder (6.4%). Among females, breast cancer occurred most frequently (27.2%), followed by lung (13.3%), cervical (7.7%), colorectal (7.4%), and thyroid (6.1%) cancers. The crude and age-standardized prevalence rates for overall cancers were 1,685.0 and 953.3 per 100,000 people, respectively.

### Age-specific prevalence

The number of cases and prevalence rates of all cancers combined for both males and females presented an inverted U-shaped pattern according to age (Figure 3). The number of cases of both sexes and the prevalence rate of males increased until reaching a maximum at 65–69 years and then decreased; however, the highest



**Figure 1** Causes of poverty for the poor and cancer patients in Heilongjiang province, 2018. (A) All poor people. (B) Poor people with cancer.



**Figure 2** Cancer prevalence rates (per  $10^5$ ) and common cancers in the rural poor of Heilongjiang province, by area, 2018.

prevalence rate in females was at 50–54 years. There were distinct age-specific distribution features between males and females. In the age group 0–24 years, both male and female age-specific cancer prevalence rates were approximately the same lower level; however, from age group 25–29 years onward, the gap between female and male prevalence rates gradually increased with the prevalence rate in females accelerating from the 35–39-year age group. At the age group 45–49 years, during the female menopause period, the gap between the two sexes peaked; thereafter, it gradually narrowed and crossed at the age of 65 years.

Among children and young people, leukemia was the most commonly diagnosed cancer for both sexes (Table 2). At age 35 years or older, lung cancer was the most frequently diagnosed cancer among men, followed by colorectal, liver or stomach, and bladder cancer. In the age range from 35 to 64 years, breast cancer was the most commonly diagnosed cancer in females, while among those aged 65 years or above, lung was the most common cancer. Figure 4 further details the distribution of the top 10 most common cancers between the sexes at different

age stages. We found a peculiar phenomenon, in that for females, the sex-related cancers, ie, breast cancer, cervical cancer, ovarian cancer, and thyroid cancer (prone to occur in women), reached the highest prevalence at an earlier age between 45 and 59 years (Figure 4B), whereas the highest prevalence in males occurred later after the age of 60 years (Figure 4A).

The time span since the first diagnosis of cancer can be regarded as one way to distinguish people needing corresponding medical care or monitoring. Tables 3 and 4 describe the duration of prevalence for all living patients by sex. For short-term prevalence, the 3-year partial prevalence for all cancers combined in 2018 in the Heilongjiang rural poor was 6,755 (67.6% of total male and 61.1% of total female cases), and the 5-year prevalence for all cancers combined was 8,432 (82.8% of total male and 77.7% of total female cases). By sex, the top five 5-year prevalent cancers in males were lung (244.0), colorectal (177.9), liver (137.8), stomach (124.7), and bladder (81.0); among females, the top five 5-year prevalent cancers were breast (364.9), lung (230.6), colorectal (109.4), cervical (108.3), and thyroid (97.8).

**Table 1** Number of cancer cases and prevalence rates in the rural poor population of Heilongjiang, by sex and rank, 2018

Site	Male				Female				Total			
	N	Prevalence 1/10 <sup>5</sup>	Proportion %	ASR 1/10 <sup>5</sup>	N	Prevalence 1/10 <sup>5</sup>	Proportion %	ASR 1/10 <sup>5</sup>	N	Prevalence 1/10 <sup>5</sup>	Proportion %	ASR 1/10 <sup>5</sup>
Lung	906	275	18.5	109.6	748	253.0	13.3	92.4	1,654	264.7	15.7	102.0
Breast	16	4.9	0.3	1.8	1,532	518.7	27.2	342.9	1,548	247.7	14.7	153.6
Colorectal	704	213.7	14.3	92.2	417	141.2	7.4	62.7	1,121	179.4	10.6	78.7
Stomach	513	155.7	10.5	58.6	151	51.1	2.7	21.7	664	106.3	6.3	40.9
Liver	496	150.5	10.1	65.7	147	49.8	2.6	20.2	643	102.9	6.1	44.7
Cervix	-	-	-	-	432	146.3	7.7	88.1	432	69.1	4.1	39.5
Leukemia	232	70.4	4.7	118.3	199	67.4	3.5	127.7	431	69.0	4.1	122
Thyroid	73	22.2	1.5	16.3	342	115.8	6.1	93.1	415	66.4	3.9	49.8
Bladder	316	95.9	6.4	35.0	96	32.5	1.7	10.7	412	65.9	3.9	23.7
Larynx	211	64.0	4.3	23.3	111	37.6	2.0	11.9	322	51.5	3.1	17.8
Nervous system	134	40.7	2.7	32.3	170	58.0	3.0	54.9	304	48.7	2.9	42.8
Lymphoma	150	45.5	3.1	39.5	111	37.6	2.0	26.9	261	41.8	2.5	33.7
Ovary	-	-	-	-	237	80.2	4.2	54.0	237	37.9	2.3	24.1
Kidney	136	41.3	2.8	18.4	99	33.5	1.8	18.3	235	37.6	2.2	18.2
Esophagus	207	62.8	4.2	21.7	19	6.4	0.3	2.4	226	36.2	2.1	12.4
Lip, oral cavity, and pharynx	91	27.6	1.9	16.5	60	20.3	1.1	12.8	151	24.2	1.4	14.6
Gallbladder and biliary	53	16.1	1.1	6.6	75	25.4	1.3	10.5	128	20.5	1.2	8.4
Pancreas	78	23.7	1.6	10.0	34	11.5	0.6	20.2	112	17.9	1.1	7.8
Nasopharynx	69	20.9	1.4	11.4	42	14.2	0.7	8.9	111	17.8	1.1	10.4
Bone	64	19.4	1.3	16.3	43	14.6	0.8	10.5	107	17.1	1	13.6
Prostate	69	20.9	1.4	5.8	-	-	-	-	69	11.0	0.7	3.2
Uterus	-	-	-	-	62	21.0	1.1	13.1	62	9.9	0.6	5.9
Melanoma of the skin	21	6.4	0.4	4.1	18	6.1	0.3	4.8	39	6.2	0.4	4.2
Testis	21	6.4	0.4	5.3	-	-	-	-	21	3.4	0.2	3.1
Brain and CNS	10	3.0	0.2	2.0	10	3.4	0.2	2.7	20	3.2	0.2	2.4
Other thoracic organs	6	1.8	0.1	1.4	7	2.4	0.1	1.1	13	2.1	0.1	1.3
All other	330	100.2	6.7	54.8	461	156.1	8.2	98.8	791	126.6	7.5	74.5
All sites	4,906	1,489.0	100	766.9	5,623	1,903.7	100	1,196.6	10,529	1,685.0	100	953.3

**Note:** Cancer sites are shown in descending order of the total prevalence (number of cases per 100,000).

**Abbreviation:** ASR, age standardized rate.

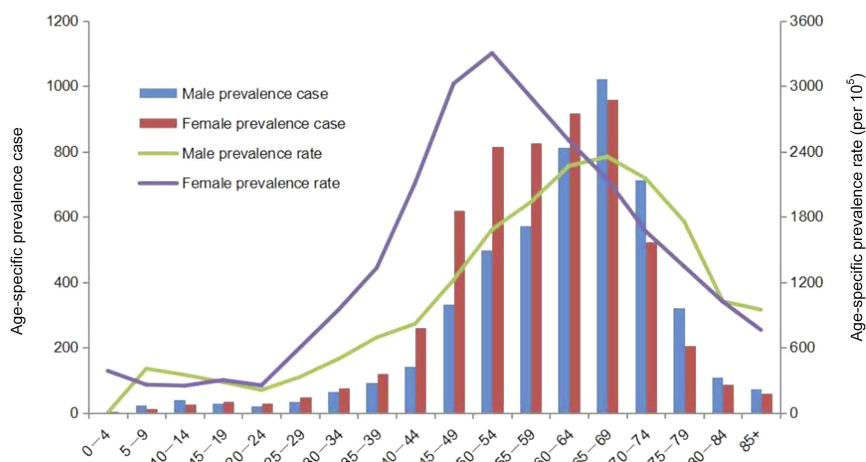


Figure 3 Age-specific prevalence cases and age-specific prevalence rates (per 10<sup>5</sup>) for all cancers, by sex, 2018.

Table 2 The prevalence rates of the top five common cancers in the rural poor population by age group and sex, 2018

Rank	Age			
	0-14	15-34	35-64	≥65
Male, number of cases per 100,000				
1	Leukemia (213.6)	Leukemia (130.7)	Lung (281.6)	Lung (407.3)
2	Lymphoma (38.3)	Colorectal (33.8)	Colorectal (219.0)	Colorectal (311.2)
3	Nervous system (27.4)	Lymphoma (29.3)	Liver (190.3)	Stomach (223.9)
4	Lip, oral cavity and pharynx (21.9)	Lung (27.0)	Stomach (168.8)	Liver (177.2)
5	Larynx (5.5)	Nervous system (22.5)	Bladder (80.8)	Bladder (168.4)
All	345.1	338.0	1598.8	1975.0
Female, number of cases per 100,000				
1	Leukemia (182.9)	Leukemia (141.3)	Breast (913.8)	Lung (383.3)
2	Nervous system (17.7)	Breast (69.4)	Lung (252.0)	Breast (278.4)
3	Lip, oral cavity and pharynx (11.8)	Nervous system (43.7)	Cervix (236.0)	Colorectal (187.5)
4	Breast (5.9)	Thyroid (43.7)	Thyroid (209.5)	Cervix (102.1)
5	Kidney (5.9)	Cervix (28.3)	Colorectal (157.9)	Larynx (62.2)
All	259.6	480.5	2701.1	1701.2

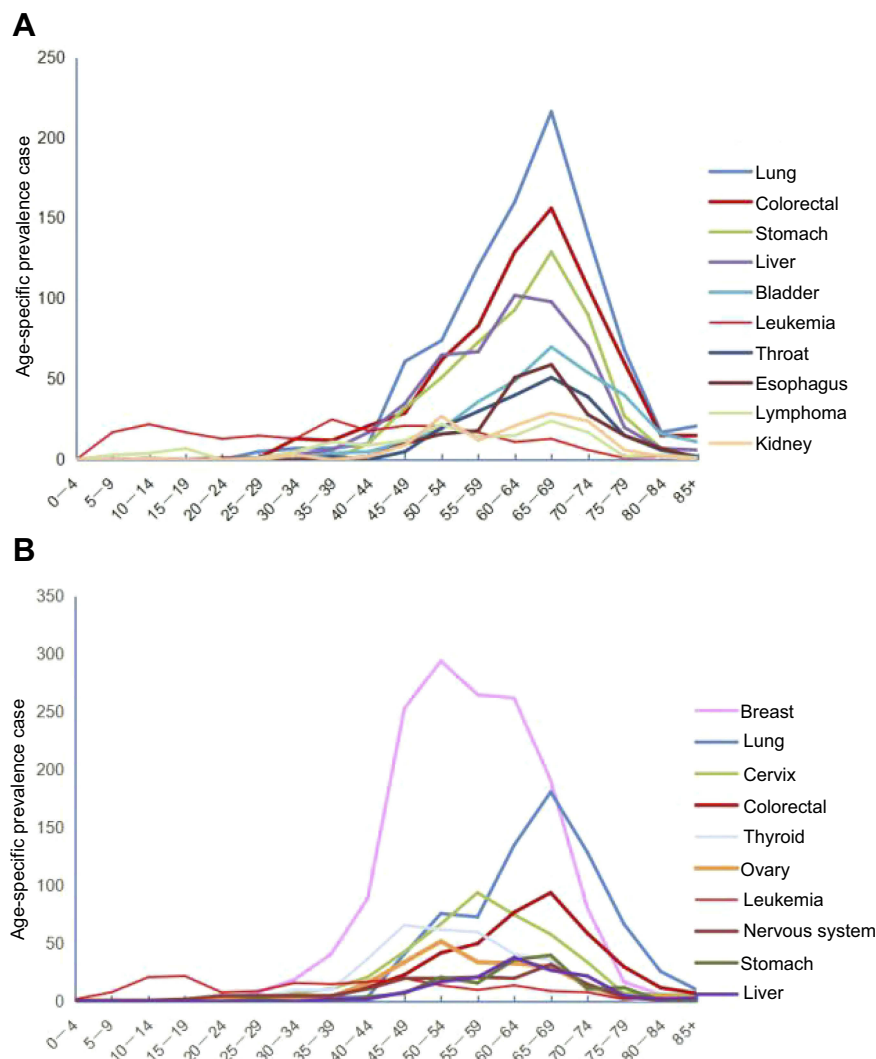
For cancer sites studied, breast (93.8%), liver (91.5%), lip, oral cavity, and pharynx (89.0%), lung (88.7%), and prostate (88.4%) in males had a higher proportion of the 5-year partial prevalence; in females, pancreas (97.1%), gallbladder and biliary (92.0%), lung (91.0%), melanoma of the skin (88.9%), and liver (87.8%) had a higher proportion of cases diagnosed within 5 years.

### Discussion

This research provides systematic information on total and partial cancer prevalence for the rural poor in Heilongjiang, the characteristics of cancer prevalence were broken down by age pyramid, sex, region as well as cancer site. Overall, the number of the poor affected by

cancer was 10,529 in 2018, the crude prevalence rate for all cancers combined was 1,685.0 per 100,000 people. The 5-year prevalence rates (1,233.1 per 100,000 in men and 1,479.1 per 100,000 in women) were much higher than the national 5-year cancer prevalence (666 per 100,000 in urban and 440 per 100,000 in rural, for both sexes) in 2011,<sup>6</sup> while they were lower than that had been reported in Korea<sup>10</sup> (3,162.8 per 100,000 people) and Western Australia (37.6 per 1,000 males and 36.5 per 1,000 females). The higher prevalence among the rural poor compared to the national level can be attributed to many factors, although there was no definite evidence that poverty would increase cancer prevalence due to economic conditions and unhealthy lifestyles. However, one reason





**Figure 4** Age-specific prevalence rates (per  $10^5$ ) of the top 10 cancers, 2018. (A) Male. (B) Female.

that may explicate the disparities is the aging structure (average age 53 years) of the poor population,<sup>11</sup> while according to the sixth national population census, the average age of Chinese people was less than 40 years old. In addition, Chen and colleagues found people living in Heilongjiang Province had the highest overall level of combined risks of modifiable factors for cancer among 31 provinces in China, with women ranked first and men ranked second.<sup>23</sup>

The prevalence of cancer shows geographic differences.<sup>2,24,25</sup> There were substantial variations in the cancer prevalence rate and cancer site between areas. The poverty-stricken population in eastern Heilongjiang had higher cancer prevalence rates than other areas. The top three common cancers in the poor population were lung, breast and colorectal cancer, but their ranking varied

among regions. Further research should be conducted to explore the ecological, environmental, and economic factors that contribute to regional differences in the distribution of cancer, and effective control measures should be devised to cope with relatively higher local risks.

The prevalence of cancers was higher among females than in males (the ratio of female to male is 1.15). This finding is consistent with previous national<sup>3,6</sup> and Sudanese<sup>5</sup> statistics; however, it is contrary to the global,<sup>2</sup> French,<sup>8</sup> and Japanese<sup>26</sup> statistics. There were also significant differences in cancer types between different sexes. The most common cancers were lung, colorectal, stomach, liver, and bladder in men, and breast, lung, cervical, colorectal and thyroid in women. A published review article showed that cancer prevalence usually peaks at ages 85–89 years, after which the rates

**Table 3** Time since first diagnosis among cancer cases in poor males, 2018

Site	Years since diagnosed						3 years prevalence			5 years prevalence		
	0-1	2-3	4-5	6-10	11-15	≥15	N	Proportion (%)	3 years prevalence rate (1/10 <sup>5</sup> )	N	Proportion (%)	5 years prevalence rate (1/10 <sup>5</sup> )
	Lung	313	379	112	81	15	6	692	76.4	210	804	88.7
Colorectal	196	273	117	87	23	8	469	66.6	142.3	586	83.2	177.9
Stomach	142	181	88	72	17	13	323	63.0	98.0	411	80.1	124.7
Liver	171	223	60	33	5	4	394	79.4	119.6	454	91.5	137.8
Bladder	99	105	63	32	15	2	204	64.6	61.9	267	84.5	81.0
Leukemia	63	72	35	40	11	11	135	58.2	41.0	170	73.3	51.6
Larynx	53	66	40	33	6	13	119	56.4	36.1	159	75.4	48.3
Esophagus	64	83	24	27	7	2	147	71.0	44.6	171	82.6	51.9
Lymphoma	50	54	19	20	4	3	104	69.3	31.6	123	82.0	37.3
Kidney	32	53	28	20	1	2	85	62.5	25.8	113	83.1	34.3
Nervous system	25	29	24	41	7	8	54	40.3	16.4	78	58.2	23.7
Lip, oral cavity, and pharynx	34	38	9	5	4	1	72	79.1	21.9	81	89.0	24.6
Pancreas	22	38	5	10	3	0	60	76.9	18.2	65	83.3	19.7
Thyroid	25	18	11	13	4	2	43	58.9	13.1	54	74.0	16.4
Nasopharynx	15	24	12	16	2	0	39	56.5	11.8	51	73.9	15.5
Prostate	27	24	10	6	0	2	51	73.9	15.5	61	88.4	18.5
Bone	15	20	17	9	1	2	35	54.7	10.6	52	81.3	15.8
Gallbladder and biliary	19	17	8	7	1	1	36	67.9	10.9	44	83.0	13.4
Testis	7	7	4	1	2	0	14	66.7	4.2	18	85.7	5.5
Melanoma of the skin	5	7	5	3	0	1	12	57.1	3.6	17	81.0	5.2
Breast	5	7	3	1	0	0	12	75.0	3.6	15	93.8	4.6
Brain and CNS	1	6	1	2	0	0	7	70.0	2.1	8	80.0	2.4
Other thoracic organs	1	2	0	2	0	1	3	50.0	0.9	3	50.0	0.9
All other	92	115	51	44	15	13	207	62.7	62.8	258	78.2	78.3
All	1,476	1,841	746	605	143	95	3,317	67.6	1,006.7	4,063	82.8	1,233.1



**Table 4** Time since first diagnosis among cancer cases in poor females, 2018

Site	Years since diagnosed						3 years prevalence			5 years prevalence		
	0-1	2-3	4-5	6-10	11-15	≥15	N	Proportions (%)	3 years prevalence rate (1/10 <sup>5</sup> )	N	Proportions (%)	5 years prevalence rate (1/10 <sup>5</sup> )
Breast	323	474	281	318	86	50	797	52.0	269.8	1078	70.4	364.9
Lung	270	299	112	57	8	2	569	76.1	192.6	681	91.0	230.6
Cervix	93	120	107	88	17	7	213	49.3	72.1	320	74.1	108.3
Colorectal	111	154	58	79	10	5	265	63.5	89.7	323	77.5	109.4
Thyroid	100	126	63	43	5	5	226	66.1	76.5	289	84.5	97.8
Ovary	53	100	34	38	10	2	153	64.6	51.8	187	78.9	63.3
Leukemia	59	76	27	28	5	4	135	67.8	45.7	162	81.4	54.8
Nervous system	41	45	27	34	11	12	86	50.6	29.1	113	66.5	38.3
Stomach	35	71	16	24	3	2	106	70.2	35.9	122	80.8	41.3
Liver	49	61	19	15	2	1	110	74.8	37.2	129	87.8	43.7
Larynx	14	30	15	31	11	10	44	39.6	14.9	59	53.2	19.9
Lymphoma	30	41	22	14	2	2	71	64.0	24.0	93	83.8	31.5
Kidney	28	40	15	8	5	3	68	68.7	23.0	83	83.8	28.1
Bladder	30	34	16	10	5	1	64	66.7	21.7	80	83.3	27.1
Gallbladder and biliary	24	33	12	2	2	2	57	76.0	19.3	69	92.0	23.4
Uterus	22	27	4	7	0	2	49	79.0	16.6	53	85.5	17.9
Lip, oral cavity, and pharynx	19	24	7	4	2	4	43	71.7	14.6	50	83.3	16.9
Bone	16	7	9	9	2	0	23	53.5	7.8	32	74.4	10.8
Nasopharynx	7	16	5	10	1	3	23	54.8	7.8	28	66.7	9.5
Pancreas	11	16	6	1	0	0	27	79.4	9.1	33	97.1	11.2
Esophagus	4	6	3	4	1	1	10	52.6	3.4	13	68.4	4.4
Melanoma of the skin	4	6	6	1	0	1	10	55.6	3.4	16	88.9	5.4
Brain and CNS	4	3	1	2	0	0	7	70.0	2.4	8	80.0	2.71
Other thoracic organs	2	3	0	1	1	0	5	71.4	1.7	5	71.4	1.7
All other	118	159	66	80	22	16	277	60.1	93.8	343	74.4	116.1
All	1,467	1,971	931	908	211	135	3,438	61.1	1,163.9	4,369	77.7	1,479.1

decrease.<sup>11</sup> However, cancer prevalence rates in this study showed a much earlier peak for both sexes and then dropped suddenly; cancer prevalence rate in men peaked in the 65–69 years age group, while in women it peaked at an even earlier age of 50–54 years. The earlier decline in prevalence might be associated with earlier deaths due to lack of effective early diagnostic strategies and suboptimal treatment, as well as poor economic support.<sup>18,19</sup> Previous study showed that the survival rate for all cancer patients in China was lower in rural areas than in urban areas: the urban–rural survival gap was 13.1% in 2012–2015.<sup>1</sup>

The ranking of cancer prevalence in this study is different from that in China. For example, the most common cancers diagnosed in five years were lung, colorectal and liver in males, and breast, lung and colorectal in females, but national statistical results<sup>6</sup> show that the most frequent cancers for males diagnosed in five years were stomach, lung and colorectal, and those for females were breast cancer, colorectal and cervix.

It is worth noting that 5-year prevalence of lung cancer in the poor population (244.0 per 100,000 in males and 230.6 per 100,000 in females) was much higher than in the 2011 national statistics (84.6 in males and 45.6 in females),<sup>6</sup> the ratios were about 2.88 times for males and 5.06 times for females. Heilongjiang province is the coldest province located in the most northeastern part of China. The higher prevalence of lung cancer in the rural poor may be associated with outdoor and indoor air pollution caused by burning large amounts of solid fuels during cooking and heating.<sup>15</sup> Smoking was reported to be the highest risk factor of cancer among females in Heilongjiang province, this finding may partly explain the high prevalence among females.<sup>23</sup> Breast cancer is the most frequent type of cancer in females worldwide.<sup>2,27</sup> In this study, the prevalence of breast cancer was the most common cancer among the poor in 8 of 13 regions in Heilongjiang province, and accounted for 27.2% of all cancer cases among poor rural females. Colorectal cancer was the second most common type in poor males; the prevalence rate of colorectal cancer was higher in males than in females. Leukemia was not a particularly common cancer among poor people; however, it accounted for the majority of cases in poor children and young people, which was consistent with previous studies.<sup>4,28</sup> In addition, the prevalence rate of leukemia was very high (ranked second) after age standardization in the rural poor. In this study, we also found that several high-prevalence cancers, including stomach cancer (third common in males and ninth common in females), liver cancer (third common in males), and

cervical cancer (third common cancer in females) are attributable to infection.<sup>24,29</sup> Therefore, one of the effective ways to tackle the huge burden of cancer is to intervene in these infectious disease-related cancers, such as by vaccination.

In view of the broad definition of prevalence, partial prevalence makes it possible to identify the approximate number of patients needing clinical treatment and surveillance care.<sup>6–10</sup> The usual classification is cancer patients who were diagnosed within 1 year and in the last year of life are cases related to the highest levels of health service utilization; 2–3 years indicates that the cases ought to have clinical follow-up; 2–5 years indicates they should be under close surveillance due to high probability of recurrence; 5–10 years indicates the probability of recurrence is low; and beyond 15 years, patients can be deemed to be cured. In the rural poor of Heilongjiang, 3-year prevalence and 5-year prevalence accounted for large proportions of the total cases (64.2% and 80.1%, respectively). This implies huge cancer treatment cost for poor households as well as a substantial economic burden to the local government in further financing and expanding the coverage of catastrophic medical schemes. In addition, it also exerts a huge social care burden on members of poor families who usually take over all the responsibilities and burden of those cancer patients.

This study found that the rural poor with cancer were confronted with unique multi-vulnerabilities, including poor and seriously ill, long-term and high medical treatment cost as well as social care burden, senior ages (mean age 65 years), without labor capacity (77.2%) and less educated. In addition, there is an unbalanced distribution of health-care resources between rural and urban regions.<sup>30,31</sup> The national bureau of statistics of China in 2018 showed that in Heilongjiang Province, the number of health personnel per 1,000 was 10.25 in urban and only 4.19 in rural areas.<sup>5</sup> Hospitals in China are rigorously classified into three levels, primary, secondary and tertiary, among which the tertiary hospitals are believed to provide the highest quality of medical services.<sup>30,32</sup> Almost all tertiary hospitals are located in urban areas, while the county hospitals and township health centers usually have difficulty in diagnosing and treating complicated diseases like cancer due to a shortage of qualified professionals and medical technology.<sup>33,34</sup> Due to the above reasons, poor cancer patients living in rural areas often have to travel long distances to the urban areas to get a more accurate diagnosis and complicated treatment, often generating additional costs to them. The

combination of these unfavorable factors leads to difficulties in ongoing efforts of the government to get those who were stricken by both poverty and disease out of their dire situation. It is the government's responsibility to establish a multiple health system guarantee for these vulnerable poor people, and more medical resources and capacity building should be provided to cope with the heterogeneous demands of medical care support. Cost-effectiveness analysis of cancer treatment and support should also be considered in poverty alleviation programs, and palliative therapy should be properly administered according to the actual situation of patients to avoid the large burden that families and society would have to bear due to excessive treatment.

## Conclusion

Cancer imposes significant medical, financial, and social care burdens on the rural poor population. For the first time in China, this study drew a clear cancer prevalence profile among poor people. This study found out that there exists diverse distribution in cancers based on geography, age, and sex. In addition, the 5-year prevalence, which was deemed as an important way to identify patients needing treatment and care, was as high as 80.1%. The results of this study suggest that the government should formulate targeted treatment and poverty alleviation strategies for these vulnerable groups in order to meet the unique challenges. Timely economic assistance and rational allocation of finite health-care resources to address medical burden should depend on accurate quantification of future demands of high cancer prevalence. Determining the prevalence for the timely and high quality treatment of cancer treatment is closely related to prognosis for vulnerable poor populations. This study can also serve as a baseline for future comparisons with different regions and different groups of people. In addition, future rural health planning should focus on identifying risk factors and changing unhealthy lifestyles for good primary prevention.

## Abbreviation list

HPAIS, Health Poverty Alleviation Information System; CR, crude rate; ASR, age-standardized rate; ISCD, insurance scheme for catastrophic diseases.

## Ethics approval

This study was reviewed and approved by the Research Ethics Committee of Harbin Medical University.

## Availability of data and materials

Cancer data were acquired from the Health Poverty Alleviation Information System (HPAIS) of Heilongjiang. To protect personal privacy, the data are not publically available.

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## Author Contributions

All authors contributed to data analysis, drafting the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

## Disclosure

The authors report no conflicts of interest in this work.

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