

## Original Article

## Liver cancer incidence and mortality in China, 2009

Wan-Qing Chen, Rong-Shou Zheng and Si-Wei Zhang

## Abstract

Liver cancer is a common cancer and a leading cause of cancer deaths in China. To aid the government in establishing a control plan for this disease, we provided real-time surveillance information by analyzing liver cancer incidence and mortality in China in 2009 reported by the National Central Cancer Registry. Liver cancer incidence and cases of death were retrieved from the national database using the ICD-10 topography code "C22". Crude incidence and mortality were calculated and stratified by sex, age, and location (urban/rural). China's population in 1982 and Segi (world) population structures were used for age-standardized rates. In cancer registration areas in 2009, the crude incidence of liver cancer was 28.71/100,000, making it the fourth most common cancer in China, third most common in males, and fifth most common in females. The crude mortality of liver cancer was 26.04/100,000, making it the second leading cause of cancer death in China and urban areas and the third leading cause in rural areas. Incidence and mortality were higher in males than in females and were higher in rural areas than in urban areas. The age-specific incidence and mortality were relatively low among age groups under 30 years but dramatically increased and peaked in the 80–84 years old group. These findings confirm that liver cancer is a common and fatal cancer in China. Primary and secondary prevention such as health education, hepatitis B virus vaccination, and early detection should be carried out both in males and females, in urban and rural areas.

**Key words** Liver cancer, cancer registry, incidence, mortality, China

Liver cancer is a common and fatal cancer in the world. According to world cancer statistics, 749,000 new cases were diagnosed and 695,000 deaths were reported in 2008<sup>[1]</sup>. In China, liver cancer has been the second leading cause of cancer death since the 1990s<sup>[1]</sup>. Time trend analysis showed that the crude incidence of liver cancer is increasing, and a slight downward trend has been observed over the last 20 years after adjusted by age.

The National Central Cancer Registry (NCCR) of China is the government organization in charge of collecting cancer information nationwide and reporting cancer statistics annually. Since 2008, the Chinese

Cancer Registry annual report has provided cancer incidence and mortality data with which to create strategies for cancer prevention and control. In 2012, NCCR collected data for the calendar year of 2009 from 104 registries. After comprehensive quality control, data from 72 registries were accepted as sources of the annual report to reflect cancer incidence and mortality in the registration areas in 2009. In this study, liver cancer cases were retrieved from the national database for analysis.

## Materials and Methods

## Data source

All new cancer cases diagnosed in 2009 were reported to local cancer registries from all hospitals, community health centers, and the other departments, including centers of township medical insurance and the New-type Rural Cooperative Medical System. Vital

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statistics were linked and matched with the cancer registration database for identifying cancer deaths and missed cases.

For all 104 cancer registries (46 cities and 58 counties from 27 provinces) reporting cancer registration data to NCCR, the overall population coverage was 109,476,347, accounting for 8.20% of the whole population in 2009. The cancer registries coded cancer site and histology according to the International Classification of Diseases for Oncology, third edition (ICD-03) and tenth edition (ICD-10). Invasive cases of liver cancer (topography code as C22) were retrieved from the NCCR database and analyzed. Demographic information was provided by the National Statistics Bureau.

### Quality control

Based on “Guideline of Chinese Cancer Registration” and the standard of data inclusion in “Cancer Incidence in Five Continents Volume IX”<sup>[2]</sup>, cancer registration data were evaluated by the following quality indicators: proportion of morphologic verification (MV%), percentage of cancer cases identified with death certification only (DCO%), and mortality-to-incidence ratio (M/I)<sup>[3-5]</sup>. The detailed standard for data inclusion was shown previously<sup>[6]</sup>. Generally, data with DCO% less than 20%, overall MV% more than 55%, and M/I between 0.55 and 0.95 were considered acceptable.

### Statistical analysis

Crude incidence and mortality of liver cancer were calculated by sex, area, and for 19 total age groups (<1, 1–4, 5–9, ...80–84, ≥85 years). Age-standardized rates were calculated using the Chinese population in 1982 and Segi (world) population. The cumulative risk of developing or dying from cancer before 75 years of age (in the absence of competing causes of death) was calculated and presented as a percentage. Software including MS-FoxPro, MS-Excel, and IARCcrgTools issued by International Agency for Research on Cancer (IARC) and International Association of Cancer Registry (IACR) were used for data checkup. SAS software was used to calculate the incidence and mortality rates.

## Results

### Pooled data

Data from 72 population-based cancer registries were accepted for the annual report after evaluation based on quality control criteria. The population covered by these cancer registries was 85,470,522, including

43,231,554 males and 42,238,968 females, accounting for 6.40% of the whole national population. A total of 31 registries were from urban areas, covering a total population of 57,489,009, and 41 registries were from rural areas, covering a total population of 27,981,513. The MV%, DCO%, and M/I of liver cancer for the national pooled data were 34.10%, 5.91%, and 0.91, respectively. The MV%, DCO%, and M/I were 38.11%, 6.08%, and 0.91, respectively, in urban areas and 27.46%, 5.63%, and 0.91, respectively, in rural areas. There were 24,536 new cases of liver cancer (18,155 males and 6,381 females) and 22,255 liver cancer deaths (16,409 males and 5,846 females) in 2009. Population and liver cancer incidence and deaths in each cancer registry are shown in Table 1.

### Incidence

The crude incidence of liver cancer was 28.71/100,000 in 2009, accounting for 10.04% of overall new cancer cases and ranking fourth in all cancer sites. The age-standardized incidences by the Chinese population (ASIRC) and world population (ASIRW) were 14.78/100,000 and 19.28/100,000, respectively. Among persons under the age of 75, the cumulative incidence was 2.20%.

Liver cancer occurred more often in males than in females. For males, liver cancer was the third most common cancer, with a crude incidence of 41.99/100,000, whereas the ASIRC and ASIRW were 22.49/100,000 and 29.17/100,000, respectively. For females, liver cancer was the fifth most common cancer, with a crude incidence of 15.11/100,000, whereas the ASIRC and ASIRW were 7.11/100,000 and 9.52/100,000, respectively. The crude incidence in urban areas (26.63/100,000) was lower than that in rural areas (32.98/100,000) but ranked fourth in both areas. After age standardization, the incidence in urban areas (ASIRW = 17.18/100,000) was still lower than that in rural areas (ASIRW = 24.04/100,000) (Table 2).

The age-specific incidence was relatively low in subjects under 30 years old but dramatically increased in those over 30, peaking in the 80–84 years old group in both males and females. Notably, after the age of 30, incidence in males was more than double that in females, although there were slight differences among those under 30. The age-specific liver cancer incidence in urban areas was generally lower than that in rural areas both in males and females, especially in older age groups (Table 3, Figure 1).

### Mortality

The crude mortality for liver cancer was 26.04/100,000 in 2009, accounting for 14.42% of overall

**Table 1. Population and number of new liver cancer cases and deaths in cancer registries in 2009**

Registry	Area	Population			New cancer cases			Cancer death		
		Both	Male	Female	Both	Male	Female	Both	Male	Female
Beijing	Urban	7,645,186	3,859,586	3,785,600	1,498	1,093	405	1,323	970	353
Qianxi	Rural	361,312	182,138	179,174	89	68	21	66	51	15
Shexian	Rural	394,944	205,168	189,776	80	49	31	80	61	19
Cixian	Rural	634,333	322,621	311,712	103	69	34	101	72	29
Baoding	Urban	948,612	478,051	470,561	161	103	58	180	104	76
Yangquan	Urban	683,165	346,023	337,142	109	72	37	92	61	31
Yangcheng	Rural	383,165	192,119	191,046	133	84	49	130	84	46
Chifeng	Urban	1,203,006	613,725	589,281	460	343	117	355	260	95
Shenyang	Urban	3,497,815	1,722,976	1,774,839	796	567	229	803	590	213
Dalian	Urban	2,266,224	1,136,772	1,129,452	713	547	166	622	458	164
Zhuanghe	Rural	915,660	461,826	453,834	262	189	73	284	203	81
An'shan	Urban	1,471,775	731,916	739,859	446	327	119	400	291	109
Benxi	Urban	955,409	475,113	480,296	275	206	69	282	218	64
Dandong	Urban	767,011	378,794	388,217	317	212	105	266	195	71
Donggang	Rural	640,853	323,798	317,055	333	235	98	218	157	61
Dehui	Rural	943,395	479,486	463,909	228	158	70	228	157	71
Yanji	Rural	440,957	215,260	225,697	146	121	25	131	103	28
Daoli District, Harbin	Urban	713,264	351,071	362,193	210	153	57	170	121	49
Nangang District, Harbin	Urban	1,020,233	508,921	511,312	230	166	64	217	163	54
Shangzhi	Rural	616,046	314,864	301,182	251	167	84	166	111	55
Shanghai	Urban	6,181,334	3,084,496	3,096,838	1,729	1,225	504	1,593	1,151	442
Jintan	Rural	545,000	262,407	282,593	88	60	28	119	85	34
Suzhou	Urban	2,392,087	1,183,716	1,208,371	619	445	174	545	378	167
Haian	Rural	936,785	463,612	473,173	361	250	111	332	237	95
Qidong	Rural	1,114,951	548,805	566,146	843	611	232	783	569	214
Haimen	Rural	1,016,228	501,407	514,821	544	415	129	506	373	133
Lianyungang	Urban	886,862	452,358	434,504	194	154	40	204	155	49
Donghai	Rural	1,117,858	579,751	538,107	268	201	67	220	168	52
Guanyun	Rural	1,015,229	534,502	480,727	351	261	90	333	255	78
Chuzhou District, Huai'an	Urban	1,174,877	609,088	565,789	281	212	69	206	152	54
Huaiyin District, Huai'an	Urban	900,027	465,502	434,525	268	214	54	249	197	52
Xuyi	Rural	759,450	388,180	371,270	239	172	67	190	140	50
Jinhu	Rural	352,292	176,689	175,603	77	57	20	70	60	10
Sheyang	Rural	965,817	494,682	471,135	415	302	113	379	270	109
Jianhu	Rural	805,465	410,369	395,096	200	163	37	194	158	36
Dafeng	Rural	724,147	363,326	360,821	264	191	73	229	172	57
Yangzhong	Rural	272,046	134,758	137,288	48	33	15	55	41	14
Taixing	Rural	1,128,840	613,199	515,641	453	350	103	405	315	90
Hangzhou	Urban	6,753,509	3,403,893	3,349,616	2,056	1,533	523	1,974	1,430	544
Jiaxing	Urban	509,367	253,819	255,548	139	94	45	130	90	40
Jiashan	Rural	382,475	189,692	192,783	153	106	47	160	109	51
Haining	Rural	653,957	322,969	330,988	146	100	46	139	92	47
Shangyu	Rural	771,321	383,462	387,859	282	223	59	282	217	65
Xianju	Rural	490,070	255,438	234,632	177	141	36	183	149	34
Feixi	Rural	858,895	449,882	409,013	145	121	24	154	113	41
Maanshan	Urban	633,477	323,834	309,643	125	105	20	113	90	23
Tongling	Urban	433,545	221,375	212,170	67	44	23	64	47	17
Changle	Rural	673,717	355,091	318,626	194	148	46	133	103	30
Xiamen	Urban	1,160,135	583,873	576,262	415	339	76	393	312	81

*(To be continued)*

**Table 1. Population and number of new liver cancer cases and deaths in cancer registries in 2009 (continued)**

Registry	Area	Population			New cancer cases			Cancer death		
		Both	Male	Female	Both	Male	Female	Both	Male	Female
Zhanggong District, Ganzhou	Urban	420,759	212,159	208,600	174	145	29	148	110	38
Linqu	Rural	817,857	417,434	400,423	214	143	71	210	157	53
Wenshang	Rural	762,828	388,454	374,374	114	85	29	153	112	41
Feicheng	Rural	733,501	358,739	374,762	175	123	52	141	101	40
Yanshi	Rural	602,266	306,192	296,074	119	81	38	100	64	36
Linzhou	Rural	1,080,241	557,392	522,849	147	98	49	139	96	43
Xiping	Rural	858,002	434,899	423,103	279	189	90	254	174	80
Wuhan	Urban	4,832,174	2,484,622	2,347,552	1,211	933	278	941	722	219
Yunmeng	Rural	524,801	261,237	263,564	155	105	50	188	133	55
Hengdong	Rural	713,458	373,923	339,535	235	179	56	149	113	36
Guangzhou	Urban	3,968,216	2,014,580	1,953,636	1,320	1,043	277	1,242	951	291
Sihui	Rural	413,363	211,351	202,012	164	127	37	140	109	31
Zhongshan	Urban	1,468,391	732,333	736,058	343	288	55	300	250	50
Liuzhou	Urban	1,038,208	533,050	505,158	347	277	70	250	197	53
Fusui	Rural	444,332	236,000	208,332	311	256	55	239	195	44
Jiulongpo District, Chongqing	Urban	798,618	402,961	395,657	149	117	32	189	145	44
Qinyang District, Chengdu	Urban	534,701	277,154	257,547	120	90	30	107	83	24
Ziliujing District, Zigong	Urban	357,600	179,873	177,727	138	109	29	101	78	23
Yanting	Rural	610,103	316,499	293,604	316	213	103	280	190	90
Jingtai	Rural	233,609	119,953	113,656	61	38	23	54	36	18
Liangzhou District, Wuwei	Urban	990,583	524,276	466,307	182	128	54	297	210	87
Xining	Urban	882,839	439,175	443,664	215	141	74	129	89	40
Xinyuan	Rural	271,944	138,895	133,049	66	48	18	53	36	17
Total		85,470,522	43,231,554	42,238,968	24,536	18,155	6,381	22,255	16,409	5,846

**Table 2. Liver cancer incidence by sex and area in registration areas in 2009**

Location	Sex	No. of cases	Crude incidence (1/10 <sup>5</sup> )	Percentage (%)	ASIRC (1/10 <sup>5</sup> )	ASIRW (1/10 <sup>5</sup> )	Cumulative rate (%) Age 0–74	Rank <sup>a</sup>
All areas	Both	24,536	28.71	10.04	14.78	19.28	2.20	4
	Male	18,155	41.99	13.21	22.49	29.17	3.31	3
	Female	6,381	15.11	5.97	7.11	9.52	1.11	5
Urban	Both	15,307	26.63	8.78	13.13	17.18	1.95	4
	Male	11,425	39.42	11.94	20.32	26.43	2.98	3
	Female	3,882	13.62	4.93	6.05	8.15	0.94	5
Rural	Both	9,229	32.98	13.19	18.52	24.04	2.77	4
	Male	6,730	47.24	16.12	27.33	35.26	4.03	4
	Female	2,499	18.19	8.86	9.57	12.70	1.48	5

<sup>a</sup>The proportion rank of liver cancer in all cancer types.

ASIRC, age-standardized incidence by Chinese population; ASIRW, age-standardized incidence by world population.

cancer deaths in 2009. The ASMRC and ASMRW for mortality were 13.06/100,000 and 17.26/100,000, respectively. Among patients at 0–74 years of age, the cumulative mortality was 1.96%.

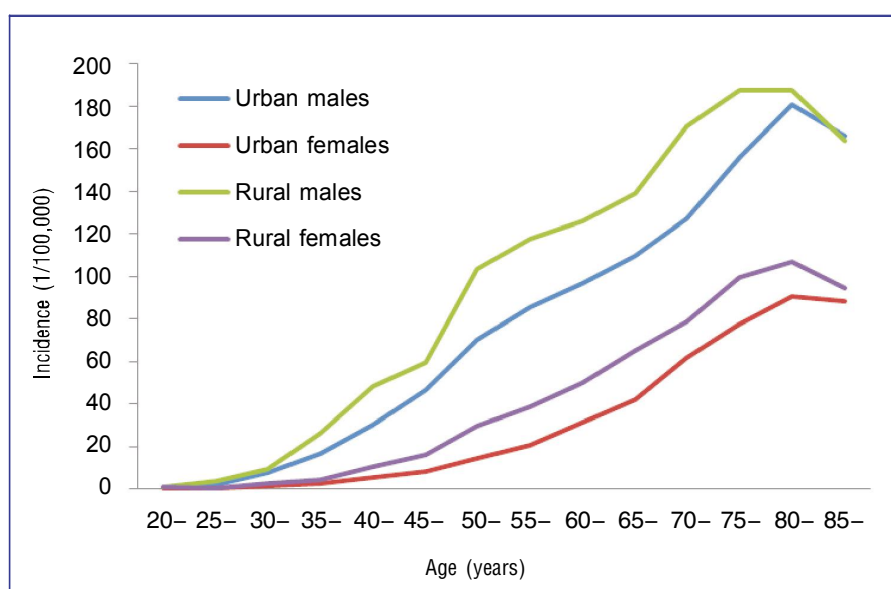
The mortality was higher in males than in females. The crude mortality, ASMRC, and ASMRW were

37.96/100,000, 19.91/100,000, and 26.14/100,000, respectively, for males and 13.84/100,000, 6.28/100,000, and 8.54/100,000, respectively, for females. These values were 24.15/100,000, 11.51/100,000, and 15.27/100,000, respectively, in urban areas and 29.91/100,000, 16.54/100,000, and

**Table 3. Age-specific incidences of liver cancer in cancer registration areas in 2009**

Age group	All areas			Urban areas			Rural areas		
	Both	Male	Female	Both	Male	Female	Both	Male	Female
All	28.71	41.99	15.11	26.63	39.42	13.62	32.98	47.24	18.19
0–	1.13	1.53	0.68	1.30	1.99	0.55	0.85	0.79	0.91
1–	0.44	0.55	0.31	0.65	0.90	0.37	0.10	0.00	0.21
5–	0.14	0.16	0.12	0.14	0.18	0.10	0.13	0.13	0.14
10–	0.18	0.17	0.18	0.23	0.22	0.24	0.10	0.10	0.11
15–	0.31	0.57	0.04	0.28	0.55	0.00	0.37	0.61	0.11
20–	0.73	0.87	0.59	0.61	0.78	0.44	1.02	1.10	0.94
25–	1.53	2.66	0.37	1.34	2.19	0.45	1.98	3.72	0.18
30–	5.18	8.39	1.91	4.74	7.79	1.65	5.97	9.47	2.40
35–	11.51	19.82	3.10	9.53	16.49	2.51	15.45	26.41	4.28
40–	21.82	36.31	7.02	17.90	30.28	5.29	29.69	48.37	10.51
45–	30.81	50.40	10.50	27.57	46.27	8.09	38.12	59.76	15.89
50–	49.50	79.55	18.51	42.49	70.06	14.20	67.34	103.47	29.59
55–	60.65	95.18	25.90	52.96	85.51	20.77	79.03	117.58	38.52
60–	71.62	106.20	36.93	63.47	96.54	31.06	89.24	126.30	50.10
65–	84.24	119.88	49.43	75.07	109.94	41.97	102.52	138.87	64.95
70–	101.76	140.14	66.49	92.66	127.13	61.53	123.65	170.49	78.76
75–	121.72	164.58	83.63	114.57	155.97	77.44	140.27	187.35	99.46
80–	133.99	182.74	95.30	131.10	180.85	90.66	141.29	187.76	106.61
85–	119.44	165.76	90.12	119.04	166.35	88.33	120.48	164.13	94.63

All values are presented as incidence (1/100,000).



**Figure 1. Age-specific incidence of liver cancer in males and females in urban and rural areas in 2009.** The age-specific incidence kept increasing with the age increase and reached at peak in the 80–84 years old group. Incidences in rural areas were higher than those in urban areas and incidences in males were higher than those in females in any age group.

21.72/100,000, respectively, in rural areas. Liver cancer was ranked the second leading cause of cancer death in

urban and third in rural areas (Table 4, Figure 2).

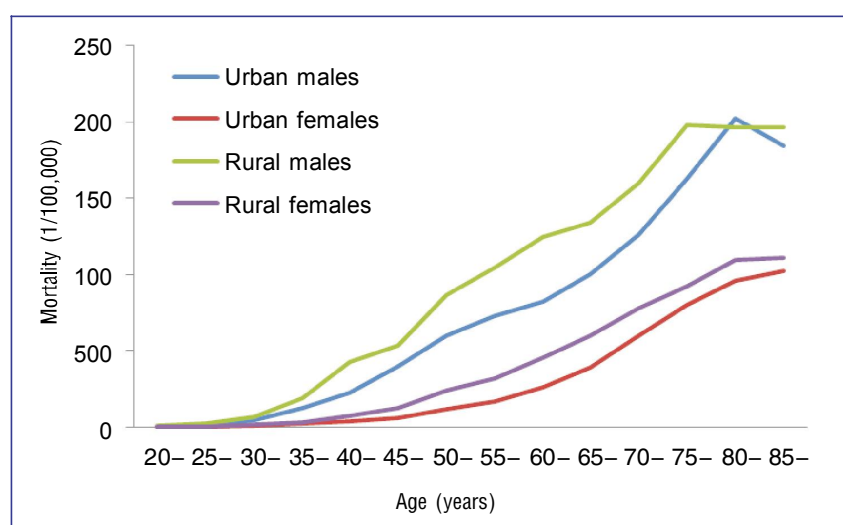
Mortality was relatively low in age groups under 35

**Table 4. Liver cancer mortality in cancer registration areas in 2009**

Location	Sex	No. of cases	Crude mortality (1/10 <sup>5</sup> )	Percentage (%)	ASMRC (1/10 <sup>5</sup> )	ASMRW (1/10 <sup>5</sup> )	Cumulative rate (%) Age 0–74	Rank <sup>a</sup>
All areas	Both	22,255	26.04	14.42	13.06	17.26	1.96	2
	Male	16,409	37.96	16.93	19.91	26.14	2.95	2
	Female	5,846	13.84	10.19	6.28	8.54	0.99	3
Urban	Both	13,885	24.15	13.28	11.51	15.27	1.72	2
	Male	10,268	35.43	15.85	17.76	23.40	2.62	2
	Female	3,617	12.69	9.09	5.39	7.38	0.84	4
Rural	Both	8,370	29.91	16.82	16.54	21.72	2.50	3
	Male	6,141	43.11	19.10	24.65	32.17	3.66	3
	Female	2,229	16.23	12.66	8.34	11.22	1.32	4

<sup>a</sup>The proportion rank of liver cancer in all cancer types.

ASMRC, age-standardized mortality by Chinese population; ASMRW, age-standardized mortality by world population.



**Figure 2. Age-specific mortality of liver cancer in males and females in urban and rural areas in 2009.** The age-specific mortality kept increasing with the age increase and reached at peak in the 80–84 years old group except for urban females. Mortalities in rural areas were higher than those in urban areas and mortalities in males were higher than those in females in any age group.

and peaked in the 80–84 year old age group in overall areas and urban areas. In rural areas, mortality in the over 85 age group was the highest among all age groups. After the age of 15, age-specific mortality was higher in rural areas than in urban areas and was higher in males than in females (Table 5).

## Discussion

For this analysis of liver cancer incidence and mortality, we assessed data from 72 cancer registries covering 85.47 million people from 27 provinces—the largest population coverage since NCCR started to publish annual reports in 2008. We found that there were 24,536 new cases and 22,255 deaths from liver cancer.

Although a large sample size was included in this study, further representative analysis should follow.

In terms of quality control, morphologic verification for liver cancer is relatively low compared with other cancers, especially in rural areas, because medical resources are limited and pathologic examination cannot always be performed (e.g., for late-stage liver cancer). In global data, the MV% of liver cancer fluctuated markedly among different countries and registries<sup>[7]</sup>.

The national cancer registry program was established by the Ministry of Health in 2008, providing grants from central finance to build a national cancer registry network. The number of cancer registries has increased from 43 in 2007 to 222 in 2012, with the covered population reaching 200 million. It is estimated that there will be more than 300 registries covering 20% of the national population by the end of 2015.



**Table 5. Age-specific mortality of liver cancer in cancer registration areas in 2009**

Age group	All areas			Urban areas			Rural areas		
	Both	Male	Female	Both	Male	Female	Both	Male	Female
All	26.04	37.96	13.84	24.15	35.43	12.69	29.91	43.11	16.23
0–	0.48	0.61	0.34	0.78	1.00	0.55	0.00	0.00	0.00
1–	0.37	0.42	0.31	0.47	0.68	0.25	0.19	0.00	0.41
5–	0.08	0.11	0.06	0.05	0.09	0.00	0.13	0.13	0.14
10–	0.04	0.04	0.05	0.04	0.07	0.00	0.05	0.00	0.11
15–	0.24	0.39	0.08	0.14	0.28	0.00	0.42	0.61	0.22
20–	0.57	0.74	0.39	0.50	0.67	0.32	0.74	0.92	0.56
25–	1.02	1.63	0.39	0.88	1.29	0.45	1.35	2.39	0.27
30–	3.27	5.46	1.03	2.68	4.54	0.80	4.32	7.12	1.46
35–	8.80	14.89	2.63	7.50	12.62	2.35	11.38	19.38	3.21
40–	17.38	29.21	5.31	13.55	22.86	4.07	25.09	41.93	7.80
45–	26.49	44.15	8.17	23.65	40.19	6.41	32.90	53.12	12.12
50–	41.98	67.95	15.21	36.17	60.04	11.69	56.77	87.90	24.24
55–	51.61	82.20	20.81	44.50	72.82	16.51	68.59	103.95	31.43
60–	63.48	95.14	31.71	53.98	82.43	26.11	83.99	121.59	44.29
65–	78.18	111.31	45.82	68.96	100.01	39.49	96.53	132.88	58.97
70–	99.36	136.48	65.25	91.48	126.22	60.09	118.33	160.41	78.00
75–	125.44	172.50	83.63	119.39	163.05	80.22	141.18	197.50	92.36
80–	144.15	200.47	99.46	143.42	202.21	95.62	146.01	195.86	108.81
85–	136.80	187.58	104.66	134.64	184.60	102.21	142.44	195.81	110.83

All values are presented as mortality (1/100,000).

Compared with the results in 2008<sup>[8]</sup>, the crude incidence and mortality fluctuated slightly in 2009 due to different population coverage. However, after adjusting for age, the rates remained stable, reflecting the good quality of the registration data<sup>[6]</sup>. Chen *et al.* reported that there were 339,000 incident cases of liver cancer in China in 2005<sup>[9]</sup> and predicted that number would reach 381,000 in 2020<sup>[10]</sup>. Recent trend analysis showed that although age-adjusted incidence has decreased, the liver cancer burden is increasing<sup>[11]</sup>.

China is a high-risk region for liver cancer, representing more than half of new cases and liver cancer deaths in the world<sup>[12]</sup>. Since high-risk areas like Qidong in Jiangsu province implemented hepatitis B virus (HBV) vaccination for children, the HBV infection rate has fallen, reducing the incidence of liver cancer in the young generation. Early in the 21st century, when expanded program immunization was carried out in China, hepatitis B was effectively controlled, providing a benefit for liver cancer control<sup>[13,14]</sup>. In Qidong, liver cancer screening programs were introduced in 2006<sup>[15]</sup>. Similarly,

some high-risk areas gradually started early detection and treatment for liver cancer. HBV vaccination and screening as well as health education and promotion have become areas of focus for high-risk areas in China.

In conclusion, although the incidence of liver cancer has started to decrease in most age groups, especially in the young generation, it is still a major public issue in China. The cancer registry provides timely and dynamic information for making national, regional, and local policies for cancer control. As NCCR continues to expand the national cancer registry system, primary and secondary prevention of liver cancer is expected to improve.

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