Population-based cancer incidence analysis in Beijing, 2008-2012

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Objective: To analyze the incidence of cancer during 2008-2012 in Beijing, China, and compare the cancer spectrum with that during 1998-1999.

Methods: Data from the Beijing Cancer Registry (BCR), which covered 12 million residents and 16 administrative regions in Beijing, were checked and evaluated on basis of the criteria of data quality from the National Central Cancer Registry (NCCR) of China. Incidences were calculated stratified by cancer type, sex, areas (urban/rural), and age. The Chinese census population in 1982 and the world Segi's population were used for calculating the age-standardized incidences.

Results: A total of 177,101 new cancer cases were diagnosed in Beijing between 2008 and 2012. The crude incidence rate (CR) of all cancers was 282.64/100,000 (290.71/100,000 in males and 274.45/100,000 in females). The age-standardized rates by Chinese standard population (ASR-China) and by world standard population (ASR-world) were 124.46/100,000 and 161.18/100,000, respectively. Female breast cancer was the most common cancer, followed by lung cancer, colorectal cancer, liver cancer, and stomach cancer, with the CR of 59.87/100,000, 59.21/100,000, 32.49/100,000, 19.81/100,000 and 17.96/100,000, respectively. In urban areas, female breast cancer (68.50/100,000) was still the most common cancer, followed by lung cancer (61.23/100,000), colorectal cancer (37.23/100,000), prostate cancer (20.49/100,000) and stomach cancer (20.07/100,000). In rural areas, lung cancer (55.94/100,000) was the most common cancer, followed by female breast cancer (45.87/100,000), colorectal cancer (24.77/100,000), liver cancer (20.68/100,000) and stomach cancer (14.52/100,000). Great changes of the cancer spectrum were found from the period of 1998-1999 to the period of 2011-2012 in Beijing.

Conclusions: The cancer burden in Beijing was heavier than the national average level. Cancer prevention and control strategies, especially for lung, colorectal, prostate and female thyroid cancers, should be enhanced.

Keywords: Cancer registry; incidence; epidemiology; Beijing

Introduction

The National Central Cancer Registry (NCCR) of China estimated that there were 3,093,039 new cases of cancer diagnosed in 2010 in China (1). As the capital of China, Beijing is facing a heavy burden of disease due to the rapid economy development and the ageing of population. Cancer has been the leading cause of death in Beijing since 2007 and drawn much attention in public health. The population-based cancer registries (PBCRs) play an important role on estimating the incidence of cancer, and are very useful in the prevention and control of cancer. We reported the incidence of cancer during 1998-2007 in urban Beijing in a previous study (2). In this paper, we updated the cancer incidence with data from 2008 to 2012 and compared the cancer spectrum with that during 1998-1999.

Materials and methods

Data source

Cancer incidence database was derived from the Beijing

Cancer Registry (BCR), which was founded in 1976 and was a member of the International Association of Cancer Registries (IACR). Since 1998, the cancer registration area has expanded to the whole administrative districts of Beijing, include six urban areas (Dongcheng, Xicheng, Chaoyang, Haidian, Fengtai, Shijingshan) and ten rural areas (Daxing, Tongzhou, Shunyi, Pinggu, Miyun, Huairou, Yanqing, Changping, Mentougou, Fangshan). The medical records of the newly diagnosed cancer patients from all 140 hospitals in Beijing were monthly required to report to BCR with online platform. Information was collected at the patient level, including demographics, origin site, histology, morphology, date of incidence, most valid basis of diagnosis, behavior, stage, reporting hospital and cost of treatment. Death certificate information from vital statistic department of the Center for Disease Control and Prevention of Beijing was used as a supplementary information source. To prevent duplication and identify non-Beijing residents, all data were reviewed and checked with existing registry information (ID number, name, birthday, telephone number, contact person's name and work place, etc.) before data entry. Population data (real registered data of population in covered areas) were derived from the Statistic Department of Beijing Municipal Bureau of Public Security.

Quality control

The morphology of cancer was coded according to the International Classification of Diseases for Oncology, Second Edition (ICD-O-2), and cancer sites were coded according to the International Statistical Classification of Diseases and Related Health Problems 10th revision (ICD-10). Incidence data were checked and evaluated based on the "Guideline for Chinese Cancer Registration" (3) and quality criterion of "Cancer Incidence in Five Continents Volume IX" by International Agency for Research on Cancer (IARC)/IACR (4). Proportion of morphological verification (MV%), percentage of cancer cases identified with death certification only (DCO), and mortality to incidence ratio (M/I) were used to evaluate the completeness, validity and reliability of cancer statistics.

Statistical analysis

Crude cancer incidence rate (CR) was analyzed stratified by areas (urban/rural), cancer type, sex (male/female), and age (grouped by 0, 1-4, 5-9, …, 80-84, 85 years old and above). The cumulative incidence rate (0-74 years old) was

calculated as the sum of age-specific incidences multiplied the interval between two age groups. The 1982 Chinese census population and world Segi's population were applied for calculating the age-standardized rate (ASR). Database software, including MS-Excel and IARCcrgTools issued by IARC/IACR (5), was used for data check, evaluation and calculation.

Results

Data quality

The cancer incidence database covered 62,660,382 populations (urban =38,830,688, rural =23,829,694), including 31,540,511 males and 31,119,871 females during the period of 2008-2012. The overall indicators of MV%, DCO%, and M/I ratio were 73.42%, 0.27% and 0.60, respectively. They were 75.57%, 0.28% and 0.59 in urban districts, compared to 69.02%, 0.24% and 0.61 in rural districts. For males, they were 69.49%, 0.27% and 0.69, compared to 77.64%, 0.26% and 0.50 for females.

Incidence of overall cancers

A total of 177,101 new cancer cases were diagnosed in Beijing between 2008 and 2012. The CR of all cancers was 282.64/100,000 (290.71/100,000 in males and 274.45/100,000 in females). The ASR by Chinese standard population (ASR-China) and by world standard population (ASR-world) were 124.46/100,000 and 161.18/100,000 respectively. The CRs and the age-standardized incidence rate in urban areas were higher than those in rural areas. After stratified by sex, the similar results were found for both CRs of men and women in urban areas than those in rural areas. However, both the ASR-China and ASR-world of men were lower in urban than those in rural areas. The cumulative incidence (0-74 years old) rate was 18.43%. After stratified by sex and area, the highest cumulative incidence rate (19.95%) was found among rural men, followed by urban men (19.30%) and urban women (18.40%) (*Table 1*).

Age-specific incidence rate for all cancer sites

The age-specific cancer incidence in Beijing was low before age 30, rapidly increased after age 40, and peaked at age 80-84 in both genders. The similar pattern was found both in urban and rural areas. The age-specific cancer incidence was relatively higher in urban than that in rural

Table 1 Incidence of cancer in Beijing from 2008 to 2012

Area	Sex	No. of cases	Incidence rate (1/10^5)	ASR China*	ASR World**	Cumulative rate 0-74 (%)
All	Both	177,101	282.64	124.46	161.18	18.43
	Male	91,693	290.71	126.41	166.88	19.54
	Female	85,408	274.45	123.75	157.29	17.55
Urban areas	Both	118,871	306.13	126.81	164.41	18.71
	Male	60,446	308.73	125.21	165.46	19.30
	Female	58,425	303.48	129.84	165.31	18.40
Rural areas	Both	58,230	244.36	120.06	154.92	17.95
	Male	31,247	261.22	128.18	168.82	19.95
	Female	26,983	227.36	112.93	142.78	16.02

*, age-standardized cancer incidence using the 1982 Chinese census population; **, age-standardized cancer incidence using world Segi's population.

Table 2 Age-specific incidence rate for all cancers in Beijing, 2008-2012

Age groups (year)	All areas			Urban			Rural		
	Both	Male	Female	Both	Male	Female	Both	Male	Female
0-	24.35	24.66	24.03	23.07	23.00	23.14	26.48	27.41	25.48
1-	17.49	17.93	17.01	18.73	19.38	18.03	15.56	15.68	15.45
5-	8.76	9.13	8.36	8.82	8.64	9.02	8.67	9.78	7.48
10-	10.32	9.72	10.94	9.73	8.92	10.59	10.99	10.66	11.36
15-	10.79	10.94	10.64	11.08	11.37	10.77	10.44	10.41	10.47
20-	15.40	13.04	17.90	14.95	12.68	17.33	16.09	13.58	18.76
25-	28.10	21.14	35.48	28.17	21.23	35.68	27.97	20.98	35.14
30-	54.76	36.75	73.42	55.23	35.89	75.62	53.90	38.33	69.55
35-	84.86	55.33	115.29	87.92	53.42	123.60	80.36	58.16	103.09
40-	137.90	93.39	184.08	141.89	90.60	195.74	132.47	97.21	168.54
45-	211.02	162.20	262.38	218.92	160.51	281.97	198.43	164.97	232.19
50-	298.92	270.05	328.17	305.05	266.58	344.30	288.08	276.26	299.91
55-	409.32	411.81	406.91	415.75	407.36	423.92	398.63	419.29	378.91
60-	556.88	610.89	505.65	565.93	607.09	526.65	543.00	616.77	473.69
65-	769.57	907.19	646.53	776.20	888.61	679.15	758.58	936.58	589.88
70-	1,048.05	1,253.74	863.22	1,060.55	1,243.54	904.41	1,020.15	1,274.65	763.54
75-	1,274.58	1,545.09	1,013.28	1,303.85	1,548.92	1,065.35	1,202.99	1,535.62	887.53
80-	1,406.90	1,725.85	1,107.04	1,467.84	1,752.38	1,186.51	1,251.71	1,651.63	921.18
85-	1,185.16	1,484.04	937.12	1,244.21	1,505.77	1,010.93	1,008.02	1,407.16	742.15
All	282.64	290.71	274.45	306.13	308.73	303.48	244.36	261.22	227.36

areas after age 25 (*Table 2*).

Incidence for top 10 common cancers in Beijing

In Beijing, female breast cancer was the most common cancer, followed by lung cancer, colorectal cancer, liver cancer, and stomach cancer, with the CR of 59.87/100,000, 59.21/100,000, 32.49/100,000, 19.81/100,000 and 17.96/100,000, respectively. The top 10 cancers accounted for 71.06% of all cancers in Beijing (*Table 3*).

Table 3 Top 10 cancer incidence in Beijing, China, 2008-2012

Rank	Both					Male					Female				
	Site	Cases	Incidence (1/10^5)	%	ASR	Site	Cases	Incidence (1/10^5)	%	ASR	Site	Cases	Incidence (1/10^5)	%	ASR
1	Female breast (C50)	18,632	59.87	10.52	36.29	Lung (C33-C34)	23,116	73.29	25.21	40.06	Breast (C50)	18,632	59.87	21.82	36.29
2	Lung (C33-C34)	37,104	59.21	20.95	31.00	Colorectum (C18-C21)	11,284	35.78	12.31	19.85	Lung (C33-C34)	13,988	44.95	16.38	22.54
3	Colorectum (C18-C21)	20,361	32.49	11.50	17.36	Liver (C22)	9,111	28.89	9.94	17.08	Colorectum (C18-C21)	9,077	29.17	10.63	15.02
4	Liver (C22)	12,410	19.81	7.01	11.24	Stomach (C16)	7,578	24.03	8.27	13.08	Thyroid (C73)	4,536	14.58	5.31	10.20
5	Stomach (C16)	11,252	17.96	6.35	9.53	Prostate (C61)	4,966	15.75	5.42	7.76	Uterus (C54-C55)	4,480	14.40	5.25	8.65
6	Prostate (C61)	4,966	15.75	2.80	7.76	Esophagus (C15)	4,842	15.35	5.28	8.42	Stomach (C16)	3,674	11.81	4.30	6.24
7	Uterus (C54-C55)	4,480	14.40	2.53	8.65	Bladder (C67)	4,511	14.30	4.92	7.76	Ovary (C56)	3,386	10.88	3.96	6.72
8	Kidney (C64-C66,68)	7,120	11.36	4.02	6.58	Kidney (C64-C66,68)	4,276	13.56	4.66	8.12	Liver (C22)	3,299	10.60	3.86	5.55
9	Ovary (C56)	3,386	10.88	1.91	6.72	Lymphoma (C81-C85,88,90,96)	3,009	9.54	3.28	5.86	Kidney (C64-C66,68)	2,844	9.14	3.33	5.09
10	Esophagus (C15)	6,138	9.80	3.47	5.06	Pancreas (C25)	2,906	9.21	3.17	5.11	Cervix (C53)	2,597	8.35	3.04	5.46

ASR, age-standardized rates.

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For males, lung cancer (CR: 73.29/100,000) was the most common cancer, followed by colorectal cancer (35.78/100,000), liver cancer (28.89/100,000), stomach cancer (24.03/100,000) and prostate cancer (15.75/100,000). For females, breast cancer (59.87/100,000) was the most common cancer, followed by lung cancer (44.95/100,000), colorectal cancer (29.17/100,000), thyroid cancer (14.58/100,000), and uterus cancer (14.40/100,000).

In urban areas, female breast cancer (68.50/100,000) was still the most common cancer, followed by lung cancer (61.23/100,000), colorectal cancer (37.23/100,000), prostate cancer (20.49/100,000), and stomach cancer (20.07/100,000). The top 5 common sites of cancer were lung, colorectum, liver, stomach and prostate in males, while were breast, lung, colorectum, thyroid and uterus cancer in females (*Table 4*).

In rural areas, lung cancer (55.94/100,000) was the most common cancer, followed by female breast cancer (45.87/100,000), colorectal cancer (24.77/100,000), liver cancer (20.68/100,000) and stomach cancer (14.52/100,000). The top 5 common sites of cancer were lung, liver, colorectum, stomach and esophagus in males, while were breast, lung, colorectum, Uterus, thyroid in females (*Table 5*).

Comparison of cancer spectrum in 1998-1999 and 2011-2012 in urban Beijing

Among males, lung cancer was the most common cancer, with the ASR-world of 35.89/100,000, followed by liver cancer (16.63/100,000), stomach cancer (16.54/100,000), colorectal cancer (14.64/100,000) and esophagus cancer (9.20/100,000) during the period of 1998-1999. However, great changes of the cancer spectrums were found during the period of 2011-2012 in urban Beijing. Although lung cancer was still the most common cancer among males, colorectal cancer became the second common cancer, followed by liver, stomach and prostate cancers in 2011-2012.

Among females, there was no change for the top 3 cancers (breast cancer, followed by lung and colorectal cancers) in 2011-2012 compared with that in 1998-1999. However, thyroid cancer and uterus cancer, instead of stomach cancer and liver cancer in 1998-1999, became the fourth and fifth common cancer in 2011-2012 (*Table 6*).

Discussion

Since 2003, all designated hospitals have reported cancer incidence data to BCR using the online Health Information System (HIS). The HIS, instead of traditional manpower data collection method using notification card, has dramatically improved the work efficiency and the data quality of BCR. In order to further improve the quality of registration data, continuous quality control was processed including medical records re-checking in every 2 years, merging the death certification database from vital statistics department of Beijing Center for Disease Control and Prevention (CDC) and active follow-up in the communities of Beijing. The indicators including MV%, DCO%, M/I ratio were calculated to evaluate the completeness, comparability and invalidity of the incidence data in Beijing.

As shown in our study, a total of 177,101 new cases were diagnosed with cancer during 2008 to 2012 in Beijing. The overall cancer incidence rate in urban Beijing was much higher than that in the rural areas. Result was not changed after adjusted by standard population, but the incidence gap was largely reduced between urban and rural areas. Our results indicated that the ageing of population could be a major reason for the heavy burden in the areas with high socioeconomic level.

As a result of urban-rural dual structure, the spectrum of cancer in Beijing had experienced both the characteristics of cancer spectrum found in the developed and developing regions. As shown in our data, the incidences of stomach cancer, esophageal cancer, liver cancer and cervical cancer, which were negatively associated with the economic level, did not show an obvious decrease. However, the incidences of breast cancer and colorectal cancer, which were positively associated with the economic level (6,7), did show an obvious increase. Moreover, as the largest tobacco consumption country around the world, both the high smoking rate in Chinese men and the high passive-smoking rate in Chinese female had greatly contributed to the heavy burden of lung cancer both in the whole nation and Beijing (8,9). The results had signaled us that if no more urgent tobacco control initiatives in Beijing, lung cancer cannot be replaced in the top one burden cancer and top one mortality cancer.

Comparison of top 10 cancers in different areas of Beijing

As shown in our data, among the males in Beijing, the burden of prostate was higher in the urban areas than that in the rural areas; in contrast, the burden of esophageal cancer was higher in the rural areas than that in the urban areas. The rank of liver cancer in the urban females was lower than that in the rural females, but the rank of stomach cancer in urban females was higher than that in rural

Table 4 Top 10 cancer incidence in urban Beijing, China, 2008-2012

Rank	Both					Male					Female				
	Site	Cases	Incidence (1/10⁵)	%	ASR	Site	Cases	Incidence (1/10⁵)	%	ASR	Site	Cases	Incidence (1/10⁵)	%	ASR
1	Female breast (C50)	13,188	68.50	11.09	40.64	Lung (C33-C34)	14,482	73.97	23.96	37.04	Breast (C50)	13,188	68.50	22.57	40.64
2	Lung (C33-C34)	23,774	61.23	20.00	29.28	Colorectum (C18-C21)	7,946	40.59	13.15	21.08	Lung (C33-C34)	9,292	48.27	15.90	22.07
3	Colorectum (C18-C21)	14,458	37.23	12.16	18.47	Liver (C22)	5,449	27.83	9.02	15.63	Colorectum (C18-C21)	6,512	33.83	11.15	16.05
4	Prostate (C61)	4,012	20.49	6.64	3.38	Stomach (C16)	5,195	26.53	8.59	13.36	Thyroid (C73)	3,251	16.89	5.56	11.77
5	Stomach (C16)	7,792	20.07	6.56	9.87	Prostate (C61)	4,012	20.49	6.64	9.31	Uterus (C54-C55)	2,934	15.24	5.02	8.91
6	Liver (C22)	7,481	19.27	6.29	10.29	Kidney (C64-C66,68)	3,230	16.50	5.34	9.48	Stomach (C16)	2,597	13.49	4.45	6.66
7	Uterus (C54-C55)	2,934	15.24	2.47	8.91	Bladder (C67)	3,102	15.84	5.13	7.90	Ovary (C56)	2,292	11.91	3.92	7.10
8	Kidney (C64-C66,68)	5,359	13.80	4.51	7.59	Esophagus (C15)	2,478	12.66	4.10	6.44	Kidney (C64-C66,68)	2,129	11.06	3.64	5.74
9	Ovary (C56)	2,292	11.91	1.93	7.10	Lymphoma (C81-C85,88,90,96)	2,129	10.87	3.52	6.35	Liver (C22)	2,032	10.56	3.48	5.09
10	Thyroid (C73)	4,266	10.99	3.59	7.67	Pancreas (C25)	2,034	10.39	3.37	5.41	Lymphoma (C81-C85,88,90,96)	1,724	8.96	2.95	4.97

ASR, age-standardized rates.

Table 5 Top 10 cancer incidence in rural Beijing, China, 2008-2012

Rank	Both					Male					Female				
	Site	Cases	Incidence (1/10^5)	%	ASR	Site	Cases	Incidence (1/10^5)	%	ASR	Site	Cases	Incidence (1/10^5)	%	ASR
1	Lung (C33-C34)	13,330	55.94	22.89	33.88	Lung (C33-C34)	8,634	72.18	27.63	45.23	Breast (C50)	5,444	45.87	20.18	28.91
2	Female breast (C50)	5,444	45.87	9.35	28.91	Liver (C22)	3,662	30.61	11.72	19.58	Lung (C33-C34)	4,696	39.57	17.40	23.12
3	Colorectum (C18-C21)	5,903	24.77	10.14	15.14	Colorectum (C18-C21)	3,338	27.91	10.68	17.51	Colorectum (C18-C21)	2,565	21.61	9.51	12.93
4	Liver (C22)	4,929	20.68	8.47	12.87	Stomach (C16)	2,383	19.92	7.63	12.50	Uterus (C54-C55)	1,546	13.03	5.73	8.10
5	Stomach (C16)	3,460	14.52	5.94	8.85	Esophagus (C15)	2,364	19.76	7.57	12.21	Thyroid (C73)	1,285	10.83	4.76	7.69
6	Uterus (C54-C55)	1,546	13.03	2.65	8.10	Bladder (C67)	1,409	11.78	4.51	7.44	Liver (C22)	1,267	10.68	4.70	6.35
7	Esophagus (C15)	2,892	12.14	4.97	7.18	Kidney (C64-C66,68)	1,046	8.74	3.35	5.75	Ovary (C56)	1,094	9.22	4.05	6.05
8	Ovary (C56)	1,094	9.22	1.88	6.05	Prostate (C61)	954	7.98	3.05	4.75	Stomach (C16)	1,077	9.08	3.99	5.44
9	Cervix (C53)	1,012	8.53	1.74	5.57	Lymphoma (C81-C85,88,90,96)	880	7.36	2.82	4.96	Cervix (C53)	1,012	8.53	3.75	5.57
10	Prostate (C61)	954	7.98	1.64	4.75	Leukemia (C91-C95)	873	7.30	2.79	6.22	Gallbladder (C23-C24)	756	6.37	2.80	3.68

ASR, age-standardized rates.

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Table 6 Comparison of top 10 cancer incidence in two different periods in urban Beijing, China (2011-2012 *vs.* 1998-1999)

Rank	Male						Female					
	1998-1999			2011-2012			1998-1999			2011-2012		
	Site	Cases	ASR	Site	Cases	ASR	Site	Cases	ASR	Site	Cases	ASR
1	Lung (C33-C34)	3,267	35.89	Lung (C33-C34)	6,087	36.71	Breast (C50)	2,424	26.53	Breast (C50)	5,749	42.92
2	Liver (C22)	1,478	16.63	Colorectum (C18-C21)	3,523	22.35	Lung (C33-C34)	2,003	20.89	Lung (C33-C34)	3,941	22.31
3	Stomach (C16)	1,504	16.54	Liver (C22)	2,198	14.93	Colorectum (C18-C21)	1,158	12.29	Colorectum (C18-C21)	2,809	16.58
4	Colorectum (C18-C21)	1,333	14.64	Stomach (C16)	2,157	13.20	Stomach (C16)	672	7.03	Thyroid (C73)	1,934	17.29
5	Esophagus (C15)	849	9.20	Prostate (C61)	1,863	10.47	Liver (C22)	531	5.62	Uterus (C54-C55)	1,329	9.79
6	Bladder (C67)	533	5.91	Kidney (C64-C66,68)	1,420	9.93	Ovary (C56)	468	5.41	Ovary (C56)	918	6.94
7	Kidney (C64-C66,68)	463	5.23	Bladder (C67)	1,368	8.27	Uterus (C54-C55)	425	4.58	Stomach (C16)	1,058	6.60
8	Lymphoma (C81-C85,88,90,96)	410	4.96	Lymphoma (C81-C85,88,90,96)	906	6.53	Esophagus (C15)	351	3.58	Kidney (C64-C66,68)	929	5.86
9	Pancreas (C25)	426	4.70	Esophagus (C15)	963	6.01	Pancreas (C25)	317	3.31	Lymphoma (C81-C85,88,90,96)	771	5.43
10	Prostate (C61)	381	4.08	Pancreas (C25)	863	5.47	Kidney (C64-C66,68)	278	2.99	Liver (C22)	799	4.75

ASR, age-standardized rates.

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females. The different ranks of stomach cancer between the urban women and rural women (6th *vs*. 8th) told us that the stomach cancer may not only be negatively associated with the poor diet and health conditions, but also be positively associated with the high psychological pressure.

Comparison of top 10 cancers in different periods in urban Beijing

After comparing the cancer incidences in 1998-1999 with those in current urban Beijing males, we observed a rapid increase in the rank of colorectal cancer and prostate cancer, and an obvious decrease in the rank of esophageal cancer. For females, an increase was found in the rank of kidney cancer and thyroid cancer, and a decrease in the rank of esophagus cancer, stomach cancer, and liver cancer. This trend showed us that the infection-associated cancers would experience a decrease in the future in urban Beijing, especially for males (10).

As one of the most developed regions in China, Beijing is facing the huge changes in almost every aspect, including lifestyle, behavior and diet pattern. And the results from our study had clearly reminded us that these changes experienced by the current Beijing residences could be the very important reasons for the heavy burden of cancer in the near future. It is time to take up the challenges posed by the markedly increasing number of cancer cases in Beijing. The particularly heavy burden for lung, colorectal, prostate, breast and female thyroid cancers makes it implausible to treat our way out of cancer. Therefore, elucidating the causes and devising effective prevention strategies are essential components of cancer control in the near future in Beijing.

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