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Cancer statistics in Chinese older people, 2022: current burden, time trends, and comparisons with the US, Japan, and the Republic of Korea

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Largely due to population ageing, the cancer burden from older people has been rising, which imposed considerable pressure on current Chinese healthcare system. We provide comprehensive information about cancer burden of Chinese older people based on the most recent data from National Central Cancer Registry of China. The logarithmic linear regression was used to project the current cancer burden in 2022, and Joinpoint regression was used for temporal trend analysis from 2000 to 2017. We also estimated cancer statistics of older people in the US, Japan and the Republic of Korea for comparisons. It is estimated that 2.79 million cases and 1.94 million deaths occur for Chinese older people, representing 55.8% and 68.2% of cases and deaths in all population in 2022. The overall cancer incidence rate gradually increased among older women, while the mortality rates declined for both sexes. Notably, approximately 10.0% of all cases and 17.7% of all deaths are from people aged over 80 years, and cancer incidence and mortality in this age group showed upward trends for women. Lung cancer and digestive cancers are the leading cancer types for Chinese older people. Compared with other countries, China has lower incidence rates but higher mortality rates for older people. The rapidly growing burden of prostate cancer, breast cancer, colorectal cancer, and declines in esophageal cancer, stomach cancer, and liver cancer among older people indicate the cancer pattern in China is being in a transition stage to that in developed countries. Our findings imply that it should be the national health priority to meet the growing demands for cancer diagnosis, treatment and care services from the older people as the rapid population ageing in next few decades.

cancer burden, older people, temporal trend, cancer pattern, population ageing

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INTRODUCTION

Cancer is a major public health concern, and incidence and mortality rates increase with age. It was estimated worldwide that nearly 64% of cancer cases in the whole population were from people over 60 years, and the proportion reached over 70% of cancer deaths (http://www.who.int/data/gho). According to the 7th National Census data in 2020, the proportion of people aged over 60 years has increased from 10.5% to 18.7% in the last two decades, people aged over 80 years from 0.99% to 2.54%, and the life expectancy from 71.4 to 77.93 years in China (http://www.stats.gov.cn). Mainly due to population ageing and improvement in life expectancy, the number of older cancer patients has been rising, which imposes considerable burden on the healthcare

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system.

Compared with young and middle-aged adults, the cancer pattern in older people shows different characteristics. Given the common prevalence of comorbidity, frailty and decline of functional status, cancer management in older adults may be more complex (Hurria, 2013). For the oldest patients (aged over 80 years), challenges of highest cancer mortality and under-treatment due to the considerable heterogeneity in terms of health status are widespread (DeSantis et al., 2019). In view of the unprecedented growth of the older people, it is crucial to provide information about the cancer burden from the older people and its temporal change over time to inform better policies for cancer management.

As the most developed country with improved healthcare systems, the US is a valuable reference for cancer registration, clinical treatment and prevention strategies worldwide. As the neighboring countries of China, Japan and the Republic of Korea showed similar cultural backgrounds and lifestyles while being ahead of China in the stages of population ageing and socioeconomic development (Sun et al., 2020). Additionally, Japan and the Republic of Korea have more improved systems of cancer screening programs and prevention strategies than China. Therefore, the comparisons with the US, Japan and the Republic of Korea in cancer statistics for the older people can provide useful information on cancer prevention and control strategies with the rapid development of population ageing.

Previous studies from National Cancer Center have reported the Chinese cancer statistics (Zhang et al., 2021; Zheng et al., 2022). However, the most recent cancer statistics are available lag several years behind the current year because of the time required for data collection, compilation, quality control, and dissemination. Additionally, few studies provided the systematic analysis of cancer burden and temporal trends of Chinese older people based on national data. In this study, we made estimations of the cancer burden in 2022 and analyzed the time trends of cancer incidence and mortality rates among older people (aged over 60 years) and oldest people (aged over 80 years). Meanwhile, we made comparisons with the United States, Japan and the Republic of Korea.

RESULTS

Expected cancer cases and deaths in Chinese older people and oldest people in 2022

It is estimated that 2.79 million cases (1.68 million for men and 1.11 million for women) occur among Chinese older adults in 2022, accounting for 55.8% of cases in all population, of which 10.0% (0.5 million) are from the oldest people. The most common cancers are lung cancer, colorectal cancer, stomach cancer, liver cancer and esophageal cancer for older men, and lung cancer, colorectal cancer, breast cancer, stomach cancer and liver cancer for older women. The proportions of older people in total cases are highest in esophageal cancer, prostate cancer, and laryngeal cancer (Table 1, Figure 1).

A total of 1.94 million Chinese older people (1.26 million older men and 0.68 million older women) die from cancers in 2022, representing 68.2 % of cancer deaths in all age groups. There are 0.50 million deaths (17.7%) from the oldest people. The five leading causes of cancer death among the Chinese older people are lung cancer, stomach cancer, liver cancer, esophageal cancer, colorectal cancer for older men, lung cancer, colorectal cancer, liver cancer, stomach cancer, and breast cancer for older women. The proportions of older deaths in all age groups are highest in esophageal cancer, stomach cancer, and lung cancer (Table 1, Figure 1).

Comparisons with Japan, the Republic of Korea and the US in the estimated incidence and mortality rates of leading cancers in 2022

The overall cancer age-standardized incidence rates (ASIRs) of the Chinese older people (1,211.84 per 100,000 for men and 779.11 per 100,000 for women) are lower than the rates in the US (1896.32 per 100,000 for men and 1,328.56 per 100,000 for women) and Japan (2,173.72 per 100,000 for men and 1,201.20 per 100,000 for women) for both sexes, and the Republic of Korea (1,697.36 per 100,000 for men and 865.78 per 100,000 for women) for older men. In the oldest groups, Japan had the highest ASIRs for both sexes, followed by the US and the Republic of Korea. China had the lowest incidence rates in oldest people of both sexes, with the ASIR of 1,787.38 per 100,000 for men and 1,119.24 per 100,000 for women. Compared with other countries, China has the higher ASIRs for lung cancer, esophageal cancer, cervical cancer and liver cancer, while lower ASIRs in prostate cancer, breast cancer and pancreatic cancer in the older people. Notably, prostate cancer is expected to be the most common cancer in Japan and the US, while the ASIR is much lower in China. In contrast, the ASIRs of cervical cancer in other countries are much lower than the rate in China. Additionally, similar cancer spectrums are observed in the three Asian countries, especially for the heavy burden of digestive cancers (Table 2 and Figure 2).

China has relatively higher age-standardized mortality rates (ASMRs) of all cancers combined (889.43 per 100,000 for older men and 436.75 per 100,000 for older women) than the US (643.47 per 100,000 for older men and 447.76 per 100,000 for older women) for older man, Japan (711.63 per 100,000 for older men and 356.85 per 100,000 for older women) and the Republic of Korea (696.54 per 10,000 for older men and 281.65 per 100,000 for older women) for both sexes. The ASMR of all cancers for oldest men in China (1,860.04 per 100,000) is lower than the rates in Japan

Table 1 Estimated new cases (thousands) and truncated age-standardized incidence rates (per 100,000) by sexes and age groups in China, 2022

Sites	ICD-10	Incidence				Mortality			
		60+ years		80+ years		60+ years		80+ years	
		NO. (Thousand)	ASIR[a)] (95% CI)	NO. (Thousand)	ASIR[a)] (95% CI)	NO. (Thousand)	ASMR[a)] (95% CI)	NO. (Thousand)	ASMR[a)] (95% CI)
MALE									
Lip, oral cavity, & pharynx (except nasopharynx)	C00-C10, C12-C14	24.55	18.68 (13.61 to 23.75)	2.96	18.66 (13.23 to 24.09)	17	12.91 (12.58 to 13.24)	2.79	17.94 (16.75 to 19.13)
Nasopharynx	C11	14.31	11.43 (8.45 to 14.41)	1.26	8.07 (6.25 to 9.89)	11.43	8.68 (8.48 to 8.88)	1.31	8.44 (7.47 to 9.41)
Esophagus	C15	150.46	108.53 (105.56 to 111.50)	23.04	143.27 (138.86 to 147.68)	118.66	84.34 (82.85 to 85.83)	21.97	137.49 (135.57 to 141.41)
Stomach	C16	204.54	146.41 (143.32 to 149.50)	29.7	183.03 (179.41 to 186.65)	159.96	110.57 (109.26 to 111.88)	37.33	233.56 (229.17 to 237.95)
Colorectum	C18-C21	216.5	157.83 (155.91 to 159.75)	37.26	235.52 (231.07 to 239.97)	112.6	77.85 (76.61 to 79.09)	33.29	216.25 (213.13 to 219.37)
Liver	C22	152.38	113.78 (111.18 to 116.38)	23.93	152.28 (143.77 to 160.79)	135.06	99.91 (98.52 to 101.30)	21.64	137.94 (135.27 to 140.61)
Gallbladder	C23-C24	23.26	16.42 (11.71 to 21.13)	5.13	31.68 (21.22 to 42.14)	18.16	12.53 (12.28 to 12.78)	5.11	31.76 (30.34 to 33.18)
Pancreas	C25	47.22	33.67 (32.51 to 34.83)	9.16	57.69 (56.34 to 59.04)	41.97	29.56 (28.60 to 30.52)	9.23	58.42 (56.94 to 59.90)
Larynx	C32	16.9	12.74 (9.00 to 16.48)	1.86	11.71 (7.86 to 15.56)	10.64	7.78 (7.67 to 7.89)	1.89	12.04 (10.99 to 13.09)
Lung	C33-C34	477.67	347.35 (337.35 to 357.35)	77.47	490.30 (469.30 to 511.30)	425.97	302.40 (298.94 to 305.86)	87.74	556.94 (544.93 to 568.95)
Other thoracic organs	C37-C38	4.14	3.10 (2.38 to 3.82)	0.65	4.11 (2.93 to 5.29)	3	2.15 (1.99 to 2.31)	0.57	3.65 (3.28 to 4.02)
Bone	C40-C41	8.43	6.00 (4.81 to 7.19)	1.46	9.34 (7.31 to 11.37)	7.53	5.31 (5.03 to 5.59)	1.77	11.37 (10.17 to 12.57)
Melanoma of the skin	C43	2.48	1.78 (1.46 to 2.10)	0.51	3.22 (2.37 to 4.07)	2.07	1.42 (1.31 to 1.53)	0.48	2.95 (2.62 to 3.28)
Prostate	C61	123.44	84.36 (82.99 to 85.73)	27.53	172.90 (168.75 to 177.05)	44.65	28.16 (27.59 to 28.73)	24.08	157.42 (153.96 to 160.88)
Testis	C62	0.75	0.55 (0.48 to 0.62)	0.13	0.86 (0.48 to 1.24)	0.45	0.30 (0.26 to 0.34)	0.12	0.70 (0.52 to 0.88)
Kidney	C64-C66, C68	36.93	27.63 (17.76 to 37.50)	5.16	32.30 (20.54 to 44.06)	18.09	12.69 (12.36 to 13.02)	4.62	30.00 (28.98 to 31.02)
Bladder	C67	58.05	40.65 (40.23 to 41.07)	14.22	91.41 (88.69 to 94.13)	25.51	16.76 (16.24 to 17.28)	11.02	72.87 (70.11 to 75.63)
Brain, CNS[b)]	C70-C72	26.69	19.95 (14.18 to 25.72)	3.43	21.55 (14.22 to 28.88)	21.54	15.93 (15.61 to 16.25)	3.64	23.19 (21.77 to 24.61)
Lymphoma	C81-C85, C88, C90, C96	41.95	30.69 (21.05 to 40.33)	5.91	36.87 (23.14 to 50.60)	27.82	19.76 (19.12 to 20.40)	5.78	36.87 (35.49 to 38.25)
Leukemia	C91-C95	32.43	22.98 (16.71 to 29.25)	4.62	27.27 (16.74 to 37.80)	24.36	16.96 (16.57 to 17.35)	4.67	27.83 (26.98 to 28.68)
All sites	C00-C96	1,675.65	1,211.84 (1155.05 to 1268.63)	282.88	1,787.38 (1,703.67 to 1,871.09)	1259.96	889.43 (882.00 to 896.86)	291.05	1,860.04 (1,833.88 to 1,886.20)
FEMALE									
Lip, oral cavity, & pharynx (except nasopharynx)	C00-C10, C12-C14	10.67	7.41 (5.80 to 9.02)	1.89	9.70 (6.30 to 13.10)	6.03	3.77 (3.61 to 3.93)	2.46	12.84 (12.00 to 13.68)
Nasopharynx	C11	5.99	4.44 (3.71 to 5.17)	0.54	2.76 (2.22 to 3.30)	4.67	3.24 (3.12 to 3.36)	0.81	4.09 (3.37 to 4.81)
Esophagus	C15	55.46	35.24 (34.45 to 36.03)	15.79	81.00 (79.00 to 83.00)	44.15	27.07 (26.31 to 27.83)	15.15	78.19 (75.80 to 80.58)
Stomach	C16	84.97	55.75 (54.53 to 56.97)	20.43	104.99 (102.51 to 107.47)	64.96	40.53 (39.88 to 41.18)	20.98	108.43 (105.96 to 110.90)
Colorectum	C18	142.17	95.89 (94.58 to 97.20)	32.53	165.81 (161.30 to 170.32)	74.58	46.37 (45.65 to 47.09)	27.19	139.52 (137.19 to 141.85)
Liver	C22	76.95	51.54 (50.22 to 52.86)	17.83	91.40 (88.69 to 94.11)	69.07	44.41 (43.28 to 45.54)	19.93	102.43 (98.54 to 106.32)
Gallbladder	C23-C24	25.98	17.02 (12.69 to 21.35)	6.84	35.38 (26.99 to 43.77)	19.32	12.30 (12.08 to 12.52)	6.27	32.56 (31.81 to 33.31)
Pancreas	C25	39.52	25.74 (25.22 to 26.26)	10.5	54.47 (52.65 to 56.29)	33.66	21.62 (20.76 to 22.48)	9.31	47.89 (45.42 to 50.36)

(*To be continued on the next page*)

(*Continued*)

Sites	ICD-10	Incidence				Mortality			
		60+ years		80+ years		60+ years		80+ years	
		NO. (Thousand)	ASIR[a)] (95% CI)	NO. (Thousand)	ASIR[a)] (95% CI)	NO. (Thousand)	ASMR[a)] (95% CI)	NO. (Thousand)	ASMR[a)] (95% CI)
Larynx	C32	2.36	1.50 (1.30 to 1.70)	0.73	3.85 (3.39 to 4.31)	1.49	0.93 (0.85 to 1.01)	0.37	1.94 (1.64 to 2.24)
Lung	C33-C34	238.56	163.56 (160.43 to 166.69)	52.34	268.97 (255.99 to 281.81)	178.57	113.57 (111.87 to 115.27)	58.89	302.72 (294.34 to 311.06)
Other thoracic organs	C37-C38	3.09	2.22 (1.87 to 2.57)	0.55	2.79 (2.26 to 3.32)	1.95	1.33 (1.25 to 1.41)	0.42	2.15 (1.87 to 2.43)
Bone	C40-C41	7.05	4.86 (4.09 to 5.63)	1.39	7.05 (5.45 to 8.65)	5.8	3.85 (3.66 to 4.04)	1.41	7.16 (6.60 to 7.72)
Melanoma of the skin	C43	3.68	2.31 (2.13 to 2.49)	1.53	8.09 (7.05 to 9.13)	1.76	1.08 (0.94 to 1.22)	0.78	4.30 (4.02 to 4.58)
Breast	C50	123.7	97.93 (96.73 to 99.13)	9	45.66 (43.57 to 47.75)	41.04	29.39 (28.86 to 29.92)	9.11	47.04 (44.25 to 49.83)
Cervix	C53	52.51	41.43 (40.13 to 42.73)	3.76	18.87 (17.44 to 20.30)	25.76	18.90 (18.34 to 19.46)	3.71	18.68 (17.56 to 19.80)
Uterus	C54-C55	27.21	21.31 (15.24 to 27.38)	1.78	8.81 (4.35 to 13.27)	9.25	6.53 (6.28 to 6.78)	1.7	8.84 (8.31 to 9.37)
Ovary	C56	26.64	19.66 (14.79 to 24.53)	2.27	11.53 (4.25 to 18.81)	23.42	16.50 (16.21 to 16.79)	3.73	18.52 (17.65 to 19.39)
Kidney	C64-C66, C68	23.87	16.77 (11.87 to 21.67)	3.61	18.01 (10.39 to 25.63)	10.54	6.68 (6.32 to 7.04)	3.36	16.87 (16.11 to 17.63)
Bladder	C67	15.76	10.20 (9.93 to 10.47)	4.4	22.61 (21.28 to 23.94)	8.05	4.67 (4.52 to 4.82)	4.18	22.00 (21.01 to 22.99)
Brain, CNS	C70-C72	36.44	26.59 (20.06 to 33.12)	5.66	28.34 (19.38 to 37.30)	17.77	11.95 (11.64 to 12.26)	4.54	23.04 (21.98 to 24.10)
Lymphoma	C81-C85, C88, C90, C96	31.62	22.67 (17.18 to 28.16)	4.23	21.36 (13.27 to 29.45)	19.63	12.84 (12.36 to 13.32)	5.67	28.77 (27.72 to 29.82)
Leukemia	C91-C95	22	14.86 (12.10 to 17.62)	4.75	23.82 (18.52 to 29.12)	16.19	10.80 (10.56 to 11.04)	4.1	20.51 (19.62 to 21.40)
All sites	C00-C96	1,115.04	779.11 (765.61 to 792.61)	219.25	1,119.24 (1,092.47 to 1,146.01)	677.56	436.75 (431.23 to 442.27)	211.46	1,087.76 (1,070.38 to 1,105.14)

a) ASIR and ASMR were calculated by using Segi's world standard population. b) CNS, central nervous system.

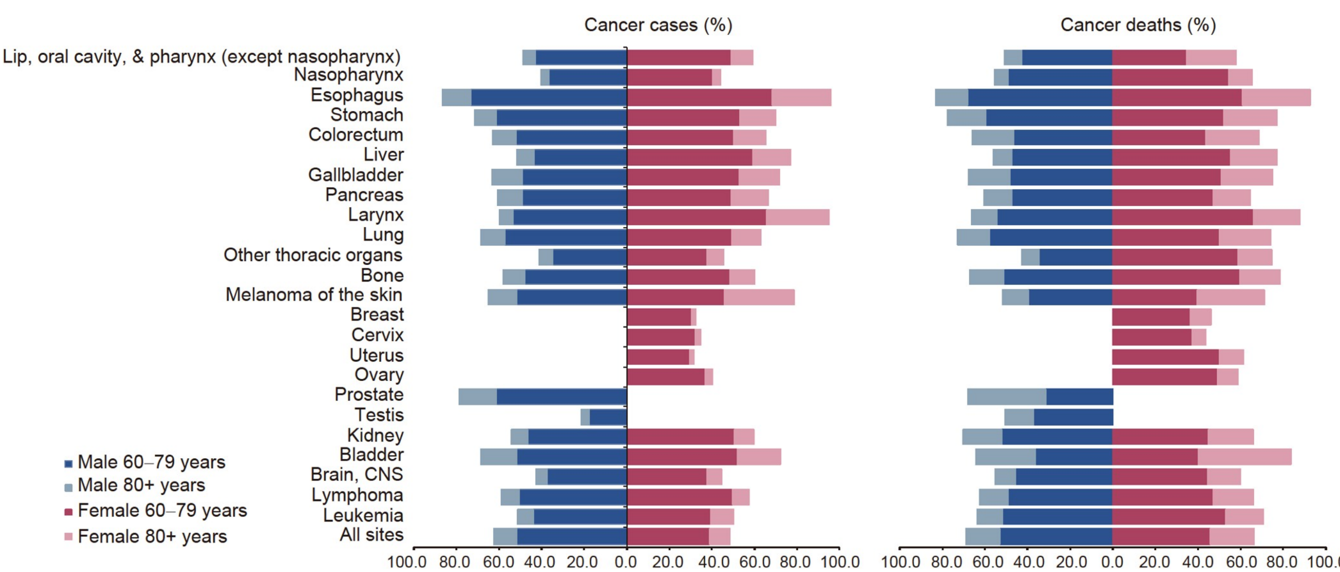

Figure 1 Estimated proportions of older people in cancer cases and deaths by sexes and age groups in China, 2022.

(2,272.07 per 100,000) and the Republic of Korea (2,280.27 per 100,000) and higher than the rate in the US (1,708.57 per 100,000). The ASMR for oldest women in China (1,087.76 per 100,000) is similar to the rates in Japan (1,090.02 per 100,000) and US (1,071.83 per 100,000), while it is higher than the rate in the Republic of Korea (976.14 per 100,000). Lung cancer is the leading cause of cancer deaths in four countries. China had lower ASMRs of prostate cancer, pancreatic cancer and bladder cancer than the other three countries and lower ASMRs of breast cancer than the rates in

Table 2 Estimated cancer incidence and mortality rates for all cancers combined by sexes and age groups in China, US, Japan and the Republic of Korea, 2022

Country	ASIR[a)] (per 100,000)		ASMR[a)] (per 100,000)	
	60+ years	80+ years	60+ years	80+ years
Male				
China	1,211.84 (1,155.05 to 1,268.63)	1,787.38 (1,703.67 to 1,871.09)	889.43 (882.00 to 896.86)	1,860.04 (1,833.88 to 1,886.20)
Japan	2,173.72 (2,106.22 to 2,241.22)	3,933.44 (3,550.32 to 4,316.56)	711.63 (702.63 to 720.63)	2,272.07 (2,225.10 to 2,319.04)
Republic of Korea	1,697.36 (1,610.86 to 1,783.86)	3,048.94 (2,862.34 to 3,235.54)	696.54 (679.94 to 713.14)	2,280.27 (2,152.08 to 2,408.46)
US	1,896.32 (1,854.38 to 1,938.26)	2,408.93 (2,343.73 to 2,474.13)	643.47 (640.75 to 646.19)	1,708.57 (1,696.59 to 1,720.55)
Female				
China	779.11 (765.61 to 792.61)	1,119.24 (1,092.47 to 1,146.01)	436.75 (431.23 to 442.27)	1,087.76 (1,070.38 to 1,105.14)
Japan	1,201.20 (1,169.55 to 1,232.85)	1,816.43 (1,722.41 to 1,910.45)	356.85 (354.25 to 359.45)	1,090.02 (1,080.69 to 1,099.35)
Republic of Korea	865.78 (790.42 to 941.14)	1,393.56 (1,323.38 to 1,463.74)	281.65 (275.85 to 287.45)	976.14 (931.22 to 1,021.06)
US	1,328.56 (1,314.36 to 1,342.76)	1,692.58 (1,654.10 to 1,731.06)	447.76 (445.22 to 450.30)	1,071.83 (1,062.49 to 1,081.17)

a) ASIR and ASMR were calculated by using Segi's world standard population.

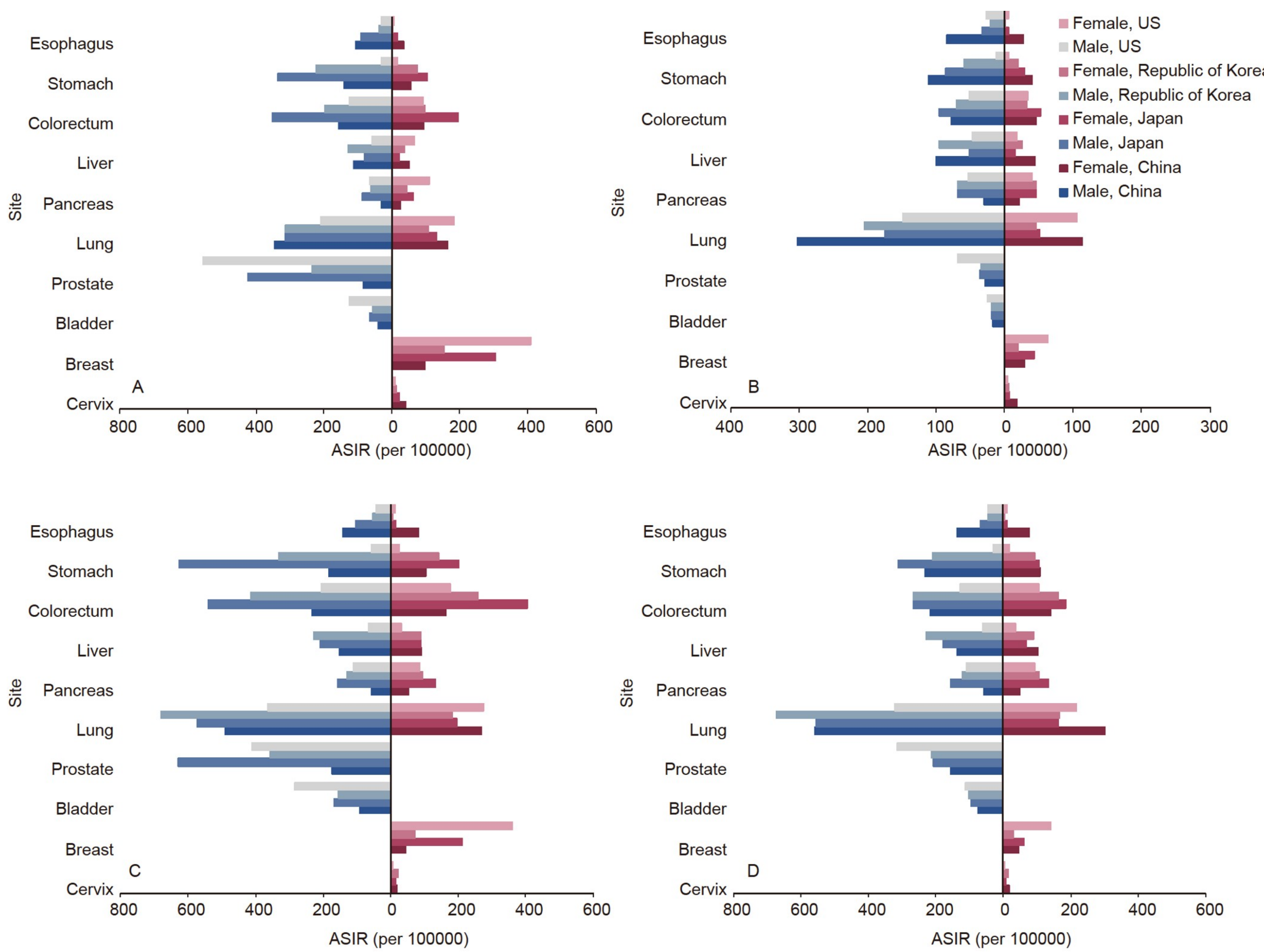

Figure 2 Estimated cancer incidence and mortality rates for selected cancer types in older people (aged over 60 years) (A and B) and oldest people (aged over 80 years) (C and D) by sexes in China, US, Japan and the Republic of Korea, 2022. ASIR and ASMR were the truncated age-standardized incidence and mortality rates, adjusted to Segi Standard Population.

Japan and the US. For other cancer types, the Chinese older people have higher mortality burden, especially for liver cancer, esophageal cancer and cervical cancer (Table 2 and Figure 2).

Trends in cancer incidence and mortality rates of older people and oldest people, 2000 to 2017

Figure 3 showed the trends of ASIR of all cancers combined for older people and oldest people by sexes in four countries. The overall ASIR of older men in China was stable from 2000 to 2017, while the trends of ASIR increased both in older women and oldest women, with the average annual percent changes (AAPCs) of 1.1% and 1.6% respectively. Similar increasing trends were also observed in both sexes of Japan, and women of the Republic of Korea. In contrast, the US had decreasing trends of overall ASIR for both sexes.

Apparent variations were observed in time trends of ASIRs of selected cancer types between US and Asian countries. The ASIRs of breast cancer, prostate cancer and colorectal cancer were rapidly increased in three Asian countries, while reverse trends were observed for the latter two in the US. In contrast, the ASIRs of liver cancer gradually increased in the US while significantly declined in Asian countries. For lung cancer, the incidence rates showed downward trends for both sexes in the US and older men in the Republic of Korea, while the upward trends for both sexes in Japan and older women in China and the Republic of Korea. Additionally, the ASIRs of pancreatic cancer gradually increased for both sexes in all countries. The ASIRs of upper gastrointestinal cancers showed decreasing trends in the US, China and the Republic of Korea while increasing trend in Japan (Table S 1a–d in Supporting Information).

A significant drop was observed in the overall ASMRs of the Chinese older people, by −1.2% for older men and −0.9% for older women annually. The declining trends of ASMRs in older men and women were also observed in Japan, the Republic of Korea and the US. For the oldest group, China had a stable trend of the ASMRs in oldest men while increasing trend in oldest women, with the AAPC of 1.5%. The overall ASMRs for oldest people decreased in Japan and the US, by −0.4% and −1.4% in men, and −0.5% and −0.7% in women, respectively. The overall ASMR in the Republic of Korea increased by 0.9% per year for the oldest men while remained stable for the oldest women (Figure 4).

Declining trends of ASMRs in the older people were common in most cancers among the selected four countries. However, the ASMRs of breast cancer, prostate cancer, pancreatic cancer, colorectal cancer and cervical cancer in China, pancreatic cancer and liver cancer in the US, pancreatic cancer and breast cancer in Japan, pancreatic cancer, breast cancer and prostate cancer in the Republic of Korea still gradually increased in older people from 2000 to 2017 (Table S1 e–h in Supporting Information).

DISCUSSION

Our study provided comprehensive information on the current cancer burden and time trends of Chinese older people. It is estimated that 2.79 million cases and 1.94 million deaths occur in Chinese older people, representing 55.8% of cases and 68.2% of deaths among the whole population in 2022. Lung cancer and digestive cancers are the leading cancer types for Chinese older people. The overall cancer incidence rate gradually increased among older women, while the mortality rates declined for both sexes. Notably, approximately 10.0% of cases and 17.7% of deaths among all population are from people aged over 80 years, and cancer incidence and mortality in this age group showed upward trends for women from 2000 to 2017. The increases in the burden of prostate cancer, breast cancer, colorectal cancer, and the decreases in esophageal cancer, stomach cancer, and liver cancer among the older people, imply that the cancer pattern in China is being in a transition stage to that in a developed country.

Compared with the US, Japan and the Republic of Korea, China has lower cancer incidence rates, but relatively higher cancer mortality rates of all cancers combined in older people, which can be explained by following reasons. Firstly, there are significant differences in cancer pattern of older people between China and other countries. The cancer pattern of Chinese older people is dominated by lung cancer and digestive cancers, all of which had high mortality and poor prognosis. In contrast, prostate cancer, breast cancer and colorectal cancer tended to be more common in US, Japan and the Republic of Korea, while these cancers have better prognosis under the current medical conditions (Arnold et al., 2019; Quaresma et al., 2015). Another possible explanation is that much higher proportions of cancer cases were identified at an early stage by screening in the three developed countries (Balchen and Simon, 2016; Jung, 2015; Mabe et al., 2022; Winters et al., 2017), while the population-based screening programs were conducted insufficiently in Chinese older people. According to our results, the ASIR and ASMR for all cancers combined maintained downward trends for both sexes in the US. Despite the trends of ASMRs were decreased in three Asian countries, significantly upward trends of ASIR were observed in older women of China and the Republic of Korea and in both sexes of Japan. These differences between the US and other countries in trends of cancer burden to some extent reflected the significant progress in controlling the behaviors associated with cancer risk and improvement in medical practice in US (Siegel et al., 2022), such as quitting smoking and cancer screening, which can provide some effective measures for cancer prevention and management for other countries.

The burden of digestive cancers in China, Japan and the Republic of Korea is higher than the US, partly due to the high-sodium dietary patterns, infectious factors and geographical conditions (Kamangar et al., 2009; Kim et al., 2015). The remarkable downward trends of upper gastro-

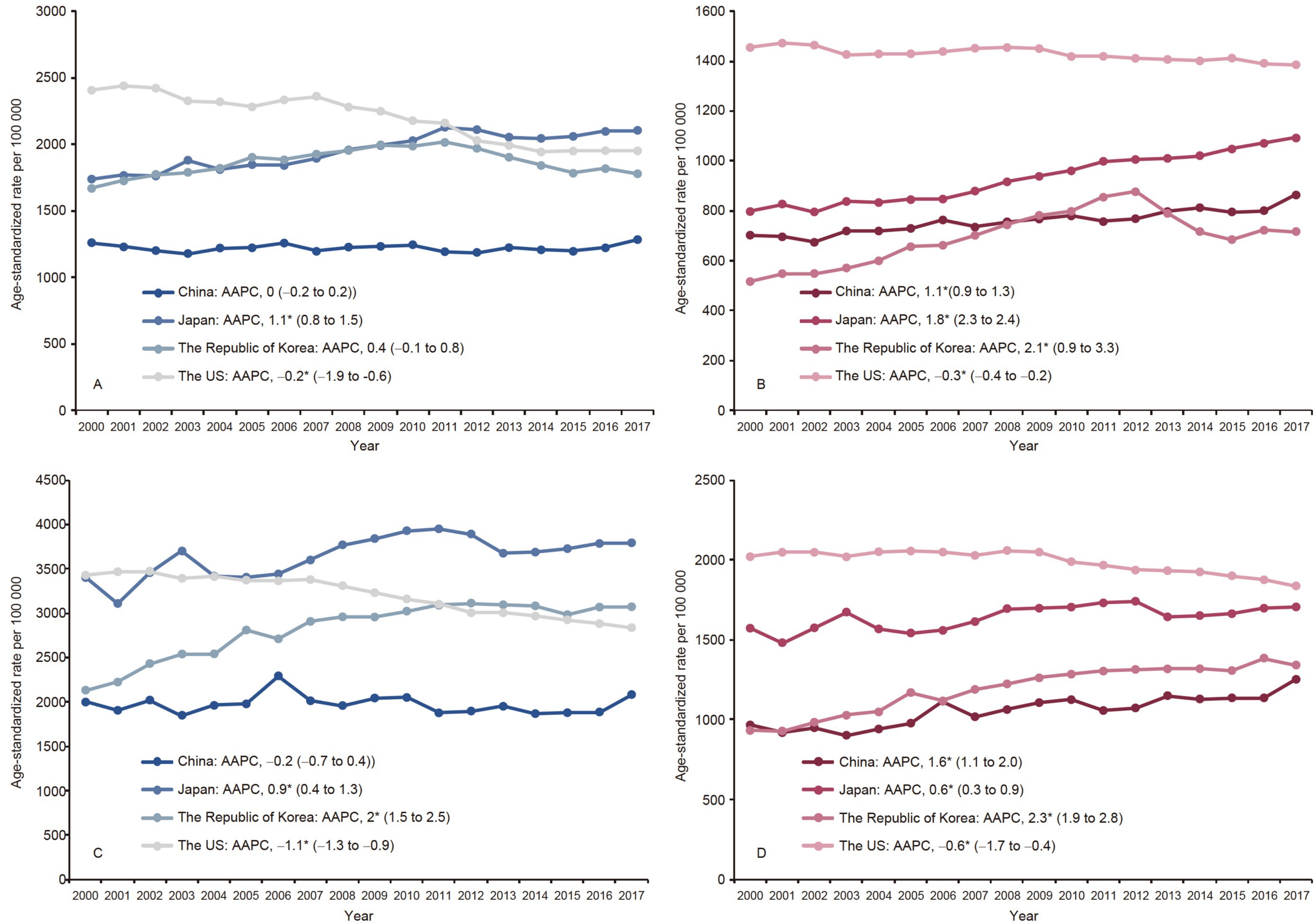

Figure 3 Trends on age-standardized incidence rates for all cancers combined in older people (aged over 60 years) (A: older men; B: older women) and oldest people (aged over 80 years) (C: oldest men; D: oldest women) by sexes in China, US, Japan and the Republic of Korea, 2000–2017. AAPC, average annual percentage changes. * The AAPC are significantly different from zero ($P<0.05$).

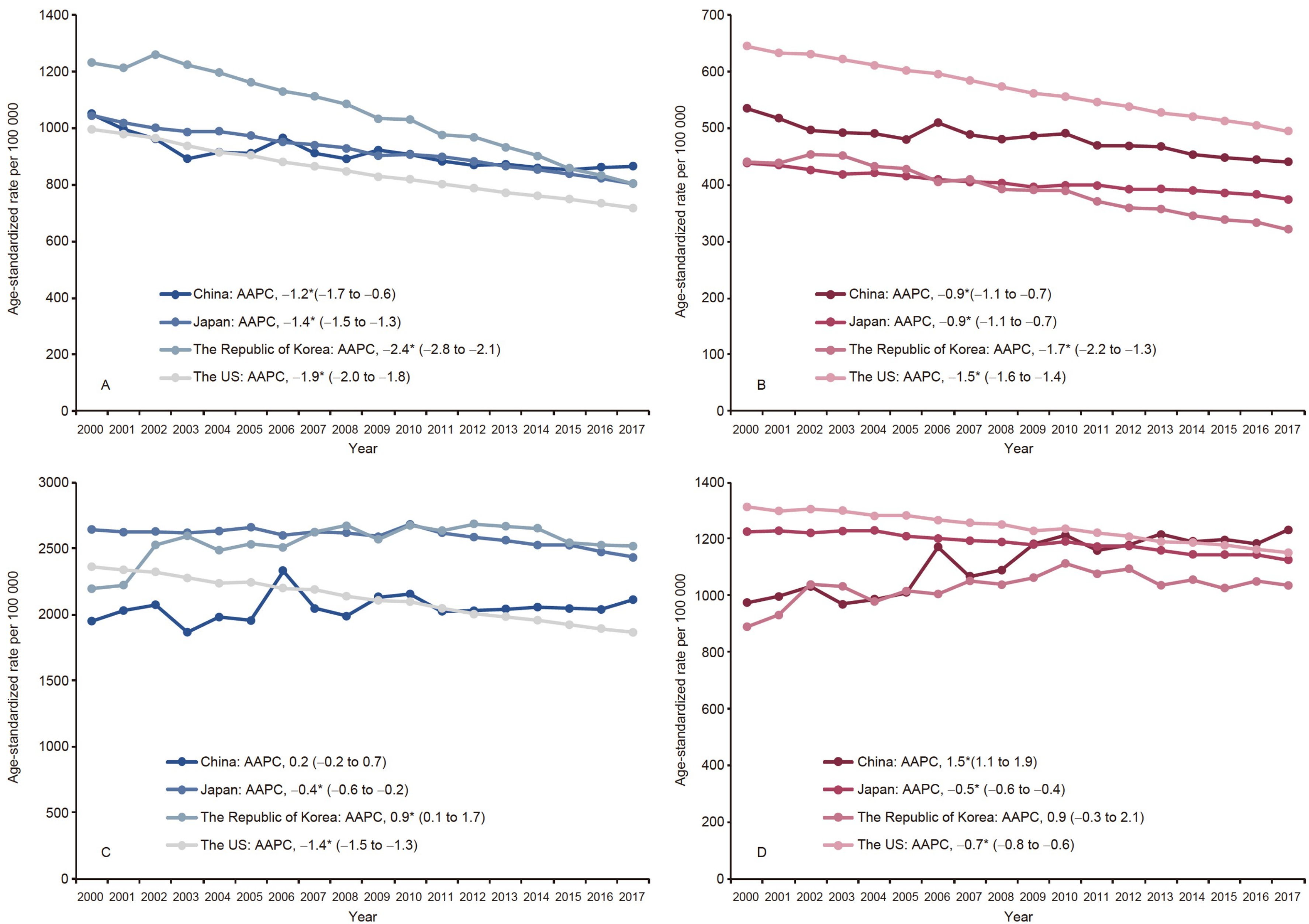

Figure 4 Trends on age-standardized mortality rates for all cancers combined in older people (aged over 60 years) (A: older men; B: older women) and oldest people (aged over 80 years) (C: oldest men; D: oldest women) by sexes in China, US, Japan and the Republic of Korea, 2000–2017. AAPC, average annual percentage changes. * The AAPC are significantly different from zero (P<0.05).

intestinal cancer burden among Chinese older people, to great extent, benefited from the increasing socioeconomic levels, dietary improvements and controls of infectious factors (Li et al., 2020; Wu et al., 2021b). In recent decades, significant drops were observed in the incidence and mortality rate of liver cancer among Chinese older people. The drops in liver cancer burden among Chinese older people were mainly attributed to the improvement of socioeconomic levels, increased consciousness of healthcare and the advances in clinical diagnosis and treatment. The reduced intake of aflatoxin in dietary might be one of the most significant factors for the declining trend of liver cancer, as evidenced by decrease of exposure biomarkers in population living in high-risk areas (Chen et al., 2013; Sun et al., 2013). The infection of hepatitis B or C virus (HBV or HCV) was regarded as a critical modifiable risk factor for liver cancer in China (Wang et al., 2014). The expanded program on immunization was conducted in 1992, resulting in a substantial decline in the incidence of hepatitis B among young people, while the incidence of HBV infection was still increased among older people (Zhang et al., 2019). However, the improvement of medical care and the application of antiviral drugs reduced the development of the viral hepatitis into liver cancer. Most antiviral drugs such as Tenofovir have been included in the national basic medical insurance reimbursement list as partial out-of-pocket expenses in 2017, which contributed to the improvement of treatment coverage and compliance (Hou et al., 2017). Additionally, large-scale screening programs of HBsAg testing, AFP testing and ultrasound examination conducted in high-risk population of China were proved to be the effective practices for the declining trends in burden of liver cancer (Bai et al., 2018; Zhang et al., 2004).

The significant upward trends of prostate cancer, breast cancer, and colorectal cancer are the typical remark that the cancer pattern in China is being in a transition stage to that in developed country. Similar characteristics are also observed in Japan and the Republic of Korea. The common potential reasons are the gradual conduction of screening programs, the prevalence of westernized lifestyles and obesity (Goss et al., 2014; Varghese and Shin, 2014). Notably, the rapidly growing burden of prostate cancer is probably attributed to the increased prevalence of hospital opportunistic prostate-specific antigen screening (PSA) and improved biopsy techniques (Ito, 2014). With the popularization of the PSA test in Japan since the 1990s (Ito et al., 2019), the mortality rate has been observed to decline though the incidence rate of prostate cancer has been still rapidly growing in recent decades. However, the evidence of the coverage and efficacy of PSA screening conducted in China is limited, and more large-scale cohort studies are required for recommendations for prostate cancer screening. Additionally, the screening programs for breast and cervical cancer have been conducted among women aged 35 to 64 years in nationwide rural areas from 2009, and the incidence rates for the two women's cancers are estimated to grow in the next few decades (Fan et al., 2014; Wang et al., 2019). The most effective measure of improving the survival rate of colorectal cancer is regarded as removing cancer lesions endoscopically or surgically at an earlier stage, which mainly depends on colonoscopy screening. Compared with other countries, China faces a greater challenge in the conduction of colonoscopy screening programs, due to the relatively low participation rate even in high-risk areas (14%) (Chen et al., 2019).

The current cancer profile in older adults is attributed to the long-term exposure to risk factors. Tobacco was regarded as the first rank among cancer contributors in China, and was associated with 26% of cancer deaths and 43% of lung cancer deaths (Islami et al., 2017). Both ever-smoking and second-hand smoking increase the burden for main cancer types, and the associations tend to be more significant among older people due to the longer exposure years (Barengo et al., 2019). However, it has been proved that quitting smoking for older adults contributes to the declines in cancer incidence and mortality in different populations. Smoking cessation counseling should also target at old smokers in primary health care (Barengo et al., 2019; Lam et al., 2007; Lim et al., 2013; Whitson et al., 2006). Additionally, other prevention strategies, such as dietary modification, physical activities and reduction of alcohol drinking are still proved to be effective among the older people (Chao et al., 2004; Jankovic et al., 2017). Controlling the modifiable risk factors has been the most sustainable and cost-effective way to decline the cancer burden for all population including older people.

Early diagnosis of cancers strongly improved the chance to access optimal treatment strategies. However, routine cancer screening programs are usually not targeted at older people due to overdiagnosis of indolent diseases. As the population ages, more studies investigated the screening programs for older people, and have been proved that most screening-detected cancers in old patients were invasive, and the conduction of screening in older adults was effective (Brassell et al., 2011; Hartman et al., 2015; Varlotto et al., 2014). However, the recommended upper age limits for different cancer screening programs are still controversial. Given the common prevalence of frailty, declines of functional status and comorbidities in old patients, the strict screening age cut off should not be the only standard, and the comprehensive evaluation of age, health status, the exposure to risk factors and overall life expectancy should be necessary for identifying the screening candidates. In the US, the younger older people have been fully considered in the cancer screening guidelines. For breast cancer and prostate cancer, screening programs are recommended for those with good status and over 10-year life expectancy; for lung cancer, the screening program is recommended for the heavy current and former smokers before 75 years old (Smith et al., 2019). In China, people aged 75 years and over are usually unable to access the routine cancer screening programs. Given the immense scale of the population and a lack of evidence for the efficacy among the older people, the popularization of organized screening programs among older adults is still facing challenges in China. The early diagnosis for high-risk older people mainly depends on the hospital opportunistic screening, which faces enormous variations by regional distribution. Given the rapid population ageing in China, more large-scale cohort studies related to the cost-effectiveness of the conduction of cancer screening in older adults are required for the development of the screening guideline for older people.

In our analysis, the cancer burden of oldest people is much more worthy of attention. Almost one in ten cancer cases and one in five cancer deaths are from the oldest people, which account for less than 3% of the population, and the figures are rapidly increasing in the next few decades. It is crucial to provide oldest patients with high-quality and effective care to improve their quality of life and avoid early death. Due to the high prevalence of frailty, comorbidities, malnutrition and disabilities, the oldest patients can not receive optimal treatment and even refuse surgery, which leads to the much lower survival rate, even the age is not a contraindication for surgical treatment (DeSantis et al., 2019; Fang et al., 2017). Furthermore, the current clinical treatment guidelines and professional training are difficult to satisfy these vulnerable patients. The oldest patients are underrepresented in clinical research that sets the guidelines for efficacy and safety of various cancer treatments, leading to a dearth of knowledge of the optimal therapy for oldest patients. Additionally, supportive and palliative care can help relieve the pains of those with advanced cancers, physically and mentally, and is regarded as an essential part of geriatric cancer management. For most countries, investment in supportive and palliative care is cost-effective for healthcare systems (Chalkidou et al., 2014). In the US, a series of programs for improving palliative and end-of-life care were conducted widely in the 2000s, such as the large-scale palliative care training for physicians and the nationwide establishment of the Center to Advance Palliative Care (CAPC), and Clinical Practice Guidelines for Palliative Care was published in 2009 (Grant et al., 2009). Though there has been a common sense of rising demand for palliative care in China, the development of hospice and palliative care is still limited by the lack of professional nurses and related training programs (Lu et al., 2018).

Compared with other three countries, Chinese incidence rate of cancer among older people was relatively low; However, as one of the largest populous countries, Chinese population has been ageing in an unprecedented speed and scale, and Chinese older people was projected to exceed 0.49 billion in 2050 according to the estimation from United Nations (https://population.un.org/wpp). Even maintain the current levels of exposure for risk factors in the next decades, the huge number of older patients due to the rapid population ageing will bring the heavy burden for the healthcare systems and social development in China. However, the Chinese ageing process is still facing the daunting challenges. Facing the huge gaps of socioeconomic development and healthcare services with other ageing countries, China has the characteristic of "aging before getting rich" in ageing process. The capita GDP was 939 dollars when China entered ageing society in 2000, much lower than those in other developed countries at the same ageing stage (e.g., the capita GDP of Japan in 1970s was 2,026 dollars) (https://data.worldbank.org), and medical insurance and social welfare are still inadequate to guarantee the medical services for growing burden of diseases from ageing population (Fang et al., 2020). Additionally, there are vast regional differences in the socioeconomic development and the healthcare resources, and the inequity still exists in health status and health services utilization, especially in central and western areas (Wu et al., 2021a). Furthermore, the urban-rural inversion of population ageing resulting from the immigration of young and middle aged labour has been presented for a long term, and will continue to 2040 (Du et al., 2010). In recent years, the rural population have been ageing faster than urban population, and the 7th National Census in 2020 revealed the proportion of older people in rural areas was 6.58% higher than the proportion in urban areas.

Japan is regarded as the most ageing country worldwide, and entered the ageing society in 1970s. According to our results, cancer incidence rate of Japan is almost twice as the rate in China among older people, while the older mortality rate in Japan is much lower than China, which means there have been the heavy burden of older cancer survivors in Japan. To satisfy the fast growing need for care services from older patients, Japan introduced the Government-initiated, mandatory, public, long-term care insurance in 2000, which provided care services for those older people in need by care-workers (Tamiya et al., 2011). This policy has achieved significant progress in improvement of the care quality and volume and reduction of the burden from family caregivers of older patients. With the similar cultural background and lifestyles, China can learn from the experience of Japan to cope with the forthcoming cancer burden from the fast fast-growing ageing population.

Our study has several strengths in the authenticity of the estimated results. The reported Chinese cancer incidence and mortality rates of GLOBOCAN2020 were estimated based on data from 92 Chinese registries. In contrast, we used the most recent cancer data from 487 Chinese cancer registries, covering over 381 million population, and population data was based on the latest published 7th National Census data in

2020, all of which to great extent ensure the authenticity of the estimated results. Due to the limited timelines of cancer data, the estimated rates of most cancers in GLOBOCAN 2020 were replaced by the weighted or simple average of the local rates from 2010 to 2012. In our study, the current incidence and mortality rates in 2022 are extrapolated according to the trends from 2010 to 2016 by logarithmic linear regression, with due consideration of changes in the rates over time.

Although the Chinese data presented in this study has been updated compared with previous estimates, it still only represents a proportion of total population, especially for the continuous data for the long term. The population coverage of Chinese cancer registries needs to be further expanded in the future. Additionally, we estimated the current cancer burden of the other three countries by using the most recent data from their national cancer registries, which to a great extent ensured the accuracy and representativeness of the results, but the bias caused by the differences in data resources and methods of quality-control could not be avoided. Additionally, results in oldest groups must be explained cautiously. It is difficult to identify the causes of death in oldest people, because most of them present with fatal comorbidities. In addition, many oldest cancer patients give up medical diagnosis and treatment, especially in some lower socioeconomic areas. All of these may lead to an underestimation of cancer burden in the oldest people.

DATA SOURCE AND METHODS

Data source

The estimation for the numbers of new cases and deaths of Chinese older people in 2022 were based on the most recent data from the National Central Cancer Registry (NCCR), including data from 487 population-based cancer registries in 2016 (covering 381,565,422, about 27.60% of the national population), and the continuous data from 115 registries during 2010 to 2016 (covering about 9.5% of national population). The long-term trends for all cancers combined and selected cancer types were based on the continuous data from 2000 to 2017 in 22 registries, representing 3.34% of national population. The list of included 487 cancer registries was shown in Table S2 in Supporting Information. Additionally, national and regional population data by 5-year age group and sex were obtained from statistics, public security census or calculations based on census data.

All of the included data passed quality control checks based on the criteria of "Guideline for Chinese Cancer Registration" and criteria of International Agency for Research on Cancer/International Association of Cancer Registries (IARC/IACR) (Bray and Parkin, 2009; Parkin and Bray, 2009). The percentages of cases with death certificate-only (DCO), morphological verification of diagnosis % (MV%) and mortality/incidence (M/I) ratios for all cancers combined and selected cancer types were shown in Figure S1 in Supporting information, and these indicators of each cancer registry were reported in *China Cancer Registry Annual Report*, *2019* (He et al., 2021).

As the comparisons, the cancer data of other countries were extracted from National Cancer Institute's (NCI's) Surveillance, Epidemiology, and End Results (SEER) program, National Cancer Registry in Japan and Korea Central Cancer Registry. The detailed information was described in Table S3 in Supporting Information.

All cancer cases were coded according to the 10th edition of the International Classification of Diseases (ICD-10) and the 3rd edition of the International Classification of Diseases for Oncology (ICD-O-3). Groups of cancer types were classified according to the criteria of the *Cancer Incidence in Five Continents (CI5)* (Forman et al., 2013) and previous studies from NCCR (Chen et al., 2016).

Statistical analysis

A logarithmic linear regression model was used for the projection of age-specific rates for cancer incidence and mortality in 2022. To estimate new cases and deaths among people aged over 60 years and people aged over 80 years in 2022, we calculated the age-specific rates in 2016 stratified by sex and urban/rural from 487 cancer registries, then extrapolated according to the age-specific trends from 2010 to 2016 (calculated by data from 115 registries), and applied to age-specific Chinese population in 2022. The long-term trends of cancer incidence and mortality rates from 2000 to 2017 (22 registries) were estimated by fitting Joinpoint regression model. Joinpoint regression 4.3.1.0 was used to calculate the annual percent change (APC) and average annual percent change (AAPC).

We calculated truncated age-standardized incidence rates (ASIRs) and truncated age-standardized mortality rates (ASMRs) of people aged over 60 years and people aged over 80 years, using Segi's world standard population for 5-year age intervals. The 95% confidence intervals (CIs) of cancer incidence and mortality rates for 2022 were calculated by a logarithmic linear regression (Faraway, 2009; Malvezzi et al., 2011). All analyses were undertaken using SAS 9.4 statistical software.

CONCLUSION

We provided comprehensive information of the current cancer burden and temporal trends of Chinese older people. The overall cancer mortality rate declined in Chinese older people, while the incidence rate was not declined in older men, and even increased in older women. The current Chinese cancer burden is mainly from older people, and the proportion will continue to increase as the rapid population ageing. It should be the national health priority to meet the growing demands for cancer diagnosis, treatment and care services from older people in the next few decades.

Compliance and ethics *The author(s) declare that they have no conflict of interest.*

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SUPPORTING INFORMATION

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