Cancer burden and trends in China: A review and comparison with Japan and South Korea

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Abstract

Objective: To summarize the cancer burden and trends in China, compare the differences among China, Japan, and South Korea and discuss possible causes of the disparities.

Methods: Incidence and mortality data were extracted from the online cancer database including the GLOBOCAN 2018 and the Global Burden of Disease Study 2017. Trend analysis was conducted using the join-point analysis, and annual percent changes were calculated.

Results: Cancers resulted in approximately 62.9 million disability-adjusted life years (DALYs) in China in 2017. Lung cancer had the greatest contribution, followed by liver cancer, stomach cancer, and esophageal cancer. The trajectory of progress in the reduction of liver and stomach cancers was observed in China. However, China still faced a heavy burden of lung cancer and a growing burden of cancers related to westernized lifestyle such as colorectal cancer, while Japan and South Korea have achieved reductions in colorectal cancer and lung cancer, respectively. Besides, China had a lower age-standardized cancer incidence rate but higher cancer mortality and DALY rates than Japan and South Korea.

Conclusions: China is in the cancer transition stage with a rising burden of colorectal, prostate, and breast cancers along with a heavy burden of lung and upper digestive tract cancers. Taking into consideration the effectiveness of screening and tobacco control in Japan and South Korea, improvement in the current tobacco control policy and cancer screening systems may contribute to cancer control in China.

Keywords: Cancer burden; trend; China; comparison

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Introduction

Cancer is the leading cause of death worldwide (1). Distinct geographic disparities exist in cancer burden across the world (2). China, Japan, and South Korea are all located in East Asia. As neighboring countries, Japan and South Korea share similar genetic backgrounds and similar culture with China. Also, in terms of cancer burden, these three countries are all facing a heavy burden of upper digestive tract cancers. But China, Japan, and South Korea are at different stages of socio-economic development. Japan and South Korea are ahead of China in industrialization and urbanization and have higher incidence rates of some westernized lifestyle-related cancers, such as breast cancer and colorectal cancer (3). Besides, Japan and South Korea have a longer history of nationwide cancer control programs than China (4,5). Comparison among these three countries for the cancer burden and trends could be useful to track the effectiveness of national screening programs and to identify modifiable risk factors. The results can serve as a scientific reference for cancer control policy planning. Thus, we sought to provide an overview of cancer burden and trends in China and to compare them with those in Japan and South Korea. Considering the credibility, availability, and comparability of data, we conducted the analysis based on the online cancer database from the GLOBOCAN 2018 (6) and the Global Burden of Disease Study 2017 (GBD 2017) (7) and we also reviewed cancer survival data from the CONCORD-3 (8), cancer registry reports from China (9,10), Japan (11,12), and South Korea (5,13). We hope that this comparative analysis could contribute to improving measures of cancer control in China.

Materials and methods

Data sources

National estimates of age-standardized incidence and mortality for China, Japan, and South Korea in 2018 were obtained from the GLOBOCAN 2018 (6). The GLOBOCAN project initiated by the International Agency for Research on Cancer (IARC) systematically quantified the incidence, mortality, and prevalence in 185 countries or territories for 36 cancer types. The projected national rates for China in the GLOBOCAN 2018 were based on the recent data from 92 cancer registries. Observed national rates, including incidence and mortality in South Korea, and mortality in Japan, were available and applied to predict the corresponding rates in 2018. Incidence rates in Japan were estimated using mortality-to-incidence ratios derived from cancer registries (14). For the trend analysis, we referred to the cancer incidence in five continents (CI5) series (15). The incidence data in CI5 series were derived from high-quality national population-based registries including five registries in China, five in South Korea and four in Japan. All age-standardized rates of incidence and mortality were calculated using the world standard population. Cancer survival data were retrieved from the CONCORD-3 (8), which provides the largest and latest international cancer survival data. Age-standardized fiveyear survival rates were calculated using the International Cancer Survival Standard weights (16).

Disability-adjusted life years (DALYs) attributable to cancers for China, Japan, and South Korea in 1990 and 2017 were retrieved from the GBD online results tool (7) engineered by the Institute for Health Metrics and Evaluation (IHME). The GBD annually provides age-sexspecific DALYs for countries across the world. Detailed methods for the GBD 2017 study have been reported in previous studies (17,18). In this study, DALYs per 100,000 population estimates for 29 cancer sites in China, Japan, and South Korea in 2017 were presented by sex and age. To reflect the trends of cancer burden, we also showed the percentage change in all-age and age-standardized DALY rates in China, Japan, and South Korea from 1990 to 2017. The age-standardized DALY rates were based on the GBD reference population (18).

Statistical analysis

Join-point models were used (19) to examine the time trends in age-standardized incidence rates for selected cancer sites in China, Japan, and South Korea. We applied the logarithmic transformation of the rates and a maximum number of two join-points (three line segments) in the models. The annual percent change (APC) was calculated to indicate the direction and magnitude of the trends. The term "increase" or "decrease" was used if the APC was statistically different from zero. P<0.05 was considered statistically significant. The trend analysis was conducted by Joinpoint Regression Program (V.4.7.0.0, National Cancer Institute, 2019).

Results

Current cancer burden in China

According to the estimates by the GLOBOCAN 2018, about 4,285,033 new cancer cases were diagnosed in China in 2018, which included 2,366,010 males and 1,919,023 females. The crude and age-standardized incidence rates (ASIR) for all cancers were 301.1 and 201.7 per 100,000, respectively. An estimated 2,865,174 cancer deaths occurred in 2018, with 1,791,805 deaths occurring in males and 1,073,369 in females. The crude and age-standardized mortality rates (ASMR) were 201.3 and 130.1 per 100,000, respectively. The incidence and mortality rates were higher in males than females. Table 1 and Figure 1 show that breast cancer has the highest ASIR in both sexes combined, followed by lung cancer, colorectal cancer, and stomach cancer. Lung cancer was the leading cause of cancer death, followed by stomach cancer, liver cancer, and esophageal cancer.

Table 2 shows all age and age-standardized DALYs per 100,000 populations in China in 2017. The GBD 2017 estimated that cancers resulted in approximately 62.9 million DALYs in China. Lung cancer had the greatest

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Index	Gender	All					Ra	ank				
Index	Gender	cancers	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Incidence	Both	201.7	Breast	Lung	Colorectum	Stomach	Liver	Esophagus	Cervix uteri	Thyroid	Prostate	Corpus uteri
			36.1	35.1	23.7	20.7	18.3	13.9	10.7	10.1	9.1	7.1
	Male	223.0	Lung	Stomach	Colorectum	Liver	Esophagus	Prostate	Pancreas	Bladder	Leukemia	NHL
			47.8	29.5	28.1	27.6	19.7	9.1	6.2	5.9	5.8	4.8
	Female	182.6	Breast	Lung	Colorectum	Thyroid	Stomach	Cervix uteri	Liver	Esophagus	Corpus uteri	Ovary
			36.1	22.8	19.4	15.8	12.3	10.7	9.0	8.2	7.1	5.3
Mortality	Both	130.1	Lung	Stomach	Liver	Esophagus	Colorectum	Breast	Pancreas	Prostate	Cervix uteri	Leukemi
			30.9	17.5	17.1	12.7	10.9	8.8	4.9	4.7	4.4	3.5
	Male	166.6	Lung	Liver	Stomach	Esophagus	Colorectum	Pancreas	Prostate	Leukemia	Brain, CNS	NHL
			43.4	25.6	25.0	18.2	13.1	5.6	4.7	4.4	3.6	2.8
	Female	95.2	Lung	Stomach	Colorectum	Breast	Liver	Esophagus	Cervix uteri	Pancreas	Ovary	Brain, Cl
			19.0	10.4	8.8	8.8	8.6	7.4	4.4	4.2	2.9	2.8

Table 1 Age-standardized cancer incidence and mortality rates per 100,000 populations by gender in China in 2018

CNS, central nervous system; NHL, non-Hodgkin lymphoma. The estimates are from Global Cancer Observatory 2018, IARC, 2018 (6). Age-standardized rates are calculated using the direct method and the world standard population.

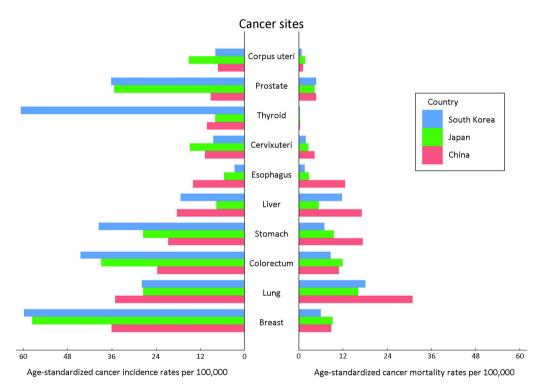


Figure 1 Age-standardized incidence and mortality rates per 100,000 populations of selected types of cancers in China (red), Japan (green), and South Korea (blue) in 2018. The data used to generate this figure were from the GLOBOCAN database (6).

contribution (24.3%) to the cancer DALY burden in China in 2017, followed by liver cancer (17.7%), stomach cancer (12.4%), and esophageal cancer (7.1%). These four cancer types accounted for more than 60% of cancer DALYs in

China. *Figure 2* illustrates the etiologic constituent of DALYs by age and sex. Leukemia dominated among the youth (<20 years), but brain and nervous system cancer was also an important cancer among young age groups. For

Table 2 All age and age-standardized DALYs rates	per 100,000 populations by gender in China in 2017

Index	Gender	All					F	Rank				
Index	Gender	cancers	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
All age rates	Both	4,450.2	Lung	Liver	Stomach	Esophagus	Colorectum	Breast	Leukemia	Other	Brain, CNS	Pancreas
			1,079.9	789.6	553.3	316.1	301.2	186.8	163.2	143.2	138.7	133.9
	Male	5,607.2	Lung	Liver	Stomach	Esophagus	Colorectum	Leukemia	Brain, CNS	Other	Pancreas	Prostate
			1,479.7	1,195.4	758.1	469.8	356.7	187.4	162.5	159.9	153.1	122.2
	Female	3,243.2	Lung	Breast	Liver	Stomach	Colorectum	Cervical	Esophagus	Leukemia	Other	Brain, CNS
			662.7	370.4	366.3	339.6	243.3	194.1	155.8	137.9	125.9	113.9
Age- standardized rates	Both	3,257.9	Lung	Liver	Stomach	Esophagus	Colorectum	Leukemia	Breast	Other	Brain, CNS	Pancreas
			757.6	552.1	391.7	222.6	216.2	171.0	130.6	126.1	124.6	94.3
	Male	4,202.8	Lung	Liver	Stomach	Esophagus	Colorectum	Leukemia	Brain, CNS	Other	Pancreas	Prostate
			1,075.4	852.4	553.7	341.2	265.5	194.2	146.1	136.2	111.3	101.6
	Female	2,344.3	Lung	Breast	Liver	Stomach	Colorectum	Leukemia	Cervical	Other	Esophagus	Brain, CNS
			451.8	253.0	251.6	235.5	168.9	146.6	132.3	117.9	107.6	102.3

DALYs, disability-adjusted life years; CNS, central nervous system; Other, other malignant neoplasms. The estimates are from the Institute for Health Metrics and Evaluation (IHME) website (7). Age-standardized rates are calculated using the GBD reference population (18).

young and middle-aged adult males, liver cancer and lung cancer were the leading causes of DALYs. Breast cancer resulted in the greatest part of the DALY burden among young and middle-aged adult females. Among elderly adults (>50 years), lung cancer and liver cancer represented the highest disease burden for each sex separately and combined.

Time trends in China

Table 3 shows that the ASIR for all cancers in females was stable from 1998 to 2012 in China. But a significant downward trend was observed in males during this period. As is shown in *Figure 3*, the ASIR of lung cancer held steady in both sexes since 2009. Upward trends in the ASIR were observed for colorectal cancer, prostate cancer, and thyroid cancer in males and breast cancer in females. In contrast, the ASIR of stomach cancer, esophageal cancer, and liver cancer showed significant declines for each sex.

Figure 4A shows the DALYs of 29 cancer types in China, ranked by the number of DALYs in 2017. Lung cancer became the leading cause of DALYs in 2017, replacing liver cancer in 1990. All-age and age-standardized DALY rates of stomach cancer have decreased by 10.7% and 50.3% since 1990, leading to a decrease in its ranking from the second to the third. Esophageal cancer was still the fourth leading cancer for all-cause DALYs, even though the age-standardized DALY rate decreased by 50.1% over the last

27 years. Colorectal cancer and breast cancer both increased in the ranking to become the fifth and sixth leading cancers of all-age DALYs. The all-age DALYs rates increased for colorectal cancer (69.8%) and breast cancer (64.9%) from 1990 to 2017. The all-age and age-standardized DALY rates have increased substantially for pancreatic cancer, ovarian cancer, and lip and oral cavity cancer since 1990. Age-standardized DALY rate of uterine cancer declined by 53% over this period, leading it from 14th in 1990 to fall outside the top 20 causes in 2017.

Comparison with Japan and South Korea in current burden

As estimated by the GLOBOCAN 2018, there was a marked variation in cancer incidence rates among China, Japan, and South Korea, with the incidence in Japan and South Korea being higher than that in China. Overall, the ASIR per 100,000 in South Korea observed among males (332.1) and females (310.6) were nearly 1.5 times higher than the rates among males (223.0) and females (182.6) in China. In contrast to incidence rates, mortality rates in China were nearly 1.5 times higher than those in Japan and South Korea within each sex.

Table 1 and Supplementary Table S1 show the top ten cancer types by the ASIR and ASMR for males, females, and combined in China, Japan, and South Korea. Lung cancer, stomach cancer, and colorectal cancer were listed in

			China	าล					Japan	an					South Korea	Korea		
Sites	Trei	Trend 1	Trend 2	d 2	Trend 3	13	Trend 1	-	Trend 2	d 2	Trend 3	e	Trend 1	11	Trend 2	d 2	Trend 3	d 3
	Years	APC	Years	APC	Years	APC	Years	APC	Years	APC	Years	APC	Years	APC	Years	APC	Years	APC
Male										-						-		
All cancers [†]	1998- 2012	-0.8*					1998- 2002	-1.3*	2002- 2010	1.6*			1999– 2012	1.3*				
Lung	1998– 2000	0.8	2000- 2009	-2.5*	2009- 2012	-0.3	1998– 2005	-0.4	2005– 2010	1.3*			1999– 2012	-1.4*				
Liver	1998– 2012	-1.9*					1998– 2010	-4.6*					1999– 2012	-2.2*				
Stomach	1998– 2000	1.0	2000- 2006	-4.4*	2006– 2012	-2.5*	1998– 2003	-2.7*	2003- 2010	0.8			1999– 2012	-0.3				
Esophagus	1998– 2012	-3.8*					1998– 2010	0.8*					1999– 2002	-0.2	2002- 2006	-5.6*	2006– 2012	0.5
Colorectum	1998– 2012	0.7*					1998– 2010	0.5*					1999– 2009	5.8*	2009– 2012	0.3		
Prostate	1998– 2002	10.1*	2002– 2012	4.6*			1998– 2010	8.7*					1999– 2012	10.3*				
Thyroid	1998– 2000	-7.9	2000- 2008	9.1*	2008– 2012	22.9*	1998– 2002	-2.3	2002- 2010	8.2*			1999– 2001	7.6	2001– 2009	27.9*	2009– 2012	12.9*
Female																		
All cancers⁺	1998– 2000	3.1	2000- 2009	0	2009- 2012	2.9	1998– 2003	0.1	2003- 2010	3.1*			1999– 2003	2.2	2003- 2012	5.7*		
Lung	1998– 2012	-0.2					1998– 2005	0.5	2005– 2010	ю. Ю			1999– 2003	-2.9*	2003- 2012	2.4*		
Liver	1998– 2012	-2.1*					1998– 2010	-3.3*					1999– 2012	-2.2*				
Stomach	1998– 2012	-3.1*					1998– 2003	-3.4*	2003- 2010	0.4			1999– 2012	-0.4				
Esophagus	1998– 2012	-6.1*					1998– 2010	2.2*					1999– 2012	-2.5*				
Colorectum	1998– 2001	2.0	2001– 2012	-0.6*			1998– 2010	1.1*					1999– 2008	4.4*	2008– 2012	1.5		
Breast	1998– 2000	8.3	2000- 2009	1.6*	2009- 2012	4.5*	1998– 2010	4.2*					1999– 2012	5.7*				
Thyroid	1998– 2003	3.7*	2003- 2012	12.7*			1998– 2002	-4.2*	2002- 2006	11.2*	2006– 2010	4.2	1999– 2009	23.8*	2009– 2012	10.1		

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cancers exclude non-melanoma skin.

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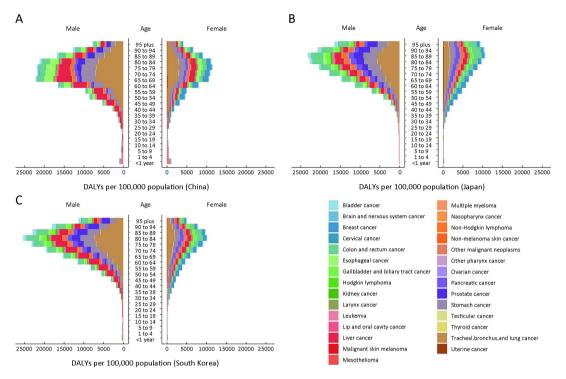


Figure 2 Disability-adjusted life years (DALYs) per 100,000 populations attributable to cancers by age and gender in China (A), Japan (B), and South Korea (C) in 2017. The estimates used to generate this figure were from the Institute for Health Metrics and Evaluation (IHME) website (7).

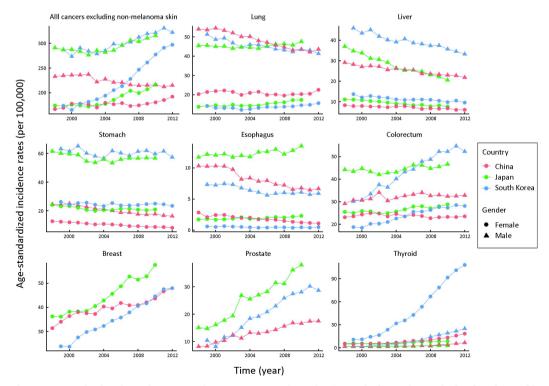


Figure 3 Trends in age-standardized incidence rates by cancer site and gender (triangle for male; circle for female) in China (red), Japan (green), and South Korea (blue). The data used to generate this figure were from the Cancer Incidence in Five Continents database (15).

the top five common cancers for males in each country. For females, breast cancer, lung cancer, colorectal cancer, stomach cancer, and thyroid cancer were common cancers in the three countries. *Figure 1* illustrates the ASIR and ASMR of selected types of cancers in China, Japan, and South Korea in 2018. South Korea had a much higher thyroid cancer incidence than Japan and China. Also, Japan and South Korea had higher incidence rates of breast, colorectal and prostate cancers than China. But the mortality rates of thyroid, breast, colorectal and prostate cancers were similar in these three countries. Another notable aspect was that China had a lower incidence rate but a higher mortality rate of stomach cancer than Japan and South Korea. Correspondingly, Table 4 indicates that Chinese cancer patients had lower 5-year survival rates. Especially for stomach cancer, the survival rate in South Korea has achieved 68.9% but its counterpart was less than 36% in China.

Supplementary Table S2 shows all age and agestandardized DALYs rates in Japan and South Korea in 2017. Age-standardized DALY per 100,000 populations for all cancers was higher in China when compared with Japan and South Korea. *Figure 2* shows DALYs per 100,000 populations by age and gender in China, Japan, and South Korea in 2017. Evaluating DALYs by age, we could see that the population with the highest rates of cancer burden in China were younger than those in Japan and South Korea. Lung cancer represented the highest cancer burden for the three countries, followed by gastrointestinal and liver cancers. In terms of the composition of DALYs by age and sex, leukemia was the highest DALY group among the youth in the three countries, followed by brain and nervous system cancer. For young and middle-aged adult males, the largest contributors to DALYs were liver cancer in China and South Korea and colorectal cancer in Japan, respectively. Breast cancer was the leading cause of DALY among young and middle-aged adult females in the three countries. Among elderly adults (>50 years) in the three countries, lung cancer was the top contributor to cancer burden for males, females, and combined, except being replaced with colorectal cancer in Japanese females.

Comparison with Japan and South Korea in time trends

Figure 3 shows trends in ASIR by cancer site and gender in China, Japan, and South Korea. In contrast to China, upward trends of ASIR in Japan and South Korea were observed. Rising prostate and female breast cancers contributed the greatest part to the increase of all cancers incidence rates. Lung cancer incidence rate remained generally high in China, Japan, and South Korea. Lung cancer jumped to the first cause of DALYs in 2017, replacing live cancer in China, stomach cancer in Japan and

Table 4 Age-standardized 5-year survival rates (%) with 95% CI in adults aged 15–99 years from 2000 to 2014 in China, Japan, and South Korea

Ocumentaria		-				5-year surviva	l rate (95% Cl)			
Country	Years	Lung	Stomach	Liver	Esophagus	Colon	Rectum	Breast	Pancreas	Prostate	Cervix uteri
China	2000-2004	18.7	30.2	11.7	22.9	51.4	49.5	75.9	14.4	57.7	53.3
		(18.0–19.4)	(29.3–31.1)	(10.9–12.5)	(22.0–23.9)	(49.6–53.3)	(47.5–51.4)	(70.9–80.9)	(12.8–16.0)	(52.3–63.0)	(48.1–58.5)
	2005–2009	17.7	33.2	11.6	27.1	55.6	52.5	80.4	10.2	62.5	63.0
		(17.4–18.1)	(32.7–33.7)	(11.1–12.0)	(26.5–27.7)	(54.6–56.5)	(51.5–53.6)	(79.3–81.5)	(9.4–11.0)	(59.9–65.1)	(61.2–64.9)
	2010-2014	19.8	35.9	14.1	29.7	57.6	56.9	83.2	9.9	69.2	67.6
		(19.4–20.2)	(35.3–36.5)	(13.6–14.7)	(29.0–30.4)	(56.6–58.6)	(55.8–58.0)	(82.1–84.3)	(9.1–10.7)	(66.4–72.0)	(65.8–69.5)
Japan	2000–2004	29.3	50.5	25.7	27.7	63.4	58.6	85.9	6.9 (6.4–7.4)	85.9	67.5
		(28.1–30.5)	(50.0–50.9)	(25.1–26.3)	(26.4–29.0)	(62.7–64.0)	(57.6–59.5)	(85.2–86.6)		(84.9–87.0)	(66.3–68.7)
	2005–2009	29.3	57.6	28.6	33.3	66.8	64	88.9	7.6 (7.2–7.9)	91.4	69.2
		(28.9–29.7)	(57.3–57.9)	(28.1–29.1)	(32.3–34.2)	(66.3–67.3)	(63.3–64.6)	(88.4–89.3)		(90.8–92.0)	(68.3–70.1)
	2010-2014	32.9	60.3	30.1	36.0	67.8	64.8	89.4	8.3 (7.8-8.7)	93.0	71.4
		(32.3–33.4)	(59.9–60.7)	(29.5–30.6)	(34.8–37.3)	(67.3–68.4)	(64.0–65.7)	(88.9–89.9)		(92.4–93.6)	(70.4–72.3)
South	2000–2004	15.3	48.6	15.3	18.6	60.5	60.8	79.5	7.6 (7.2-8.1)	76.0	76.0
Korea		(15.0–15.6)	(48.2–48.9)	(15.0–15.7)	(17.6–19.6)	(59.9–61.2)	(60.0–61.6)	(78.0–81.0)		(74.6–77.5)	(75.3–76.7)
	2005–2009	19.9	61.1	22.4	26.9	68.1	68.1	84.0	8.4 (8.0-8.9)	87.3	77.0
		(19.6–20.2)	(60.8–61.5)	(22.1–22.8)	(25.8–28.0)	(67.6–68.6)	(67.5–68.7)	(83.0-85.0)		(86.5–88.1)	(76.4–77.7)
	2010-2014	25.1	68.9	27.2	31.3	71.8	71.1	86.6	10.5	89.9	77.3
		(24.8–25.4)	(68.6–69.2)	(26.8–27.6)	(30.3–32.4)	(71.4–72.2)	(70.6–71.7)	(85.8–87.5)	(10.0–10.9)	(89.2–90.5)	(76.6–78.0)

95% CI, 95% confidence interval. The estimates are from the CONCORD-3 (8). Age-standardized rates are calculated using the International Cancer Survival Standard weights (16).

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				B B					
Cancer 1990 China	Cancer 2017 China	Change in Rank DALY rates	all-age Change in age-standa ;, % (UI) DALY rates, % (UI)		ncer 1990 Japan	Cancer 2017 Japan	Ran	Change in all-age DALY rates, % (UI)	Ch
iver cancer	Tracheal, bronchus, and lung cancer	1 103.6 (84.1 to	118.3) 13.1 (2.3 to 21.2)		ich cancer	Tracheal, bronchus, and lung cancer		52.7 (47.9 to 57.8)	-14.
									-14.
Stomach cancer	Liver cancer				eal, bronchus, and lung cancer	Colon and rectum cancer	2	50.8 (45.6 to 56.7)	
fracheal, bronchus, and lung cancer	-Stomach cancer	3 -10.7 (-17.3 to			and rectum cancer	 Stomach cancer 	3	-26.2 (-28.7 to -23.2)	-57.
Esophageal cancer	Esophageal cancer	4 -7.2 (-14.6 to -		4 Liver ca		Pancreatic cancer		81.4 (75.5 to 87.7)	6.0
eukemia	Colon and rectum cancer	5 69.8 (49.5 to 8			eatic cancer	-Liver cancer		-16.8 (-30.0 to -8.5)	-52
Colon and rectum cancer	Breast cancer	6 64.9 (4.2 to 90		6 Breast c		Breast cancer		50.6 (43.6 to 57.8)	13.8
Other malignant neoplasms	Leukemia	7 -49.6 (-58.6 to			adder and biliary tract cancer	Gallbladder and biliary tract cancer	7		-39.
Breast cancer	Pancreatic cancer	8 137.7 (119.1 to		8 Leuken		Esophageal cancer		29.6 (24.2 to 35.0)	-19.
Brain and nervous system cancer	Other malignant neoplasms	9 7.3 (-3.8 to 30.		9 Esophaj		Non-Hodgkin lymphoma		43.4 (36.7 to 50.3)	-16.3
Nasopharynx cancer	-Brain and nervous system cancer	10 -8.4 (-28.9 to 3			malignant neoplasms	Other malignant neoplasms		40.1 (10.2 to 62.4)	0.7 (
Cervical cancer	Non-Hodgkin lymphoma	11 31.6 (20.0 to 4			lodgkin lymphoma	Leukemia		-15.5 (-18.9 to -11.6)	-41.3
Non-Hodgkin lymphoma	- Cervical cancer	12 42.1 (-35.8 to)		12 Ovarian		Prostate cancer	12	143.4 (95.3 to 166.6)	11.3
Pancreatic cancer	Nasopharynx cancer	13 -24.8 (-31.6 to		13 Cervica	cal cancer	Bladder cancer	13	82.3 (76.1 to 89.2)	-11.5
Jterine cancer	Prostate cancer	14 98.9 (81.3 to 1	27.4) 0.4 (-8.0 to 13.2)	14 Prostate	te cancer	Ovarian cancer	14	12.4 (7.3 to 18.1)	-14.1
Prostate cancer	Ovarian cancer	15 123.5 (89.5 to	149.2) 35.8 (15.0 to 51.6)	15 Bladder	er cancer	Kidney cancer	15	77.4 (53.3 to 88.6)	5.5 (
arynx cancer	Bladder cancer	16 39.2 (25.5 to 7		16 Kidney	y cancer	Cervical cancer	16	1.4 (-3.1 to 7.0)	-17.1
Bladder cancer	Lip and oral cavity cancer	17 111.1 (92.4 to			and nervous system cancer	Multiple myeloma		59.2 (46.0 to 83.0)	-10.5
Gallbladder and biliary tract cancer	- Larvnx cancer	18 27.7 (18.8 to 3		18 Multiple		Lip and oral cavity cancer		75.9 (69.2 to 84.4)	12.3
Ovarian cancer	Gallbladder and biliary tract cancer	19 73.9 (15.3 to 1		19 Uterine		Uterine cancer		40.3 (32.8 to 48.0)	-2.11
Kidney cancer	Kidney cancer	20 70.4 (23.1 to 9			d oral cavity cancer	Brain and nervous system cancer		67.1 (-18.0 to 96.0)	36 (-)
ip and oral cavity cancer	Uterine cancer	21 -19.2 (-27.2 to		20 Lip and 21 Larvnx		Other pharynx cancer		147.0 (133.7 to 165.1)	61.3
Jodgkin lymphoma	Non-melanoma skin cancer	22 93.6 (73 to 112		21 Laryix 22 Thyroid		Thyroid cancer		40.5 (33.8 to 48.5)	-18.3
Multiple myeloma	Multiple myeloma	23 63.2 (38.0 to 8			pharvnx cancer	Mesothelioma		99.5 (81.4 to 134.9)	20.3
Non-melanoma skin cancer	Thyroid cancer	24 50.2 (33.9 to 7			harvnx cancer			-3.0 (-7.7 to 1.3)	
Non-metanoma skin cancer						Larynx cancer	24		-43.4
Malignant skin melanoma	Other pharynx cancer Malignant skin melanoma	25 37.3 (11.9 to 8 26 25.9 (-28.4 to)		25 Mesothe		-Nasopharynx cancer		43.8 (35.6 to 53.9)	-1.4
					nelanoma skin cancer	Non-melanoma skin cancer		79.9 (71.0 to 91.0)	-4.7 (
Other pharynx cancer	Mesothelioma	27 69.3 (17.6 to 1	34.8) 5.9 (-25.9 to 43.8)		nant skin melanoma	Malignant skin melanoma		45.0 (17.8 to 58.1)	5.8 (-
l'esticular cancer									
Mesothelioma	Hodgkin lymphoma Testicular cancer	28 -69.9 (-76.2 to 29 -52.0 (-63.5 to Change in a	-54.3) -75.8 (-80.8 to -63.1) -40.9) -59.0 (-68.6 to -49.8)	28 Testicul 29 Hodgkin	ular cancer	Hodgkin lymphoma	28	3.9 (-20.8 to 17.0) -35.4 (-42.1 to -28.9)	-14.0 -31.3
	Testicular cancer		-54.3) -75.8 (-80.8 to -63.1) -40.9) -59.0 (-68.6 to -49.8) all-age Change in age-standa ,% (UI) DALY rates,% (UI)	28 Testicul 29 Hodgkin	ular cancer	Hodgkin lymphoma	28	3.9 (-20.8 to 17.0)	-14.0
Vesothelioma Cancer 1990 South Korea	Testicular cancer Cancer 2017 South Korea	29 -52.0 (-63.5 to Change in a Rank DALY rates	-54.3) -75.8 (-80.8 to -63.1) -40.9) -59.0 (-68.6 to -49.8) all-age Change in age-standa ,% (UI) DALY rates, % (UI) 6.9) -14.9 (-21.9 to -6.7)	28 Testicul 29 Hodgkin	ular cancer	Hodgkin lymphoma	28	3.9 (-20.8 to 17.0)	-14.0
Mesothelioma Cancer 1990 South Kores Stomach cancer Jiver cancer	Testicular cancer Cancer 2017 South Korea Tracheal, bronchus, and lung cancer Liver cancer	29 -52.0 (-63.5 to Change in a DALY rates 1 79.7 (65.0 to 9 2 -4.0 (-21.0 to 1	-54.3) -75.8 (-80.8 to -63.1) -40.9) -59.0 (-68.6 to -49.8) all-age Change in age-standa % (UI) DALY rates, % (UI) 6.9) -14.9 (-21.9 to -6.7) 9.7) -51.6 (-60.0 to -39.7)	28 Testicul 29 Hodgkin	ular cancer	Hodgkin lymphoma	28	3.9 (-20.8 to 17.0)	-14.0
Mesothelioma Cancer 1990 South Korea Stomach cancer .iver cancer Tracheal, bronchus, and lung cancer	Testicular cancer Cancer 2017 South Korea Tracheal, bronchus, and lung cancer Liver cancer Stomach cancer	29 -52.0 (-63.5 to Change in a DALY rates 1 79.7 (65.0 to 9 2 -4.0 (-21.0 to 1 3 -50.6 (-55.2 to	-54.3) -75.8 (-80.8 to -63.1) -40.9) -59.0 (-68.6 to -49.8) all-age Change in age-standa g/8 (UI) DALY rates, % (UI) 6.9) -14.9 (-21.9 to -6.7) 9.7) -51.6 (-60.0 to -39.7) -45.8) -74.9 (-77.2 to -72.5)	28 Testicul 29 Hodgkin	ular cancer	Hodgkin lymphoma	28	3.9 (-20.8 to 17.0)	-14.0
Mesothelioma Cancer 1990 South Korea Stomach cancer Liver cancer Tracheal, bronchus, and lung cancer eukemia	Cancer 2017 South Korea Tracheal, bronchus, and lung cancer Liver cancer Stomach cancer Colon and rectum cancer	29 -52.0 (-63.5 to Change in a DALY rates 1 79.7 (65.0 to 9 2 -4.0 (-21.0 to 1 3 -50.6 (-55.2 to 4 135.2 (111.4 to	-54.3) -75.8 (+80.8 to -63.1) -40.9) -59.0 (+68.6 to -49.8) -40.9) -59.0 (+68.6 to -49.8) -11-30 -69.0 (+14.9 (-21.9 to -6.7) -6.9) -14.9 (-21.9 to -6.7) -9.7) -51.6 (-60.0 to -39.7) -45.8) -74.9 (-77.2 to -72.5) -159.1) 11.7 (0.8 to 22.6)	28 Testicul 29 Hodgkin	ular cancer	Hodgkin lymphoma	28	3.9 (-20.8 to 17.0)	-14.0
Mesothelioma Cancer 1990 South Korea Stomach cancer View cancer Tracheal, bronchus, and lung cancer Jeukemia Join and rectum cancer	Testicular cancer Cancer 2017 South Korea Tracheal, bronchus, and lung cancer Liver cancer Stomach cancer Colon and rectum cancer Panercatic cancer	29 -52.0 (-63.5 to Change in a DALY rates 1 79.7 (65.0 to 9 2 -4.0 (-21.0 to 1 3 -50.6 (-55.2 to 4 135.2 (111.4 to 5 98.3 (81.0 to 1	-54.3) -75.8 (+80.8 to -63.1) +40.9) -59.0 (+68.6 to +49.8) all-age Change in age standa (% (UI) D4(V rates, % (UI) 6.9) -14.9 (+21.9 to -6.7) 9.7) -51.6 (+60.0 to -9.7) +4.5.8) -74.9 (-77.2 to -72.5) 1159.1) 11.7 (0.8 to 22.6) 115.7) -8.4 (+6.3 to 0.6)	28 Testicul 29 Hodgkin	ular cancer	Hodgkin lymphoma	28	3.9 (-20.8 to 17.0)	-14.0
Mesothelioma Cancer 1990 South Korez iomach cancer i/ver cancer Fracheal, bronchus, and lung cancer cuckenia John and rectum cancer Jalbladder and billary tract cancer	Testicular cancer Cancer 2017 South Korea Incicla. Ironchas. and lung cancer Liver cancer Somach cancer Colon and rectum cancer Pancratic cancer Brancratic cancer Brancratic cancer	29 -52.0 (-63.5 to Change in a DALY rates 1 79.7 (65.0 to 9 2 -4.0 (-21.0 to 1 3 -50.6 (-55.2 to 4 135.2 (11.4 to 5 98.3 (81.0 to 1 6 85.5 (63.5 to 1 6 85.6 (63.5 to 1)	-54.3) -75.8 (+80.80 - 63.1) -40.9) -59.0 (+68.6 to -49.8) -40.9) -59.0 (+68.6 to -49.8) -40.9 -10.4 (+68.6 to -49.8) -80.0 (11) -14.9 (+21.9 (+10.4 - 67.7) -70.7 -51.6 (+60.0 to -39.7) -71.9 (+77.2 to -72.5) -74.9 (+77.2 to -72.5) -71.9 (+70.8 to 22.6) -74.9 (+77.2 to -72.5) -75.1 (+0.8 to 22.6) -75.1 (+0.8 to 10.6) 70.5 -7.9 (+2.9 (+2.1 to 14.8)	28 Testicul 29 Hodgkin	ular cancer	Hodgkin lymphoma	28	3.9 (-20.8 to 17.0)	-14.0
Mesothelioma Cancer 1990 South Korea Stomach cancer Jiver cancer Tracheal, bronchus, and lung cancer eukemia Jolon and rectum cancer Jallbladder and biliary tract cancer Janteratic cancer	Testicular cancer Cancer 2017 South Korea Tractical, bronchus, and lung sancer Urer cancer Colon and rotum cancer Parcoatic cancer Breast cancer Giblishder and bility tract cancer	29 -52.0 (-63.5 to Change in a DALY rates 1 79.7 (65.0 to 9 2 -4.0 (-21.0 to 1 3 -50.6 (-55.2 to 4 135.2 (111.4 to 5 98.3 (81.0 to 1 6 85.6 (63.5 to 1 7 20.8 (-3.1 to 5	54.3) -75.8 (400.8 to 64.51) -40.9) -59.0 (+86.6 to 49.8) all-age Change in age-standa (%) DALY rates, % (10) (%) DALY rat	28 Testicul 29 Hodgkin	ular cancer	Hodgkin lymphoma	28	3.9 (-20.8 to 17.0)	-14.0
Kesothelioma Cancer 1990 South Korez Stomach cancer Jiver cancer Tracheal, bronchus, and lung cancer culcernia Johon and rectum cancer Janbadder and biliary tract cancer Janeratic cancer Tarsat cancer	Testicular cancer Cancer 2017 South Korea Tracheal, bronchus, and lung cancer Liver cancer Somach cancer Colon and rectum cancer Pancratic cancer Galibladder and bilary tract cancer Leakemia	29 -52.0 (-63.5 to Change in a DALY rates 1 79.7 (65.0 to 9) 2 -4.0 (-21.0 to 1) 3 -506 (-55.2 to 4 135.2 (111.4 to 5 98.3 (81.0 to 1) 6 85.6 (63.5 to 1) 7 20.8 (-3.1 to 5 8 -45.6 (-51.7 to	54.3) -75.8 (400.8 to 63.1) -40.9) -59.0 (-68.6 to 49.8) -40.91 -14.9 (Contage intage-standard) -14.91 -14.9 (Contage intage-standard) -14.91 -14.9 (Contage intage-standard) -9.91 -14.9 (Contage intage-standard) -14.91 -17.10 (No 10.2 contage) -14.91 -17.10 (No 10.2 contage) -17.51 -8.4 (-6.3 to 0.3) -17.52 -2.6 (-2.0 to 14.3) -19.91 -16.6 (-5.8 to -3.3) -3.871 -4.6 (-5.8 to 13.3)	28 Testicul 29 Hodgkin	ular cancer	Hotgkin hymphoma -Testicular cancer	28	3.9 (-20.8 to 17.0)	-14.0
Mesothelioma Cancer 1990 South Kores isomach cancer viver cancer evicernia colon and rectum cancer iallibiadder and biliary tract cancer interctuic cancer interctuic cancer biter malignan heoplasms	Testicular cancer Cancer 2017 South Korea Tractical, bronchus, and lung cancer Liver cancer Somach cancer Colon and restumencer Colon and restumence Colon and restum	29 -52.0 (-63.5 to Change in a DALY rates DALY rates 1 79.7 (65.0 to 9) 2 -4.0 (-21.0 to 1) 3 -50.6 (-55.2 to 1) 4 155.2 (11.4 kr 5 98.3 (81.0 to 1) 6 85.6 (63.5 to 1) 7 20.8 (-3.1 to 5) 8 -45.6 (-51.7 to 0) 9 -22.7 (-42.0 to 1)	54.3) -75.8 (400.8 to -63.1) -40.9) -59.0 (-68.6 to -49.8) -50.0 (-68.0 to -49.8) -59.0 (-68.6 to -49.8) -50.0 (-61.0 to -50.0 to -50.7) -51.6 (-63.0 to -60.0 to -50.7) -51.6 (-53.0 to -60.0 to -50.7) -29.6 (-28.1 to -13.6) -75.5 -84.1 (-63.6 to -60.0 to -30.7) -51.6 (-68.4 to -33.6) -54.1 (-63.6 to -47.9) -54.1 (-59.6 to -47.9) -54.1 (-59.6 to -47.9)	28 Testicul 29 Hodgkin	ular cancer	Hodgkin lymphoma	28	3.9 (-20.8 to 17.0)	-14.0
Mesiothelioma Cancer 1990 South Korea Jore cancer Jore cancer Liver cancer Liver cancer Linkader and billing tract cancer vanceratic cancer Vaneratic cancer Vaneratic cancer Vasta cancer Different cancer Sophageal cancer	Testicular caucer Cancer 2017 South Korea Testicular South Korea Testicular South Korea Testicular South Korea Testicular Content Content Content Content Content Particular Content C	29 -52.0 (-63.5 to Change in a DALY rates 1 79.7 (65.0 to 9 2 -4.0 (-21.0 to 1 3 -50.6 (-55.2 to 4 135.2 (111.4 to 5 98.3 (81.0 to 1 6 85.6 (63.5 to 1 7 20.8 (-3.1 to 5 8 -45.6 (-51.7 to 9 -22.7 (-42.0 to 10 54.7 (-36.7 to 7	54.3) -75.8 (408.81 - 63.1) -409 -59.0 (-66.81 - 49.8) all-age Change in age-standa (% (U)) DALY rates, % (U) (% (U)) DALY rates, % (U) (% (U)) -31.6 (-60.01 - 39.7) -44.83 -74.9 (-72.16 - 72.26) -15.9 11.7 (0.81 to 22.0) 07.5 2.9 (-22.16 + 14.5) 07.5 2.9 (-22.16 + 14.5) 19.9 -46.6 (-58.41 to 33.6) -35.7 -44.1 (-59.61 to 47.7) 14.2) -44.9 (-58.51 to 71.8) 2.30 0.6 (-12.46 to 10.5)	28 Testicul 29 Hodgkin	ular cancer	Hotgkin hymphoma -Testicular cancer	28	3.9 (-20.8 to 17.0)	-14.0
Mesiothelioma Cancer 1990 South Korea Jover cancer Jover cancer eachemia eachemia eachemia eachemia materialis cancer Merratic sumer Merratic sumer Merratical cancer Jovien and gana neoplasms Joriga cancer Devical ancer	Testicular cancer Cancer 2017 South Korea Tracical, bronchus, and lung cancer Liver cancer Somach cancer Colon and rectum cancer Parcentic cancer Calibration of bilary tract cancer Leakemia Born-Hodgkin brumbona Besphaged cancer	29 -52.0 (-63.5 to Change in a DALY rates DALY rates 1 79.7 (65.0 to 9 2 -4.0 (-21.0 to 10 3 -50.6 (-55.2 to 98.3 (81.0 to 1 7 20.8 (-31.0 to 98.3 (81.0 to 10) 7 20.8 (-31.0 to 99.2 co 2.27 (-42.0 to 10) 54.7 (36.7 to 7) -22.7 (-42.0 to 10)	54.3) -75.8 (50.8 to -63.1) -00 -550 (c6.8 to -69.8) all-age Change in age-standa \$50.01 DALY rates, \$50.01 \$70 51.6 (c4.00 to 33.7) -15.8 74.9 (c7.12 to 72.5) 15.91 11.7 (08 to 22.6) 17.5 24.6 (c3.8 to 0.6) 07.5 24.6 (c3.8 to 0.33.6) 16.7 24.6 (c3.8 to 0.33.6) 17.1 14.2 14.2 -44.9 (c3.8 to 10.5) 23.9 0.6 (c1.24.8 to 10.5) 23.9 0.6 (c4.8 to 5.9.6)	28 Testicul 29 Hodgkin	ular cancer	No change	28	3.9 (-20.8 to 17.0)	-14.0
Mesothelioma Cancer 1990 South Kores Normen cancer Inscheal, bronchus, and lang cancer racheal, bronchus, and lang cancer Salthäuder and biliary tract cancer Amercatic cancer Amercatic cancer Amercatic cancer Sophagael cancer Saria and nervous system cancer	Testicular cancer Cancer 2017 South Korea Finetical busines, and lung anner Somek-anner Colon and rectum cancer Pareast cancer Colon and rectum cancer Calculation Pareast cancer Calculation Calculat	29 -52.0 (-63.5 to Change in a DALY rates 1 79.7 (65.0 to 9 2 -4.0 (-21.0 to 1) 3 -50.6 (-55.2 to 4 135.2 (111.4 to 5 98.3 (81.0 to 1) 6 85.6 (63.5 to 1) 7 20.8 (-31.to 5) 8 -45.6 (-51.7 to 9 -22.7 (-42.0 to 10 54.7 (-45.7 to 10 54.7 (-45.7 to 11 -23.6 (-35.5 to 12 -15.2 (-45.9 to 12 -15.2 (-45.9 to	543) 75% (400% to -6%) 943) 590 (46% to -49%) 940) 590 (46% to -49%) 941) 940 (47% to -49%) 941) 940 (47% to -49%) 941) 940 (47% to -49%) 941) 941 (42% to -49%) 971) 51.6 (450 to -39%) 973) 51.6 (450 to -39%) 974) 51.6 (450 to -39%) 975) 54.6 (458 to -59%) 976) 54.6 (456 to -17%) 976) 54.6 (456 to -17%) 977) 54.6 (456 to -17%) 978) 54.1 (456 to -17%) 974) 54.1 (456 to -17%) 974) 54.1 (454 to -15%) 974) 54.1 (454 to -15%) 974) 64.2 (458 to -5%0) 974) 64.2 (458 to -5%0) 974) 64.2 (458 to -5%0) 974) 38.2 (45.7 tr -11.5)	28 Testicul 29 Hodgkin	ular cancer	No change	28	3.9 (-20.8 to 17.0)	-14.0
Cancer 1990 South Korea Storach cancer Jwer cancer aukeria torichica and lang cancer eukeria calkenia aukeriatic cancer Amercatic cancer Amercatic cancer Amercatic cancer Amercatic cancer Amercatic cancer Carvical cancer Carvical cancer Strain and nervous system cancer son-Hodgkin tymphoma	Cancer 2017 South Korea Cancer 2017 South Korea Trackalar bandhas and illugancer Liver cancer Colon and restme cancer Parcentic cancer Callbladder and bilary tract cancer Colon and cancer Songhaged cancer Songhaged cancer Particulate cancer Particulate cancer	29 - 52.0 (-63.5 to Change in : 1 79.7 (650 to 9) 2 - 40 (-210 to 1 3 - 506 (-552 to 9 43 (510 to 1 6 85.6 (63.5 to 1 7 20.8 (-3.1 to 5 8 - 45.6 (-51.7 to 9 - 22.7 (-42.0 to 10 54.7 (36.7 to 7) 11 - 23.6 (-33.5 to 13 22.5 (-55.7 to 13 23.5 (-55.7 to 14 - 23.5 (-55.7 to 15 23.7 to 15 23.7 to 16 - 55.7 to 17 23.7 to 18 - 55.7 to 18 - 55.7 to 19 - 55.7 to 10 - 55.7 to 1	5-43) -75.8 (+0.00 km - 0.54) -95.9 (+0.66 km - 0.45) -95.9 (+0.66 km - 0.45) iil-age Change in age stands -50.01 -14.9 (-0.10 km - 0.15) -50.01 -14.9 (-0.10 km - 0.15) -14.9 (-0.10 km - 0.15) -14.9 (-0.10 km - 0.15) -15.9 (-0.10 km - 0.15) -14.9 (-0.12 km - 2.5) -15.9 (-0.11 km - 0.15) -14.7 (-0.12 km - 2.5) -15.9 (-0.11 km - 0.15) -14.0 (-0.15 km - 1.7) -14.1 (-0.15 km - 1.7) -14.0 (-0.15 km - 1.7) -14.1 (-0.15 km - 1.7) -14.0 (-0.15 km - 1.7) -15.9 (-0.11 km - 0.15) -14.0 (-0.15 km - 1.7) -15.9 (-0.11 km - 0.15) -14.0 (-0.15 km - 1.7) -15.9 (-0.11 km - 0.15) -14.0 (-0.15 km - 1.7) -15.9 (-0.11 km - 0.15) -14.0 (-0.15 km - 1.7) -15.9 (-0.11 km - 0.15) -14.0 (-0.15 km - 1.7) -15.9 (-0.11 km - 0.15) -14.0 (-0.15 km - 1.7) -15.9 (-0.11 km - 0.15) -14.0 (-0.15 km - 1.7) -15.9 (-0.11 km - 0.15) -14.0 (-0.15 km - 1.7) -15.9 (-0.11 km - 0.15) -14.0 (-0.15 km - 1.7) -15.9 (-0.11 km - 0.15) -14.0 (-0.15 km - 1.7)	28 Testicul 29 Hodgkin	ular cancer	Hotgkin hymphoma -Testicular cancer	28	3.9 (-20.8 to 17.0)	-14.0
Mesothelioma Cancer 1990 South Korea Somach caucer Intende, brookhan, and lung cancer cachemia Intende, and biling tract cancer Mineradie cancer Mineradie cancer Mineradie cancer Soma and erevino system cancer soma long cancer Soma cancer S	Testicular cancer Cancer 2017 South Korea Tracical, bronchus, and Jung cancer Someth cancer Colon and rectum cancer Parceatic cancer Galibadder and bilary tract cancer Leakenia Ober Indigitant neoplasm Doer Indigitant neoplasm Brain and nevrous system cancer Prostate cancer Kindy cancer Kindy cancer Kindy cancer Kindy cancer	29 -52.0 (-63.5 te) Change in : 79.7 (65.0 te) 2 -4.0 (-21.0 te) 3 -50.6 (-55.2 te) 4 -132.2 (111.4 te) 9 -83.2 (81.0 te) 6 -85.6 (-51.7 te) 9 -22.7 (-42.0 te) 10 -54.7 (-36.7 te) 11 -23.6 (-33.5 te) 12 -152.2 (-45.9 te) 13 -225.3 (95.5 te) 14 -233.2 (-43.1 te) 14 -232.2 (-43.1 te) 15 -232.2 (-43.1 te) 16 -232.2 (-43.1 te) 17 -232.2 (-43.1 te) 18 -232.2	s-stal -73.8 (-80.8 to -stal) -95.0 (-65.6 to -45.8) -95.0 (-65.6 to -45.8) -97.0 (-15.6 to -15.8) -13.0 (-65.6 to -15.8) -15.1 (-15.0 to -15.8) -3.4 (-65.8 to -15.8) -35.1 (-15.8 to -15.8) -3.4 (-65.8 to -15.8) -35.1 (-15.6 to -15.8) -3.4 (-65.8 to -15.8) -35.1 (-15.6 to -15.8) -3.4 (-65.8 to -15.8) -35.1 (-15.6 to -15.8) -3.4 (-65.8 to -15.8) -35.1 (-15.8 to -15.8) -3.4 (-65.8 to -15.8) -35.1 (-15.8 to -15.8) -3.4 (-65.8 to -15.8) -35.1 (-15.8 to -15.8) -3.4 (-15.8 to -15.8) -35.2 (-15.8 to -15.8) -3.4 (-15.8 to -15.8) -35.2 (-15.8 to -15.8) -3.4 (-15.8 to -15.8) -35.2 (-15.8 to -15.8) -3.4 (-15.8 to -15.8) </td <td>28 Testicul 29 Hodgkin</td> <td>ular cancer</td> <td>No change</td> <td>28</td> <td>3.9 (-20.8 to 17.0)</td> <td>-14.0</td>	28 Testicul 29 Hodgkin	ular cancer	No change	28	3.9 (-20.8 to 17.0)	-14.0
Aesothelioma Cancer 1990 South Kores Simuch cancer Jover ancor Instead, Joneonku, and Jung cancer Colona and rectame cancer Jahladade rata biling strate cancer Sophageal cancer	Cancer 2017 South Korea Cancer 2017 South Korea Trackelar browhow, and lung cancer Liver cancer Colon and rectum cancer Prest cancer Colon and rectum cancer Heast cancer Lokemin Other malignan neoplasms Non-Hodgkin hyphoma Sophagaal ancer Brain an ervous system cancer Kking-vancer Kking-vancer	29 - 52.0 (43.5 to Change in: 2 179.7 (55.0 m) 2 - 40.4 (-21.0 m) 3 - 50.6 (-55.2 m) 4 - 15.5 (-11.4 m) 5 - 83.6 (33.5 m) 3 - 45.6 (-31.7 m) 3 - 45.6 (-31.7 m) 3 - 45.6 (-31.7 m) 3 - 45.6 (-31.7 m) 3 - 22.7 (-42.0 m) 1 - 23.6 (-33.5 m) 1 - 23.5 (-35.5	543) -753.6 (400 km e-63.1) 9430 -550.6 (456 km -459.8) all-age Change in age stands % (104) DAW rates, % (101) 9430 -164.6 (156 km -169.1) 9430 -164.6 (156 km -169.1) 14130 -147.0 (126 km -169.1) 1413 -466.6 (458 km -137.6) 1414 -44.9 (-54.5 km -17.8) 1413 -466.6 (454 km -34.6) 1414 -44.9 (-54.5 km -17.8) 1200 -34.8 (-44.7 km -11.5) 2100 -34.8 (-45.7 km -11.5) 2100 -34.8 (-45.7 km -11.5) 2101 -34.8 (-45.7 km -11.5) 2102 -34.8 (-45.7 km -11.5) 2103 -34.8 (-45.7 km -11.5) 2104 -34.8 (-45.7 km -1.5) 2104 -34.8 (-45.7 km -1.5) 2114 -34.8 (-45.7 km -1.5) 2124 -30.1 (126 km -100.8) 2134 -30.1 (126 km -100.8)	28 Testicul 29 Hodgkin	ular cancer	No change Rank increased	28	3.9 (-20.8 to 17.0)	-14.0
Mesothelioma Cancer 1990 South Korea Sore racer aver raiser Javer raiser Javer raiser Jambader and biling yrac cancer raiseratic cancer Jambader and biling yrac cancer Jambader and biling yrac cancer Jambader and yrac races raiser and yrac south and yr Arrise cancer Jambader and yr Jambader and yr Jambader and yr	Testicular cancer Cancer 2017 South Korea Tractical, broadbas, and lung cancer Liver cancer Colon and rotum cancer Parceatic cancer Golon and rotum cancer Parceatic cancer Golon and rotum cancer Lackemia Object malignant neoplasm Non-Hodgkin hymphoma Besphaged cancer Brain and ances system cancer Brain and ancers Covida cancer Covida cancer Covida cancer	29 - 52.0 (43.5 to Change in 2 77.7650.00 2 - 4.0 (22.10 to - 4.0 to - 4.0 (22.10 to - 4.0	$\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$	28 Testicul 29 Hodgkin	ular cancer	No change	28	3.9 (-20.8 to 17.0)	-14.0
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Figure 4 Rank changes in disability-adjusted life years (DALYs) attributable to cancers and percentage change in all age and agestandardized DALY rates in China (A), Japan (B), and South Korea (C) from 1990 to 2017. The estimates used to generate this figure were from the Institute for Health Metrics and Evaluation (IHME) website (7). Age-standardized rates were calculated using the GBD reference population (18).

South Korea (*Figure 4*). But *Table 3* indicates that the ASIR of lung cancer decreased constantly among males in South Korea. *Table 4* shows the age-standardized 5-year cancer survival rates in China, Japan, and South Korea from 2000 to 2014. Survival trends were generally increasing in common types of cancers in the three countries, except for the pancreas cancer survival rate in China.

China, Japan, and South Korea experienced significant downward trends in ASIR and DALYs for liver cancer. As for stomach cancer, declining incidence was also observed in China and Japan, and the incidence decreased but not statistically significant in South Korea (*Table 3*). For Japan and South Korea, stomach cancer declined from being the leading cause of all-age DALYs in 1990 to the third in 2017 (*Figure 4B,C*). The trend analysis indicated that the incidence of esophageal cancer decreased in China and South Korea but increased in Japan. The burden of colorectal cancer in China, Japan, and South Korea has increased over the past several decades. In regard with prostate and thyroid cancers, a constantly growing burden was observed in China, Japan, and South Korea. Besides, there was an alarming trend to increase in breast cancer incidence rates in the three countries.

Discussion

In this study, we performed a comprehensive epidemiological analysis of cancer burden and trends in China and compared the differences between China, Japan and South Korea using high-quality data. We found that China was faced with a rising burden of colorectal, prostate, and breast cancers as well as a heavy burden of lung and upper digestive tract cancers. Compared with Japan and South Korea, China has higher ASMR and DALY rates.

China had a higher ASMR and a relatively lower ASIR for all cancers than Japan and South Korea. Several reasons could explain the seemingly paradoxical situation. Firstly, the significant difference in the composition of incident cancers could result in the higher mortality rate in China. The most common incident cancer was lung cancer in China rather than colorectal cancer, which ranked first for ASIR in Japan and South Korea. The ASIR of lung cancer with a poor prognosis, was higher in China (35.1 per 100,000) than that in Japan (27.5 per 100,000) and South

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Korea (27.8 per 100,000). In addition, prostate cancer with a low fatality rate ranked fourth in Japanese males and South Korean males, while it fell outside the first five common cancers for ASIR in Chinese males. Secondly, China had lower survival rates of thyroid, breast, colorectal, prostate and stomach cancers. One possible explanation is that higher screening uptake rates in Japan and South Korea may drive the inflation of cancer incidence rates and promote the early detection (4,20). For example, endoscopic screening performed in Japan and South Korea (20,21) may bring about the higher survival rates of stomach cancer. Poor access to cancer care in China also could result in the disparities (4).

Concerning the time trends, similar to previous studies (22,23), we found that China, Japan, and South Korea experienced significant downward trends in the burden of liver and stomach cancers. This trend has been explained by a series of lifestyle changes and public health interventions. For example, the spread of hepatitis B virus vaccination (5,24) and reduced aflatoxin exposure (25) are thought to have contributed to the reduction of liver cancer in China. In Japan, it might be associated with the reduced hepatitis C virus infection (26,27). But the increasing prevalence of obesity and diabetes presents a threat to the favorable trend (28). For stomach cancer, the decreasing prevalence of Helicobacter pylori infection, improved living conditions, and better food preservation practices lead to the declining rates (29). Similar to our analysis, an updated analysis from the National Cancer Center of Japan reported an increase of age-standardized esophageal cancer incidence. But the declining mortality was observed (11). Reasons for this divergent trend have yet to be identified. Endoscopic screening conducted in Japan may have an influence.

Another notable sign for optimism is that lung cancer incidence for males in South Korea has been decreasing constantly in recent years, which reflects a corresponding decline in the smoking prevalence in South Korea. Smoking prevalence among South Korean males dropped from 71.7% in 1992 to 39.7% in 2016 (30). Tobacco control can prevent lung cancer effectively. Nevertheless, though some progress in tobacco control has been made (31,32), China still faces high smoking rates. The National Health Service Survey conducted in 2013 found that more than 45% of Chinese males are current smokers (33). Also, faltering tobacco control policies is criticized in Japan (34). South Korea serves as an example of tobacco control to China and Japan (35). Stronger tobacco control is urgently needed such as increasing tobacco excise taxes and introducing a national smoke-free law.

In our analysis, colorectal, prostate and breast cancers tended to be more common in China, Japan, and South Korea. But according to the latest data from national cancer registries, colorectal cancer incidence and mortality have shown signs of declining in Japan and South Korea (11,12,36). The long-standing national screening programs may have an impact (37-39). Another notable aspect is that Japan and South Korea set up institutions responsible for providing comprehensive cancer information to enhance public awareness (40,41). The rapid rise of prostate cancer incidence could be explained by the widespread prostatespecific antigen testing. Besides, prostate cancer incidence and mortality in Japan and South Korea has seemingly plateaued in recent years (11,36). The rapidly increasing incidence of thyroid cancer in South Korea (42) sounded the alarm that screening also has the potential to promote overdiagnosis. Limited knowledge could explain the rapid increase in female breast cancer. This trend may reflect a collaboration of changed environmental factors, including the delay of childbearing, increases in the levels of obesity, and the spread of breast cancer screening (3).

Our work has several limitations. First, the comparison of estimates in different countries might be compromised because of variations in data collection and reporting systems across countries. Second, our trend analysis was only based on several registries due to insufficient data availability. The observed trends may not represent national profiles. Moreover, trends in the recent ten years could not be evaluated owing to unavailable up-to-date data. It is required to update the analysis based on more contemporary data and use more compressive analysis such as age-period-cohort analysis.

Conclusions

At the transition cancer stage, China still had a heavy burden of lung and upper digestive tract cancers and faced a rising burden of colorectal, prostate, and breast cancers. China, Japan, and South Korea shared similar cancer profiles and time trends. Although the strategies established in Japan and South Korea should be adapted to the specific contexts of China, we could draw some useful lessons. Compared with Japan and South Korea, China had higher age-standardized cancer mortality and DALY rates but lower incidence. Relatively lower mortality and favorable trends of colorectal and lung cancers appeared in Japan or South Korea indicated the effectiveness of screening and tobacco control. Improvement in the current tobacco control policy and cancer screening systems may contribute to cancer control in China. Also, given huge geographic disparities in cancer burden across China, evidence-based approaches are needed for cancer control programs, and tailored to local profile and population risk.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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	voloci	10000	AII						Rank				
	Yanii		cancers	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Japan	Incidence	Both	248.0	Breast	Colorectum	Prostate	Lung	Stomach	Corpus uteri Cervix uteri	Cervix uteri	Pancreas	Ovary	Bladder
				57.6	38.9	35.4	27.5	27.5	15.1	14.7	9.7	9.5	8.7
		Male	285.9	Colorectum	Lung	Stomach	Prostate	Bladder	Liver	Pancreas	Kidney	Esophagus	NHL
				49.1	41.4	40.7	35.4	15.1	12.3	11.7	11.2	9.3	8.7
		Female	220.5	Breast	Colorectum	Stomach	Lung	Corpus uteri	Cervix uteri	Thyroid	Ovary	Pancreas	NHL
				57.6	29.6	16.0	15.6	15.1	14.7	11.2	9.5	7.7	6.1
	Mortality	Both	85.2	Lung	Colorectum	Stomach	Breast	Pancreas	Liver	Prostate	Gallbladder	Ovary	Esophagus
				16.2	12.0	9.5	9.3	7.8	5.4	4.4	3.3	3.3	2.8
		Male	111.9	Lung	Colorectum	Stomach	Pancreas	Liver	Esophagus	Prostate	Gallbladder	NHL	Leukemia
				26.5	15.2	14.3	9.5	8.6	5.1	4.4	4.2	3.5	3.1
		Female	64.3	Breast	Colorectum	Lung	Pancreas	Stomach	Ovary	Liver	Cervix uteri	Gallbladder	NHL
				9.3	9.2	7.8	6.2	5.6	3.3	2.7	2.7	2.5	1.9
South Korea	Incidence Both	Both	313.5	Thyroid	Breast	Colorectum	Stomach	Prostate	Lung	Liver	Cervix uteri	NHL	Kidney
				60.7	59.8	44.5	39.6	36.2	27.8	17.3	8.4	8.0	7.9
		Male	332.1	Colorectum	Stomach	Lung	Prostate	Liver	Thyroid	Kidney	NHL	Pancreas	Gallbladder
				59.5	57.8	41.7	36.2	27.7	21.8	11.5	0.0	8.7	8.4
		Female	310.6	Thyroid	Breast	Colorectum	Stomach	Lung	Cervix uteri	Liver	Corpus uteri	NHL	Ovary
				100.5	59.8	31.3	23.5	17.2	8.4	8.2	7.8	7.1	6.5
	Mortality	Both	80.7	Lung	Liver	Colorectum	Stomach	Pancreas	Breast	Prostate	Gallbladder	Ovary	Leukemia
				18.1	11.8	8.7	7.0	6.1	6.0	4.7	4.1	2.4	2.3
		Male	115.2	Lung	Liver	Colorectum	Stomach	Pancreas	Gallbladder	Prostate	Esophagus	Leukemia	NHL
				31.4	19.5	11.8	10.0	7.6	5.0	4.7	3.3	3.0	2.8
		Female	55.0	Lung	Colorectum	Breast	Liver	Pancreas	Stomach	Gallbladder	Ovary	Cervix uteri	Leukemia
				8.2	6.3	6.0	5.2	4.9	4.8	3.4	2.4	2.0	1.7

		07000	AII					Ra	Rank				
Country	llidex	Gerider	cancers -	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Japan A	All age rates	Both	5,123.6	Lung	Colorectum	Stomach	Pancreas	Liver	Breast	Gallbladder	Gallbladder Esophagus	Other	Prostate
				933.5	709.5	656.0	411.9	386.8	275.6	222.4	177.2	167.3	165.3
		Male	6,404.7	Lung	Stomach	Colorectum	Liver	Pancreas	Prostate	Esophagus	Esophagus Gallbladder	Other	NHL
				1,400.2	936.8	859.3	562.2	472.1	339.2	312.4	252.8	197.0	191.0
		Femal	∋ 3,906.3 i	Female 3,906.3 Colorectum	Breast	Lung	Stomach	Pancreas	Liver	Gallbladder	Ovarian	Other	Cervix
				567.2	534.0	490.1	389.1	354.7	220.2	193.6	171.3	139.2	137.6
~ -	Age-standardized Both rates	ed Both	2,285.5	Lung	Colorectum	Stomach	Pancreas	Liver	Breast	Other	Leukemia (Gallbladder Esophagus	Esophagu
				372.7	303.9	275.3	172.2	158.6	155.4	106.7	93.0	82.5	77.8
		Male	2,907.5	Lung	Stomach	Colorectum	Liver	Pancreas	Pancreas Esophagus	Other	Prostate	Leukemia	Gallbladder
				590.2	409.1	391.8	250.4	213.5	141.1	125.9	125.5	112.1	104.4
		Female	Female 1,768.6	Breast	Colorectum	Lung	Stomach	Pancreas	Ovarian	Other	Cervix	Liver	Leukemia
				303.8	225.9	186.5	160.6	133.9	98.5	89.6	85.1	75.3	75.1
South / Korea	All age rates	Both	3,727.0	Lung	Liver	Stomach	Colorectum Pancreas	l Pancreas	Breast	Gallbladder	Leukemia	Other	NHL
				689.1	605.7	473.6	388.8	227.5	201.7	165.9	116.3	106.0	90.8
		Male	4,728.6	Lung	Liver	Stomach	Colorectum Pancreas Gallbladder	I Pancreas (Gallbladder	Prostate	Leukemia E	Esophagus	Other
				1,002.3	954.8	659.8	480.0	264.0	188.8	166.9	136.3	136.1	119.7
		Femal	Female 2,710.2	Breast	Lung	Colorectum	Stomach	Liver	Pancreas	Gallbladder	Ovarian	Cervix	Leukemia
				404.0	371.2	296.2	284.7	251.3	190.5	142.6	112.2	109.2	95.9
~ -	Age-standardized _{Both} rates	ed Both	2,386.1	Lung	Liver	Stomach	Colorectum Pancreas	l Pancreas	Breast	Gallbladder	Leukemia	Other	Brain, CNS
				421.7	371.5	297.4	242.1	139.2	128.4	102.1	101.2	83.6	65.4
		Male	3,269.5	Lung	Liver	Stomach	Colorectum Pancreas Gallbladder	Pancreas (Gallbladder	Prostate	Leukemia	Other	Esophagus
				688.5	614.9	444.8	329.0	174.9	130.9	128.3	121.4	97.6	89.5
		Femal	Female 1,669.7	Breast	Lung	Stomach	Colorectum	n Liver	Pancreas	Leukemia	Gallbladder	Other	Cervix
				250.1	210.6	175.1	170.8	145.2	107.3	81.9	78.8	71.2	6.69
				451.8	253.0	251.6	235.5	168.9	146.6	132.3	117.9	107.6	102.3