Original Article

Colorectal cancer burden and trends: Comparison between China and major burden countries in the world

Jiachen Zhou[1,2], Rongshou Zheng[2], Siwei Zhang[2], Hongmei Zeng[2], Shaoming Wang[2], Ru Chen[2], Kexin Sun[2], Minjuan Li[2], Jianhua Gu[2], Guihua Zhuang[1], Wenqiang Wei[2]

[1]Department of Epidemiology and Biostatistics, School of Public Health, Xi'an Jiaotong University Health Science Center, Xi'an 710061, China; [2]National Central Cancer Registry, National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing 100021, China

Correspondence to: Wenqiang Wei, MD, PhD. National Central Cancer Registry, National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing 100021, China. Email: weiwq@cicams.ac.cn; Rongshou Zheng. National Central Cancer Registry, National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing 100021, China. Email: zhengrongshou@163.com.

Abstract

Objective: To summarize the colorectal cancer (CRC) burden and trend in the world, and compare the difference of CRC burden between other countries and China.

Methods: Incidence and mortality data were extracted from the GLOBOCAN2018 and Cancer Incidence in Five Continents. Age-specific incidence trend was conducted by Joinpoint analysis and average annual percent changes were calculated.

Results: About 1.85 million new cases and 0.88 million deaths were expected in 2018 worldwide, including 0.52 million (28.20%) new cases and 0.25 million (28.11%) deaths in China. Hungary had the highest age-standardized incidence and mortality rates in the world, while for China, the incidence and mortality rates were only half of that. CRC incidence and mortality were highly correlated with human development index (HDI). Unlike the rapid increase in Republic of Korea and the downward trend in Canada and Australia, the age-standardized incidence rates by world standard population in China and Norway were rising gradually. The age-specific incidence rate in the age group of 50–59 years in China was increasing rapidly, while in Republic of Korea and Canada, the fastest growing age group was 30–39 years.

Conclusions: The variations of CRC burden reflect the difference of risk factors, as well as levels of HDI and screening (early detection activities). The burden of CRC in China is high, and the incidence of CRC continues to increase, which may lead to a sustained increase in the burden of CRC in China in the future. Screening should be expanded to control CRC, and focused on young people in China.

Keywords: Colorectal cancer; burden; China; trend

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Introduction

Colorectal cancer (CRC) is the mainly prevalent malignant cancer in the world which is a collective term for colon cancer, rectal and anal cancer. Adenocarcinoma formed by glandular epithelial cells is the mainly pathological type of CRC (1,2). Although it is believed that CRC is mainly prevalent in developed countries, the incidence is also rising rapidly in countries undergoing economic development and changing lifestyles. The United States and other affluent countries are gradually reducing incidence and mortality through screening and improved

treatment (3,4). However, the prevention and control measures in developing countries are still limited (5).

The etiology and trend changes of CRC are all related to economic and social factors, and many countries like China have experienced tremendous economic changes in just a few decades. Therefore, we try to figure out the differences between different economies by analyzing burden and trends of major countries worldwide. Comparing the current situation of China's CRC burden in the world, we can clarify the possible problems in the next stage. This research provides scientific data support for the formulation of cancer prevention and control policies through the analysis of the International Agency for Research on Cancer (IARC) public database.

Materials and methods

Data sources

World CRC incidence and mortality data were extracted from GLOBOCAN2018 (6). The GLOBOCAN2018 systematically estimated the incidence and mortality in 185 countries or territories for 36 cancer major types in 2018. According to International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10), colon cancer, rectal and anal cancer coded as C18 and C19-21 were extracted for analysis. We used the same regional classification criteria as GLOBOCAN2018 dividing the world into 20 major regions. The human development index (HDI) was derived from the Human Development Report 2019 (7) released by the United Nations Development Programme. For trend analysis, data were extracted from Cancer Incidence in Five Continents (CI5) (8). According to the rank of age-standardized incidence rate by world standard population (ASIRW) in GLOBOCAN2018, countries with the highest incidence in each continent and China were selected for comparative analysis.

Statistical analysis

The ASIRW was used for trend analysis, grouped by sex and subsite in Canada, Republic of Korea, Uganda, Norway, Australia and China, because data from other countries are not available. The Joinpoint Regression Program (Version 4.3.1.0, National Cancer Institute) (8) was used to analyze the trend change of age-specific incidence in China, Republic of Korea and Canada, grouped by sex. Temporal trend was divided into three periods at most and trends were expressed as average annual percentage change (AAPC) (9-11). The Z test was used to analyze statistical differences.

Results

CRC incidence and mortality in 2018

Approximately there were 1.85 million new cases worldwide in 2018. The crude incidence rate was 24.2 per 100,000 and the ASIRW was 19.7 per 100,000. We selected countries with the highest ASIRW in each region for regional burden comparisons. Of the 20 regions in the world, countries in Europe generally had a high incidence rate. The ASIRW in four European countries had exceeded 35 per 100,000, and the crude incidence rate in Hungary had even exceeded 100 per 100,000. However, the incidence rate of CRC was generally low in African countries and varied greatly in Asia, America and Oceania. China had the largest cases, accounting for 28.20% of the world. The ASIRW and crude incidence of China were both in a medium to high level. The trend was basically the same in both sexes (*Table 1*).

There were 0.88 million deaths worldwide in 2018. The crude mortality rate was 11.5 per 100,000 and the age-standardized mortality rate by world standard population (ASMRW) was 8.9 per 100,000. Hungary's crude mortality rate was 52.4 per 100,000, which was the highest in the world. The mortality rate of CRC was low in Africa and Oceania and varies greatly in Asia and America. China had the largest deaths in the world, accounting for 28.11%. The ASMRW and crude mortality rate of China were higher than the world level in both sexes (*Table 2*).

ASIRW of Hungary and Norway ranked first in males and females, respectively. Regardless of sex, European countries tended to rank higher while African countries ranked lower. China's rate was just above the world level in both sexes. Hungary had a higher ASMRW among males, and there was little difference in ASMRW among females between countries. Republic of Korea had a high ASIRW but low ASMRW for both males and females (*Figure 1*).

With the increase of the HDI, its incidence and mortality had increased rapidly. It was found that HDI had an exponential relationship with crude incidence and mortality rates. The correlation between incidence rate and HDI was stronger than correlation between mortality rate and HDI (*Figure 2*).

Table 1 Estimated incidence of CRC in the world's major burden countries and China in 2018

Area	Population	Both			Male			Female		
		New cases	Crude rate ($1/10^5$)	ASIRW ($1/10^5$)	New cases	Crude rate ($1/10^5$)	ASIRW ($1/10^5$)	New cases	Crude rate ($1/10^5$)	ASIRW ($1/10^5$)
	World	1,849,518	24.2	19.7	1,026,215	26.6	23.6	823,303	21.8	16.3
	China	521,490	36.6	23.7	303,853	41.5	28.1	217,637	31.5	19.4
Asia										
Eastern	Republic of Korea	42,363	82.8	44.5	26,143	102.1	59.5	16,220	63.4	31.3
South Eastern	Singapore	4,202	72.5	36.8	1,994	69.7	38.9	2,208	75.4	34.0
South Central	Kazakhstan	3,049	16.6	15.4	1,392	15.6	17.7	1,657	17.5	14.1
Western	Turkey	20,031	24.5	21.0	11,548	28.6	27.4	8,483	20.4	16.0
Europe										
Western	Netherlands	14,921	87.3	37.8	8,513	100.1	45.3	6,408	74.7	31.1
Northern	Norway	4,887	91.3	42.9	2,530	93.6	46.9	2,357	88.9	39.3
Eastern	Hungary	10,809	111.6	51.2	6,115	132.6	70.6	4,694	92.4	36.8
Southern	Slovenia	1,987	95.5	41.1	1,301	125.8	58.9	686	65.5	25.5
Americas										
Northern	Canada	24,617	66.6	31.5	13,039	71.1	35.2	11,578	62.2	28.0
Central	Costa Rica	1,128	22.8	16.7	560	22.6	17.6	568	22.9	15.9
Caribbean	Barbados	219	76.5	38.9	118	86.1	50.3	101	67.6	28.8
South	Uruguay	2,273	65.5	35.0	1,152	68.7	43.8	1,121	62.5	28.3
Africa										
Northern	Algeria	5,537	13.2	13.9	2,910	13.7	14.8	2,627	12.6	13.0
Eastern	Mauritius	288	22.7	14.7	156	24.9	17.4	132	20.6	12.6
Southern	South Africa	6,937	12.1	14.4	3,508	12.5	18.1	3,429	11.7	12.0
Middle	Congo[a]	3,568	4.2	9.1	1,627	3.9	9.0	1,941	4.6	9.2
Western	Mali	917	4.8	10.5	385	4.0	9.0	532	5.6	11.7
Oceania										
Melanesia	Papua New Guinea	684	8.1	13.0	439	10.3	19.3	245	5.9	8.4
Polynesia[b]	Samoa	37	18.7	22.6	24	23.5	30.6	13	13.6	14.8
Australia[c]	Australia	17,782	71.8	36.9	9,643	78.1	41.9	8,139	65.5	32.4

CRC, colorectal cancer; ASIRW, age-standardized incidence rate by world standard population; [a], Democratic Republic of Congo; [b], Polynesia and Micronesia; [c], Australia and New Zealand.

Temporal trends in CRC incidence

Countries met the data quality and selection requirements were Canada (except Nunavut, Quebec and Yukon), Republic of Korea (5 registries), Uganda (Kampala), Norway and Australia. Their trend data from 2003 to 2012 were extracted for comparison with China (5 registries).

The trend in CRC for males showed that ASIRW in Republic of Korea had rapidly increased to the first, while Australia had gradually decreased from first to third. Canada had a slowly downward trend, while China and Norway had gradually upward trend. Although ASIRW of China had been rising, it was still the fifth in 2012. In males, the ASIRW of rectal cancer was lower than that of colon cancer, but the trend was basically the same. The trend change had become more obvious after combination of colon cancer and rectal cancer (*Figure 3*).

The trend in CRC for females showed that ASIRW in Norway was higher than that in other countries consistently. In Republic of Korea and Australia, the trend

Table 2 Estimated mortality of CRC in the world's major burden countries and China in 2018

Area	Population	Both			Male			Female		
		Deaths	Crude rate ($1/10^5$)	ASMRW ($1/10^5$)	Deaths	Crude rate ($1/10^5$)	ASMRW ($1/10^5$)	Deaths	Crude rate ($1/10^5$)	ASMRW ($1/10^5$)
	World	880,792	11.5	8.9	484,224	12.6	10.8	396,568	10.5	7.2
	China	247,563	17.4	10.9	142,476	19.4	13.1	105,087	15.2	8.8
Asia										
Eastern	Republic of Korea	9,762	19.1	8.7	5,445	21.3	11.8	4,317	16.9	6.3
South Eastern	Singapore	1,980	34.2	17.3	1,050	36.7	20.2	930	31.7	14.6
South Central	Kazakhstan	2,108	11.5	10.5	1,023	11.5	13.3	1,085	11.4	8.9
Western	Turkey	10,033	12.2	10.2	5,571	13.8	13.1	4,462	10.7	7.9
Europe										
Western	Netherlands	6,442	37.7	13.8	3,443	40.5	16.5	2,999	35.0	11.5
Northern	Norway	1,750	32.7	13.2	915	33.8	15.3	835	31.5	11.3
Eastern	Hungary	5,076	52.4	21.5	2,867	62.2	31.2	2,209	43.5	14.8
Southern	Slovenia	740	35.6	12.5	423	40.9	17.1	317	30.3	8.9
Americas										
Northern	Canada	9,494	25.7	10.1	5,086	27.7	12.2	4,408	23.7	8.2
Central	Costa Rica	617	12.5	8.6	316	12.8	9.5	301	12.2	7.7
Caribbean	Barbados	101	35.3	16.6	53	38.7	21.4	48	32.1	12.4
South	Uruguay	1,093	31.5	15.0	555	33.1	19.3	538	30.0	12.1
Africa										
Northern	Algeria	3,027	7.2	7.5	1,684	7.9	8.5	1,343	6.5	6.6
Eastern	Mauritius	173	13.6	8.6	92	14.7	10.3	81	12.6	7.1
Southern	South Africa	3,664	6.4	7.6	1,898	6.7	10.2	1,766	6.0	6.1
Middle	Congo[a]	2,831	3.4	7.4	1,314	3.1	7.5	1,517	3.6	7.3
Western	Mali	686	3.6	8.3	290	3.0	7.3	396	4.2	9.1
Oceania										
Melanesia	Papua New Guinea	447	5.3	8.7	307	7.2	14	140	3.4	4.8
Polynesia[b]	Samoa	13	6.6	7.8	8	7.8	10.9	5	5.2	6.3
Australia[c]	Australia	6,131	24.7	10.9	3,237	26.2	12.8	2,894	23.3	9.2

CRC, colorectal cancer; ASMRW, age-standardized mortality rate by world standard population; [a], Democratic Republic of Congo; [b], Polynesia and Micronesia; [c], Australia and New Zealand;

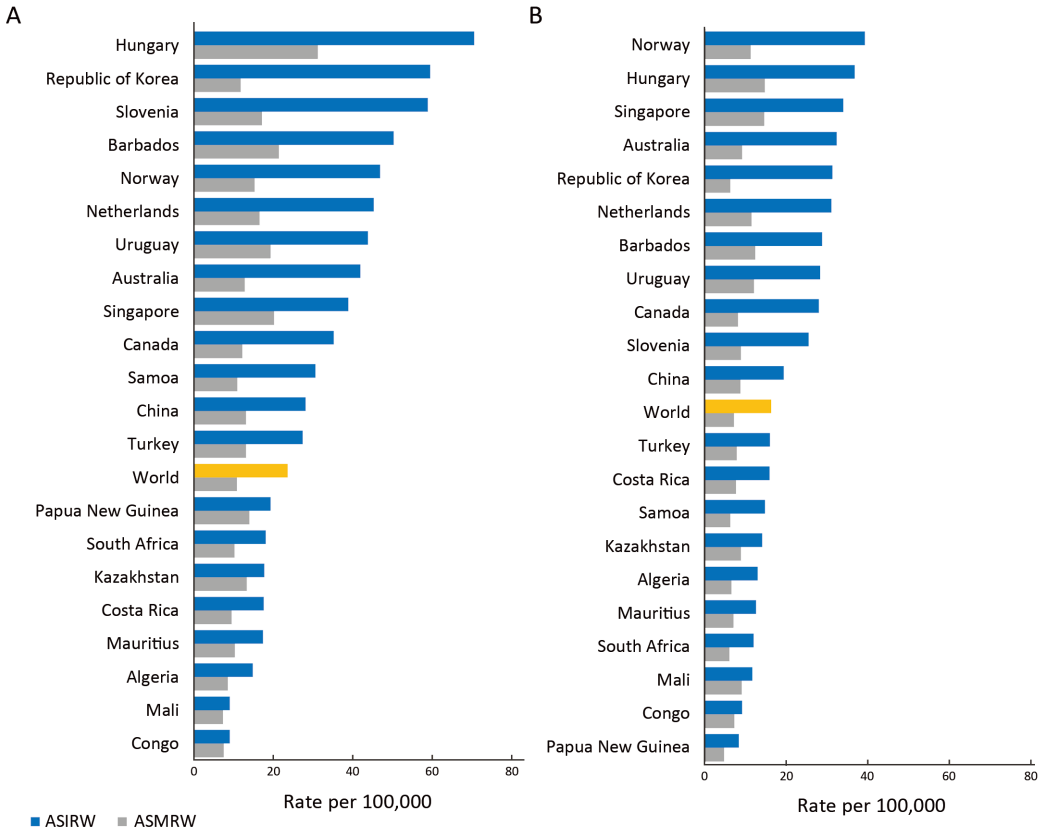

Figure 1 Rank of countries with major burden of CRC in (A) male and (B) female in 2018. CRC, colorectal cancer; ASIRW, age-standardized incidence rate by world standard population; ASMRW, age-standardized mortality rate by world standard population.

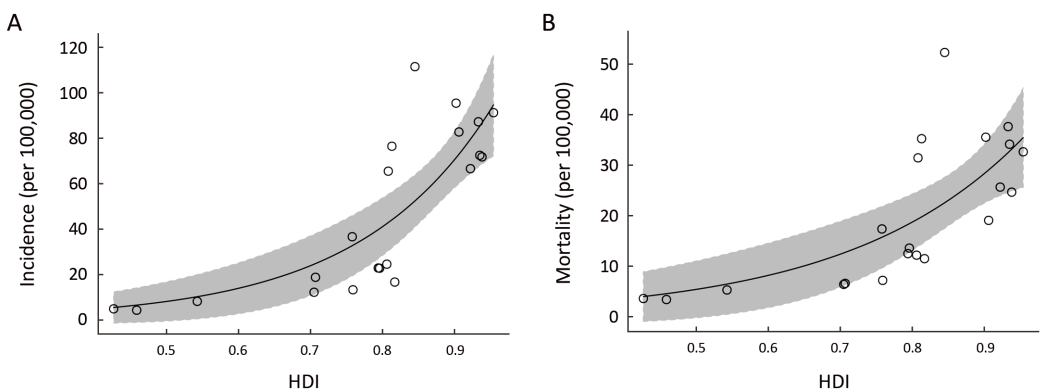

Figure 2 Ecological correlation between a country's HDI and CRC crude incidence rates (P<0.0001) (A) and mortality rates (P<0.0001) (B), respectively, in 2018. HDI, human development index; CRC, colorectal cancer.

of change in females was not as obvious as that in males. In the trend analysis of rectal cancer, Republic of Korea showed an obvious upward trend. The trend of CRC was similar to that of colon cancer (*Figure 3*).

Age-specific incidence trend

Trends for age-specific incidence rate were compared between Republic of Korea, Canada and China. Both males and females in the age group of 40–59 years in China had an upward trend. The upward trend in the Republic of Korea was more obvious than that in China, especially for males in the age group of 60–69 years. Although the incidence of Korean females was rising, the incidence rate of people over 60 years old was lower than that of China

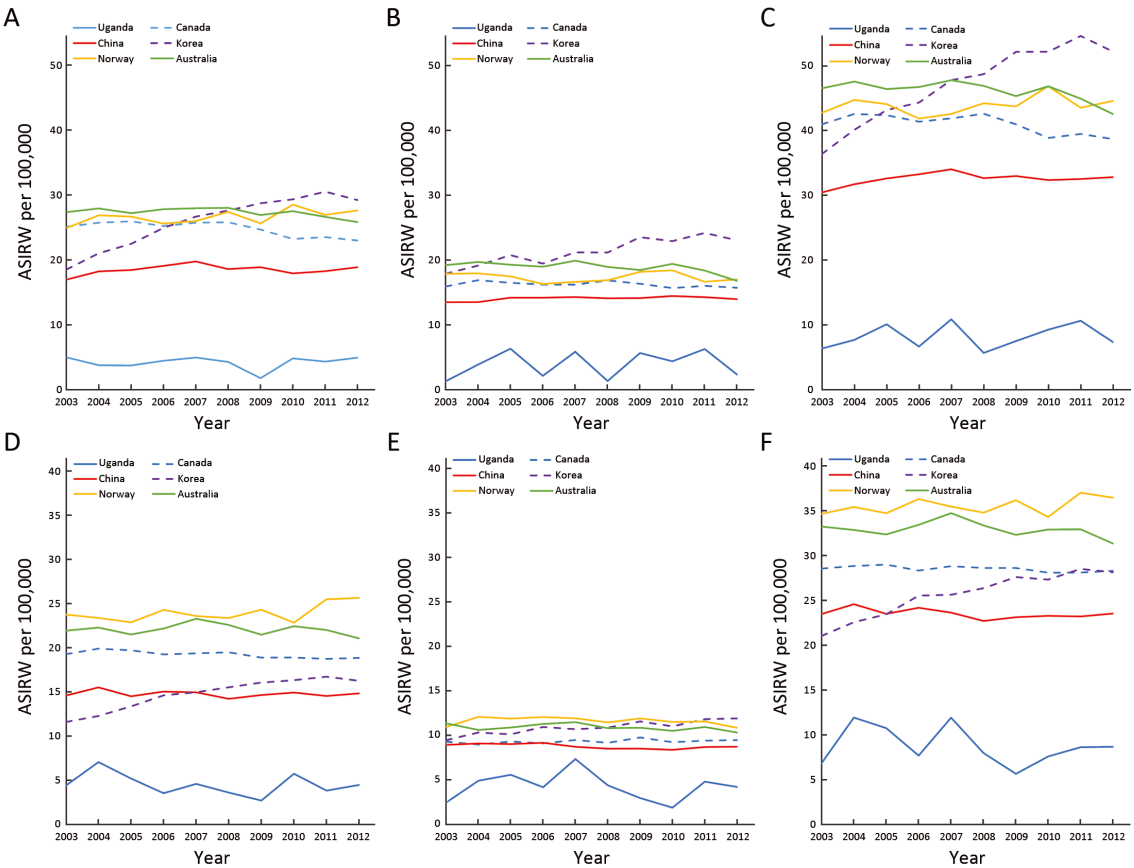

Figure 3 Trend changes of ASIRW of CRC in China and major burden countries in five continents. (A) Male colon incidence; (B) Male rectum and anus incidence; (C) Male CRC incidence; (D) Female colon incidence; (E) Female rectum and anus incidence; (F) Female CRC incidence. ASIRW, age-standardized incidence rate by world standard population; CRC, colorectal cancer.

and Canada. However, the incidence rate in Canada had a downward trend in 2003–2012 (*Figure 4*).

The incidence rate of Chinese males aged 50–59 years showed an increasing trend, with an AAPC of 1.8 (95% CI: 0.8, 2.8). However, females aged 60–69 years had a decreasing trend with an AAPC of −1.2 (95% CI: −2.0, −0.4). All age groups of males and females in Korea showed an upward trend and the males aged 30–39 years had the most significant growth with an AAPC of 6.2 (95% CI: 4.5, 8.0). In Canada, the high-age group showed a downward trend while the low-age group showed an upward trend (*Table 3*).

Discussion

In this study, we comprehensively performed an epidemiological analysis of CRC incidence and mortality in 20 worldwide regions and compared the ten-year incidence trend changes in countries of each continent with China. We also separately compared the trends in age-specific incidence rates in China, Republic of Korea and Canada. The incidence rate of CRC in China was relatively low compared with that of developed countries. However, the burden of CRC would continue to increase in the future due to China's large population and the current upward trend.

According to the IARC estimates, in 2018, CRC accounted for 10.2% of all incidence in the world, with approximately 1,026,215 cases in men and 823,303 cases in women (12). CRC was the second leading cause of cancer death in 2018 with about 484,224 and 396,568 deaths estimated in males and females, respectively. CRC is considered to be related to changes in lifestyles after economic and social development (13). The burden of developed countries is generally heavier than developing countries, but with development, the incidence in developing countries is increasing rapidly. Genetics contribute to individual risk (14), but CRC incidence is

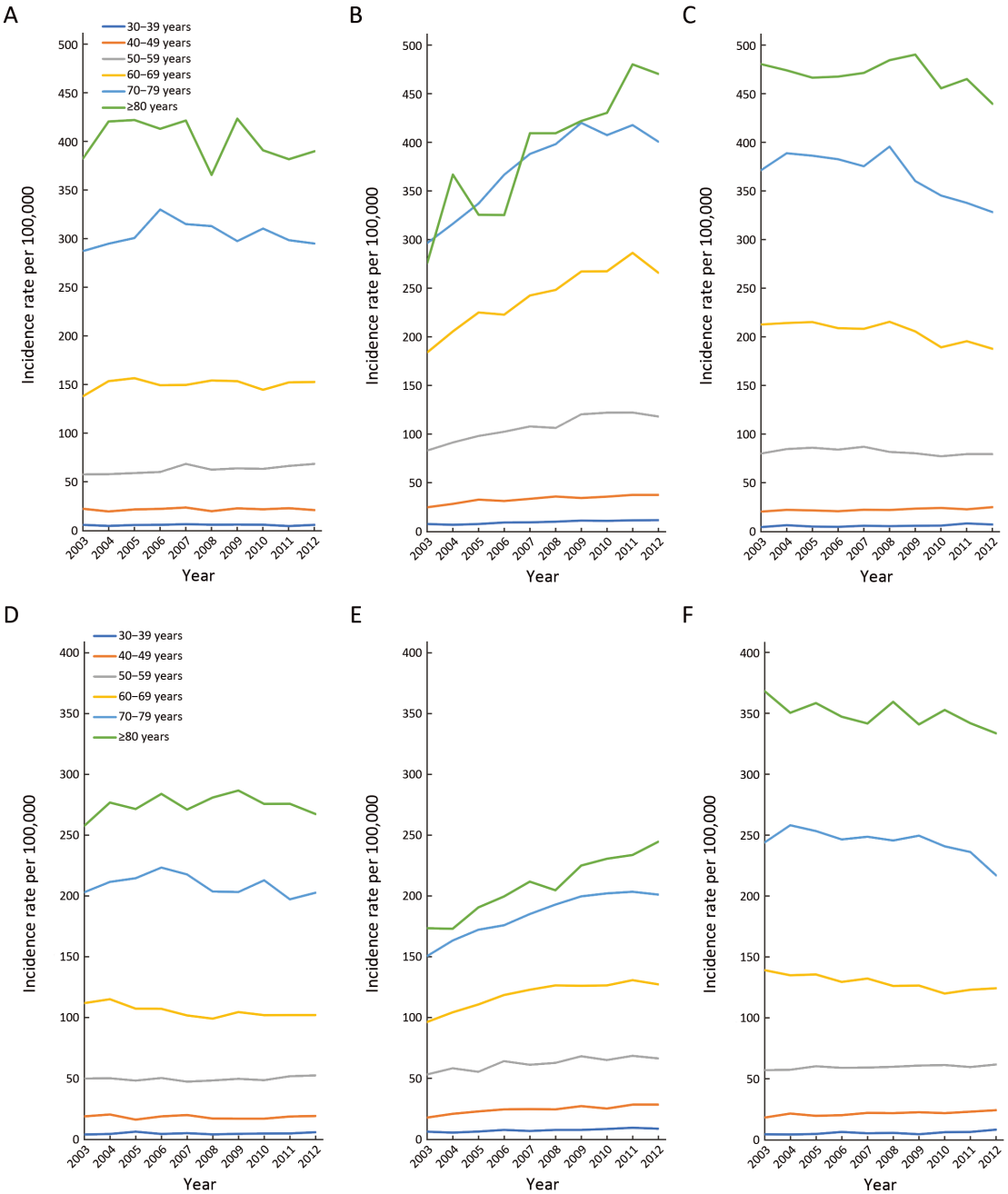

Figure 4 Age-specific incidence trends in CRC between Republic of Korea, Canada and China. (A) Males of China; (B) Males of Republic of Korea; (C) Males of Canada; (D) Females of China; (E) Females of Republic of Korea; (F) Females of Canada. CRC, colorectal cancer.

largely affected by modifiable diet and lifestyle factors (13). CRC's risk factor mainly includes obesity, physical inactivity, smoking, alcohol drinking and dietary patterns. Immigration epidemiological studies have shown that after immigrants change their eating habits, the incidence rate quickly approaches local residents (15). Therefore, the key to controlling the incidence of CRC is to correct lifestyles in time. Physical activity is the most direct method of prevention which can benefit gut motility, the immune system and metabolic hormones (16).

In comparison between countries of five continents and China, the incidence rate of most countries is increasing from 2003 to 2012. These five countries represent the highest level of incidence in each continent in CI5.

Table 3 Age-specific incidence trends in CRC between Republic of Korea, Canada and China

Country	Age group (year)	Trend 1		Trend 2		2003–2012 AAPC (95% CI) (%)
		Period	APC (95% CI) (%)	Period	APC (95% CI) (%)	
Male						
China	30–39	2003–2012	0.1 (–3.0, 3.2)			0.1 (–3.0, 3.2)
	40–49	2003–2012	0.3 (–1.3, 2.0)			0.3 (–1.3, 2.0)
	50–59	2003–2012	1.8* (0.8, 2.8)			1.8* (0.8, 2.8)
	60–69	2003–2012	0.3 (–0.6, 1.3)			0.3 (–0.6, 1.3)
	70–79	2003–2006	4.1* (0.8, 7.6)	2006–2012	–1.4* (–2.5, –0.3)	0.4 (–0.6, 1.4)
	80+	2003–2012	–0.6 (–1.9, 0.8)			–0.6 (–1.9, 0.8)
Republic of Korea	30–39	2003–2012	6.2* (4.5, 8.0)			6.2* (4.5, 8.0)
	40–49	2003–2005	13.4* (1.5, 26.8)	2005–2012	2.4* (0.9, 3.9)	4.8* (2.6, 7.0)
	50–59	2003–2010	5.4* (3.7, 7.1)	2010–2012	–2.2 (–13.3, 10.3)	3.6* (1.3, 6.0)
	60–69	2003–2012	4.4* (3.1, 5.7)			4.4* (3.1, 5.7)
	70–79	2003–2009	5.9* (4.7, 7.2)	2009–2012	–1.8 (–5.2, 1.7)	3.3* (2.2, 4.4)
	80+	2003–2012	5.5* (3.4, 7.6)			5.5* (3.4, 7.6)
Canada	30–39	2003–2012	4.4* (1.1, 7.9)			4.4* (1.1, 7.9)
	40–49	2003–2012	1.8* (0.9, 2.7)			1.8* (0.9, 2.7)
	50–59	2003–2012	–0.7 (–1.6, 0.1)			–0.7 (–1.6, 0.1)
	60–69	2003–2012	–1.5* (–2.2, –0.7)			–1.5* (–2.2, –0.7)
	70–79	2003–2008	0.2 (–1.2, 1.7)	2008–2012	–4.2* (–6.1, –2.2)	–1.8* (–2.7, –0.8)
	80+	2003–2012	–0.5 (–1.3, 0.2)			– 0.5 (–1.3, 0.2)
Female						
China	30–39	2003–2012	1.6 (–2.2, 5.6)			1.6 (–2.2, 5.6)
	40–49	2003–2012	–0.4 (–2.5, 1.7)			–0.4 (–2.5, 1.7)
	50–59	2003–2008	–0.9 (–2.9, 1.2)	2008–2012	2.2 (–0.8, 5.2)	0.5 (–0.8, 1.8)
	60–69	2003–2012	–1.2* (–2.0, –0.4)			–1.2* (–2.0, –0.4)
	70–79	2003–2012	–0.5 (–1.5, 0.4)			–0.5 (–1.5, 0.4)
	80+	2003–2012	0.3 (–0.5, 1.1)			0.3 (–0.5, 1.1)
Republic of Korea	30–39	2003–2012	5.2* (3.2, 7.1)			5.2* (3.2, 7.1)
	40–49	2003–2005	13.8 (–1.4, 31.4)	2005–2012	2.8* (0.9, 4.8)	5.2* (2.4, 8.0)
	50–59	2003–2012	2.5* (1.4, 3.7)			2.5* (1.4, 3.7)
	60–69	2003–2007	6.4* (5.0, 7.9)	2007–2012	0.6 (–0.3, 1.6)	3.2* (2.5, 3.8)
	70–79	2003–2009	4.6* (3.6, 5.6)	2009–2012	0.0 (–2.7, 2.9)	3.1* (2.2, 3.9)
	80+	2003–2012	4.0* (3.3, 4.7)			4.0* (3.3, 4.7)
Canada	30–39	2003–2012	5.3* (1.6, 9.1)			5.3* (1.6, 9.1)
	40–49	2003–2012	2.4* (1.3, 3.6)			2.4* (1.3, 3.6)
	50–59	2003–2012	0.7* (0.3, 1.1)			0.7* (0.3, 1.1)
	60–69	2003–2012	–1.4* (–1.9, –0.9)			–1.4* (–1.9, –0.9)
	70–79	2003–2010	–0.3 (–1.3, 0.7)	2010–2012	–5.6 (–12.6, 1.9)	–1.5* (–2.9, –0.1)
	80+	2003–2012	–0.7* (–1.3, –0.1)			–0.7* (–1.3, –0.1)

CRC, colorectal cancer; APC, annual percentage change; AAPC, average annual percentage change; 95% CI, 95% confidence interval; *, P<0.05.

Although incidence in China is lower, the increasing trend of incidence is clear. There are some differences in the etiology of colon and rectum cancer but the trend of change is basically the same. The proportion of

pathological types in different populations is significantly different. Proximal colon cancer is more prevalent in women and descending colon cancer is more common in men (17). Proximal colon cancer is the most common subtype among white and black Americans, and rectal cancer accounts for the highest proportion among Koreans (13,18,19).

There are many methods for CRC screening, including fecal occult blood test (FOBT) and fecal immunochemical test (FIT), and even multitarget stool DNA testing. These testing methods are non-invasive, low cost, easy to accept, and convenient to carry out in the large population. But colonoscopy, the gold-standard screening method, is a highly sensitive test. Colonoscopy can reduce the incidence and mortality of CRC, and over-diagnosis and over-treatment caused by colonoscopy are also acceptable (20,21). Some studies also confirm that screening is cost-effective compared with no screening (22). Many countries combine colonoscopy with FOBT and FIT to develop their own screening programs to deal with the high disease burden. Generally, the age for CRC screening is set at 50–74 years old. Canada formulated the Canadian Strategy for Cancer Control (CSCC) in 2005 and implemented it in 2006 (23). The CSCC has gradually carried out CRC screening projects throughout Canada. Republic of Korea began screening for five common cancers including CRC in 1999, and continued to expand the scale of screening (24). China launched the Rural Cancer Screening Project in 2004. In 2005, Haining and Jiashan in Zhejiang province took the lead in starting CRC screening and the project gradually expanded to 33 sites nationwide. The three countries are at different stages of screening. Screening in China is gradually expanding, and Korea has already in the stage where the incidence rate is rising rapidly after a large number of cases have been detected through screening. In Canada, the incidence rate has decreased, but the incidence in the younger age group has begun to rise. With the expansion of screening, the trend in Korea and Canada will also happen in China.

The phenomenon of early-onset cases of CRC needs to be focused on. People under 50 years old in Canada show an increasing trend in both sexes, and AAPC is statistically significant. This increasing trend weakens with age increases. Considering disease progression of CRC takes time, studies believe that these people have been in a westernized lifestyle and diet for a long time in childhood (25). Therefore, the early onset of CRC is worth studying and special attention should be paid to childhood obesity and living habits.

The disadvantage of this study is that the data set used is a public database and lacks pathological types. If the composition comparison and trend analysis of pathological types can be carried out, it can have more valuable references for health policy formulation.

Conclusions

The incidence of CRC in China was in the world average level, but was lower than that of developed countries. However, because of the large population in China and the increasing trend of CRC, the burden of this disease will continue to increase in the future with the development of social economy and population aging. Developed countries have gone through this process and explored feasible screening programs to reduce the burden of CRC. Facing the growth burden of CRC, China should learn the experience of developed countries and formulate comprehensive prevention and control policies. Screening should be expanded to control CRC and more attention should be paid to young people in China.

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Footnote

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

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