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Urban–rural disparity in colorectal cancer incidence and increasing trend in relation to socioeconomic development and urbanization in China

Denggui Wen[1], Wendi Zou[2], Xiaoduo Wen[3], Yi Yang[3], Yuetong Chen[1], Yutong He[1], Guiying Wang[1] and Baoen Shan[1]

Abstract

Objective: To study urban–rural disparity in colorectal cancer incidence and the increasing trend in relation to rapid socioeconomic development and urbanization in China.

Methods: We compared the age-standardized incidence rates (ASRs) of colorectal cancer between rural and urban areas in China in 2012 and analyzed the trend in Shexian County for 2000–2015 using population-based tumor registration data collected in Shijiazhuang city (2012) and Shexian County (2000–2015).

Results: The ASRs of colorectal cancer in Shijiazhuang (urban) were considerably higher than in Shexian (rural) in both men (22.8 vs. 11.9/100,000) and women (15.0 vs. 9.3/100,000). The difference was similar to that between countries with high and medium human development indices according to GLOBOCAN 2012. In trend analysis, the biennial ASR in Shexian increased from 6.6 in 2000–2001 to 15.9/100,000 in 2014–2015 in men (averaged biennial percent change (ABPC) = +6.0%), and from 4.0 to 11.7/100,000 in women (ABPC=+5.5%).

Conclusions: The incidence of colorectal cancer in China is rising in parallel with socioeconomic development and urbanization. Integrated efforts should be made to reduce the incidences of overweight and obesity in society to help prevent this increase.

[1]Cancer Center, the Fourth Hospital of Hebei Medical University, Shijiazhuang, China
[2]Medical Imaging, Hospital of Sinopec Shengli Oilfield, Dongying, China
[3]Medical Imaging, the Fourth Hospital of Hebei Medical University Shijiazhuang, China

Corresponding author:
Guiying Wang, Cancer Center, 4th Hospital of Hebei Medical University, Jiankanglu 12, Shijiazhuang 050011, China.
Email: guiyingwang136@163.com

Keywords
Colorectal cancer, socioeconomic development, urbanization, overweight, obesity, healthy food, food education

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List of abbreviations

age-standardized incidence rate (ASR); averaged biennial percent change (ABPC).

Introduction

Global trends in the incidence of colorectal cancer closely follow economic fortunes. According to the International Agency for Research on Cancer,[1,2] the incidence trends in Western Europe, the United States, and Japan have remained relatively flat for two decades, coinciding with a period of economic stability or decline. In contrast, Eastern European countries such as Slovakia have achieved rapid economic growth in recent decades and the age-standardized incidence rate (ASR) of colorectal cancer has risen continually from 1990 to 2005. China has experienced even more rapid socioeconomic development and urbanization in recent decades, but studies on the trends in colorectal cancer have been limited and the results are less conclusive. For example, a national study in 2016 reported that the annual percent changes (APCs) in ASR in both men and women were significant (+4.2% and +3.2%, respectively) from 2000 to 2006, but thereafter (from 2006 to 2011) increased significantly among men (APC =+1.3%) but not among women (APC =+0.2%).[3] Another study using earlier data had reported that the APCs in ASR for urban men and women, and for rural women were all significant from 1997 to 2008 (+3.7%, +2.5%, and + 2.5%, respectively), while the APC for rural men was non-significant (+2.3%) from 1997 to 2004, but was subsequently significant from 2004 to 2008 (APC=+8.4%, 95% CI 3.3%–13.8%, $P<0.001$).[4] To provide evidence for these trends and differences, we examined urban–rural disparity in colorectal cancer incidences between Shijiazhuang city and Shexian County, and also investigated the increasing trend in colorectal cancer incidence in Shexian County between 2000 and 2015 in relation to rapid economic growth and urbanization. We previously conducted a similar study of female breast cancer in the same population.[5] The current study aimed to clarify the status of colorectal cancer in urban and rural areas of China to inform the establishment of useful prevention measures.

Methods

Shexian County and Shijiazhuang city

As a rural area, Shexian County in Hebei Province is an entirely mountainous region in the South Taihang mountains, ranging from 36° 17' to 36° 55' north, and adjoining the provinces of Hebei, Henan, and Shanxi (Figure 1). It lies north of Linxian County in Henan Province and north-west of Cixian County in Hebei Province. All these counties are noted for extraordinarily high incidence rates of esophagogastric cancers.[6] Shexian consists of a county town and 580 villages, with a total population of 408,995 in 2012, of whom 48% live in

Figure 1. Geographic locations of urban Shijiazhuang city (upper right) at the foot of Taihang Mountain and Shexian County located 250 km southwest in the Taihang mountain ranges.

the county town and 52% live in the villages. People in the county town are largely employed in the iron/steel and thermal power industries, agricultural product refining, food manufacture, and tourism, while the rural population grows rice, wheat, persimmon, Chinese prickly ash, and walnuts. The average gross domestic product (GDP) per capita in the county in 2012 was USD 2700. The diet in Shexian follows the traditional agrarian style, with a staple food of rice or steamed buns supplemented by dishes of vegetables, pork, or eggs, although a transition towards a more westernized diet began in the 1990s. Physical activities for people in the villages mainly involve occupational manual exertion, while most people aged 60 or above living

in the county town walk or jog in the morning or evening.

As an urban counterpart,[5] Shijiazhuang city is located 250 km northeast of Shexian County (Figure 1). It was not considered an urban city at the beginning of the 20th century, and consisted of over a dozen villages located at the crossing point of the north–south-bound Peking–Wuhan railway and the east–west-bound Shijiazhuang–Taiyuan railway. Its main urbanization only began after 1953 when it was chosen by the Chinese central government as the capital of Hebei Province and as one of the cities with development priority during the first national 5-year program (1953–1957). During this program, five modern textile plants were established in Shijiazhuang city and the North China Pharmaceutical Corporation established the biggest antibiotic factory in Asia. By completion of the program, the total number of municipal employees had increased from 81,067 to 182,188, and the total municipal population from 182,188 to 376,792.

Urban–rural disparity in socioeconomic development

Despite starting from a similar rural agrarian background 60 years ago, Shexian is considerably less-developed than Shijiazhuang. As indicated in a previous report,[5] the respective GDPs per capita in 2012 were USD 6964.8 and USD 2700 and the yearly disposable incomes per capita were USD 1538 vs USD 750. People in Shijiazhuang spent around 40% of their disposable income on food, compared with less than 20% for people in Shexian, with 30% and 19% of animal products in Shijiazhuang and Shexian, respectively. Shexian people are physically more active at work or through walking than those in Shijiazhuang (Table 1[7–14]), and the age structure in Shijiazhuang is older than that in Shexian (Figure 2).

Tumor registration and population data

Population-based cancer registration was established in Shexian County in 1999 and in Shijiazhuang city in 2010 under agreement with the National Central Cancer Registry of China (NCCRC) and International Association of Cancer Registration, as reported previously.[5] The Ministry of Health of China provides a running budget. Cancer diagnoses are reported to local cancer registries from multiple sources, including local hospitals and community health centers, as well as the local Urban Resident Basic Medical Insurance program and the New Rural Cooperative Medical Scheme, both of which are public insurance programs with almost complete coverage of registered urban or rural residents achieved around 2009. Data quality is assessed and supervised annually by the NCCRC before publication. Population data concerning the sex and age distributions in Shexian County and Shijiazhuang city were obtained from the Population Division of the local Public Security Bureau, as described previously.[5] The population of Shexian County in 2012 was 408,998 (male:female ratio 1.07:1) and that of urban Shijiazhuang was 2,374,827 (male:female ratio 0.95:1). The population pyramid is depicted in Figure 2. Data for both regions are available upon request.

Statistical analysis of the incidence rates of colorectal cancer

Sex- and age-specific incidence rates of colorectal cancer were calculated and the global ASR was calculated using the Segi standard world population (modified by Doll).[15] In the analyses, we compared the ASRs of colorectal cancer between Shexian County and Shijiazhuang city according

Table 1. Comparison of demographic and lifestyle characteristics between urban Shijiazhuang and rural Shexian in 2012.

Demographic	Urban Shijiazhuang	Rural Shexian
Population	2,374,827[7]	408,995[8–11]
Urban population %	100%[7]	48%[8–11]
Altitude (m above sea level)	30–100[7]	1000[8–11]
Latitude N	37°27′–38°47′[7]	36°17′–36°55′[8–11]
GDP per capita	USD 6964.8[7]	USD 2700[8–11]
Annual disposable income per capita	USD 1538[7]	USD 750[8–11]
Annual disposable income spent on diet	40%[12–14]	20%[8–11]
Animal products in diet	>30%[12–14]	<10%[8–11]
Household automobile	40%[7]	12%[8–11]
People regularly doing exercise	60%[12–14]	10%[8–11]
People doing physical work	20%[12–14]	70%[8–11]
Daily smokers (men 2010)	35%[12–14]	40%[13]
Habitual alcohol drinkers (men 2010)	38%[12–14]	25%[13]
Overweight (BMI ≥24 kg/m^2) (18–69 years, men 2010)	43.7%[12–14]	30.2%[13]
Overweight (BMI ≥24) (18–69 years, female 2010)	36.7%[12–14]	35.4%[13]
Obese (BMI ≥28) (18–69 years, men 2010)	19.9%[12–14]	14.5%[13]
Obese (BMI ≥28) (18–69 years, women 2010)	23.2%[12–14]	17.1%[13]
People aged under 25 years	31.5%[12–14]	36.3%[8–11]
People aged 65 years or over	11.2%[12–14]	7.0%[8–11]
Life expectancy in 2012 (years)	75[12–14]	71[8–11,11–14]
		http://www.doc88.com/p-4764727453747.htm

BMI, body mass index.

to the methods described by Esteve et al.[16] The local rates were also compared to Chinese national data for 77 tumor registration cities and 100 counties in 2011,[17] and to international data from GLOBOCAN 2012.[1] The trends in biennial ASRs of colorectal cancer in Shexian from 2000 to 2015 were analyzed using Joinpoint version 4.2.0.2.[18] The study was approved by the Ethics Review Committee of the 4th Hospital of Hebei Medical University (No. 326).

Results

Urban–rural disparity in incidence rates of colorectal cancer

A total of 641 colorectal cancer cases were diagnosed among the 2.37 million registered urban inhabitants in Shijiazhuang city in 2012, giving a crude incidence rate of 27.0/100,000. Colorectal cancer accounts for 11.40% of all new cancer cases and is the third most common cancer in both

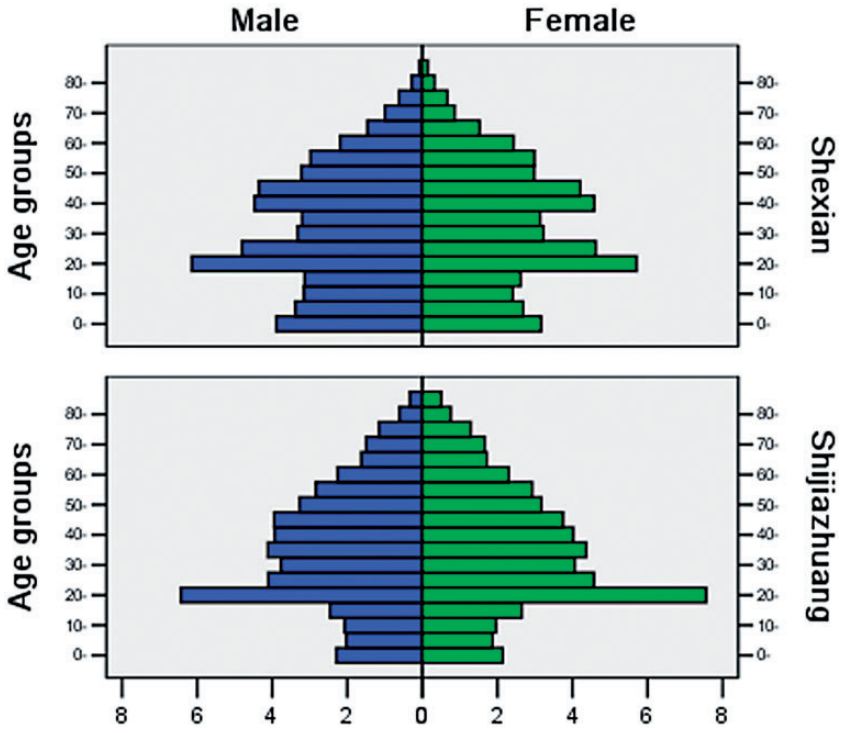

Figure 2. Comparison of population pyramids for rural Shexian County and urban Shijiazhuang city in 2012.

sexes, after lung and stomach cancer in men and breast and lung cancer in women. The crude incidence rates of colorectal cancer in men and women were 33.2 and 21.6/100,000, and the ASRs were 22.8 and 14.9/100,000, respectively (Tables 2 and 3).

In comparison, a total of 51 colorectal cancer cases were diagnosed among the 408,995 inhabitants of Shexian in 2012, giving a crude incidence rate of 12.5/100,000. Colorectal cancer accounts for only 3.9% of all new cancer cases in Shexian, and is the fifth most common cancer in men after stomach, esophagus, lung, and liver cancer, and the seventh most common cancer in women after stomach, esophagus, cervix, lung, breast, and liver cancer. The colorectal cancer crude incidence rates in men and women in Shexian were 13.7 and 11.1/100,000, and the ASRs were 11.9 and 9.3/100,000, respectively (Tables 2 and 3).

The ASRs of colorectal cancer in urban Shijiazhuang were 1.9 times higher than those in rural Shexian in men (22.8 vs. 11.9/100,000, $P<0.01$) and 1.6 times higher in women (14.9 vs. 9.3, $P<0.05$). The cumulative incidence rate for men from 0 to 74 years was 2.1 times higher in urban Shijiazhuang than in rural Shexian (2.9% vs. 1.4%, $P<0.01$), and 1.5 times higher in women (1.9% vs. 1.2%, $P<0.05$) (Table 2).

In addition, the incidence of female breast cancer was significantly higher in Shijiazhuang than in rural Shexian (45.3 vs. 14.4/100,000, $P<0.01$), while the incidences of kidney, pancreas, thyroid, prostate, and ovary cancers were also significantly higher (Table 3).

Table 2. Comparison of colorectal cancer incidence rates among urban Shijiazhuang, rural Shexian County, urban China (77 Chinese tumor registration cities), and rural China (100 Chinese rural counties).

	Shijiazhuang 2012		77 Chinese cities 2011[8]		Shexian County		100 Rural counties[8] 2011*	
Age group (years)	Male	Female	Male	Female	Male	Female	Male	Female
0 – <1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 – <5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
5 – <10	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
10 – <15	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
15 – <20	0.0	0.0	0.4	0.3	0.0	0.0	0.1	0.2
20 – <25	0.0	0.0	1.0	0.7	0.0	0.0	0.9	0.6
25 – <30	0.0	2.8	1.3	1.6	0.0	0.0	1.3	1.2
30 – <35	3.4	2.1	3.2	2.4	7.4	0.0	2.6	2.8
35 – <40	5.1	2.9	5.8	5.3	7.6	0.0	5.5	4.8
40 – <45	25.7	11.5	11.2	9.6	10.9	0.0	9.6	8.3
45 – <50	25.6	21.3	20.9	17.9	16.8	5.8	19.0	13.4
50 – <55	34.8	30.6	38.0	29.2	22.8	16.4	27.6	20.3
55 – <60	66.6	43.1	64.0	43.7	32.8	24.6	45.0	31.4
60 – <65	91.5	64.0	98.2	64.4	44.7	50.3	66.7	43.8
65 – <70	121.5	81.0	124.9	87.5	66.7	64.2	80.3	53.7
70 – <75	208.1	111.8	180.7	127.5	73.4	85.1	106.0	73.1
75 – <80	218.9	140.7	234.7	162.1	117.5	111.0	134.8	88.6
80 – <85	123.5	83.6	264.9	173.5	86.6	74.8	127.8	86.0
85+	103.2	16.7	231.2	150.1	0.0	0.0	115.7	75.3
Crude rate (1/105)	33.2	21.6	31.7	24.7	13.7	11.1	19.8	15.2
ASR (1/105)	22.8	14.9	23.3	16.5	11.9	9.3	15.3	10.7
Cum rate 0–74 years (%)	2.9	1.9	2.8	2.0	1.4	1.2	1.8	1.3

ASR, age-standardized incidence rate; Cum rate, cumulative rate.

Table 3. Comparison of age-standardized incidence rates of major cancer types between urban Shijiazhuang (men 1,157,390, women 1,217,437) and rural Shexian County (men 211,579, women 197,416) in 2012.

	Incidence rate ($1/10^5$)		Rank (%)		ASR ($1/10^5$)		
Tumor site	Shijiazhuang	Shexian	Shijiazhuang	Shexian	Shijiazhuang	Shexian	*P**
Men							
Lung (C33-34)	67.9	33.4	1 (25.2)	3 (9.3)	46.5	30.0	<0.01
Stomach (C16)	40.5	180.4	2 (15.1)	1 (50.2)	28.5	162.0	<0.01
Colorectal (C18-21)	32.9	13.7	3 (12.2)	5 (3.7)	22.8	11.9	<0.01
Liver (C22)	24.1	21.3	4 (9.0)	4 (5.9)	17.4	18.5	
Esophagus (C15)	23.0	79.8	5 (8.5)	2 (22.2)	15.7	72.1	<0.01
Kidney (C64-66,68)	9.9	2.3	6 (3.7)	8 (0.6)	6.9	2.2	<0.05
Prostate (C61)	9.2	0.9	7 (3.4)	10 (0.3)	5.3	0.7	<0.01
Leukemia (C91-95)	9.0	4.2	8 (3.3)	6 (1.2)	6.5	4.0	<0.20
Bladder (C67)	8.7	2.3	9 (3.2)	8 (0.6)	5.8	3.0	<0.20
Lymphoma (C81-85,88,90,96)	8.6	3.7	10 (3.2)	7 (1.0)	6.3	3.1	<0.10
Pancreas (C25)	4.3	0.0	11 (1.6)	11 (0.1)	3.1	0.1	<0.01
Larynx (C32)	3.4	1.9	12 (1.3)	9 (0.5)	2.4	1.6	
Gallbladder (C23-24)	3.3	1.9	13 (1.2)	9 (0.5)	2.4	1.6	
Thyroid (C73)	2.5	0.0	14 (0.9)	11 (0.1)	1.9	0.1	<0.05
Brain (C70-72)	2.3	4.2	15 (0.9)	6 (1.2)	2.0	4.5	<0.05
Nasopharynx (C11)	1.8	2.3	16 (0.7)	8 (0.6)	1.3	2.1	
Bone (C40-41)	1.2	4.2	17 (0.4)	6 (1.2)	0.9	4.1	<0.01
All male cancers	269.1	359.5	100.0	100.0	187.5	325.2	<0.01
Women							
Breast (C50)	59.6	18.1	1 (28.7)	5 (6.6)	45.3	14.4	<0.01
Lung (C33-34)	28.4	23.1	2 (13.7)	4 (8.4)	19.0	20.8	
Colorectal (C18-21)	21.4	11.1	3 (10.3)	7 (4.0)	14.9	9.3	<0.05
Stomach (C16)	11.3	83.2	4 (5.4)	1 (30.3)	7.7	71.5	<0.01
Cervix (C53)	10.8	32.1	5 (5.2)	3 (11.7)	8.4	25.0	<0.01
Corpus uteri (C54)	10.4	9.0	6 (5.0)	8 (3.3)	7.9	7.0	
Ovary (C56)	9.2	3.0	7 (4.4)	11 (1.1)	7.0	2.1	<0.05
Lymphoma (C81-85,88,90,96)	7.6	3.0	8 (3.7)	11 (1.1)	5.5	2.5	<0.10
Esophagus (C15)	6.5	43.1	9 (3.1)	2 (15.7)	4.1	36.2	<0.01
Liver (C22)	6.1	15.0	10 (2.9)	6 (5.5)	4.2	13.3	<0.01
Leukemia (C91-95)	5.4	4.0	11 (2.6)	10 (1.5)	4.6	5.3	
Thyroid (C73)	4.9	1.0	12 (2.4)	15 (0.4)	3.9	0.8	<0.05
Kidney (C64-66,68)	4.9	0.5	2.4	0.2	3.9	0.5	<0.05
Pancreas (C25)	3.6	1.0	1.7	0.4	2.4	0.8	<0.10
Bladder (C67)	1.7	2.0	1.7	0.2	1.4	2.0	
Gallbladder (C23-24)	1.6	2.5	0.8	0.9	1.3	2.3	
Brain (C70-72)	1.0	9.0	0.5	3.3	1.0	7.3	<0.01
Bone (C40-41)	0.9	4.5	0.4	1.6	0.8	4.0	<0.01
Nasopharynx (C11)	0.7	0.0	0.4	0.0	0.7	0.0	
Larynx (C32)	0.1	1.5	0.0	0.5	0.1	1.1	<0.01
All female cancers	207.6	274.2	100.0	100.0	150.4	230.7	<0.01

*According to approximate method for comparing disease incidences between two groups.[16]

Similarities in colorectal cancer disparities between Shijiazhuang–Shexian in 2012 and between urban Chinese tumor registration cities and rural counties in 2011

The difference in the incidence of colorectal cancer between Shijiazhuang and Shexian was similar to that between 77 Chinese cities and 100 Chinese counties in 2011, as reported by Liu et al.[17] This previous study found ASRs of 23.3 vs. 15.3/100,000 ($P<0.01$) in men and 16.5 vs. 10.7/100,000 ($P<0.05$) in women, and cumulative incidence rates for men aged 0 to 74 years of 2.8% vs. 1.8% ($P<0.01$) and for women of 2.0% vs. 1.3% ($P<0.05$) (Table 2).

Comparison with GLOBOCAN 2012

Compared with GLOBOCAN 2012,[1] the sex-specific ASRs of colorectal cancer in urban China (23.3 and 16.5/100,000 for 77 Chinese cities in 2011,[17] and 22.8 and 14.9/100,000 for Shijiazhuang city in 2012) were higher than those in countries with high human development indices (19.9 and 15.7/100,000[1]), whereas those in rural China (15.3 and 10.7/100,000 for 100 rural counties in 2011,[17] and 11.9 and 9.3/100,000 for Shexian County in 2012) were similar to countries with medium human development indices (13.5 and 9.3/100,000)[1] (Figure 3). Compared with specific countries in GLOBOCAN 2012,[1] the rates of colorectal cancer in urban China and Shijiazhuang were lower than in Japan (42.1 and 23.5/100,000), South Korea (58.7 and 33.3/100,000), Israel (43.0 and 30.3/100,000), and Singapore (40.1 and 28.0/100,000), while the rates in rural China and Shexian County were similar to those in Thailand (15.2 and 10.1) and Vietnam (11.5 and 9.0/100,000) (Figure 3).

Trends in colorectal cancer incidence in Shexian County in relation to socioeconomic development and urbanization from 2000 to 2015

As described previously,[5] Shexian underwent rapid socioeconomic development

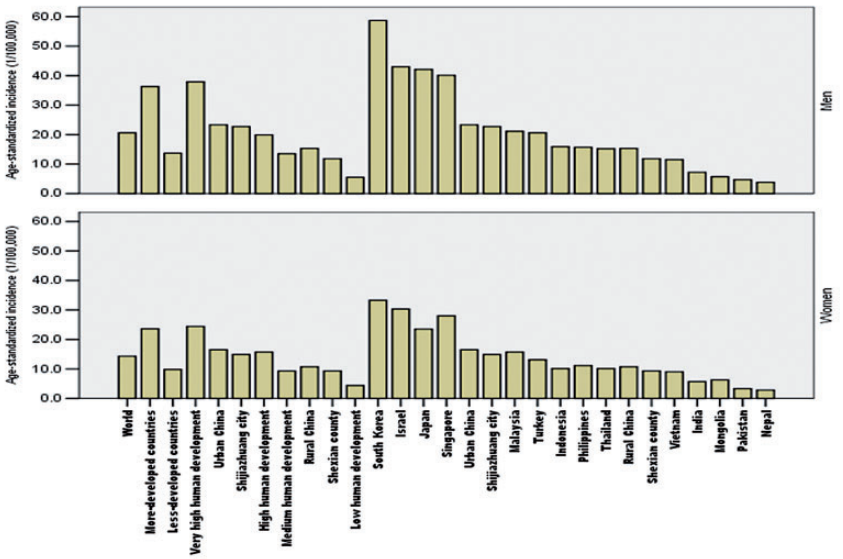

Figure 3. Age-standardized incidence rate of colorectal cancer in urban Shijiazhuang and rural Shexian in 2012 as compared with Chinese national data and GLOBOCAN 2012.

and urbanization from 2000 to 2015. Meanwhile the biennial ASRs of colorectal cancer in Shexian County increased from 2000 to 2015 by 141% in men from 6.6 to 15.9 per 100,000 (average biennial percent change (ABPC)=+6.0%, $P<0.01$), and by 193% in women from 4.0 to 11.7 per 100,000 (ABPC=5.5%, $P<0.01$) (Table 4, Figure 4).

Discussion

Worldwide incidence rates of colorectal cancer increase with industrialization and urbanization

According to GLOBOCAN 2012,[1] colorectal cancer is more common in industrialized than in developing countries, though there is an increasing trend in developing countries. The ASRs are above 40 per 100,000 in the United States, Australia, and New Zealand, but remain as low as 5 per 100,000 in Africa and Asia.[1] The rates have more than doubled since the mid-1970s in recently industrialized countries such as South Korea, Singapore, and some Eastern European countries.[1]

Although Shijiazhuang and Shexian had similar socioeconomic statuses before 1953, subsequent unequal socioeconomic development resulted in a significant urban–rural difference in colorectal cancer incidences among identical Han ethnic populations by 2012, when the respective GDPs per capita were USD 7000 and USD 2700. The difference in ASRs between these two areas was in line with the national urban–rural difference between 77 cities and 100 counties identified in 2011.[17] Moreover, the trends in the incidence colorectal cancer, as well as other westernization-associated cancers, have shown significant increases in Shexian between 2000 and 2015, in parallel with rapid urbanization and socioeconomic development.

Increasing overweight and obesity as underlying factors in colorectal cancer

After a 3-year systematic review of worldwide scientific evidence, the expert panel of the World Cancer Research Fund (WCRF)/American Institute for Cancer Research (AICR) produced the second report on Food, Nutrition, Physical Activity and Prevention of Cancer in 2007,[19] which concluded that body fatness was a convincing cause of cancers arising in the colon and rectum, breast (post-menopause), endometrium, esophagus (adenocarcinoma), pancreas, and kidney, and was a probable cause of gallbladder cancer.

According to data compiled by the United Nations,[20] the percentage of people living in urban areas increased from 35% in 1975 to 49% in 2005 globally, in parallel with socioeconomic development, and is expected to reach 60% by 2030. Daily activities for rural populations typically involve manual labor and walking, which protects against obesity. Furthermore, their staple diet consists of grain and rice, supplemented mainly by vegetables, which is relatively low in energy and high in dietary fiber. In contrast, the urban lifestyle is more sedentary, with manual labor being replaced by computer-based work and walking replaced by automobiles, while leisure time is occupied by watching television or using the internet. Moreover, modern urban foods are increasingly manufactured, including more energy-dense materials such as meat, fats, oil, and sugar, but are low in dietary fiber. In addition, food industrialization results in food being cheaper and more readily available, making it easy for people to consume more energy than their bodies require.[21,22] As a result, many developing populations become obese before they get rich, and the burden of obesity has shifted markedly to the less-well educated groups, as seen in China.

Table 4. Biennial age-standardized incidence rates of major cancer sites between 2000 and 2015, average biennial percent change, and trends in Shexian County*

Cancer (ICD-10)	Age-standardized incidence rate ($1/10^5$)									
	2000–2001	2002–2003	2004-2005	2006–2007	2008–2009	2010–2011	2012–2013	2014–2015	ABPC1-8*	P<
Men										
All cancers	378.2	402.6	414.1	385.6	363.4	336.1	306.4	283.0	−2.5	0.001**
Stomach (C16) 37.5%	196.1	191.8	209.0	181.9	174.2	150.0	136.1	130.1	−3.4	0.001**
Esophagus (C15)	117.4	128.5	108.9	94.1	84.8	75.2	61.3	52.0	−6.0	0.001**
Liver (C22)	20.6	25.5	28.5	33.0	24.1	23.6	20.8	16.0	−2.4	0.20
Lung (C33-34)	15.9	24.6	32.3	32.6	29.5	28.3	31.6	34.7	2.8	0.05*
Colorectal (C18-21)	6.6	8.6	11.5	10.2	18.5	20.5	16.4	15.9	6.0	0.001**
Larynx (C32)	5.5	3.8	2.7	4.2	3.6	4.0	2.9	1.9	−4.4	0.001**
Brain (C70-72)	3.9	3.3	4.6	4.9	3.9	4.3	6.9	3.3	2.0	0.40
Leukemia (C91-95)	2.8	4.3	2.1	3.8	3.9	5.2	5.9	7.7	7.4	0.001**
Pancreas (C25)	1.9	0.9	0.7	1.6	2.4	2.5	2.0	3.4	6.5	0.10
Bladder (C67)	0.6	2.1	3.0	2.8	3.7	2.1	3.0	2.3	0.4	0.90
Lymphoma (C81-85,88,90,96)	1.6	1.9	3.5	3.8	3.2	4.3	3.3	2.9	3.0	0.20
Bone (C40-41)	1.0	1.5	0.7	4.3	1.8	4.1	2.8	2.1	4.2	0.40
Prostate (C61)	0.6	0.3	0.3	0.6	1.5	1.2	0.7	1.2	6.4	0.10
Nasopharynx (C11)	0.4	0.6	1.1	1.3	0.8	2.3	1.4	0.5	0.4	0.90
Kidney (C64-66,68)	0.2	0.3	2.1	1.3	1.3	1.3	2.1	2.9	9.0	0.10
Thyroid (C73.9)	0.2	0.3	0.9	0.2	0.5	0.8	0.8	1.5	3.2	0.10
Gallbladder (C23-24)	0.1	0.2	0.5	0.7	2.3	0.4	2.3	2.4	28.7	0.001*
Women										
All cancers	238.5	228.6	223.2	241.6	204.4	198.6	201.2	193.6	−1.6	0.001**
Stomach (C16)	114.5	98.7	81.7	79.0	61.3	57.9	57.0	46.4	−6.0	0.001**
Esophagus (C15)	74.1	55.9	58.0	59.0	40.0	38.8	34.1	34.0	−5.5	0.001**
Liver (C22)	13.1	17.6	15.1	14.6	10.4	9.0	6.3	5.9	−7.1	0.001**
Cervix (C53)	11.3	19.9	19.4	28.3	27.2	28.4	27.7	23.5	2.2	0.10
Lung (C33-34)	9.6	10.9	10.0	14.4	12.5	10.9	13.9	16.7	3.4	0.001**
Colorectal (C18-21)	4.0	5.7	8.9	7.7	9.4	8.4	11.1	11.7	5.5	0.001**

(continued)

Table 4. Continued

Cancer (ICD-10)	Age-standardized incidence rate ($1/10^5$)								ABPC1-8*	$P<$
	2000–2001	2002–2003	2004-2005	2006–2007	2008–2009	2010–2011	2012–2013	2014–2015		
Breast (C50)	2.8	5.5	5.5	12.6	15.1	15.5	18.1	17.3	10.2	0.001**
Leukemia (C91-95)	2.3	2.2	2.5	3.9	2.9	3.4	5.1	6.2	7.9	0.001**
Larynx (C32)	1.4	1.5	2.3	1.6	0.5	0.7	0.7	0.5	−10.0	0.001**
Uterus (C54-55)	0.8	3.2	4.2	3.6	5.8	2.5	4.7	4.6	7.8	0.30
Bladder (C67)	0.3	0.7	0.9	2.1	0.5	0.2	1.6	0.9	5.7	0.70
Pancreas (C25)	0.8	0.3	0.6	1.1	1.1	1.5	1.0	1.0	4.1	0.10
Brain (C70-72)	0.7	0.6	4.1	2.8	3.3	5.6	4.9	5.2	18.5	0.10
Lymphoma (C81-85,88,90,96)	1.0	2.6	2.2	2.1	2.8	2.3	1.8	2.3	1.2	0.60
Gallbladder (C23-24)	0.3	0.6	0.4	0.4	1.4	2.1	1.4	2.7	15.6	0.001*
Bone (C40-41)	0.1	0.9	1.6	1.2	1.0	1.0	1.4	0.7	24.5	0.001**
Nasopharynx (C11	0.2	0.6	0.6	0.9	0.3	0.5	0.6	0.6	0.10	0.90
Kidney (C64-66,68)	0.0	0.2	0.6	0.9	0.7	0.9	1.7	2.4	16.2	0.001**
Ovary (C56)	0.2	0.3	1.7	1.2	3.5	2.7	3.3	4.3	12.4	0.001**
Thyroid (C73.9)	0.2	0.2	1.5	0.9	2.5	1.5	2.1	4.2	23.4	0.001**

ABPC, average biennial percent change.

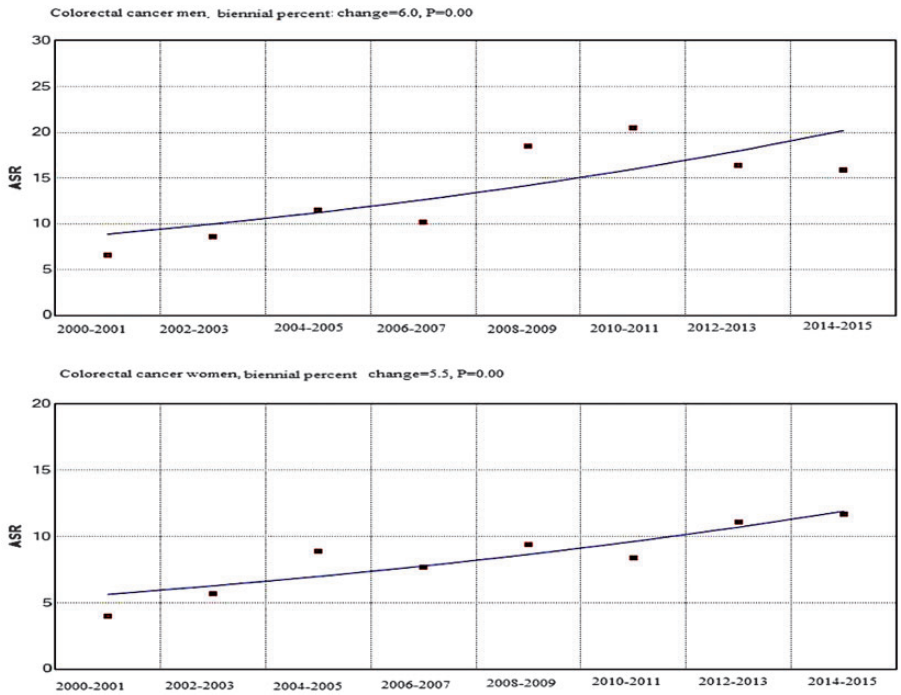

Figure 4. Trends in biennial age-standardized incidence rates of colorectal cancer in rural Shexian County between 2000 and 2015 by Joinpoint version 4.2.0.2 with join point set at zero (1: men, $P<0.001$; 2: women, $P<0.001$).

Burden of colorectal cancer will rise in China

Several studies have reported that both the number and prevalence of overweight and obese people in China have increased substantially since the 1980s, in parallel with rapid economic development.[23–26] A large study estimated that the prevalence of overweight or obese men had increased by 13.7% from 1989 to 2000 and that of women by 7.9%.[26] However, there is still huge urban–rural disparity in development in China. Hong Kong remains the most westernized city in China, with an ASR for colorectal cancer of 37.0/100,000 in 2011 for both sexes combined,[27] which was almost twice as high as that for the 77 Chinese mainland cities combined (19.8/100,000).[17]

Urbanization in China proceeded at a rate of 3.1% annually between 2010 and 2015,[28] and 1 billion people are expected to live in Chinese cities by 2030.[29] These predictions suggest that the burden of colorectal cancer will continue to rise in the future.

Prevention of colorectal cancer by interventions targeting overweight and obesity

The expert panel of the first and second reports on Food, Nutrition, Physical Activity and Prevention of Cancer concluded that body fatness caused not only cancers, but also cardiovascular and cerebrovascular diseases and type-2 diabetes.[19,30] The World Health Organization has long suggested that

the prevention of cardiovascular diseases begins with preventing obesity,[31] and the same may apply to colorectal cancer, with a daily routine of physical activity and the consumption of low energy-dense foods recommended by the expert panel.[19]

However, controlling overweight and obesity involves more than simple lifestyle modifications at the individual level. Wang and Zhai[32] pointed out that China has not yet developed a healthy food environment, and although the economy continues to grow and society prospers, enterprise has not been held environmentally and socially responsible. Health promotion is not considered a social responsibility by enterprises, and food companies pursue profits without considering the healthiness of their products. Furthermore, the public is unclear about what constitutes healthy food, and laws regulating food manufacture and marketing are unsystemic or lacking; for example there are no policies regarding the marketing of food on television, and no requirements for package labeling of foods sold in the supermarkets and convenience stores, which dominate the Chinese food system. Furthermore, little has been done to control the rapid increase in the consumption of fast food and sugary beverages among children, and there is no fiscal taxation or price regulation in place to shift consumption towards healthier foods. Integrated efforts by all members of society are needed to establish these measures, which include political commitment, legislation, government regulation, taxation, and above all, health food education.

Conclusion

The incidence rates of colorectal cancer in urban and rural areas of China have surpassed those in countries with high and medium human development indices, respectively, and are expected to continue to rise. The prevention of colorectal cancer starts with controlling overweight and obesity, which represent major risk factors for many non-communicable diseases and are thus key to China's sustainable development.[33] Chinese people traditionally eat a lot of vegetables and cereals but relatively few animal products. Vigorous food-price regulations/taxation and health food education may help China carry forward these healthier diet patterns and mitigate the obesity-generating effects of urbanization and globalization. Specific suggestions for daily life should include increasing physical activity, avoiding energy-dense foods and a sedentary way of life, eating a variety of fruits, vegetables, and whole grains, and limiting consumption of alcohol, red meat, and processed meat.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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