

Urban Rural Disparity in Westernization Related Cancers and the Increasing Incidence in Parallel with Socioeconomic Development and Urbanization from 2000-2015 among a Rural Chinese Population: An Observational Study

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Abstract

China used to have great urban rural disparity in socioeconomic development. Since the late 1980s, rapid socioeconomic development and urbanization have been taking place in rural settings. It is epidemiologically established that cancer scale and profile will transit as economy prospers and urbanization develops. However, there are few published studies reporting what changes are undergoing in cancer pattern in Chinese rural settings. Population-based tumor registration data collected by us in urban Shijiazhuang city (available for 2,374,827 people in 2012) and in rural Shexian County (available for 408,995 people since 2000) were used for urban rural comparison of age standardized incidence rate (ASIR) of westernization-related cancers in 2012, and the trend of biennial ASIR of these cancers for 2000-2015 in Shexian County was examined following a decade of rapid socioeconomic development and urbanization. From 1988-2015, the Gross Domestic Product per Capita (GDP) in rural Shexian County increased from 860 to 3000 US\$, and urbanization rate from 22.4% to 54.8%. The biennial ASIRs of lung, colorectal, gallbladder cancer and leukemia in both sexes, and that of breast, ovary, thyroid, and kidney cancer in women increased significantly from 2000 - 2015. The increase from 2000-2001 to 2014-2015 in man and women for lung cancer was from 15.9 to 34.7 per 10⁵ (P = 0.05) and 9.6 to 16.7 (P = 0.00), for

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colorectal cancer from 6.6 to 15.9 ($P = 0.00$) and 4.0 to 11.7 ($P = 0.00$), for gallbladder cancer from 0.1 to 2.4 ($P = 0.00$) and 0.3 to 2.7 ($P = 0.00$), for leukemia from 2.8 to 7.7 ($P = 0.00$) and 2.3 to 6.2 ($P = 0.00$); and in women for cancer of breast from 2.8 to 17.3 ($P = 0.00$), kidney from 0.2 to 2.4 ($P = 0.00$), ovary from 0.2 to 4.3 ($P = 0.00$), and thyroid from 0.2 to 4.2 ($P = 0.00$). Notwithstanding these increases, their ASIRs in 2012 in Shexian County were still significantly lower than that in Shijiazhuang city. Westernization-related cancer is increasing rapidly in rural China. Comprehensive measures are needed to strengthen prevention to ensure sustainable development.

Keywords

Urban-Rural Disparity In Westernization Related Cancer, Population Based Tumor Registration, Socioeconomic Development, Urbanization, Westernization Related Cancer

1. Introduction

China has experienced rapid socioeconomic development and urbanization since the late 1980s. It is epidemiologically established that cancer scale and profile will transit as economy prospers and urbanization develops [1]. However, there are few published studies reporting what changes are undergoing in cancer pattern and how fast have the changes occurred in Chinese settings [2] [3] [4] [5] [6]. Using population-based tumor registration data, we previously reported a rapidly decreasing trend in the age standardized incidence rate (ASIR) of Helicobacter Pylori infection-related upper gastrointestinal cancer (UGIC) in parallel with socioeconomic development and urbanization from 2000-2015 in Shexian County, a rural area where endemic rates of upper gastrointestinal cancers were found in the past [7]. This time we studied the trend in the ASIR of westernization-related cancers in relation to socioeconomic development and urbanization. The ASIR of westernization-related cancers was also compared between Shexian County and a neighboring urban city (Shijiazhuang city) to examine the urban-rural disparity in relation to socioeconomic development status. Our aim is focused on prevention of westernization related cancers for sustainable development.

2. Materials and Methods

A cross sectional study is performed to assess urban-rural disparity in ASIR of westernization related cancers in 2012 between rural Shexian County and urban Shijiazhuang City. We chose 2012 for comparison because population-based tumor registration data (incidence data) in Shijiazhuang city is available only for 2012, but in Shexian County available since 2000. We then examined the increasing trend of biennial ASIR of westernization related cancers in Shexian County from 2000-2015 in parallel with progressive socioeconomic development

and urbanization.

2.1. Background of Shexian County and Shijiazhuang City

Shexian County of Hebei province is an entirely mountainous land in the up-ranges of South Taihang mountain, ranging from 36° 17' to 36° 55' north latitude and adjoining the three provinces of Hebei, Henan, and Shanxi (**Figure 1**). It is a northern neighbor of Linxian County of Henan province and a northwestern neighbor of Cixian County of Hebei province. All these counties are noted for extraordinary high incidence rates of esophagogastric cancers [8]. Shexian County consists of a county town and 580 villages, its' population was 408,995 in 2012. The economy of the county relies on grow of rice, wheat, persimmon, Chinese prickly ash, walnut, agricultural product refinery, food manufacture and tourist. A quarter of Shexian population, mainly young or middle-aged villagers, is floating between the village and the county town doing seasonal jobs. Its' domestic gross product per capita in 2012 was 2700 US\$. The traditional diet in Shexian County consists of a self-made staple food of rice or steamed bun flavored by dishes of vegetables. Physical activities for villagers mean manual labor. But in the county town, people aged 60 or above do walking or jogging in the morning or evening (**Table 1**).

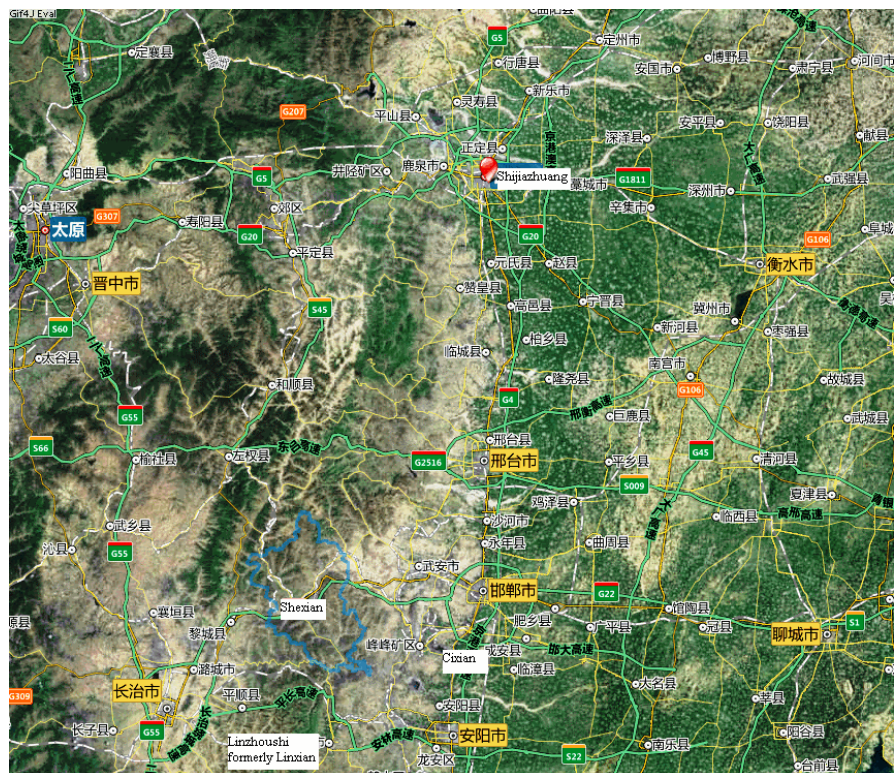


Figure 1. Geographic location of urban Shijiazhuang city (upper middle) and 250 kilometer down southwest, in the Taihang mountain range, three rural counties of Shexian (middle left), Cixian (middle right), and Linxian (bottom left) which have been noted for extraordinary high incidence rate of esophagogastric cancer in the late half of last century.

Table 1. Urban rural disparity in socioeconomic development and urbanization between Shijiazhuang city and Shexian County in 2012.

Demographic	Urban Shijiazhuang	Rural Shexian
Population (2012)	2,374,827 ¹⁴	408,995 ¹⁵⁻¹⁸
% of Urban population (2012)	100% ¹⁴	48% ¹⁵⁻¹⁸
Altitude (m above sea level)	30 - 100 m above sea level	1000 m above sea level
Latitude N	37°27' ~ 38°47'	36°17' ~ 36°55'
GDP per capita 2012 (US\$)	6964.8 ¹⁴	2700 ¹⁵⁻¹⁸
Annual net income per person 2012 (US\$)	3000 ¹⁴	1200 ¹⁵⁻¹⁸
Annual disposable income per person 2012	1538 US\$ ¹⁴	750 US\$ ¹⁵⁻¹⁸
% of annual disposable income spent on diet 2012	40% ¹⁴	20% ¹⁵⁻¹⁸
% of animal food in diet (as opposed to plant food) 2012	More than 30% ¹⁴	Less than 10% ¹⁵⁻¹⁸
% of people regularly exercise 2010	60% ¹⁴	10% ¹⁵⁻¹⁸
% of people working physically 2010	20% ¹⁴	70% ¹⁵⁻¹⁸
% daily smoker men 2010	35% ¹⁴	40% ¹⁵⁻¹⁸
% habitual alcohol drinker men 2010	38% ¹⁴	25% ¹⁵⁻¹⁸
Fertility rate 2012	1.1 ¹⁴	1.8 ¹⁵⁻¹⁸
Menarche age 2012 (years)	12.0 ¹⁴	13.0 ¹⁵⁻¹⁸
Age at first birth 2012 (years)	27 ¹⁴	23 ¹⁵⁻¹⁸
Menopause age 2012 (years)	55.8 ¹⁴	55.5 ¹⁵⁻¹⁸
Breastfeeding (% of childbirth women)2012	60% ¹⁴	95% ¹⁵⁻¹⁸
Household Automobile 2015	40% ¹⁴	12% ¹⁵⁻¹⁸
Household Mobile phone 2015	100% ¹⁴	90% ¹⁵⁻¹⁸
Household Refrigerator 2015	100% ¹⁴	60% ¹⁵⁻¹⁸
% overweight (BMI ≥ 24 kg/m ²) 18 - 69 years male 2004	43.7 ^{19,20}	30.2 ¹⁹
% overweight (BMI ≥ 24 kg/m ²) 18 - 69 years female 2004	36.7 ^{19,20}	35.4 ¹⁹
% obese (BMI ≥ 28 kg/m ²) 18 - 69 years male 2004	19.9 ^{19,20}	14.5 ¹⁹
% obese (BMI ≥ 28 kg/m ²) 18 - 69 years female 2004	23.2 ^{19,20}	17.1 ¹⁹
% people aged under 25 years old	31.46 ¹⁴	36.29 ¹⁵⁻¹⁸
% people aged 65 years old or over	11.15 ¹⁴	6.98 ¹⁵⁻¹⁸
Life expectancy in 2012 (years)	75 ¹⁴	71 ¹⁵⁻¹⁸

As of China, health care in Shexian had been hospital centered. From 1949 until 2010, only government or public employees had been protected by public medical insurance programs. For villagers, only basic medicine was provided free of charge by a rural corporative medical insurance program [9].

As the urban counterpart for comparison, Shijiazhuang is located 250 kilometer northeast of Shexian County, at the cross point of north-south bound Peking-Wuhan railway and the east-west bound Dezhou-Taiyuan railway, and at the foot of Taihang Mountain. The registered urban population in 2012 was 2,374,827.

Shijiazhuang has not been a city before 1953. It used to consist of several dozens of villages. Its urbanization began as late as 1953, when it was chosen by the Chinese central government as the capital city of Hebei Province and as one of cities with development priority during the first national five-year program (1953-1957). During implementation of the program, the North China Pharmaceutical Corporation, which is the biggest anti-biotic factory in Asia, and five modern textile plants were established in Shijiazhuang city. In 60 years, its registered urban population increased from 182,188 in 1953 to 2,374,827 in 2012. In 2012, the Gross Domestic Product (GDP) per capita of Shijiazhuang city was 6964.8 US dollar, ranking 119th among the 150 Chinese cities which had a GDP higher than the average of 6102 US \$ for a total of 293 prefecture-level cities [10].

2.2. Data Sources of Incidence Rate of Cancer by Population-Based Cancer Registration in Shexian County and Shijiazhuang City

Population-based cancer registration in Shexian County was established in 1999 and in Shijiazhuang City in 2010, under the agreement of Chinese National Cancer Registration Center and International Association of Cancer Registration (IACR). The two registries are run by the same team according to the principles of International Agency for Research on Cancer (IARC). The Ministry of Health of China provides a running budget. Cancer diagnoses are reported to registries from multiple sources, including local hospitals and community health centers, as well as the Urban Resident Basic Medical Insurance program and the New Rural Cooperative Medical Scheme, both of which are public insurance programs with universal coverage of local registered urban or rural residents achieved by 2010. Variables collected in tumor registration include patient ID, birth date, sex, age at diagnosis, bases of diagnosis, topography, histology, and survival status. Data quality of cancer registration is assessed annually by Chinese National Cancer Registration Center before publication. On July 21, 2017, the incidence data of Shexian Cancer Registry for 2008-2012 was accepted by IARC for inclusion in the “Cancer Incidence in 5 Continents Vol. XI”.

2.3. Statistical Methods

Gender and age specific cancer incidence rates were calculated, and the Segi standard world population (modified by Doll) was used to calculate ASIRs [11]. Because we had population-based tumor registration data for Shijiazhuang city only for 2012 and for Shexian County for 2000-2015, urban rural comparison of ASIR of westernization related cancers was performed only for 2012 and the difference between was tested by the approximate method [12]. The trends of biennial ASIR of cancer in Shexian between 2000 and 2015 was analyzed using Join Point Analysis 4.2.0.2 [13]. The number of minimum and maximum join point is set as 0 and 1, and Sex and year (biennial) was set as the by variable and independent variable respectively.

2.4. Collection of Socioeconomic Development and Urbanization Data

Data of socioeconomic development and urbanization in both Shexian County and Shijiazhuang city are collected by visiting local government department and their websites. Prevalence of local risk factors for westernization related cancers were obtained from published data.

The study was approved by the Institutional Ethics Review Board of 4th Hospital of Hebei Medical University.

3. Results

3.1. Urban Rural Disparity in Socioeconomic Development

Though both starting from a similar rural agrarian background 60 year ago, Shexian is considerably under developed than Shijiazhuang. In 2012 the GDP per capita were 6964.8 vs. 2700 US\$. The yearly disposable income per capita was 1538 vs. 750 US\$. Shijiazhuang people spent 40% of their disposable income on food while the percentage among Shexian people was less than 20%. The percentage of animal food in Shijiazhuang and Shexian was 30% and 19% respectively. Shexian people are physically more active for working or walking than Shijiazhuang people, and the percent of obesity is significantly lower. Regarding smoking prevalence, proportion of daily smoker among men in Shexian County in 2010 was significantly higher than in Shijiazhuang city (40% vs 35%, $P = 0.01$), but among women it was identical. In association with significant urban rural disparity in socioeconomic development, the life expectancy was 4-year longer in Shijiazhuang than in Shexian in 2012 [14]-[20] (Table 1).

3.2. Contrasting Cancer Pattern Observed between Shexian County and Urban Shijiazhuang City

ASIRs of westernization related cancers in Shijiazhuang are significantly higher than that in Shexian County, (Table 2, Figure 2); female breast cancer was more than three times higher in urban Shijiazhuang than in Shexian County (45.3 vs. 14.4/100,000, $P < 0.01$), the difference in colorectal cancer was 22.7 vs. 11.8/100,000 in men, $P < 0.01$) and 15.0 vs. 9.3/100,000 in women, $P < 0.05$, in kidney cancer was 6.9 vs. 2.2/100,000 in men, $P < 0.05$) and 3.9 vs. 0.5/100,000 in women, $P < 0.05$), in thyroid cancer 1.9 vs. 0.1/100,000, $P < 0.05$ in men and 3.9 vs. 0.8/100,000, $P < 0.05$ in women, and sex-specifically in men the difference in lung cancer was 46.5 vs. 30.0 ($P < 0.01$), in pancreatic cancer was 3.1 vs. 0.1/100,000, $P < 0.01$, in prostate cancer was 5.3 vs. 0.7/100,000, $P < 0.01$, and in ovary cancer in women was 7.0 vs. 2.1/100,000, $P < 0.05$.

3.3. Socioeconomic Development and Urbanization and the Changing Risk of Non-Communicable Diseases since the Late 1980s in Shexian County

Shexian has been a traditional rural agrarian county, but as is the case of most

Table 2. 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.

Tumor site	Incidence rate (1/10 ⁵)		Ranks (Percentage %)		ASIR (1/10 ⁵)		P*
	Shijiazhuang	Shexian	Shijiazhuang	Shexian	Shijiazhuang	Shexian	
Male							
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 Cancer	269.1	359.5	100.0	100.0	187.5	325.2	<0.01
Female							
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

Continued

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 Cancer	207.6	274.2	100.0	100.0	150.4	230.7	<0.01

*By the approximate method for the comparison of incidence of a disease in two groups as described in Cancer Research Volume IV Descriptive Epidemiology. Lyon: France IARC scientific publications128. pp 74-77.

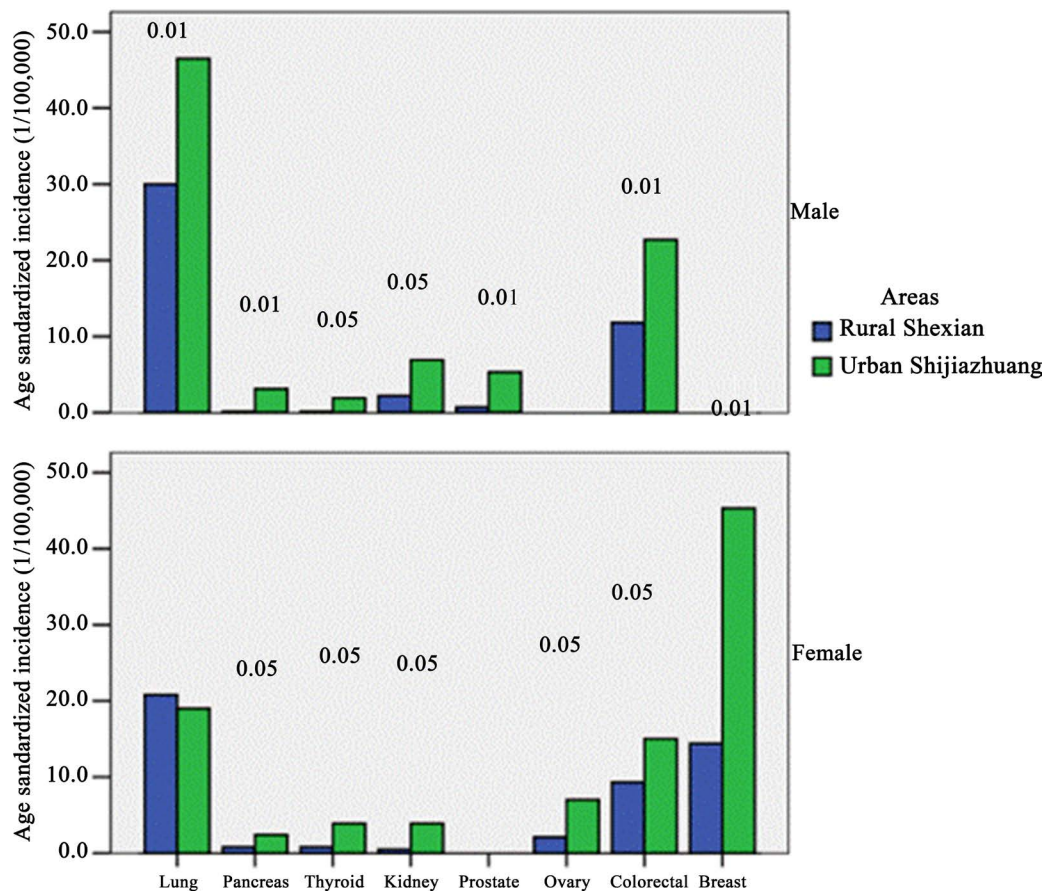


Figure 2. Comparison of age standardized incidence rate of westernization related cancers between urban Shijiazhuang city and rural Shexian County in 2012.

part of eastern and central China, rapid social economic development and urbanization has been taking place since the late 1980s, especially in the two most recent decades. From 1988 through 2015, the booming of real estate development has led the economy rebalance from agricultural and heavy industry towards services and tourism. Overall, the annual GDP of Shexian County per capita increased from 860 to 3000 US\$ [15] [16] [17] [18].

Along with increasing income and market supply of manufactured food, nu-

trition transition gradually take place, with the staple starch food formerly eaten replaced by increasing proportion of high-energy animal food such as saturated fat, meat, egg, and milk. Consumption of sausage, sweetened-soda drink, and potato chips among children become common. Though women rarely smoke or drink alcohol, the prevalence of daily smoker among Shexian men increased from 38% in 2000 to 49% in 2010, and alcohol consumption per adult men doubled between 2000 (4 liters) and 2010 (8 liters). In addition, outdoor air quality deteriorates year after year in Shexian County, as has been the case in the whole north central China where most of the power generating and steel producing industry of China is located.

In recent decades, most young or middle-aged villagers have joined the rural-urban migrant population. From 2000 to 2015, the proportion of county town residents increased from 22.4% (85,000/380,000) to 54.8% (230,000/420,000), increased by 170%, with an annual increase of 10.7% [15] [16] [17] [18].

In addition to rural-urban migration, cement or bituminous concrete roads linking villages to the county town began to be built in 2000, and by the end of 2005, it reached all of the 580 villages [15] [16] [17] [18]. Every day, buses run between the county town and villages, picking up villagers to and from working/shopping. In the past, walking is the principle means of transportation in this mountainous area, but now with greatly improved road condition, more and more villagers are in possessing of cars and motor bikes.

Because of changed diet, reduced physical activity, and migrating from the rural to urban environment, lifestyle is getting more and more westernized. The prevalence of overweight (BMI ≥ 24 kg/m²) among 18-69 years adults in Shexian County tripled from 1991 (11.0%) to 2010 (33.0%), and the prevalence of obesity (BMI ≥ 28 kg/m²) among 18 - 69 years adults reached 15% in 2010 [15] [16]. With female children, mean menarche age decreased from 13.8 years-old before 2000 to 12.4 years-old by 2015, as we surveyed retrospectively by a randomly chosen sample of high school girls at the beginning of 2000 and 2015 respectively. Regarding fertility rate, because one-child policy has been implemented from 1978 till 2013, the total fertility rate has remained stable at 1.8 in Shexian County from 2000 through 2015 [15] [16] [17] [18]. Meanwhile, the county experiences rapid population ageing. The proportion of people aged 60 or older grew from 7.9% in 2000 to 13.9% in 2015 [15] [16] [17] [18].

3.4. Trends of Westernization-Related Cancers from 2000-2015 in Shexian County in Parallel with Unsustainable Socioeconomic Development and Urbanization

In parallel with unsustainable socioeconomic development and urbanization, ASIR of westernization-related cancers increased significantly, including the cancer of lung, colorectal, gallbladder, and leukemia in both sexes and breast, ovary, thyroid, bone carcinoma, and kidney cancer in women (**Table 3, Figure 3**). Among men, the biennial ASR of lung cancer increased from 15.9 to 34.7 with an averaged biennial percent change (ABPC) of +2.8% ($P < 0.05$), colorectal

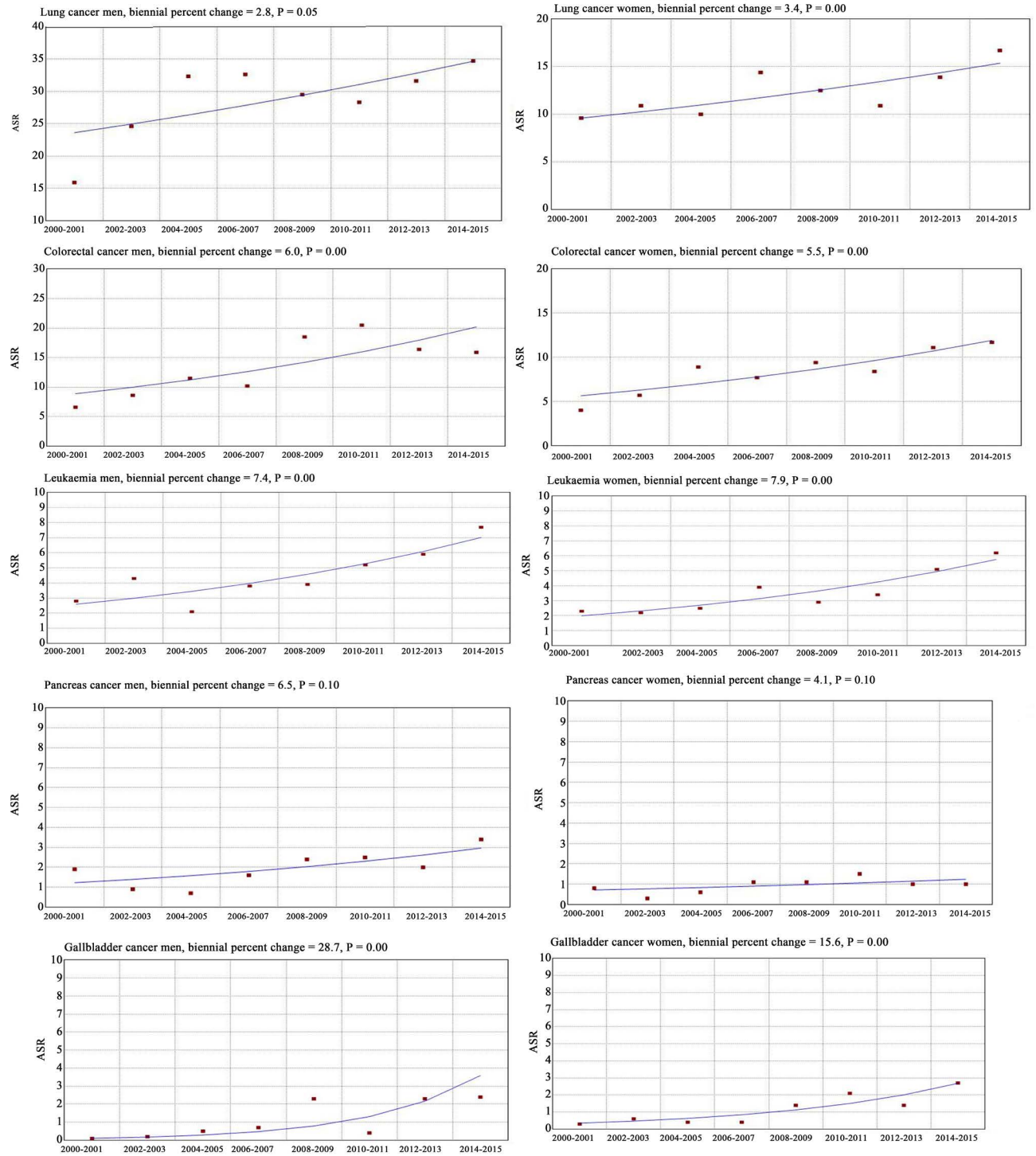
Table 3. Biennial age standardized incidence rate of cancer from 2000-2015 and averaged biennial percent change (ABPC) in Shexian County*.

Cancer (ICD-10)	Age standardized incidence rates (1/10 ⁵)								ABPC1-8*	P
	2000-2001	2002-2003	2004-2005	2006-2007	2008-2009	2010-2011	2012-2013	2014-2015		
Male										
All Cancer	378.2	402.6	414.1	385.6	363.4	336.1	306.4	283.0	-2.5	0.00**
Stomach (C16) 37.5%	196.1	191.8	209.0	181.9	174.2	150.0	136.1	130.1	-3.4	0.00**
Esophagus (C15)	117.4	128.5	108.9	94.1	84.8	75.2	61.3	52.0	-6.0	0.00**
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	0.00**
Larynx (C32)	5.5	3.8	2.7	4.2	3.6	4.0	2.9	1.9	-4.4	0.00**
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	0.00**
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	0.00**
Female										
All cancer	238.5	228.6	223.2	241.6	204.4	198.6	201.2	193.6	-1.6	0.00**
Stomach (C16)	114.5	98.7	81.7	79.0	61.3	57.9	57.0	46.4	-6.0	0.00**
Esophagus (C15)	74.1	55.9	58.0	59.0	40.0	38.8	34.1	34.0	-5.5	0.00**
Liver (C22)	13.1	17.6	15.1	14.6	10.4	9.0	6.3	5.9	-7.1	0.00**
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	0.00**
Colorectal (C18 - 21)	4.0	5.7	8.9	7.7	9.4	8.4	11.1	11.7	5.5	0.00**
Breast (C50)	2.8	5.5	5.5	12.6	15.1	15.5	18.1	17.3	10.2	0.00**
Leukemia (C91 - 95)	2.3	2.2	2.5	3.9	2.9	3.4	5.1	6.2	7.9	0.00**
Larynx (C32)	1.4	1.5	2.3	1.6	0.5	0.7	0.7	0.5	-10.0	0.00**
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	0.00**
Bone (C40 - 41)	0.1	0.9	1.6	1.2	1.0	1.0	1.4	0.7	24.5	0.00**

Continued

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	0.00**
Ovary (C56)	0.2	0.3	1.7	1.2	3.5	2.7	3.3	4.3	12.4	0.00**
Thyroid (C73.9)	0.2	0.2	1.5	0.9	2.5	1.5	2.1	4.2	23.4	0.00**

*Averaged Biennial Percent Change by Join Point Analysis 4.2.0.2.



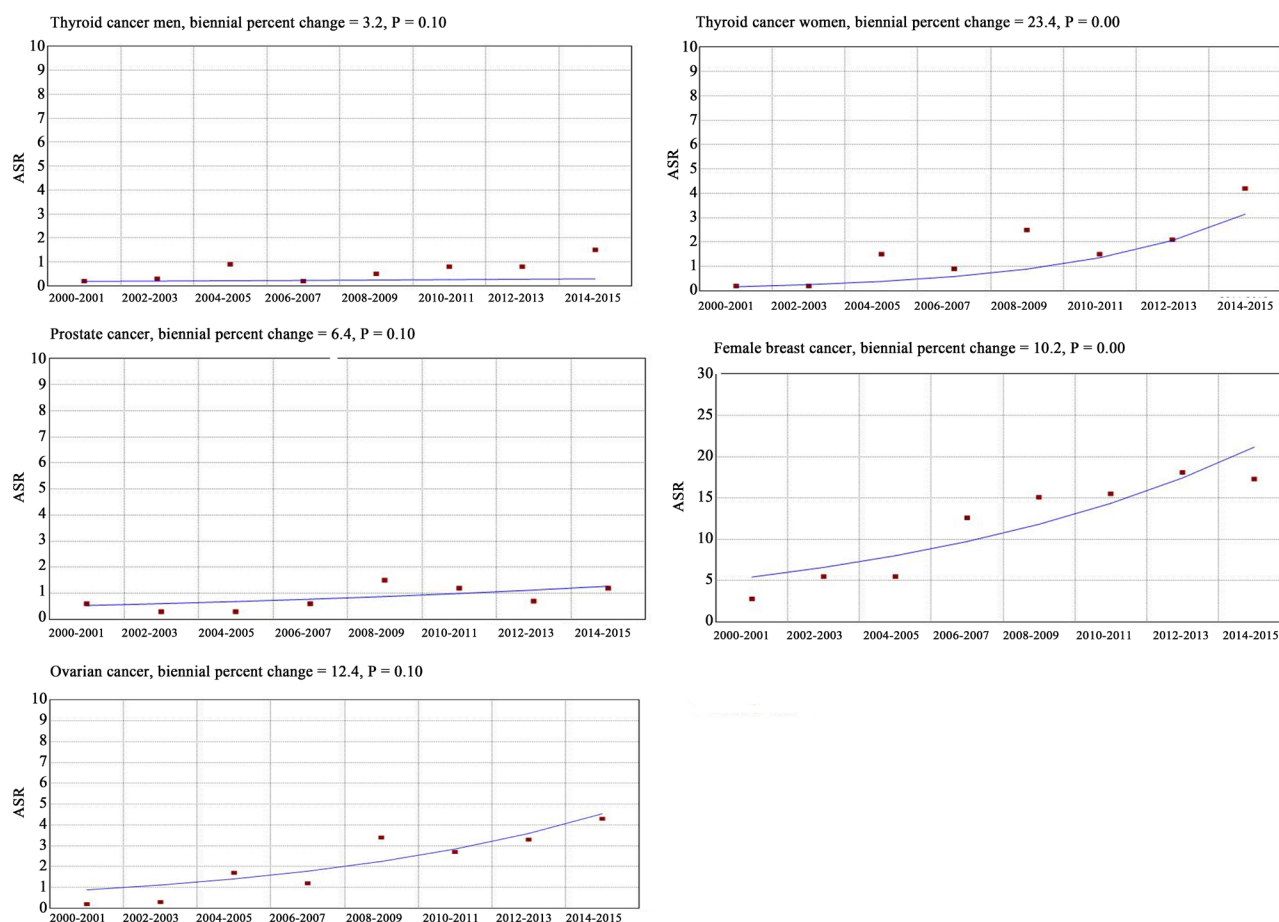


Figure 3. Biennial age standardized incidence rate of cancer from 2000-2015 and averaged biennial percent change (ABPC) in Shexian County.

cancer increased from 6.6 to 15.9 with an ABPC of +6.0% ($P = 0.00$), gallbladder cancer increased from 0.1 to 2.4 with an ABPC of +28.7% ($P = 0.00$), and leukemia increased from 2.8 to 7.7 with a ABPC of +7.4% ($P = 0.00$); and among women, the biennial ASIR of lung cancer increased from 9.6 to 16.7 with an ABPC of +3.4% ($P = 0.00$), colorectal cancer increased from 4.0 to 11.7 with a ABPC of +5.5% ($P = 0.00$), gallbladder cancer increased from 0.3 to 2.7 with an ABPC of +15.6% ($P = 0.00$), leukemia increased from 2.3 to 6.2 with an ABPC of +7.9% ($P = 0.00$), breast cancer increased from 2.8 to 17.3 with an ABPC of +10.2% ($P = 0.00$), kidney cancer increased from 0.2 to 2.4 with a ABPC of +16.2% ($P = 0.00$), ovary cancer increased from 0.2 to 4.3 with an ABPC of +12.4% ($P = 0.00$), and thyroid cancer increased from 0.2 to 4.2 with an ABPC of +23.4% ($P = 0.00$).

Notwithstanding decades of increase in the incidence rate of westernization-related cancers, by 2012 the ASIRs of most these cancers in Shexian County were still significantly lower than that of the urban counterpart (Shijiazhuang city), such as female breast (14.4 vs. 45.3, $P = 0.01$), ovary (2.1 vs. 7.0, $P = 0.05$), colorectal (11.8 vs. 22.7, $P = 0.01$ in men; 9.3 vs. 15.0, $P = 0.05$ in women), kidney (2.2 vs. 6.9, $P = 0.05$ in men; 0.5 vs. 3.9, $P = 0.05$ in women), pancreas (0.1

vs. 3.1, $P = 0.01$ in men; 0.8 vs. 2.4, $P = 0.10$ in women), thyroid (0.1 vs. 1.9, $P = 0.05$ in men; 0.8 vs. 3.9, $P = 0.05$ in women), prostate (0.7 vs. 5.3, $P = 0.01$), and male lung cancer (30.0 vs. 46.5, $P = 0.01$) (**Figure 2**), when the GDP per capita differed by US\$ 2700 vs. US\$ 6964 between the two places. These results suggest that the increasing with westernization related cancers will continue for many years in the future as economy prospers further in Shexian County.

4. Discussion

Socioeconomic development and urbanization is a double-edged sword to disease transition. Though in early stage it is most effective in tackling infection or under nutrition related diseases such as UGIC in under developed populations, the adversary aspects gradually emerge in the form of increasing incidence of non communicable diseases (NCDs), including life-style westernization related cancers [21]. In this study we found although Shijiazhuang and Shexian had similar socioeconomic statuses before 1953, subsequent unequal socioeconomic development resulted in a significant urban–rural difference in incidences of westernization related cancers among identical Han ethnic populations by 2012, when the respective GDPs per capita were USD 7000 and USD 2700. Moreover, in Shexian the trends in the biennial ASR of lung, colorectal, pancreas, gallbladder, kidney, leukemia, thyroid, prostate, female breast, and ovarian cancer showed significant or nearly significant increase in association with social economic development and urbanization (**Table 3, Figure 3**). Our results are in agreement with a recent report by IARC on the relationship between country specific ASR of cancer in GLOBOCAN 2012 and national level of the human development index (HDI), in which a positive dose-response relationship was found in both sexes for lung, colorectal, pancreas, gallbladder, kidney, leukemia, thyroid, brain, and multiple myeloma, and positive associations were also observed for testicular, bladder, lip/oral cavity, Hodgkin lymphoma, and melanoma of the skin in males, and breast, ovarian cancer, corpus uteri, and non-Hodgkin lymphoma in females. The similarity between what is observed globally and in Shexian County suggests the effect of socioeconomic development on cancer transition is universal [22].

What is happening in Shexian County has policy implication for the whole country. Between 2010 and 2015, urbanization in China had been taking place at the rate of 3.1% annually [23]. It is expected that 1 billion people will live in Chinese cities by 2030 [24]. Chinese over the age of 65 now number 140 million, and the number is expected to grow to 230 million by 2030. High-risk behaviors like population ageing, smoking, sedentary lifestyles and obesity, as well as air pollution, take a huge toll on health. Non-communicable diseases account for more than 80 percent of 10.3 million deaths every year, and are responsible for 77 percent of the loss in healthy life. As a result, expenditures on health care have been increasing continuously in recent years. A greater challenge faced by China is that the high growth rates of health expenditure may be difficult to sus-

tain under present economic slow-down [25]. Therefore we must swift to a road of environmental friendly and health development.

Fighting the obese epidemic is one of key campaigns to prevent westernization related cancers. As concluded by World Cancer Research Fund (WCRF)/ American Institute for Cancer Research (AICR) in 2007 in the second report on Food, Nutrition, Physical Activity and Prevention of Cancer, body fatness is a convincing cause of cancers of colon and rectum, breast, endometrial, esophagus (adenocarcinoma), pancreas, and kidney, and it is a probable cause of gallbladder cancer [26]. This WCRF/AICR conclusion was updated in 2016 on the bases of 1000 new studies and concluded further that absence of excess body fatness reduces the risk of another 8 cancers, including cancers of the gastric cardia, liver, gallbladder, pancreas, ovary, thyroid, meningioma, and multiple myeloma [27].

Control of overweight and obese in rural China involves more than life style modification on the individual level. As we see in Shexian, in over a decade of market economy development and urbanization, the traditional home made whole grain, vegetable, low energy but high dietary fiber food gives way to a market supplied, high animal product, and energy rich diet. As a result, the rural urban migrating populations become obese before they get rich, and the burden of obesity has shifted markedly to marginal groups and children [28]. As pointed out by Wang and Zhai [28], a healthy food environment has to be developed in rural China. In seeking profit, food companies are not bothered to consider the healthfulness of their products. The public is not very clear about what constitutes health food, and laws regulating manufacture and marketing of food are missing. For example there are no policies regarding marketing of food via television, there are no requirement over package labeling of the many thousands of food found in supermarkets and convenience stores that dominate the Chinese food system, little has been done to control the rapid increase in consumption of fast food and sugary beverages among children, and fiscal taxation and price regulation to shift consumption toward healthier foods is nonexistent. To establish any of these, incorporated efforts by all society are needed, including political commitment, legislation, government regulation, taxation, and above all, health food education.

In addition to overweight and obesity, tobacco smoking, excessive alcohol drinking, outdoor air pollution are also declared as established risk factor of westernization-related cancers by WHO [29]. Because exposure to these risk factors is determined to an extent by social economic activities and unsustainable production and consumption, prevention also requires strong and active political interventions. For example, a reduction in smoking of about a third by 2025, as suggested by the 2013 World Health Assembly to prevent lung cancer in developing countries [30], could be achieved by tripling the specific excise tax on tobacco, because this could produce multi-sector effect [31]. In 2013, IARC declared outdoor air pollution as a first class carcinogen [32]. In September 2013,

the Chinese State Council issued the Action Plan on Prevention and Control of Air Pollution with the goal of cutting PM_{2.5} (particulate matters with diameter less than 2.5 μm) concentrations by 15% - 20% over three economic zones in 2017 compared with 2012, and PM_{2.5} and other air pollutants have been measured nationwide on hourly basis since January 2013 [33]. According to James Lents, a veteran US policymaker responsible for cleaning up pollution in Los Angeles decades ago, it took the US forty years to control air pollution [34]. In comparison, China has made swift progress by incorporated environment protection policies such as cutting coal use, reducing iron/steel production, removing old vehicles, etc [35]. According to Wang *et al.*, the mean concentration of PM_{2.5} at 512 stations in China during the winter and spring of 2015 (e.g., from Dec. 2014 to Feb. 2015 and from Mar. 2015 to May 2015) decreased by 20% and 14% compared to the previous year, respectively [36].

Our study has some strength. Over a decade later after progressive socioeconomic development and urbanization in a formerly disadvantaged rural population, we noted an increasing trend of westernization-related cancers over a 16-year period. Our study reveals a realistic view regarding the effect of urbanization on cancer transition. Second, the incidence rates of cancer were obtained through population-based tumor registration by standard of International Association of Cancer Registry established by the International Agency of Cancer Research (IACR). Population-based screening programs have never been implemented for lung, female breast, and colorectal cancer in Shexian County. Therefore, the increasing trend in the incidence of urbanization related cancers should not have been influenced by screening.

A weak point of our study is only one year (2012) tumor registration data was available for urban Shijiazhuang city, this may limit the representativeness of our urban-rural comparison results. Secondly we choose only one County of Shexian to represent whole rural China. The representativeness of present study needs to be carefully considered. Our results need to be validated in other populations.

5. Conclusion

In summary, we note a clear rural-urban transition of cancer pattern along with rapid social economic development and urbanization in a rural Chinese population. We believe diet transition, increasing body fatness, and environment deterioration are responsible. To avoid the tragedy already caused by westernization cancers to many industrialized countries, we recommend that comprehensive actions including policy making, legislation, and taxation be taken by government and whole society to fight the epidemics of obesity, tobacco smoking, and air pollution, to ensure health and sustainable development.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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