RESEARCH ARTICLE

Epidemiological Patterns of Cancer Incidence in Southern China: Based on 6 Population-based Cancer Registries

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Abstract

Background: The epidemiological patterns of cancer incidence have been investigated widely in western countries. Nevertheless, information is quite limited in Jiangxi province, southern China. Materials and Methods: All data were reported by 6 population-based cancer registries in Jiangxi Province. The results were presented as incidence rates of cases by site (ICD-10), sex, crude rate (CR), age-standardized rates (ASRs) and truncated incidence rate (TR) per 100,000 person-years, using the direct method of standardization to the world population. Results: 8,765 new cancer cases were registered in our study during the period 2009-2011. Diagnosis of cancer was based on histopathology in 61.0%, clinical or radiology findings in 4.87% and death certificate only (DCO) in 3.0% of the cases. The median age at diagnosis was 62.0 years (mean, 61; standard deviation, 15). The ASRs were 170.8 per 100,000 for men and 111.2 for women. The ASRs for all invasive cancers from the urban areas (145.7 per 100,000) was higher than that of rural areas (137.1). Incidence rates for lung cancer were higher in rural (35.8) than in urban areas (27.0). Similarly, relatively high rates were observed for stomach cancer in rural (20.1) relative to urban areas (15.5). Conclusions: Our results reveal that the most common cancers were breast and lung in women and lung and liver in men. Interestingly, this study suggested a higher incidence rates for lung and stomach cancer in rural males than in urban population, which may suggest other potential causes, such as over-consumption of smoked meats and high prevalence of *Helicobacter pylori* infection, respectively. Public education and the promotion of healthy lifestyles should be actively carried out.

Keywords: Cancer - incidence - epidemiological patterns - population - based cancer registries

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Introduction

Cancer has become a major source of morbidity and mortality globally (Sylla and Wild, 2012). In 2008, there were 12.7 million new cancer cases and 7.6 million cancer deaths occurred worldwide (Ferlay et al., 2008). The World Health Organization (WHO) estimated that more than 1 million new cases of cancer will be diagnosed in China by 2025. Nowadays, cancer has become the leading cause of death (account for 25%) in urban areas and the second most common form of death (account for 21%) in rural China (Ministry of Health, the People's Republic of China, 2008). Moreover, China accounts for approximately 50% of the world's liver cancer cases (Parkin et al., 2005). In recent years, the incidence rates of breast cancer, large bowel cancer and prostate cancer have continued to grow. Jiangxi Province lies in the southeast part of China, and the major source of income is agriculture and industries. Nevertheless, there was little information on the incidence of cancer in Jiangxi province. Since 2009, the Ministry of Health (MOH) of the People's Republic of China has initiated a nationwide program aimed to strengthen existing cancer registries and establish new ones through provision of baseline training; computer software provision and support; data management and analysis. In this paper, we present estimates of cancer incidence based on data from 6 population-based cancer registries in Jiangxi province. We hoped that our study would provide information for cancer services plan and identify areas for future research in this neglected area.

Materials and Methods

Study population

Jiangxi province, located in the southern part of China, has an area of about 166, 900 km^2 and is at 24°29'14" to 30°04'41" longitude north and 113°34'36" to 118°28'58" latitude east. ZhangGong Cancer Registry (ZGCR), JingAn Cancer Registry (JACR) and ShangGao Cancer Registry (SGCR) were carried out by a network of population-based regional registries since 2009; while XinZhou Cancer Registry (XZCR), LongNan Cancer Registry (LNCR) and WuNing cancer registry (WNCR) started from 2010.ZGCR and LNCR are located in the

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Table 1. Data Quality Analysis on Cancer Incidence in Six Urban and Rural Cancer Registries

Item	Urban		Rural		Total	
	N	%	N	%	N	%
Histological verified cancer cases	3084	(69.82)	2261	(52.00)	5345	(60.98)
Death certificate only	124	(2.81)	139	(3.20)	263	(3.00)
M/I	2213/4417	(50.10)	2520/4348	(57.96)	4733/8765	(54.00)
Age of incidence Mean±SD	60.90±14.76		61.14±15.14		61.02±14.95	
Median (IQR)	62.00	(52.00-72.00)	62.00	(51.00-73.00)	62.00	(52.00-73.00)
Primary uncertain	55	(1.25)	78	(1.79)	133	(1.52)
Total number of incident cancers (all sites together)	4417	(50.39)	4348	(49.61)	8765	(100.00)
Male	2631	(49.03)	2735	(50.97)	5366	(100.00)
Female	1786	(52.54)	1613	(47.46)	3399	(100.00)

M/I, ratio between mortality and incidence; SD, Standard Deviation; IQR, interquartile range; Note: The data sources of population number of the study areas were come from the local bureau of statistics

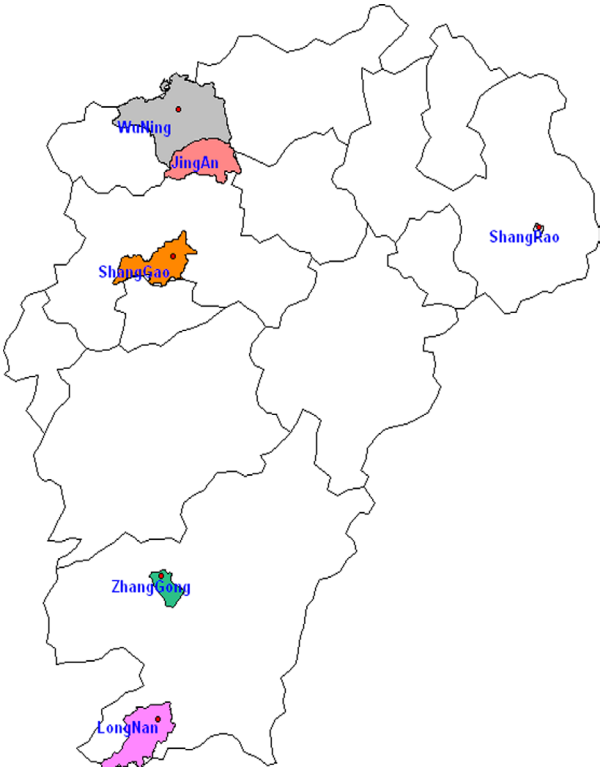

Figure 1. Map of Jiangxi Province Showing 6 Cancer Registries

South of Jiangxi province; WNCR and JACR are located in the North West; SGCR is located in the West while SRCR lies in the east of Jiangxi province (Figure 1). Data sources for number of population of the study areas were come from the local Bureau of the Census. Those 6 registries cover a combined population of over 2 million in Jiangxi province. The study population included all residents of 6 Cancer Registries, who were diagnosed with primary malignant tumors during 2009 through 2011.

Geography and quality index of six Cancer registries

Case information is actively collected from local hospitals, pathology laboratories, diagnostic radiology clinics, outpatient public and private clinics. All the cancer registries were affiliated to local center for disease control and prevention (CDC), which established a population-based cause of death surveillance system, and could provide complete death certificates for all deaths. We used the percent of death certificate only (DCO) in the study as an indicator of the completeness and quality of the cancer registry data. Cancer data were identified using the 10th revision of the International Classification of Diseases (ICD-10)coding and the classifications suggested by the United Kingdom Association of Cancer Registries Library of Recommendation on Coding and Classification Policy and Practice (United Kingdom Association of Cancer Registries CACG, 2013) .CanReg4 software was used for storing, and checking data. All quality control and duplication checks were performed by the local cancer registries.

Statistical analysis

Crude incidence rates were calculated using the number of cases per year (2009 through 2011) divided by the person-year estimates for 2009, 2010, 2011. Age-standardized rates per 100, 000, at all ages and truncated 35–64 years, were computed using the direct method, using 1985 world population as standard population (Liu et al., 2007) and were calculated as described by Boyle and Parkin (Boyle and Parkin, 1991) Besides CR and ASRs, the TR provide another assessment of incidence rates, especially in the population which has over 60% of cancers in this 35-64 year age group. They provide a useful estimate of comparison. All P-values are presented for two-tailed tests of significance at the 5% level. SPSS (SPSS Inc, Chicago, III) and MS EXCEL (Microsoft, Redmond, WA) software were used for statistical analysis.

Results

The data quality analysis on cancer incidence in six cancer registries was shown in Table 1. Diagnosis of cancer was based on histopathology in 60.98%, clinical or radiology findings in 4.87% and death certificate only (DCO) in 3.0% of the cases. A total of 8, 765 cases of malignant tumors were registered by these six Cancer Registries during the period 2009–2011. Men accounted for 61.22% of the cases, and women for 38.78%.Mean age (±SD) at the time of first diagnosis were 61.02±14.95 years (62.18±14.27 for men and 59.19±15.80 for women); around 55% of cases were diagnosed between the ages of 45 and 69 years. The ASRs was 170.78 per 100 000 for men and 111.23 per 100 000 for women (p value<0.05). The ASRs for all cancers in urban areas was 145.67 per 100, 000, and that for rural areas was 137.08 per 100,

Table 2. Comparison of Incidence on Common Cancers from Six Urban and Rural Cancer Registries

Urban				Rural			
Top 10 cancers	Incidence rate			Top 10 cancers	Incidence rate		
	CR	ASR	TR		CR	ASR	TR
Lung	40.11	27.02	41.71	Lung	38.97	35.76	52.06
Liver	30.79	21.82#	44.31	Liver	23.71	21.35*	37.68
Stomach	23.21	15.53	27.86	Stomach	22.31	20.05	32.27
Large bowel	21.33	14.61	25.15	Large bowel	12.43	11.09*	18.02
Breast	15.11	11.07	28.90	Cervix	8.83	7.35	16.47
Cervix	14.54	10.59	27.19	Breast	6.15	5.27	13.08
Esophagus	9.04	6.12	10.61	Esophagus	5.66	5.38	6.41
Lymphomas	6.45	4.72	7.50	Nasopharynx	5.13	4.61*	10.11
Nasopharynx	5.13	3.80	8.61	Brain/nerv. sys.	4.57	4.08	7.25
Pancreas	4.57	3.04	3.92	Pancreas	2.51	2.16*	2.88
All sites	207.94	145.67	265.78	All sites	151.82	137.08	226.88

Note: *The age-standardized incidence rates of lung, stomach,nasopharynx and Brain/nervous system cancer were higher in rural than in urban areas (p value<0.05); #the age-standardized incidence rates of liver cancer was higher in urban than in rural areas (p value <0.05); The age-adjusted Incidence rates per 100,000 (ASRs)and truncated rate (TR) using 1985 world population as standard population. Abbreviation: Crude rate (CR); age-adjusted incidence rates (ASRs); truncated rate (TR)

Table 3. Crude Incidence Rate, Age-standardized Incidence Rates Per 100000 and Truncated Incidence Rate for All Cancers Combined by Sex, 2009–2011

Sex	Urban			Sex	Rural		
	CR	ASR	TR		CR	ASR	TR
Male	242.41	171.16	292.91	Male	185.92	173.00	275.44
Female	175.50	124.41	241.07	Female	115.85	100.92	174.92
Total	242.41	171.16	292.91	Total	151.82	137.08	226.88

Note: Crude rate (CR); age-adjusted incidence rate (ASR); truncated rate (TR)

000, but the difference was not significant (p value>0.05). The lifetime (0–74 years of age) cumulative risk of getting cancer was higher in urban (19.30% in males; 14.07% in females) than rural areas (19.44% in males; 10.91% in females). Sex-specific incidence rates for all cancer sites combined by sex for time period 2009–2011 were shown in Table 2. The four most frequent invasive tumors were lung cancer, cancer of liver, stomach and large bowel. In comparison, surprisingly high rates were reported for lung cancer (35.76) in rural areas than in urban areas (p value<0.05), as well as for cancer of the stomach (20.05), nasopharynx (4.61) and nervous system (4.08); Digestive system malignant tumor constituted about 45.05% and 44.96% of the total cases in urban and rural areas, respectively. The ASRs for all digestive system malignant tumor in urban areas was 64.23 per 100, 000, and that for rural areas was 61.50 per 100, 000. In addition, relatively high rates were observed for liver cancer (21.82) in urban areas (p value<0.05), as well as for cancer of the large bowel (14.61), breast (11.07), cervix (10.59), esophagus (6.12) and pancreas (3.04) (Table 3). In men, the most common cancers sites were lung (44.96), followed by liver, stomach, large bowel and esophagus. The top 5 cancers in females according to the calculated ASRs were lung (16.73), breast (16.15), stomach (11.53), liver (9.87) and cervix (8.73). Lung, liver, stomach, large bowel, female breast and cervix cancers were the main contributors to the total TR in Jiangxi province.

The overall cancer incidence rates increased gradually with age in urban and rural areas; the age-specific incidence rates were slightly higher in urban than rural areas for patients aged 0-64 years. By contrast, the incidence of cancer in urban areas was lower among patients aged 65 years or older than that in rural areas (data not shown).

Discussion

Cancer registry is an important source of information for cancer control since it provides population-based incidence, death and survival information. When comparing different time periods, the incidence was age-standardized to the world population, to avoid the effect of changing age distribution during the study period. The data collection practices used in Cancer Registries were uniform, the information they provide is comparable at the level of the third digit of the ICD-10.

The median age of patients at diagnosis was 62 years in our study, and found to be 8 years younger than American patients when compared to SEER data consisting of the time period from 1999 to 2003 (Hayat et al., 2007). The ASRs for all cancers were 140.07 per 100, 000 in Jiangxi province. Our result was similar to ASRs seen in many other less developed regions, such as South-Eastern Asia countries, but lower than those seen in some Western countries.

Nowadays, lung cancer continued to be the most common causes of cancer death in men (Tas and Keskin, 2012 ; Fathallah and Dajani, 2013), while the vast majority of lung cancer deaths were attributable to cigarette smoking (Dela Cruz et al., 2011). Our findings of ASRs (45.0) in male patients with lung cancer were also

somewhat similar to the 2008 GLOBOCAN estimates for the whole country of 45.9 per 100, 000 for the period 1998–2002 (Ferlay et al., 2010). The results of the current study also showed that ASRs for of male patients with lung cancer were higher in rural (53.48) than urban areas (39.11). This also suggests that the incidence of lung cancer has increased in rural areas over time. Firstly, an increase in the number of cases was mainly due to the ageing of the population. Secondly, China is the world's largest tobacco production and consumption country. Giovino et al. reported 52.9% (95% CI 50.6–55.2) of men and 2.4% (95% CI 1.9–3.1) of women were tobacco users in China (Giovino et al., 2012). Thirdly, smoked meats consumption was observed in some rural areas, especially in WuNing county. Mutagenic heterocyclic amines and polycyclic aromatic hydrocarbons can be formed when meat is cooked at high temperatures, nitrites and related compounds in smoked, salted meats were converted to carcinogenic N-nitroso compounds (Key et al., 2002; Ciemniak et al., 2006). Thus, the increasing epidemic of lung cancer, as well as other tobacco-related cancers, is a clear indication that a tobacco control programme should also be strengthened. Additionally, with respect to secondary prevention, the impact of early diagnosis and screening for cancer needs to be evaluated in the high risk population.

Stomach cancer incidence in urban areas (15.53) from our study is lower compared to rural areas (20.05). More than 70% of cases occur in developing countries, and half the world total occurs in Eastern Asia (mainly in China) (Ferlay et al., 2010). Moreover, our findings is much higher than many South-Eastern Asia countries, such as Thailand (3) and Malaysia (6.4). High prevalence of *Helicobacter pylori* infection and salt overconsumption were observed in these areas, especially those living in the rural areas. Nowadays, the decline in stomach-cancer incidence and mortality is thought to be related to improved methods of food preservation and to a progressive decline in the prevalence of *H. pylori*.

Breast cancer is the most common causes of cancer in urban females. Our findings are also somewhat similar to the estimates for the whole country for the period 2000-2005 (Yang et al., 2006), but lower than many South-Eastern Asia (female 31.0) and Iran (36.0) (Rohani-Rasaf et al., 2013). This might be partly related to over-consumption of animal fat, exposure to ionizing radiation, hormonal factors and racial background, etc (Hartmann et al., 2005; Shaukat et al., 2013; Yoo et al., 2013). Moreover, a recent study suggested that breast cancer was associated with former smoking habits, and breast cancer risk was significantly increased in women who quite smoking at age ≤50 years (Ilic et al., 2013). However, previous study did not yield similar result. Thus, the association between breast cancer and smoking was still inconclusive.

Cervical cancer is the most common cancer among women in some African countries (Piras et al., 2011), our results (urban female 10.59, rural female 7.35) were comparable to those Eastern Asia countries, but lower than many South-Eastern Asia countries, such as Thailand (24.5) and Malaysia (17.9); our results also showed that cervical cancer was the sixth and fifth most common cancer in urban and rural areas, respectively. The main cause of cervical cancer is thought to be sexually transmitted infection with certain types of human papillomavirus (HPV); But the variations in incidence are partially due to historical patterns of sexual behavior, including contraceptive use, and possibly other screening activities.

With technical support by Cancer Institute & Hospital, Chinese Academy of Medical Sciences (CICAMS) and Cancer Foundation of China (CFC), Chinese government has initiated cancer screening programs in the last decade. As a result of these projects, approximately 1, 540, 000 women have been screened in Jiangxi province, which was probably the only chance for many women to be screened in their lifetime, particularly for women in rural areas. Importantly, these research projects will provide the necessary data to comprehensively characterize the substantial burden of breast and cervical cancer and establish programs for primary and secondary prevention.

There are some limitations in our study. Firstly, the basis of diagnosis is a measure of validity in a cancer registry. Accuracy of diagnosis is notably higher if it is more frequently based on histological verification (Bray and Parkin, 2009; Curado et al., 2009). Particular attention is focused on the accuracy of the primary site of cancer, date of diagnosis and quality control of histopathology. If there are problems with coding of these items, additional data are often requested by the cancer registries from reporting clinicians Basis of diagnosis using histology of the primary tumor in urban city was approximately 70% and 52% in rural areas in our study; Nevertheless, there were limited data regarding the proportion of cancer with stage and grade information. Secondly, incidence rates averaged over 3 years might be subject to random variation, especially with regard to rare tumors. Finally, due to lack of diagnostic medical facilities and expert clinicians in some rural areas, the results of these cancer registries may have been underestimated.

In conclusion, our results reveal that the most common cancers in women were cancer of the breast and lung; and cancers of the lung and liver in men in Jiangxi province. Interestingly, this study also suggested a higher incidence rates for lung cancer and stomach cancer in rural male than in urban population in this study which may suggest other potential causes, such as over-consumption of smoked meats and high prevalence of Helicobacter pylori infection, respectively. Public education and the promotion of healthy lifestyles should be actively carried out.

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