RESEARCH ARTICLE

Lung Cancer in a Rural Area of China: Rapid Rise in Incidence and Poor Improvement in Survival

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Abstract

Background: Lung cancer has been a major health problem in developed countries for several decades, and has emerged recently as the leading cause of cancer death in many developing countries. The incidence of lung cancer appears to be increasing more rapidly in rural than in urban areas of China. This paper presents the trends of lung cancer incidence and survival derived from a 40-year population-based cancer monitoring program in a rural area, Qidong, China. Materials and Methods: The Qidong cancer registration data of 1972-2011 were used to calculate the crude rate, age-standardized rate by Chinese population (CASR) and by world population (WASR), birth cohort rates, and other descriptive features. Active and passive methods were used to construct the data set, with a deadline of the latest follow-up of April 30, 2012. Results: The total number of lung cancer cases was 15,340, accounting for 16.5% of all sites combined. The crude incidence rate, CASR and WASR of this cancer were 34.1, 15.7 and 25.4 per 100,000, respectively. Males had higher crude rates than females (49.7 vs 19.0). Rapidly increasing trends were found in annual percent change resulting in lung cancer being a number one cancer site after year 2010 in Qidong. Birth cohort analysis showed incidence rates have increased for all age groups over 24 years old. The 5 year observed survival rates were 3.55% in 1973-1977, 3.92 in 1983-1987, 3.69% in 1993-1997, and 6.32% in 2003-2007. Males experienced poorer survival than did females. Conclusions: Lung cancer has become a major cancer-related health problem in this rural area. The rapid increases in incidence likely result from an increased cigarette smoking rate and evolving environmental risk factors. Lung cancer survival, while showing some improvement in prognosis, still remains well below that observed in the developed areas of the world.

Keywords: Lung cancer - population-based cancer registry - incidence - observed survival - relative survival

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Introduction

Lung cancer is the most commonly diagnosed cancer worldwide with more than 1.82 million cases and a standardized incidence rate of 23.1 per 100,000 estimated in 2012 (Ferlay et al., 2015a, http://globocan.iarc.fr). This cancer remains a major health problem in developed countries but incidence rates are now declining in many European and North American countries (Swerdlow et al., 1998; Simard et al., 2012; Kachuri et al., 2013). However, a continuing upwards trend of lung cancer incidence for many developing countries mandates greater attention to the implementation of global cancer control strategies (Shin et al., 2012; Chen et al., 2014). In China and other Asian countries, lung cancer has been the leading cause of cancer mortality for several years, and will remain so for the foreseeable future (Chen et al., 2014; Marugame et al., 2009; D'Souza et al., 2013). Moreover, rates of both incidence and mortality of lung cancer are increasing more rapidly in rural areas than in urban areas (Han et al., 2013; Cheng et al., 2013; Guo et al., 2012). These rural–urban differences in annual rate changes have been observed also in the United States and the United Kingdom, where the lung cancer mortality rates in non-metropolitan areas became even higher than in metropolitan areas after the mid 1980's (Singh et al., 2012; Gartner et al., 2011).

Lung cancer is difficult to treat, since it is often not discovered until the later stages of the disease. Surgery is usually used to treat earlier stage lung cancers, resulting in better prognosis for those identified in screening programs or in early detection settings. However, other factors are also associated with the prognosis of lung cancer patients, including age, tumor size, histological grade, and presence of visceral pleural invasion (Chen et al., 2013), old pulmonary tuberculosis lesions (Zhou et al., 2013), smoking status before illness (Mahesh et

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al., 2012; Nagakura et al., 2012), receipt of treatment, and socioeconomic inequalities or disparities in access to health care (Forrest et al., 2013).

Hence, the rates of lung cancer survival reported from clinical observations or hospital-based observations are unable to reflect the differences between or within countries or areas because of limitations in the number of patients who received various cancer therapies or in sub-sets of patients exhibiting various clinical characteristics. For assessing the overall efficiency of cancer health services in a given region or country, population-based cancer survival data are strongly recommended (Sankaranarayanan et al., 2011). There are many reports referring to population-based cancer incidence data as well as survival data from western countries, such as the Cancer Incidence in Five Continents (Curado et al., 2009; Forman et al., 2014) and EUROCARE Study series (Berrino et al., 1995; De Angelis et al., 2014), as well as from Asian countries (Zeng et al., 2015; Roshandel et al., 2014; Varghese et al., 2014). However, long-term survival data adequate to describe and analyze the trends in incidence and survival of lung cancer, especial in rural areas, are rare.

Qidong has been long recognized as an endemic area for liver cancer, a circumstance that triggered the establishment of the Qidong Cancer Registry (QCR) over 40 years ago. Qidong, with a current and stable population of 1.12 million, has been a largely self-sufficient agricultural region until recently. However, the agricultural and economic isolation of Qidong began to dissipate in the late 1990s. Enormous transformations over the past decade have led Qidong to become a manufacturing center with a highly urbanized city center typical of modern coastal China. The continuous operation of the QCR provides the opportunity to examine trends of lung cancer incidence and survival over 4 decades using a population-based cancer monitoring registry initiated in a rural area in China.

Materials and Methods

Case-finding

The QCR is a population-based registry designated in 1972 as the cancer registration repository by the local health authority with compulsory reporting by health care workers. The Qidong All-death Cause Registration System has been an official vital statistics source approved by the Ministry of Health of China since 1974 (Chen et al., 2006; Zhao et al., 2012; Chen et al., 1991), with death from any cause reported by death certification notifications. Meeting the International Agency for Research on Cancer / International Association of Cancer Registries standards for quality, completeness, timeliness and unresolved duplicate records, the QCR is a member of the International Association of Cancer Registries. QCR data have been included in "Cancer Incidence in Five Continents" (CI5) (Ferlay et al., 2015a, http://globocan.iarc.fr; Forman et al., 2014; Parkin et al., 1997; Parkin et al., 2002) and other publications (Chen et al., 2006; Zhao et al., 2012).

Case Follow-up

The QCR uses both active and passive methods for cancer data collection and follow-up. All data files received from lower-level registries and all other hospitals or clinics are checked with cancer report lists and death certification notifications in order to track down missing cases and to exclude duplicate registrations. If the registry personnel receive the death notification first, the patient's medical records are reviewed or a home visit is carried out to obtain further information. The deadline of the latest follow-up for the data set used in this study was April 30, 2012. The survival duration of each case with lung cancer was determined as the time difference from the date of initial diagnosis to the date of death. The proportion of cases with morphological verification was 12.72% (1951/15340), with 41 lung cancer cases recognized by death certificate only.

Population, cancer classification and rate standardization

The age distribution of the Qidong population is available from the sampling survey of 1976, and censuses of 1982, 1990, 2000, and 2010; proportional age distribution for each year was made by interpolating between these points. The International Classification of Diseases, 10th revision (ICD-10) was used for cancer classification. In this paper, lung cancer cases were those coded as C33-34 in the ICD-10. Crude rate (CR) was calculated by using population denominators. Age standardized rates by China population (CASR) 1964, and by world population 1960 were calculated; rates are expressed per 100,000 person-years, as described previously (Chen et al., 2006). The percent change in rates (r) over a particular time period is calculated by taking the difference between the average rate of the first 2 years (x, x+1) and the average rate of the last 2 years (y, y-1), and dividing the difference by the average rate of the first 2 years, and multiplying by 100 to convert it to a percent. The annual percent change is calculated by fitting a least squares regression line to the natural logarithm (Ln) of the r, using the calendar year (x) as a regression variable (Chen et al., 2006).

Survival rate calculation

Cumulative observed survival rate (OS) and relative survival rate (RS) are calculated by using Hakulinen's SURV3.01 Software (http://www.cancer.fi/@Bin/54321472/index.html). The result of RS is a ratio of survival rate for a group of patients with the same gender in the same age and the same period, i.e., $S_c(t)=S_o(t) / S_e(t)$, where $S_c(t)$ is relative survival rate, So(t) is observed survival rate; $S_e(t) = \sum n_x S_{ex}(t) / \sum n_x$, where nx is the number of patients being followed up at the age of X, $S_{ex}(t)$ is the survival rate at the time point t of age X. RS is calculated to exclude the chance of death from diseases other than this cancer. The expected survival rate for a group of people in the general population similar to the patient group with respect to gender, age and calendar registered year of observation was calculated using the Qidong life tables (Chen et al., 1998; Sankaranarayanan eds., 2011) for the years 1974-2011.

Results

Crude incidence and age standardized rate

The total numbers of cancer for all sites during the period of 1972 to 2011 were 92,780, of which 15,340 were lung cancer (16.53%). As such, lung cancer is the third leading cancer site for Qidongese after liver and stomach over this period. The crude incidence rate (CR) of lung cancer was 34.12 per 100,000 population, and the truncated rate in 35-64 year olds was 36.96 per 100,000. Table 1 indicates that there are marked upward trends for the CR, as well as CASR and WASR: from 9-16, 7-12, and 11-18 per 100,000 in 1972-1975 to 67-77, 19-22, and 32-36 per 100,000 in 2008-2011, respectively. Since 2010, lung cancer has been the number one cancer site in Qidong, with a CR of 76.09 per 100,000 in 2011.

Incidence rates by gender and the age-specific rate

Table 2 shows that the ratio of male to female incidence was 2.62:1, in which male cases were 11,028, female cases 4312, with crude rates of 49.67 per 100,000 for males, and 18.95 per 100,000 for females integrated over the 40 year period. Incidences in men and women increased rapidly from 11-21 and 7-12 per 100,000 in 1972-1975 to 97-110 and 36-46 per 100,000 in 2008-2011, respectively. The CASR and WASR have similar upwards trends during the period of 1972-2011.

The average incident ages of lung cancer were 66.22, 65.95, and 66.14 years for males, females, and both genders combined. Static between 1975 and 1999, there has been a steady increase in average incident age thereafter. The age-specific rates increase with age, peaking at 401.26, 111.81, and 234.75, per 100,000 for males, females, and both genders, within the age group of 75-79.

Table 1. Crude Rate, CASR, WASR, Truncated Rate and Cumulative Rate for Lung Cancer Incidence in Qidong, 1972-2011

Year	No. Cases	To All Sites (%)	CR per 100000	CASR per 100000	WASR per 100000	Truncated Rate of 35-64 per 100000	Cum.Rate of 0-74 (%)	Cum. Risk (%)
1972	125	7.59	12.09	9.41	14.34	27.69	1.95	1.93
1973	94	6.81	9.01	7.28	10.83	22.46	1.36	1.35
1974	159	10.14	15.10	11.50	17.81	32.50	2.44	2.41
1975	168	9.51	15.82	11.42	18.06	30.68	2.29	2.26
1976	166	9.91	15.50	11.48	18.03	30.30	2.42	2.39
1977	145	9.35	13.43	9.26	14.86	20.82	1.95	1.93
1978	185	11.85	17.02	12.08	18.83	32.15	2.30	2.28
1979	176	11.27	16.12	11.10	17.63	28.16	2.28	2.25
1980	167	10.82	15.25	10.39	16.21	22.36	2.16	2.14
1981	207	13.55	18.83	12.04	19.12	29.15	2.34	2.31
1982	217	12.17	19.61	12.55	20.48	31.82	2.87	2.82
1983	220	12.89	19.77	12.58	19.89	32.01	2.48	2.45
1984	248	13.18	22.20	13.91	21.71	33.61	2.81	2.77
1985	207	11.53	18.48	11.63	18.31	36.09	2.26	2.23
1986	256	13.48	22.79	13.39	21.26	32.22	2.79	2.75
1987	267	13.76	23.64	13.66	21.67	31.61	2.90	2.86
1988	265	14.95	23.30	13.37	21.24	32.02	2.77	2.73
1989	261	13.28	22.77	12.41	19.96	29.94	2.55	2.51
1990	318	14.87	27.54	15.50	24.25	39.22	3.27	3.22
1991	291	13.66	25.07	13.19	20.96	30.92	2.71	2.68
1992	327	15.77	28.12	14.52	22.96	40.88	2.97	2.93
1993	343	14.82	29.47	15.20	23.55	41.42	3.00	2.95
1994	339	14.92	29.12	14.48	22.53	37.01	2.93	2.89
1995	389	15.51	33.42	15.88	24.85	41.76	3.32	3.26
1996	352	14.81	30.21	13.85	21.77	35.48	2.94	2.90
1997	395	15.93	33.84	15.42	23.82	37.28	3.14	3.09
1998	463	18.76	39.68	17.11	27.11	39.59	3.82	3.75
1999	445	18.26	38.25	16.08	25.19	41.55	3.28	3.23
2000	501	18.89	43.13	17.03	27.29	40.20	3.74	3.68
2001	491	18.73	42.35	16.04	25.85	37.67	3.42	3.36
2002	536	19.91	46.45	17.13	27.33	39.17	3.64	3.57
2003	543	19.75	47.32	16.77	27.03	37.03	3.52	3.46
2004	621	19.60	54.53	18.87	30.52	43.61	4.02	3.94
2005	699	22.11	61.78	20.16	33.17	41.27	4.33	4.24
2006	739	22.11	65.60	20.66	34.16	43.07	4.36	4.27
2007	793	21.55	70.71	21.16	35.50	46.25	4.42	4.33
2008	760	20.94	68.08	20.20	33.39	42.01	4.12	4.04
2009	744	21.15	66.73	19.02	31.79	38.75	4.01	3.93
2010	864	21.78	77.27	21.89	36.40	45.18	4.46	4.36
2011	854	22.03	76.09	20.55	35.19	42.19	4.35	4.26
Total	15340	16.53	34.12	15.74	25.41	36.96	3.27	3.22

Table 2. Crude Rate, ASR per 100,000 by Gender for Lung Cancer in Qidong, 1972-2011

Year	Male				Female			
	No. Cases	CR	CASR	WASR	No. Cases	CR	CASR	WASR
1972	86	16.97	14.30	21.82	39	7.40	5.32	8.24
1973	55	10.76	9.34	13.94	39	7.34	5.58	8.23
1974	95	18.37	15.37	23.84	64	11.95	8.27	12.83
1975	109	20.87	16.85	26.39	59	10.93	6.89	11.21
1976	108	20.48	16.55	26.07	58	10.67	7.30	11.41
1977	90	16.93	12.92	20.87	55	10.04	6.26	10.02
1978	114	21.30	16.94	26.23	71	12.87	7.89	12.56
1979	117	21.76	16.46	26.39	59	10.65	6.65	10.53
1980	121	22.49	16.39	26.32	46	8.25	5.53	8.38
1981	135	24.99	17.69	28.83	72	12.87	7.43	11.56
1982	153	28.03	19.63	32.57	64	11.41	6.72	10.87
1983	161	29.32	20.10	32.40	59	10.46	6.35	9.92
1984	184	33.38	22.65	35.75	64	11.31	6.53	10.27
1985	164	29.61	20.04	32.08	43	7.59	4.36	6.85
1986	173	31.13	19.63	31.95	83	14.62	8.26	12.86
1987	183	32.77	21.01	33.31	84	14.71	7.18	11.76
1988	186	33.04	20.44	33.09	79	13.75	7.34	11.44
1989	189	33.30	19.57	32.14	72	12.44	6.35	10.15
1990	234	40.90	24.48	39.33	84	14.42	7.71	11.76
1991	199	34.57	19.22	31.52	92	15.73	7.98	12.27
1992	246	42.61	23.27	37.56	81	13.83	6.61	10.23
1993	249	43.05	23.04	36.39	94	16.06	7.93	12.10
1994	249	43.09	21.85	34.97	90	15.35	7.65	11.34
1995	307	53.22	26.09	41.56	82	13.96	6.20	9.45
1996	274	47.39	22.18	35.53	78	13.28	5.90	9.01
1997	291	50.24	23.27	36.40	104	17.69	7.76	11.92
1998	361	62.44	27.08	43.50	102	17.33	7.45	11.59
1999	328	56.91	24.71	38.66	117	19.93	7.43	11.90
2000	360	62.51	24.47	40.27	141	24.07	9.79	15.10
2001	355	61.81	23.66	38.71	136	23.25	8.61	13.57
2002	409	71.53	26.87	43.46	127	21.81	7.76	12.24
2003	402	70.71	25.49	41.63	141	24.35	8.44	13.38
2004	445	79.06	27.86	46.06	176	30.55	10.36	16.20
2005	501	89.70	30.10	50.40	198	34.56	10.89	17.54
2006	526	94.62	30.16	51.53	213	37.32	12.00	18.92
2007	570	103.06	31.69	54.37	223	39.24	11.58	18.97
2008	555	100.87	30.84	52.04	205	36.22	10.54	17.05
2009	535	97.48	28.51	49.05	209	36.92	10.56	16.84
2010	605	110.05	32.62	55.04	259	45.57	12.18	20.10
2011	604	109.54	30.82	54.00	250	43.79	11.45	19.19
Total	11028	49.67	24.04	39.55	4312	18.95	8.34	13.22

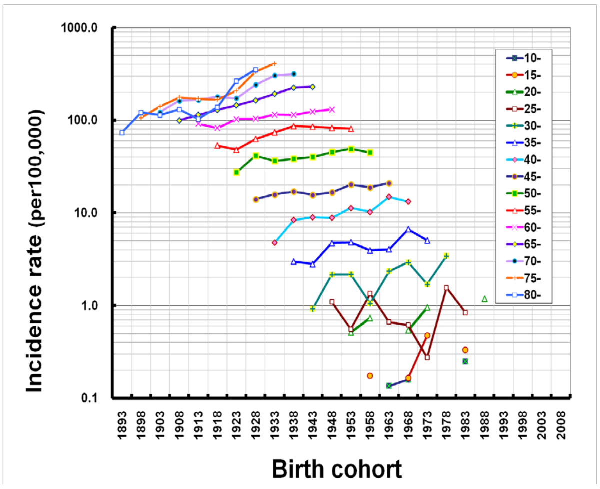

Figure 1. Incidence Rate for Lung Cancer by Birth-cohort in Qidong, China, 1972-2011

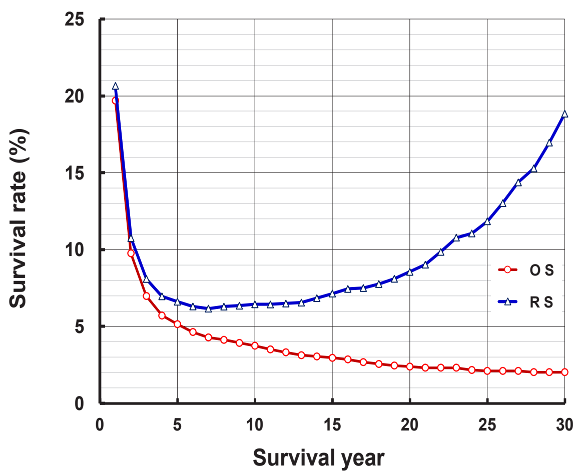

Figure 2. Observed Survival Rate and Relative Survival Rate of Lung Cancer in Qidong, China

Table 3. Observed Survival Rate of Lung Cancer by Period in Qidong, 1972-2011 (%)

Surval year	1973-1977	1978-1982	1983-1987	1988-1992	1993-1997	1998-2002	2003-2007	2008-2011
1	19.95	15.97	13.86	14.02	14.52	19.95	21.68	26.28
2	8.61	8.09	6.85	6.91	6.60	9.65	11.34	12.99
3	5.60	5.46	5.26	4.51	4.79	6.69	8.72	8.62
4	4.37	4.62	4.17	3.76	4.02	5.62	7.16	5.71
5	3.55	4.10	3.92	3.56	3.69	5.13	6.32	-
6	3.01	3.78	3.51	3.22	3.30	4.76	5.70	
7	2.73	3.47	3.17	2.87	3.14	4.48	5.27	
8	2.60	3.47	3.09	2.80	3.03	4.27	5.02	
9	2.46	3.15	2.92	2.67	2.97	4.11	4.32	
10	2.32	3.05	2.76	2.53	2.86	3.93	-	
11	2.32	2.84	2.50	2.46	2.70	3.57		
12	1.78	2.73	2.50	2.33	2.64	3.47		
13	1.78	2.21	2.34	2.26	2.59	3.30		
14	1.78	1.89	2.25	2.26	2.59	3.30		
15	1.50	1.79	2.25	2.19	2.59	-		

Birth cohort incidence and annual percent change

Figure 1 shows the incidence of lung cancer by birth cohort during the years 1972-2011. It clearly features that incidence rates have been increasing in all birth cohorts over the age of 25. The percent changes (PC) of the CR, CASR, and WASR during the 40-year period were 626.68%, 154.31%, and 184.35%; the annual percent changes (APC) were, 4.92%, 2.05%, and 2.21%, respectively. The age-specific incidence rates increased gradually within all age groups 25 and older. In age group of 75+, for instance, the specific rate rose from 52.94 per 100,000 in 1972 to 378.47 per 100,000 in 2008-2011.

Overall observed survival and relative survival

The overall OS rates of 1-, 3-, 5-, 10-, 15-, 20-, and 30-year were 19.69%, 6.98%, 5.15%, 3.75%, 2.96%, 2.39%, and 2.03%; and the RS rates were 20.65%, 8.09%, 6.61%, 6.44%, 7.14%, 8.55%, and 18.84%, respectively. The OS and RS by year are shown in Figure 2.

Survival rate by gender, age and period

Males experienced poor survival rates, with the OSs of 18.86%, 6.32%, 4.68%, 3.35%, 2.68%, 2.08%, and 1.77% for 1-, 3-, 5-,10-, 15-, 20-, and 30-year survival; in females the rates were slightly improved to 21.81%, 8.73%, 6.36%, 4.80%, 3.70%, 3.20%, and 2.76%, respectively. The RS rates show same tendency: rates were 19.85% 7.40%, 6.14%, 6.00%, 6.95%, 8.32%, and 20.13% in males and 22.66%, 9.82%, 7.78%, 7.43%, 7.55%, 9.08%, and 18.10% in females, respectively. Overall, the survival rate from lung cancer decreased with age with a 5-year OS of 13.20 within the age group of 15-34, and of 2.21 in the age group of 75+. For RSs, these were 13.31 and 4.69, respectively. Survival results by period during the 40 years give feature an unclear trend: the 5 year OSs were 3.55% in 1973-1977, 4.10% in 1978-1982, 3.92 in 1983-1987, 3.56 in 1988-1992, 3.69% in 1993-1997, 5.13% in 1998-2002, and 6.32% in 2003-2007. For the 10-year OSs, the rates oscillated between 2.32% to 3.93% during the periods of 1973-1977 to 2003-2007. Table 3 indicates a slight improvement for OS by period, but it is still very poor over these four decades.

Discussion

The incidence of lung cancer used to be significantly higher in most industrialized areas worldwide compared with undeveloped countries. Now the burden of this disease is declining in some developed countries (Siegel R et al., 2014), but, due to the rising rates in developing countries, lung cancer has become the number one cancer worldwide (Parkin, 1994; Ferlay et al., 2015b). A study shows very high WASRs of lung cancer incidence in 2012, being among 149.4 - 373.9 per 100,000 in men, and 179.0 - 293.6 per 100 000 in women in Australia, Brunei Darussalam, Japan, Korea, New Zealand, and Singapore (Varghese et al., 2014). In China, from 1991 to 2005, lung cancer deaths in men have increased by 112%, in which 62% is attributed to increased risk and 50.0% to aging of the population; in women by 154% (102% due to the altered risk and 52% due to altered population demographics) (Yang et al., 2004). A recent report shows that the lung cancer crude incidence was 63.90 (CASR: 48.44) per 100,000 for males, and 31.93 (CASR: 21.93) per 100,000 for females in 2011 in China, ranking lung cancer first in all cancer sites in men, and second in women (Chen et al., 2015).

Lung cancer in China has experienced a continuous rising during the last 5 decades. For instance in metropolitan Shanghai, the crude mortality rates of lung cancer increased from 15.57 (WASR: 28.45) in 1963-1965 to 47.94 (55.53) per 100,000 in 1976-1977 (Gao et al., 1981); and the crude incidence rates increased in males and females from 63.55 and 26.21 in 1987 to 79.00 and 34.47 per 100,000 in 1997, respectively (Gao et al., 2007). In Beijing, lung cancer crude mortality has been shown the same increasing trends from 1977-1979 to 1983-1985 (Wang et al., 1990); in the years 2008-2012, the lung cancer incidence rates in urban and suburban areas were 61.23, and 55.94 per 100,000 respectively (Yang et al., 2015). Increasing incidence rates are also reported in Zhejiang province (Mao, 2013) and in a rural area, Yanting county in Sichuan province, where the WASRs were 15.64 in 2004, and 26.06 per 100,000 in 2009 , with an APC of 12.86% (Li et al., 2011), showing the absolute rates are not so high but the upward trend is well defined.

In this 40 years perspective of the Qidong setting, we find that lung cancer has been rapidly rising with a CASR of 12.09 per 100,000 in 1972 and 76.09 in 2011 (Table 1). These values imply that the changes in rates for lung cancer have not only reflect aging of the Qidong population, but also changes in risk factors. What is noteworthy is that the crude incidence rates in recent years in this heretofore rural hinterland county have reached to over 100 per 100,000 in men, and over 40 per 100,000 in women, which surpasses the average lung cancer rate in China as a whole (Chen et al., 2015), and close to the levels reported in Shanghai and Beijing (Gao et al., 2007; Yang et al., 2015). The drivers for the increases in risk for this cancer are likely reflected in social changes, increasing urbanization, environmental pollution, and lifestyle evolution.

Risk factors of lung cancer have been known for decades: dust inhalation, radiation and radon gas and cigarette smoking (Ridge et al., 2013). Recent epidemiological surveys show that ambient air pollution contributes to risk of lung cancer (Raaschou-Nielsen et al., 2013), and is linked to exposure to urban air pollutants, mainly $PM_{2.5}$ or PM_{10} and their components (Demetriou et al., 2015; Hamra et al., 2014). Smoking is very prevalent in men in Qidong and almost absent in women. Lung cancer incidence rates have increased linearly over the past four decades (Table 1), especially in men (Chen et al., 2014). Cigarette smoking could be a major cause of lung cancer as the rate of cigarette consumption per capita in men has increased in a similar linear fashion (Chen et al., 1991). However, other factors must be in play as there has been a doubling of lung cancer incidence in Qidongese women in the past decade following a 3-decade period of no change. With the evolving urbanization of the countryside within the circle of the Shanghai Economical Zone, regional air pollution has become a public health concern. Monitoring of air pollutants in the Yangtze River delta area show that there are no real differences in the levels of ambient air pollutants such as PM_{10} between Shanghai and Qidong in recent times (De Angelis et al., 2014). This may contribute to an explanation of why non-smoking women in this area also had increased lung cancer incidence close to the rate in Shanghai in the latest decade (Gao et al., 2007; Chen et al., 2014). We conclude from the current and past trends that lung cancer incidence in the Qidong area is likely to continue increasing in the absence of effective policies to mitigate smoking and exposures to air pollutants.

There are few reports referring to long term cancer survival rates especially in rural areas from population-based cancer registration systems. In Qidong the 5-, 10-, 20-, and 30-year OSs were 5.15%, 3.75%, 2.39%, and 2.03%, and RSs were 6.61%, 6.44%, 8.55%, and 18.84%, respectively. Some progress in survival could be seen; for instance, the five-year OS was 6.32% in 2003-2007 compared to 3.55% in 1973-1977. However, these survival rates are poor compared with results from most Western countries, and some Asian countries. From a EUROCARE study the 5-year RS for the period of 1999–2007 was 13%, ranging from 16.7% in Austria to 6.2% in Bulgaria (De Angelis et al., 2014). Previous reports indicated 5-year RSs of 14% to 28% in the US (Hayat et al., 2007), Germany (Brenner et al., 2005), Korea (Jung et al., 2007), and Japan (Tsukuma et al., 2006). In a recent global surveillance of cancer survival 1995-2009, 5-year survival from lung cancer was reported higher than 20% in only three countries: Japan (30%), Israel (24%), and Mauritius (37%) (Allemani et al., 2015). In contrast, during the period of 2005-2009, the 5-year RSs were 2.2%, 10.3%, and 14.8% in African countries Libya, Tunisia, and Algeria, respectively, and were 4.4%, 6.6%, 8.1%, 10.1%, and 10.7% in Asian countries Jordan, Mongolia, Thailand, Turkey, and Malaysia (Allemani et al., 2015). These results suggest that lung cancer remains lethal in most countries, but exhibit disparities in survival between developed and developing countries.

Pooled analyses of cancer survival data of 2003-2005 from 17 registries in China showed that 5-year RS for lung cancer was 16.1%. Patients from rural areas had a poorer rate of 11.2% compared to 19.5% for those from urban areas, likely due to their poor quality of cancer care and limited access to health care (Zeng et al., 2015). This is also true for Qidong. Recent improvement in transportation infrastructure allows patients with lung cancer easier access to big city hospitals (such as Shanghai). The available data from population-based cancer registries in Shanghai (Xiang et al., 1996) and Beijing (Wang et al., 2001) have showed that the 5-year RSs of lung cancer were between 11-12%, while in a rural area Changle (Chen et al., 2000) in Southern China, it was 5.5% in men, and 3.9% for women. This poor survival is similar to our observations of 6.14% in men and 7.78% in women.

In conclusion, lung cancer has been rapidly increasing in rural area of Qidong during the last 4 decades, and may continue to rise in the foreseeable future. The poor survival from lung cancer in Qidong reflects a rural-urban disparity reflecting a lack in screening and early detection programs as well as limited options in the health care services. The recent urbanization of this region with an expanded cancer care infrastructure may lead to the improvement in survival of lung cancer in Qidong, but only if coupled with programs to reduce exposures to etiological factors..

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