Original Article

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Cancer incidence and mortality patterns in Luwan district of Shanghai during 2002-2011

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Summary **Cancer has become the leading cause of death and a major burden to public health in China. The current study analyzed the composition, incidence, mortality, and temporal trends for some major cancer types among permanent residents in Luwan district of Shanghai from 2002 to 2011, so as to provide data for cancer research. Data were collected from the database of cancer registration and management system in Shanghai. Number of new cases, number of deaths, incidence, and mortality of each cancer type were calculated. The incidence and mortality rates were standardized. Temporal trends in the incidence and mortality were assessed using average annual percent change. There were 12,843 new cancer cases and 8,331 deaths from cancer in Luwan from January 2002 to December 2011. Age-standardized incidence rates by Segi's standard were 229.46 and 205.05 per 100,000 population for males and females, respectively. For males, the most commonly diagnosed cancers were lung, colorectal, stomach, liver, prostate, bladder, pancreas, kidney, lymphoma, and esophageal cancers; for females, they were breast, colorectal, lung, stomach, thyroid, liver, ovary, pancreas, uterus, and brain cancers. The incidence rates for all cancers combined increased significantly for both males and females from 2002 to 2011 ($p < 0.05$ for both). Age-standardized mortality rates were 147.04 and 90.62 per 100,000 population for males and females, respectively. The mortality rates have stayed stable during the 10-year period for both males and females ($p > 0.05$ for both). Our results suggest that cancer incidence and mortality rates in Luwan district of Shanghai vary by age, sex, tumor type. The increasing trends in cancer incidence call for effective prevention and control measures in the district. The significance of cancer registration for disease surveillance and management needs to be further advocated.**

Keywords: Cancer, incidence, mortality, temporal trend, Shanghai

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1. Introduction

Cancer is a major public health problem in China and has become the leading cause of death since 2010 (*1*). This increase has been attributed in part to lifestyle changes associated with rapid economic development. Shanghai is the forerunner of China's urbanization and socioeconomic development. There have been tremendous changes occurring in Shanghai in recent decades, which lead to environmental changes such as air and water pollution, and lifestyle changes including

westernized diet, physical inactivity, and reproductive changes (such as late marriage and late childbearing). Luwan district, located at the southeastern part of urban Shanghai, has a total area of 8.05 km^2 and a population around 0.3 million (*2*). The relatively stable and dense aging population, optimized and upgraded industrial structure, and relatively abundant medical resources in this district assume greater representative of developed urban regions in China. Using integrated data based on the district cancer registry in an urban setting, this study provided comprehensive regional information of the cancer burden in the past 10 years.

In the current study, we comprehensively analyzed composition, incidence and mortality of cancer in Luwan district of Shanghai. All cancers and cause-specific incidence and mortality rates were calculated, and further stratified by gender, age categories, and leading causes of cancer occurrence and death. The trends of incidence and mortality rates for all cancers combined and selected cancers were tested during the period of 2002 to 2011. The purposes of this study include: 1) present the regional burden and distribution of cancer in Luwan district of Shanghai, 2) provide population-based evidence for cancer research, future policy design, and health resource allocation, and 3) demonstrate the importance of cancer registration for disease surveillance and management.

2. Materials and Methods

2.1. *Data sources*

The cancer data from January 1st 2002 to December 31st 2011 of permanent residents in Luwan district were collected from the database of cancer registration and management system in Shanghai. The population data were from Center for Disease Control and Prevention of Luwan district in Shanghai. All cancer cases were classified according to the International Classification of Diseases, 10th revision (ICD-10). Because of data corrections or case capture lags, cancer incidence rates were adjusted for reporting delays whenever possible. Percentages of cancers morphology verified (MV%) and death certificate only (DCO%) showed overall data quality is good.

2.2. *Statistical analyses*

Incidence and mortality rates were calculated as the total number of new cases/deaths each year divided by the corresponding annual average population in Luwan district and expressed per 100,000 population. The rates were standardized by the demographic composition developed in the Fifth Nationwide Census in the year 2000, and the Seig's world standard (*3,4*). Age-specific incidence and mortality were also calculated for all cancers combined and selected common cancer types. Gender difference was compared using the u-statistics for two observed Poisson variables. All above analyses were two-sided and performed using EXCEL2007 and SPSS 16.0 (SPSS, Inc., Chicago, IL). A $p < 0.05$ was considered statistical significant.

Temporal trends of the incidence and mortality rates for all cancers combined and the 10 most common cancer types stratified by sex were assessed using fitting joinpoint model by Join-point Regression Program 3.5.1 (*5*). Rates (per 100,000 population) were age-standardized according to the Segi's world standard population and log-transformed. Models were restricted to a maximum of 2 joinpoints (*i.e.*, 3 line segments), and trends were expressed as an annual percent change (APC). The statistical significance of the APC was assessed by the Z test. Terms "increase" or "decrease" were used to describe statistically significant ($p < 0.05$) APC, while the term "stable" was used for non-statistically significant trends.

3. Results

3.1. *Cancer incidence*

The annual number of new cases and incidence for all cancers are presented in Table 1. A total of 12,843 new cancer cases were diagnosed from January 2002 to December 2011. There were 6,563 (51.10%) male cancer cases, and 6,280 (48.90%) female cancer cases. The male to female ratio was 1.05:1. For all cancers combined, the crude incidences of males and females were 417.62 and 391.63 per 100,000 population, respectively. Age-standardized rates by the 2000 Chinese standard population were 191.10 and 180.11 per 100,000 population for males and females, and age-standardized rates by Segi's standard were 229.46 and 205.05 per 100,000 population for males and females, respectively. Male incidence for all cancers combined was higher than the female incidence, and the difference was statistically significant ($u = 3.65$, $p < 0.01$).

The number of new cases, crude and age-standardized incidences for commonly diagnosed cancer types by sites are presented in Table 2. The 10 most common cancer types among males were: lung, colorectal, stomach, liver, prostate, bladder, pancreas, kidney, lymphoma, and esophageal cancers, accounting for about 80 percent of all new cancer cases. Lung cancer alone was accounting for about 19 percent of all new cancer cases in males. The corresponding cancers among females were: breast, colorectal, lung, stomach, thyroid, liver, ovary, pancreas, uterus, and brain, accounting for more than 76 percent of all cases. Breast cancer alone was accounting for approximately 19 percent of all new cancer cases in females (Table 2). The incidences of lung ($u = 13.46$, $p < 0.01$), stomach ($u = 9.88$, $p < 0.01$), liver ($u = 11.96$, $p < 0.01$), bladder ($u = 9.60$, $p < 0.01$), kidney ($u = 5.38$, $p < 0.01$), esophageal ($u = 8.05$, $p < 0.01$) cancers,

Table 1. New cases and incidence of all malignant tumors in Luwan district of Shanghai, 2002-2011

Year	Males					Females					Total				
	New cases	Population	Crude rate (1/10^5)	ASR China* (1/10^5)	ASR World† (1/10^5)	New cases	Population	Crude rate (1/10^5)	ASR China* (1/10^5)	ASR World† (1/10^5)	New cases	Population	Crude rate (1/10^5)	ASR China* (1/10^5)	ASR World† (1/10^5)
2002	654	169034	386.90	188.70	227.65	582	171089	340.17	158.87	184.97	1236	340123	363.40	171.12	202.97
2003	605	164522	367.73	180.63	216.73	585	166582	351.18	164.63	185.79	1190	331104	359.40	170.39	198.47
2004	658	162074	405.99	187.74	228.07	572	164138	348.49	163.56	184.08	1230	326212	377.06	172.66	201.97
2005	586	159090	368.34	175.75	213.54	607	161257	376.42	174.51	202.79	1193	320347	372.41	173.76	206.58
2006	666	156367	425.92	195.50	234.11	592	158819	372.75	178.37	200.40	1258	315186	399.13	184.4	214.03
2007	631	154860	407.46	189.63	224.09	615	157770	389.81	170.83	193.60	1246	312630	398.55	178.69	206.92
2008	641	153593	417.34	185.99	221.81	635	157235	403.85	188.11	217.88	1276	310828	410.52	185.09	217.40
2009	681	152216	447.39	193.40	228.66	601	156526	383.96	175.73	199.44	1282	308742	415.23	183.04	212.11
2010	719	150506	477.72	194.86	238.15	738	155387	474.94	208.56	233.54	1457	305893	476.31	200.58	234.26
2011	722	149281	483.65	211.36	252.71	753	154752	486.58	217.76	244.80	1475	304033	485.14	214.01	248.13
Total	6563	1571543	417.62	191.10	229.46	6280	1603555	391.63	180.11	205.05	12843	3175098	404.49	183.68	214.83

*Age-standardized rate by Chinese standard population based on the result of national census in 2000. †Age-standardized rate by Segi's world standard population.

lymphoma (u = 8.05, p < 0.01) and leukemia (u = 2.37, p < 0.01) were significantly higher among males than females. While the incidences of thyroid (u = 9.46, p < 0.01), brain (u = 1.84, p < 0.05), and gallbladder (u = 4.77, p < 0.01) cancers were significantly higher among females than males. There were no significant differences for colorectal (u = 0.62, p > 0.05), and pancreas (u = 1.27, p > 0.05) cancers between males and females.

The age distributions of the top 5 most frequently diagnosed cancer types by sex are presented in Figure 1a and 1b. In general, incidences of the 5 most common cancer types among males increased with age (Figure 1a). For lung, colorectal, stomach, and liver cancers, the incidences gradually increased after 45 years of age, and peaked at age group 80-85. There was a sharp increase for lung, colorectal, and stomach cancers after age 55. For prostate cancer, incidence increased steeply after age 70, and peaked at age group 85+. Among females, thyroid cancer was diagnosed among almost all age groups. The incidence of breast cancer increased significantly after 35 years of age, and stayed high between the ages 45-80. The incidences of colorectal, lung, and stomach cancers also increased significantly with age, and the sharp increase was seen after ages 50, 55, and 65, respectively.

3.2. *Cancer mortality*

The annual number of deaths, crude and age-standardized mortality for all cancers are presented in Table 3. A total of 8,331 patients died of cancer from January 2002 to December 2011. There were 4,694 (56.34%) cancer deaths of males, and 3,637 (43.66%) cancer deaths of females. The male to female ratio was 1.29:1. For all cancers combined, the crude mortality of males and females were 298.69 and 226.81 per 100,000 population, respectively. Age-standardized rates by the 2000 Chinese standard population were 118.82 and 73.78 per 100,000 population for males and females, and age-standardized rates by Segi's standard were 147.04 and 90.62 per 100,000 population for males and females, respectively. Male mortality for all cancers combined was significantly higher than the female mortality (u = 12.52, p < 0.01).

The number of cancer deaths and mortality for common cancer types by sites are presented in Table 4. The top 10 causes of cancer deaths among males were: lung, stomach, colorectal, liver, pancreas, prostate, esophageal, lymphoma, bladder, and leukemia, accounting for approximately 84 percent of all cancer deaths. Lung cancer alone was accounting for about one quarter of all cancer deaths in males. The corresponding cancers among females were: lung, colorectal, stomach, breast, liver, pancreas, gallbladder, ovary, lymphoma, and brain, accounting for about 78 percent of all cancer deaths. The mortality rates of lung (u = 13.89, p < 0.01), stomach (u = 8.95, p < 0.01), liver (u = 11.38, p < 0.01),

Table 2. Cancer cases, crude and adjusted incidences by sex in Luwan district of Shanghai, 2002-2011

Site	ICD-10	Males				Females			
		Cases	Incidence (10^5)	ASR China* (10^5)	ASR World† (10^5)	Cases	Incidence (10^5)	ASR China* (10^5)	ASR World† (10^5)
Lip, oral cavity, & pharynx (except nasopharynx)	C00-10, C12-14	94	5.98	3.13	3.54	59	3.68	1.77	2.12
Nasopharynx	C11	86	5.47	3.46	3.64	33	2.06	1.28	1.31
Esophagus	C15	209	13.30	5.73	7.13	76	4.74	1.34	1.74
Stomach	C16	862	54.85	23.36	28.56	510	31.80	11.90	13.81
Colon and rectum	C18-21	940	59.81	25.90	32.19	932	58.12	21.67	26.88
Liver	C22	610	38.82	19.14	21.88	265	16.53	5.48	6.78
Gallbladder	C23-24	94	5.98	2.22	2.89	175	10.91	3.30	4.15
Pancreas	C25	254	16.16	6.93	8.40	231	14.41	4.28	5.26
Larynx	C32	77	4.90	2.16	2.68	6	0.37	0.18	0.24
Lung	C33-34	1269	80.75	33.68	41.79	693	43.22	15.46	19.38
Other thoracic organs	C37-38	24	1.53	0.99	1.00	17	1.06	0.79	0.73
Bone	C40-41	26	1.65	1.05	1.14	20	1.25	1.10	1.20
Melanoma of skin	C43	11	0.70	0.32	0.43	12	0.75	0.43	0.44
Breast	C50	8	0.51	0.24	0.26	1221	76.14	41.27	45.06
Cervix	C53	--	--	--	--	142	8.86	6.70	6.19
Uterus	C54-55	--	--	--	--	194	12.10	6.05	6.86
Ovary	C56	--	--	--	--	236	14.72	8.80	9.59
Prostate	C61	447	28.44	9.91	12.91	--	--	--	--
Testis	C62	13	0.83	0.90	0.75	--	--	--	--
Kidney	C64-66,68	240	15.27	7.94	9.42	139	8.67	3.94	4.52
Bladder	C67	263	16.74	6.80	8.63	87	5.43	1.93	2.48
Brain, CNS	C70-72	155	9.86	6.68	7.27	193	12.04	6.31	7.18
Thyroid	C73	117	7.44	5.55	5.61	319	19.89	14.85	15.02
Lymphoma	C81-85, 88, 90, 96	203	12.92	6.71	8.04	173	10.79	5.15	5.80
Leukemia	C91-95	143	9.10	5.85	6.82	108	6.74	4.09	4.44
All other sites and unspecified	A_0	418	26.60	12.46	14.50	439	27.38	12.03	13.86
All sites	ALL	6563	417.62	191.11	229.47	6280	391.63	180.11	205.05

ASR, age-standardized rate; CNS, central nervous system; ICD-10, International Classification of Diseases, 10th revision. *Age-standardized rate by Chinese standard population based on the result of national census in 2000. †Age-standardized rate by the Segi's world standard population.

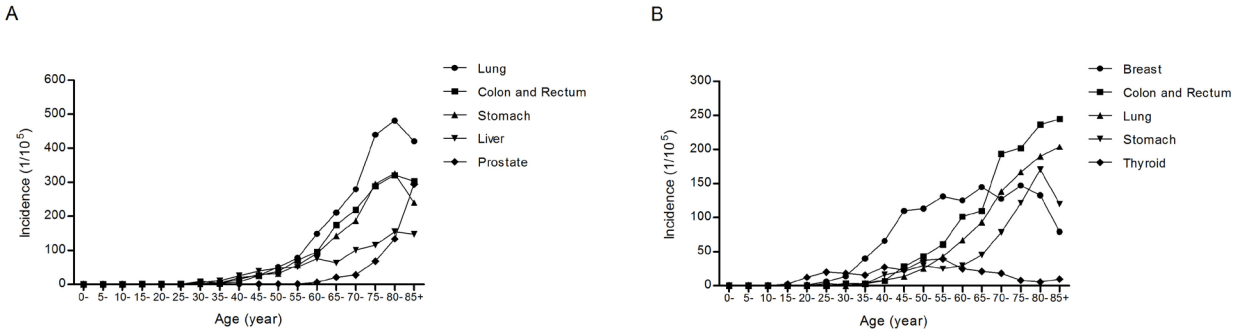

Figure 1. Age-specific incidences of the 5 most commonly diagnosed cancers among permanent residents in Luwan district of Shanghai, 2002-2011. (A) Age-specific incidences of the 5 most commonly diagnosed cancers among males in Luwan district of Shanghai, 2002-2011. **(B)** Age-specific incidences of the 5 most commonly diagnosed cancers among females in Luwan district of Shanghai, 2002-2011.

Table 3. Deaths and mortality of all malignant tumors in Luwan district of Shanghai, 2002-2011

Year	Males					Females					Total				
	Deaths	Population	Crude rate ($1/10^5$)	ASR China* ($1/10^5$)	ASR World† ($1/10^5$)	Deaths	Population	Crude rate ($1/10^5$)	ASR China* ($1/10^5$)	ASR World† ($1/10^5$)	Deaths	Population	Crude rate ($1/10^5$)	ASR China* ($1/10^5$)	ASR World† ($1/10^5$)
2002	505	169034	298.76	128.11	161.04	373	171089	218.02	80.03	97.05	878	340123	258.14	101.75	125.87
2003	463	164522	281.42	124.71	155.52	382	166582	229.32	78.22	98.15	845	331104	255.21	99.71	124.32
2004	467	162074	288.14	117.83	149.27	357	164138	217.50	77.42	91.89	824	326212	252.60	95.60	117.54
2005	440	159090	276.57	110.88	137.94	343	161257	212.70	74.82	88.38	783	320347	244.42	90.80	110.46
2006	442	156367	282.67	116.25	141.64	334	158819	210.30	68.99	85.50	776	315186	246.20	91.21	111.62
2007	428	154860	276.38	110.42	133.67	334	157770	211.70	68.54	83.16	762	312630	243.74	88.17	106.69
2008	474	153593	308.61	121.88	149.92	369	157235	234.68	76.06	93.15	843	310828	271.21	97.49	119.38
2009	501	152216	329.14	124.44	149.69	381	156526	243.41	78.54	98.24	882	308742	285.68	99.79	121.78
2010	504	150506	334.87	115.48	144.68	422	155387	271.58	73.15	93.79	926	305893	302.72	93.24	117.91
2011	470	149281	314.84	107.69	134.78	342	154752	221.00	61.89	76.60	812	304033	267.08	83.70	104.20
Total	4694	1571543	298.69	118.82	147.04	3637	1603555	226.81	73.78	90.62	8331	3175098	262.39	94.74	116.69

*Age-standardized rate by Chinese standard population based on the result of national census in 2000. †Age-standardized rate by the Segi's world standard population.

Table 4. Cancer deaths, crude and adjusted mortality rates by sex in Luwan district of Shanghai, 2002-2011

Site	ICD-10	Males				Females			
		Deaths	Mortality (10^5)	ASR China* (10^5)	ASR World† (10^5)	Deaths	Mortality (10^5)	ASR China* (10^5)	ASR World† (10^5)
Lip, oral cavity, & pharynx (except nasopharynx)	C00-10, C12-14	52	3.31	1.37	1.61	36	2.25	0.58	0.78
Nasopharynx	C11	52	3.31	1.72	2.08	17	1.06	0.38	0.47
Esophagus	C15	196	12.47	4.95	6.21	70	4.37	1.11	1.41
Stomach	C16	685	43.59	20.46	25.80	401	25.01	7.96	9.52
Colon and rectum	C18-21	546	34.74	13.03	16.47	558	34.80	10.24	12.98
Liver	C22	527	33.53	15.84	18.36	223	13.91	4.13	5.17
Gallbladder	C23-24	89	5.66	2.00	2.58	157	9.79	2.63	3.30
Pancreas	C25	230	14.64	6.11	7.36	219	13.66	3.91	4.93
Larynx	C32	47	2.99	0.97	1.29	6	0.37	0.16	0.24
Lung	C33-34	1178	74.96	28.87	36.12	609	37.98	11.92	15.01
Other thoracic organs	C37-38	19	1.21	0.50	0.71	12	0.75	0.47	0.45
Bone	C40-41	19	1.21	0.43	0.54	15	1.07	0.63	0.75
Melanoma of the skin	C43	5	0.32	0.12	0.16	2	0.12	0.03	0.10
Breast	C50	6	0.38	0.11	0.13	399	24.88	9.49	11.44
Cervix	C53	--	--	--	--	65	4.05	1.70	1.68
Uterus	C54-55	--	--	--	--	64	3.99	1.26	1.48
Ovary	C56	--	--	--	--	111	6.92	2.95	3.67
Prostate	C61	204	12.98	3.54	4.93	--	--	--	--
Testis	C62	2	0.13	0.13	0.11	--	--	--	--
Kidney	C64-66	65	4.14	1.42	1.79	60	3.74	1.15	1.44
Bladder	C67	137	8.72	2.29	3.27	51	3.18	0.60	0.82
Brain, CNS	C70-72	85	5.41	3.29	3.75	83	5.18	2.08	2.34
Thyroid	C73	11	0.70	0.29	0.37	18	1.12	0.32	0.44
Lymphoma	C81-85, 88, 90, 96	145	9.23	4.41	5.33	94	5.86	2.44	2.78
Leukemia	C91-95	112	7.13	4.24	4.96	72	4.49	2.14	2.51
All other sites and unspecified	A_0	282	17.94	6.86	8.36	295	18.40	5.52	6.93
All sites	ALL	4694	298.69	118.82	147.05	3637	226.81	73.78	90.62

ASR, age-standardized rate; CNS, central nervous system; ICD-10, International Classification of Diseases, 10th revision. *Age-standardized rate by Chinese standard population based on the result of national census in 2000. †Age-standardized rate by the Segi's world standard population.

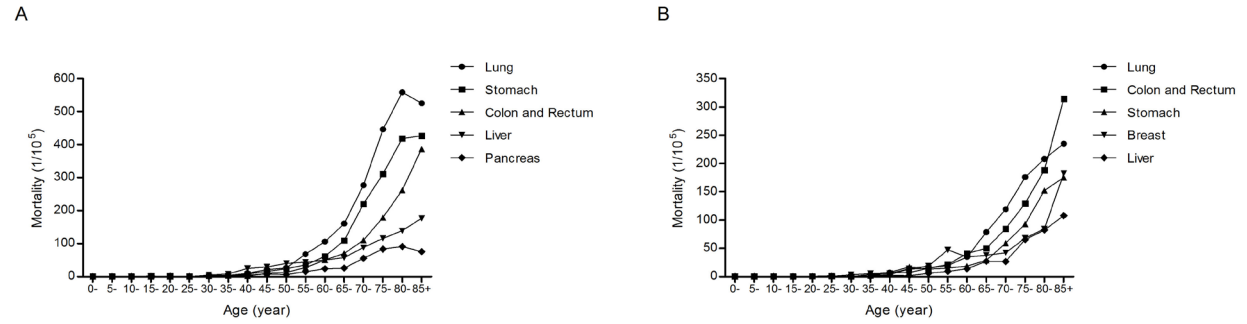

Figure 2. Age-specific mortality rates of the 5 most common causes of cancer deaths among permanent residents in Luwan district of Shanghai, 2002-2011. (A) Age-specific mortality rates of the 5 most common causes of cancer deaths among males in Luwan district of Shanghai, 2002-2011. **(B)** Age-specific mortality rates of the 5 most common causes of cancer deaths among females in Luwan district of Shanghai, 2002-2011.

Table 5. Death-to-case ratio by sex in Luwan district of Shanghai, 2002-2011

Year	Males			Females			Total		
	New cases	Deaths	Deaths /New cases	New cases	Deaths	Deaths /New cases	New cases	Deaths	Deaths /New cases
2002	654	505	0.77	582	373	0.66	1236	878	0.71
2003	605	463	0.77	585	382	0.65	1190	845	0.71
2004	658	467	0.71	572	357	0.62	1230	824	0.67
2005	586	440	0.75	607	343	0.57	1193	783	0.66
2006	666	442	0.66	592	334	0.56	1258	776	0.62
2007	631	428	0.68	615	334	0.54	1246	762	0.61
2008	641	474	0.74	635	369	0.58	1276	843	0.66
2009	681	501	0.74	601	381	0.63	1282	882	0.69
2010	719	504	0.70	738	422	0.57	1457	926	0.64
2011	722	470	0.65	753	342	0.45	1475	812	0.55
Total	5304	3726	0.70	5113	2882	0.56	10417	6608	0.63

esophageal ($u = 7.89$, $p < 0.01$), bladder ($u = 6.41$, $p < 0.01$) cancers, lymphoma ($u = 3.46$, $p < 0.01$) and leukemia ($u = 3.09$, $p < 0.01$) were significantly higher among males than females. While the mortality rate of gallbladder cancer ($u = 4.18$, $p < 0.01$) was significantly higher among females than males. There were no significant differences for colorectal ($u = 0.03$, $p > 0.05$), pancreas ($u = 0.73$, $p > 0.05$), brain ($u = 0.28$, $p > 0.05$), and kidney ($u = 0.56$, $p > 0.05$) cancers between males and females.

The age distributions of the top 5 causes of cancer deaths by sex are presented in Figure 2a and 2b. For both males and females, the mortality rates increased with age. Table 5 presents the death-to-case ration during the 10 years period.

3.3. *Trends in cancer incidence and mortality*

Trends in cancer incidence for all cancers combined and the top 10 most common cancer types are shown in Table 6. For both males and females, the age-standardized incidence rates increased significantly over the period of 2002 to 2011 ($p < 0.05$ for both). The temporal trend analyses among males showed incidences increased significantly of prostate and kidney cancers ($p < 0.05$ for both), while the incidence of stomach cancer decreased significantly ($p < 0.05$). The incidence trends for other selected cancer types in males were stable (Table 6). For females, the age-standardized incidence rate of breast cancer increased significantly from 2007 to 2011 ($p < 0.05$). A significant increase of age-standardized rate was also observed for thyroid cancer in females ($p < 0.05$). The temporal trends were stable for other selected cancer types in females (Table 6).

Table 7 shows trends in cancer mortality for all cancers combined and the top 10 most common cancer types. The age-standardized mortality rates stayed stable during the period of 2002 to 2011 for both males and females ($p > 0.05$ for both). The temporal trend analyses showed for males, the mortality rates of lung, stomach, and esophageal cancers decreased significantly ($p < 0.05$ for all three). The temporal trends of mortality for other selected cancer types in males were stable (Table 7). For females, the age-standardized mortality rate of lymphoma increased significantly from 2002 to 2011 ($p < 0.05$), and the temporal trends were stable for other selected cancer types (Table 7).

4. Discussion

The present study analyzed cancer composition, incidence, mortality and their trends among permanent

Table 6. Trends in cancer incidence rates (age-standardized to the Segi's world Standard Population) for selected cancers and all cancers combined by sex in Luwan district of Shanghai, 2002-2011

Site	ICD-10	Trends 1		Trends 2	
		Years	APC	Years	APC
Male					
Lung	C33-34	2002-2011	- 0.97		
Colon and rectum	C18-21	2002-2011	- 0.42		
Stomach	C16	2002-2011	- 3.33*		
Liver	C22	2002-2011	- 0.04		
Prostate	C61	2002-2011	6.42*		
Bladder	C67	2002-2011	1.03		
Pancreas	C25	2002-2011	2.96		
Kidney	C64-66,68	2002-2011	6.19*		
Esophagus	C15	2002-2011	- 6.24		
Lymphoma	C81-85, 88, 90, 96	2002-2011	3.22		
All sites	ALL	2002-2011	1.25*		
Female					
Breast	C50	2002-2007	- 3.31	2007-2011	10.48*
Colon and rectum	C18-21	2002-2011	0.49		
Lung	C33-34	2002-2011	1.29		
Stomach	C16	2002-2011	1.67		
Thyroid	C73	2002-2004	109.32*	2004-2011	18.28*
Liver	C22	2002-2011	0.40		
Ovary	C56	2002-2011	- 8.44		
Pancreas	C25	2002-2011	4.63		
Uterus	C54-55	2002-2011	9.56		
Brain, CNS	C70-C72	2002-2011	1.22		
All sites	ALL	2002-2011	3.06*		

APC, annual percent change; CNS, central nervous system; ICD-10, International Classification of Diseases, 10th revision. *The APC is significantly different from zero ($P < 0.05$).

Table 7. Trends in cancer mortality rates (age-standardized to the Segi's world Standard Population) for selected cancers and all cancers combined by sex in Luwan district of Shanghai, 2002-2011

Site	ICD-10	Trends 1		Trends 2		Trends 2	
		Years	APC	Years	APC	Years	APC
Male							
Lung	C33-34	2002-2011	- 3.12*				
Stomach	C16	2002-2011	- 3.34*				
Colon and rectum	C18-21	2002-2011	2.46				
Liver	C22	2002-2011	- 1.86				
Pancreas	C25	2002-2004	- 33.95	2004-2007	26.40	2007-2011	- 5.41
Prostate	C61	2002-2011	3.37				
Esophagus	C15	2002-2011	- 9.18*				
Lymphoma	C81-85, 88, 90, 96	2002-2011	6.63				
Bladder	C67	2002-2011	2.25				
Leukemia	C91-95	2002-2011	1.25				
All sites	ALL	2002-2011	- 0.83				
Female							
Lung	C33-34	2002-2004	- 23.17	2004-2007	14.6	2007-2011	- 12.26
Colon and rectum	C18-21	2002-2011	- 1.59				
Stomach	C16	2002-2011	- 2.42				
Breast	C50	2002-2011	- 0.71				
Liver	C22	2002-2011	- 0.75				
Pancreas	C25	2002-2011	- 0.41				
Gallbladder	C23-24	2002-2011	- 6.58				
Ovary	C56	2002-2011	- 1.33				
Lymphoma	C81-85, 88, 90, 96	2002-2011	21.20*				
Brain, CNS	C70-C72	2002-2011	8.13				
All sites	ALL	2002-2011	- 1.21				

APC, annual percent change; CNS, central nervous system; ICD-10, International Classification of Diseases, 10th revision. *The APC is significantly different from zero ($P < 0.05$).

residents in Luwan district of Shanghai from 2002 to 2011. A total of 12,843 new cancer cases were diagnosed during the period of 2002-2011, with a male to female ratio of 1.05:1. The crude incidences for all cancers combined were 417.62 and 391.63 per 100,000 population for males and females, respectively. The age-standardized incidences by Segi's standard population were 229.46 and 205.05 per 100,000 population for males and females, respectively. The age-standardized incidence rates of all cancers combined for both males and females increased significantly over the 10 year period, indicating the urgent needs of broadly applying effective prevention measures covering known cancer risk factors, especially for those cancer types with increasing temporal trends. From another standpoint, the high cancer incidence estimated in this developed district might be partly due to over-diagnosis of cancers by intense sensitive investigations in recent years. The total number of cancer deaths was 8,331, with a male to female ratio of 1.29:1. The crude mortality rates of all cancers combined were 298.69 and 226.81 per 100,000 population for males and females, respectively. The age-standardized mortality rates by Segi's standard population were 229.46 and 205.05 per 100,000 population for males and females, respectively. Certain cancer types, including lung, stomach, and esophageal cancers showed decreasing mortality trends in males, while the mortality of lymphoma showed a significant increasing trend in females.

The top 10 cancer types of Luwan district were different from the national statistics. Lung, stomach, liver, and esophageal cancers were the 4 most common cancer types diagnosed in China according to the cancer statistics of 2015 (*1*). Compared to the national data, lung and stomach cancers remained the most commonly diagnosed cancers in Luwan district. However, colorectal cancer (CRC) surpassed liver cancer and became the top diagnosed gastrointestinal cancer. Breast cancer was the fourth commonly diagnosed cancers and the most frequent one in females. In addition, esophageal cancer ranked 9th among males and did not make the top 10 list in females. This disparity reflected regional differences, which may be affected by many elements including changes of risk factors and detection techniques.

Lung cancer was the first and third most frequently diagnosed cancer in males and females, respectively. Similar to the national data, it was also the leading cause of cancer death among both males and females. In addition, the incidence trend of lung cancer during the 10 years period was stable, while the mortality rate decreased slightly in males. Worldwide, tobacco smoking is a major risk factor of cancer incidence and mortality including lung, stomach, pancreas, liver, kidney, urinary tract, and uterine cervix (*6*). With the high smoking rate in adult Chinese men, and still rising rates in adolescents and young adults, smoking-related cancer will continue to be a huge public health burden in China (*7,8*). Cigarette smoking is the single largest cause of lung cancer, accounting for about 90% of all diagnosed cases (*9*). For Chinese women, besides the traditional risk factors, environmental pollution such as passive smoking and cooking smog are also contributors of lung cancer (*10*). Public health campaigns and tobacco control programs to prevent initiation and promote cessation in some western countries have successfully decreased smoking rate, which preceded the decrease of lung cancer incidence and mortality rates especially among males (*11,12*). Similarly, we observed a decreasing trend of lung cancer mortality among male residents in Luwan district. However, like other areas in China (*1*), lung cancer has been and will remain to be a major health burden in Luwan district. Furthermore, most lung cancers are diagnosed at later stages, missing the best opportunity for effective treatment and resulting in poor prognosis (*13*); therefore, effective lung cancer screening, especially for high risk population is of crucial importance for improving survival and life quality. Studies have shown that compared with chest x-ray, annual screening for lung cancer with low-dose computed tomography (LDCT) significantly reduced lung cancer mortality (*14*). It is of great value to carry out such parallel screening studies in the communities of Shanghai.

A significant increase of incidence was seen for cancers of the prostate and kidney for men, and breast and thyroid for women. The exact reasons for the increase are not fully elucidated; however, westernized diet and physical inactivity may contribute to some of the changes (*1*). Improvements in several aspects, including elevation of disease awareness, completeness of the data, improvement of detection service, and gradual implementation of screening procedures such as prostate-specific antigen screening may also account for the marked increase (*1,15*). An increasing trend of breast cancer incidence was observed from 2007 to 2011, which may be partially influenced by reproductive changes in Chinese women (*16*). Breast cancer screening is well-implemented and common in the United States, while it is relatively new in China (*17,18*). Approaches or strategies for cancer prevention and early detection should be tailored according to the unique cultural beliefs of the population and the policies of the government. It is essential to raise awareness, especially in high-risk women, of the importance of breast cancer screening. Similar to the national statistics and study results from other countries (*1,19-21*), it is reported that there was a dramatic increase of thyroid cancer in women of Luwan district, and it is unclear whether the rise is due to "over-diagnosis" using new imaging technologies or is a real increase caused by change of exposure level to risk factors (*22,23*).

Major gastrointestinal cancers including cancers of esophagus, stomach, colon and rectum, liver, gallbladder, and pancreas accounted for approximately 45 percent

and 35 percent of the total new cancer cases in men and women respectively in Luwan district during the 10-year period. The high proportion of gastrointestinal cancers may reflect the changes of population characteristics such as high smoking rate, inactive life style, more meat and less fresh fruits and vegetables in diet. CRC ranked the second most common cancer type in both males and females, and has been continuously posing a threat to people's health. Regular screening has been shown to be effective in preventing CRC and reducing CRC mortality (*24*). The ongoing CRC screening program in Shanghai using fecal occult blood test has identified a sizeable proportion of high-risk individuals and is waiting for the long-term results (*25*).

Compared to other areas in China, the incidence of liver cancer in the district was relatively low, which can be attributed to the successful control of hepatitis B virus (HBV) and hepatitis C virus (HCV) infection, as well as effective implementation of the HBV vaccination program (*26*). A significantly decreasing incidence and mortality trend was observed for stomach cancer during the 10 year period in Luwan district. There was also a decreasing trend of esophageal cancer mortality. Improved sanitation and greater availability of fresh food are main contributors to the decline (*27,28*).

There are some limitations of the current study. Our dataset was from a single district in Shanghai, which was a typical urban area with well developed economy. Therefore, it may not be representative of metropolitan Shanghai. However, our study utilized complete and accurate data from the community, and population-based data are crucial to plan and assess the effectiveness of prevention and control strategies. In 2011, there was a revocation of the organizational system of Shanghai Luwan district and Huangpu district, and then the establishment of a new Huangpu district. The jurisdiction of the original Luwan district was adjusted to the new Huangpu district. Therefore, our study result is also of historical value.

In summary, the current study comprehensively analyzed community based cancer statistics including composition, incidence, mortality, and temporal trends, which provided valuable information for developing and evaluating cancer prevention and control strategies. The significance of cancer registration for disease surveillance and management should be brought into focus. With an aging population, cancer will continue to be a huge public health problem nationwide. It is important to further study the epidemiology and etiology of cancers so as to increase existing cancer control knowledge, reduce preventable cancers and ultimately relieve future cancer burden.

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References

1. Chen W, Zheng R, Baade PD, Zhang S, Zeng H, Bray F, Jemal A, Yu XQ, He J. Cancer statistics in China, 2015. CA Cancer J Clin. 2016; 66:115-132.
2. Zhou JJ, Fu ZX, Wang YJ, Gao SN, Wang J, Du Y. Trends of incidence and mortality of common gynecological malignant tumors among female residents in Luwan district of Shanghai, 2004-2011. China Cancer. 2016; 25:854-859. (in Chinese)
3. Doll R, Cook P. Summarizing indices for comparison of cancer incidence data. Int J Cancer. 1967; 2:269-279.
4. Segi M. Cancer Mortality for Selected Sites in 24 Countries (1950-57). Tohoku University School of Public Health, Sendai, Japan, 1960.
5. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with applications to Cancer rates. Stat Med. 2000; 19:335-351.
6. World Health Organization (WHO). Enforcing Bans on Tobacco Advertising, Promotion and Sponsorship; Report on the Global Tobacco Epidemic; WHO: Geneva, Switzerland, 2013.
7. Li Q, Hsia J, Yang G. Prevalence of smoking in China in 2010. N Engl J Med. 2011; 364:2469-2470.
8. Zhang J, Ou JX, Bai CX. Tobacco smoking in China: Prevalence, disease burden, challenges and future strategies. Respirology. 2011; 16:1165-1172.
9. Brawley OW, Glynn TJ, Khuri FR, Wender RC, Seffrin JR. The first Surgeon General's report on smoking and health: The 50th anniversary. Ca Cancer J Clin. 2014; 64:5-8.
10. Lin Y, Cai L. Environmental and dietary factors and lung cancer risk among Chinese women: A case-control study in southeast China. Nutr Cancer. 2012; 64:508-514.
11. Lortet-Tieulent J, Soerjomataram I, Ferlay J, Rutherford M, Weiderpass E, Bray F. International trends in lung cancer incidence by histological subtype: Adenocarcinoma stabilizing in men but still increasing in women. Lung Cancer. 2014; 84:13-22.
12. Malvezzi M, Bosetti C, Rosso T, Bertuccio P, Chatenoud L, Levi F, Romano C, Negri E, La Vecchia C. Lung cancer mortality in European men: Trends and predictions. Lung Cancer. 2013; 80:138-145.
13. Heuvers ME, Wisnivesky J, Stricker BH, Aerts JG. Generalizability of results from the National Lung Screening Trial. Eur J Epidemiol. 2012; 27:669-762.
14. National Lung Screening Trial Research Team, Aberle DR, Adams AM, Berg CD, Black WC, Clapp JD, Fagerstrom RM, Gareen IF, Gatsonis C, Marcus PM, Sicks JD. Reduced lung-cancer mortality with low-dose computed tomographic screening. N Engl J Med. 2011; 365:395-409.
15. Ito K. Prostate cancer in Asian men. Nat Rev Urol. 2014; 11:197-212.
16. Li L, Ji J, Wang JB, Niyazi M, Qiao YL, Boffetta P. Attributable causes of breast cancer and ovarian cancer in china: Reproductive factors, oral contraceptives and hormone replacement therapy. Chin J Cancer Res. 2012; 24:9-17.
17. Onega T, Beaber EF, Sprague BL, Barlow WE, Haas JS, Tosteson AN, D Schnall M, Armstrong K, Schapira MM,

Geller B, Weaver DL, Conant EF. Breast cancer screening in an era of personalized regimens: A conceptual model and National Cancer Institute initiative for risk-based and preference-based approaches at a population level. Cancer. 2014; 120:2955-2964.
18. Song QK, Wang XL, Zhou XN, Yang HB, Li YC, Wu JP, Ren J, Lyerly HK. Breast cancer challenges and screening in China: Lessons from current registry data and population screening studies. Oncologist. 2015; 20:773-779.
19. Kahn C, Simonella L, Sywak M, Boyages S, Ung O, O'Connell D. Pathways to the diagnosis of thyroid cancer in New South Wales: A population-based cross-sectional study. Cancer Causes Control. 2012; 23:35-44.
20. Morris LG, Sikora AG, Tosteson TD, Davies L. The increasing incidence of thyroid cancer: The influence of access to care. Thyroid. 2013; 23:885-891.
21. Pandeya N, McLeod DS, Balasubramaniam K, Baade PD, Youl PH, Bain CJ, Allison R, Jordan SJ. Increasing thyroid cancer incidence in Queensland, Australia 1982-2008 - true increase or overdiagnosis? Clin Endocrinol (Oxf). 2015. doi: 10.1111/cen.12724.
22. Brito JP, Morris JC, Montori VM. Thyroid cancer: Zealous imaging has increased detection and treatment of low risk tumours. BMJ. 2013; 347:f4706.
23. Xie SH, Chen J, Zhang B, Wang F, Li SS, Xie CH, Tse LA, Cheng JQ. Time trends and age-period-cohort analyses on incidence rates of thyroid cancer in Shanghai and Hong Kong. BMC Cancer. 2014; 14:975.
24. van Hees F, Saini SD, Lansdorp-Vogelaar I, Vijan S, Meester RG, de Koning HJ, Zauber AG, van Ballegooijen M. Personalizing colonoscopy screening for elderly individuals based on screening history, cancer risk, and comorbidity status could increase cost effectiveness. Gastroenterology. 2015; 149:1425-1437.
25. Zeng Y, Gong YM. Research and practice of screening for colorectal cancer in population of Shanghai. China Cancer. 2013; 22:86-89. (in Chinese)
26. Sun Z, Chen T, Thorgeirsson SS, *et al*. Dramatic reduction of liver cancer incidence in young adults: 28 year follow-up of etiological interventions in an endemic area of China. Carcinogenesis. 2013; 34:1800-1805.
27. Arnold M, Moore SP, Hassler S, Ellison-Loschmann L, Forman D, Bray F. The burden of stomach cancer in indigenous populations: A systematic review and global assessment. Gut. 2014; 63:64-71.
28. Castro C, Bosetti C, Malvezzi M, Bertuccio P, Levi F, Negri E, La Vecchia C, Lunet N. Patterns and trends in esophageal cancer mortality and incidence in Europe (1980-2011) and predictions to 2015. Ann Oncol. 2014; 25:283-290.

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