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CANCER INCIDENCE TRENDS IN URBAN SHANGHAI, 1972–1994: AN UPDATE

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Incidence rates for a number of cancers in urban Shanghai, China, have been changing markedly. Herein we update the trends using population-based data from the Shanghai Cancer Registry for 1972–1994. During 1993–1994, cancers of the lung, stomach, and liver were the 3 leading forms among men, with age-adjusted (world standard) incidence rates of 50.9, 39.2, and 26.5 per 100,000 person-years, respectively, followed by cancers of the colon (12.4) and esophagus (10.0). Among women, cancers of the breast (27.5), stomach (19.1), and lung (17.7) were the most common tumors, followed by cancers of the colon (11.3) and liver (9.4). Over the 23-year period, the rate for all cancers combined, excluding non-melanoma skin cancer, decreased from 247.5 to 215.2 among men and from 173.6 to 154.0 among women. However, trends for individual forms of cancer varied considerably. Rates doubled for cancers of the colon and biliary tract in both sexes, and they increased substantially for cancers of the brain and nervous system, kidney, pancreas, prostate, corpus uteri, female breast, and ovary, and for non-Hodgkin's lymphoma. Rates for cancers of the lung and rectum changed little. Rates declined by at least one-half for cancers of the esophagus and cervix, with notable decreases also for cancers of the stomach and liver. Some of these trends may reflect variations in diagnostic or screening practices, although changes in lifestyle and other environmental exposures are likely to play important roles. Further epidemiologic research in China is needed to identify risk factors influencing the cancer incidence trends. *Int. J. Cancer* 83:435–440, 1999.

Cancer incidence trends during 1972–1989 in Shanghai, China have been reported previously (Jin *et al.*, 1993). Remarkable changes in the cancer rates have continued since 1989, and new patterns are emerging. In this paper, we provide updated data on cancer incidence through 1994 in Shanghai in order to provide further clues for etiologic studies.

MATERIAL AND METHODS

Details on the material and methods used in this analysis have been described (Jin *et al.*, 1993). Briefly, all medical facilities in Shanghai are required to report newly diagnosed cancer cases to the Shanghai Cancer Registry, which has essentially complete coverage of incident cancer cases diagnosed since 1972. The population of the urban area was 7.3 million people in 1992. Although the boundaries of urban Shanghai and the registry coverage have changed over the years, this analysis was restricted to the 10 districts for which data were available for the entire time period. The registered cases were coded according to the 4-digit rubrics of the 9th revision of the International Classification of Diseases (ICD9) (World Health Organization, 1977) and classified for this analysis according to first three digits. Population estimates were based on periodic censuses (1973, 1979, 1982, 1985, 1990, 1992), with age- and sex-specific annual estimates derived by linear interpolation and extrapolation for the remaining years.

For this analysis, all registered incident cancer cases during 1972–1994 were tabulated by age, sex, and calendar period. Rates per 100,000 person-years for the 7 3-year periods 1972–1974 to 1990–1992 and the 2-year period 1993–1994 were calculated for 5-year age groups and age-adjusted to the world standard population using the direct method (Parkin *et al.*, 1997). Annual percent changes in incidence were estimated by means of a linear regression of the logarithm of the respective rates on the mid-point of the calendar year.

RESULTS

During the most recent time period, 1993–1994, more than 35,000 cases of cancer were diagnosed in urban Shanghai. For the major forms of cancer, the number of incident cases and age-adjusted rates during this 2-year time period are shown in Figure 1. Lung, stomach, and liver cancers were the 3 leading forms of cancer among men, followed by colon and esophageal cancers. Among women, cancers of the breast, stomach, and lung were the most common sites, followed by colon and liver cancers.

During the 23-year period 1972–1994, more than 340,000 cases of cancer were diagnosed among residents of urban Shanghai. The number of cases and age-adjusted incidence rates by cancer site are presented in Table I for the periods 1972–1974 and 1993–1994. For all cancers combined (excluding non-melanoma skin cancer), the rates in men decreased 13.1% from 247.5 to 215.2 per 100,000 person-years, or 0.5% per year, while the rates in women declined 11.3% from 173.6 to 154.0, or 0.4% per year. When examined by site, rates doubled for cancers of the colon and biliary tract among men and women, and for brain and other nervous system cancers among men. Although lung was one of the most common cancer sites in Shanghai, rates changed little. Meanwhile, rates decreased by at least one-half for cancers of the esophagus and cervix uteri. Although much lower, rates also declined for cancers of the nasal passages and sinuses and for Hodgkin's disease among men and women, for penile cancer among men, and for larynx cancer among women.

As shown in Figure 2, the substantial changes reported earlier for several of the digestive system cancers persisted in both sexes. Between 1972–1974 and 1993–1994, esophageal cancer rates declined more than 60%, while liver cancer decreased more than 20% among both men and women. The rates for stomach cancer declined more rapidly among men than women, 36.7% *vs.* 20.3%. In contrast, the rates for colon cancer rose sharply to surpass those for rectal cancer in both sexes and esophageal cancer among women in the early 1980s, and those for esophageal cancer among men and liver cancer among women in the early 1990s. Pancreatic cancer rates increased 40–50%, while biliary tract cancer rates rose about 120%.

In general, the rates for cancers of the respiratory tract and urinary tract showed little change among men or women (Fig. 3), although rates for kidney cancer have increased rapidly since the mid-1980s.

Brain and other nervous system cancers continued to increase into the 1990s, becoming the 8th most common form of cancer among both men and women (Fig. 4). Non-Hodgkin's lymphoma

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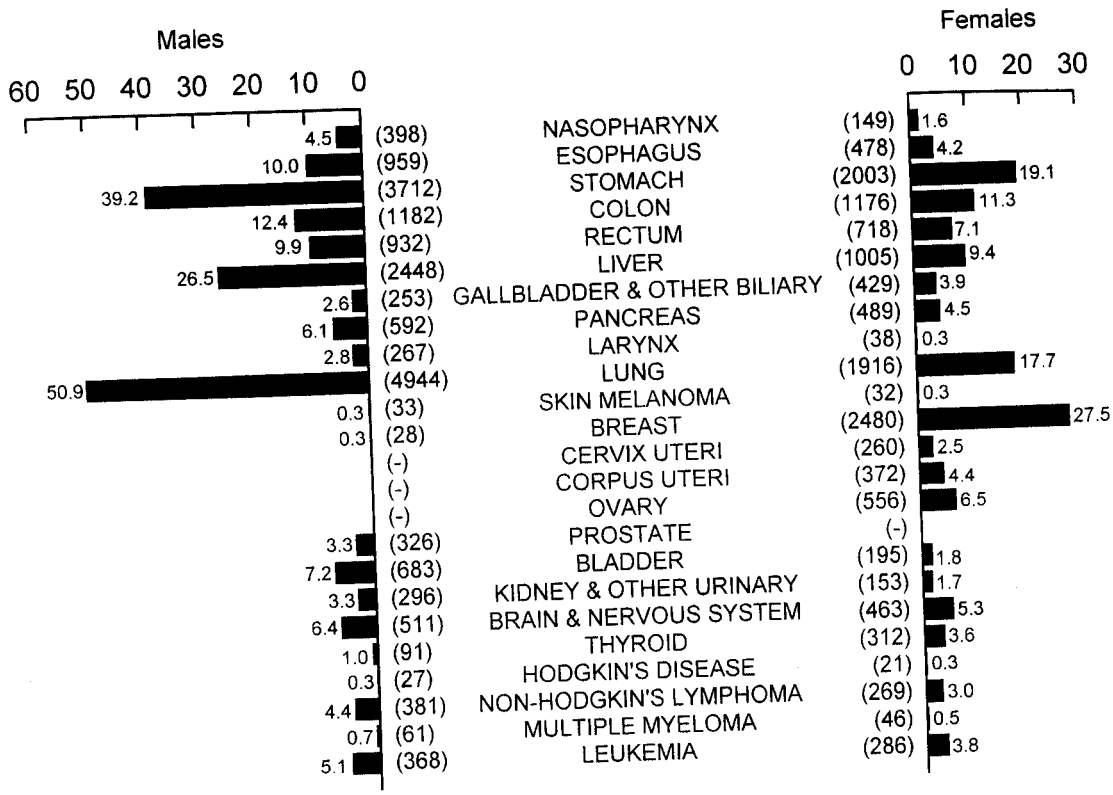

FIGURE 1 – Age-adjusted (world) incidence rates per 100,000 person-years for major cancer sites, urban Shanghai, 1993–1994. Number of registered cases is given in parentheses.

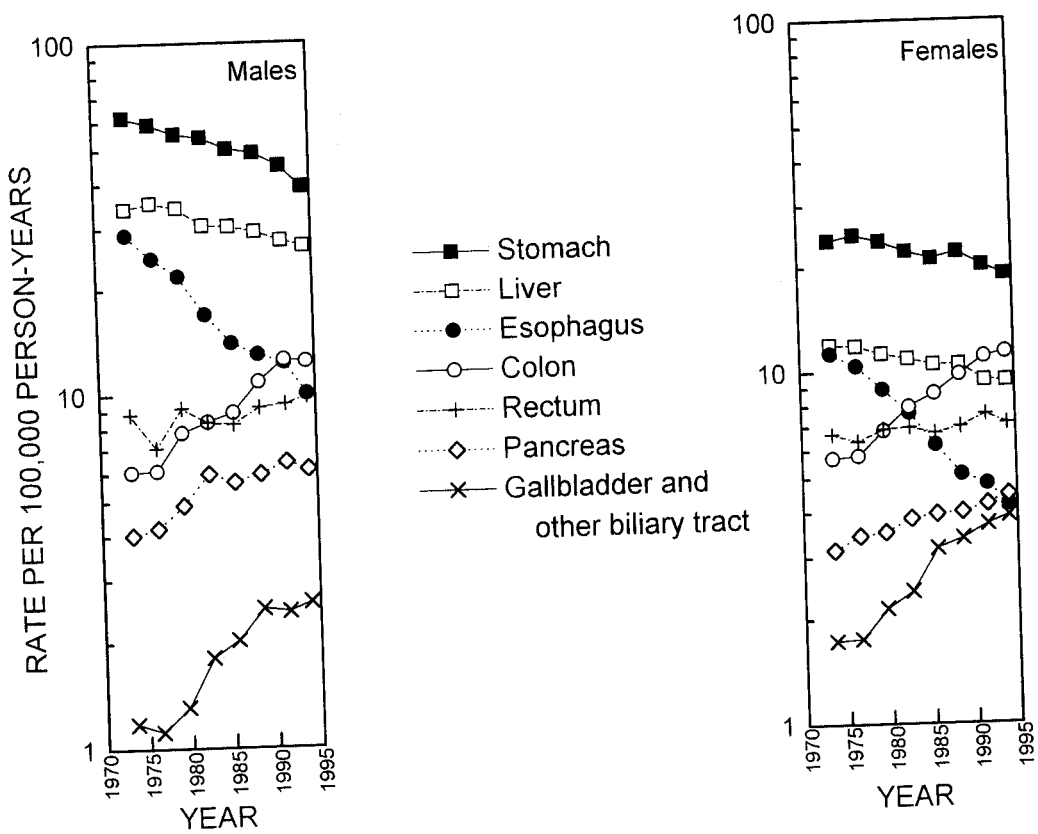

FIGURE 2 – Age-adjusted (world) incidence rates in urban Shanghai, 1972–1974 to 1993–1994: digestive system.

TABLE I – TEMPORAL TRENDS IN NUMBERS OF CANCER CASES AND INCIDENCE RATES[1] IN URBAN SHANGHAI, 1972–1974 TO 1993–1994

Site	ICD codes	Males						Females					
		1972–1974		1993–1994		Percent change[2]	APC[3]	1972–1974		1993–1994		Percent change[2]	APC[3]
		Count	Rate	Count	Rate			Count	Rate	Count	Rate		
Lip	140	16	0.2	13	0.1	−37.1	−3.0	7	0.1	12	0.1	24.6	0.1
Salivary glands	142	40	0.5	51	0.6	22.9	0.9	54	0.6	41	0.5	−22.8	−1.7[4]
Nasopharynx	147	462	5.0	398	4.5	−10.9	0.0	216	2.2	149	1.6	−25.2	−1.4[4]
Mouth and other pharynx	141, 143–6, 148–9	186	2.3	182	1.9	−16.6	−0.5	141	1.5	135	1.3	−14.9	−0.7
Esophagus	150	2202	28.9	959	10.0	−65.3	−5.0[4]	1032	11.3	478	4.2	−62.9	−5.0[4]
Stomach	151	4932	62.0	3712	39.2	−36.7	−1.9[4]	2208	23.9	2003	19.1	−20.3	−1.1[4]
Colon	153	489	6.1	1182	12.4	104.1	4.0[4]	526	5.7	1176	11.3	98.7	3.8[4]
Rectum	154	680	8.9	932	9.9	11.3	0.8	617	6.7	718	7.1	6.6	0.6[4]
Liver	155	2985	34.1	2448	26.5	−22.2	−1.4[4]	1103	12.0	1005	9.4	−21.4	−1.2[4]
Gallbladder and other biliary	156	90	1.2	253	2.6	119.2	4.5[4]	159	1.7	429	3.9	124.2	4.4[4]
Pancreas	157	334	4.0	592	6.1	52.4	2.2[4]	289	3.1	489	4.5	42.0	1.5[4]
Nasal cavities, sinuses	160	133	1.6	62	0.7	−58.0	−4.0[4]	90	1.0	40	0.4	−62.5	−5.1[4]
Larynx	161	277	3.5	267	2.8	−19.0	−0.2	75	0.8	38	0.3	−59.9	−4.3[4]
Lung	162	3794	47.9	4944	50.9	6.3	0.5	1649	18.0	1916	17.7	−1.4	−0.1
Bone	170	181	2.1	148	1.7	−18.1	−1.3[4]	167	1.8	121	1.3	−25.3	−1.6[4]
Connective tissue	171	123	1.5	137	1.6	11.7	1.6	93	1.1	92	1.1	2.6	0.9
Melanoma of skin	172	38	0.4	33	0.3	−21.9	−0.5	29	0.3	32	0.3	−1.3	−0.1
Breast	174–5	43	0.5	28	0.3	−40.1	−1.1	1760	18.3	2480	27.5	50.5	2.7[4]
Cervix uteri	180	—	0	—	—	—	—	2581	26.7	260	2.5	−90.7	−11.7[4]
Corpus uteri	182	—	—	—	—	—	—	241	2.5	372	4.4	75.1	2.8[4]
Uterus, unspecified	179	—	—	—	—	—	—	295	3.1	63	0.6	−81.2	−8.9[4]
Ovary	183	—	—	—	—	—	—	456	4.8	556	6.5	35.5	1.7[4]
Prostate	185	106	1.8	326	3.3	80.7	3.4[4]	—	—	—	—	—	—
Testis	186	60	0.7	61	0.8	8.2	0.6	—	—	—	—	—	—
Penile and other male	187	76	1.1	46	0.5	−55.2	−3.8[4]	—	—	—	—	—	—
Bladder	188	526	7.3	683	7.2	−1.4	0.3	182	2.0	195	1.8	−11.3	−0.9
Kidney	189	139	1.7	296	3.3	90.7	4.4[4]	98	1.1	153	1.7	49.2	2.8[4]
Eye	190	19	0.3	10	0.2	−34.0	−1.4	14	0.2	5	0.1	−62.3	−2.3
Brain and nervous system	191–2	280	3.2	511	6.4	98.4	3.7[4]	257	3.0	463	5.3	79.5	3.3[4]
Thyroid	193	118	1.3	91	1.0	−19.0	−2.8	409	4.4	312	3.6	−18.5	−2.3
Hodgkin's disease	201	93	1.0	27	0.3	−67.9	−4.4[4]	59	0.6	21	0.3	−52.2	−3.5[4]
Non-Hodgkin's lymphoma	200, 202	275	3.3	381	4.4	33.3	1.5[4]	164	1.8	269	3.0	66.2	2.3[4]
Multiple myeloma	203	42	0.5	61	0.7	38.3	1.5	37	0.4	46	0.5	23.4	1.5
Leukemia	204–8	434	5.3	368	5.1	−3.6	−0.3	351	4.1	286	3.8	−6.9	−0.7
All other sites[5]		859	10.7	943	10.3	−3.6	0.5	875	9.7	899	9.0	−6.5	0.2
All sites	140–208	20108	250.0	20200	216.5	−13.4	−0.5[4]	16306	175.3	15324	155.2	−11.4	−0.4
All sites except non-melanoma skin	140–208 exc 173	19914	247.5	20078	215.2	−13.1	−0.5[4]	16151	173.6	15204	154.0	−11.3	−0.4

[1]Per 100,000 person-years, directly age-adjusted using the world standard.–[2]Based on unrounded rates.–[3]Annual percent change, based on a weighted regression using log rates for seven 3-year and one 2-year time periods.–[4]$p \leq 0.05$.–[5]ICD codes 152, 158–9, 163–5, 173, 181, 184, 194–9.

rates increased, somewhat more rapidly among women than men. Rates for leukemia were relatively constant over the study period.

For the sex-specific cancers, the incidence trends continued as before (Fig. 5). Most remarkable is the decline in cervix uteri cancer, dropping 90.7% from 26.7 per 100,000 in 1972–1974 to 2.5 per 100,000 in 1993–1994. Female breast cancer increased more than 50% (2.7% per year), becoming the most frequent cancer among women. Corpus uteri cancer rates rose from 2.5 to 4.4 per 100,000, emerging as one of the 10 most common cancers among women, while rates for unspecified uterine cancer declined from 3.1 to 0.6 (Table I). An increase in ovarian cancer rates has been most apparent since the mid-1980s. Although prostate cancer rates have remained very low, there has been an upward trend since the mid-1980s.

DISCUSSION

The secular incidence trends for total cancer and many of the common cancers previously observed during the study period of 1972–1989 (Jin *et al.*, 1993) have continued through 1990–1994. Among men, decreasing rates for cancers of the esophagus and stomach were mainly responsible for the decline in total cancer, while liver cancer incidence also decreased. These 3 cancers accounted for 50.5% of all cancer cases diagnosed among men in the early 1970s, *vs.* 35.2% during 1993–1994. Among women, the most marked change was the 91% decline in the rates for invasive cancers of the cervix uteri, while substantial decreases were also seen for esophageal, stomach, and liver cancers.

Also continuing in the 1990s were the substantial increases in incidence previously noted for cancers of the colon, breast, corpus uteri, gallbladder, brain, and kidney. In particular, colon and biliary tract cancer rates were the fastest rising over the study period, while cancers of the corpus uteri and ovary increased more rapidly in the 1990s than in earlier years, and prostate cancer increased rapidly since the mid-1980s.

Increased screening and early detection probably have affected the time trends for some but not all cancers. During the 1990s in Shanghai, computerized tomography and magnetic resonance imaging were used widely in the diagnosis of brain tumors, contributing at least partly to the increasing incidence of this tumor over the study period. The marked decline in invasive cancers of the cervix uteri can be attributed largely to the widespread Pap smear screening and treatment programs first implemented in Shanghai during the late 1950s (Wu, 1997). Changes in sexual behavior, such as the virtual elimination of prostitution and increases in the use of barrier contraception, may also have played an important role. On the other hand, the increases in breast cancer incidence cannot be ascribed entirely to greater awareness of breast

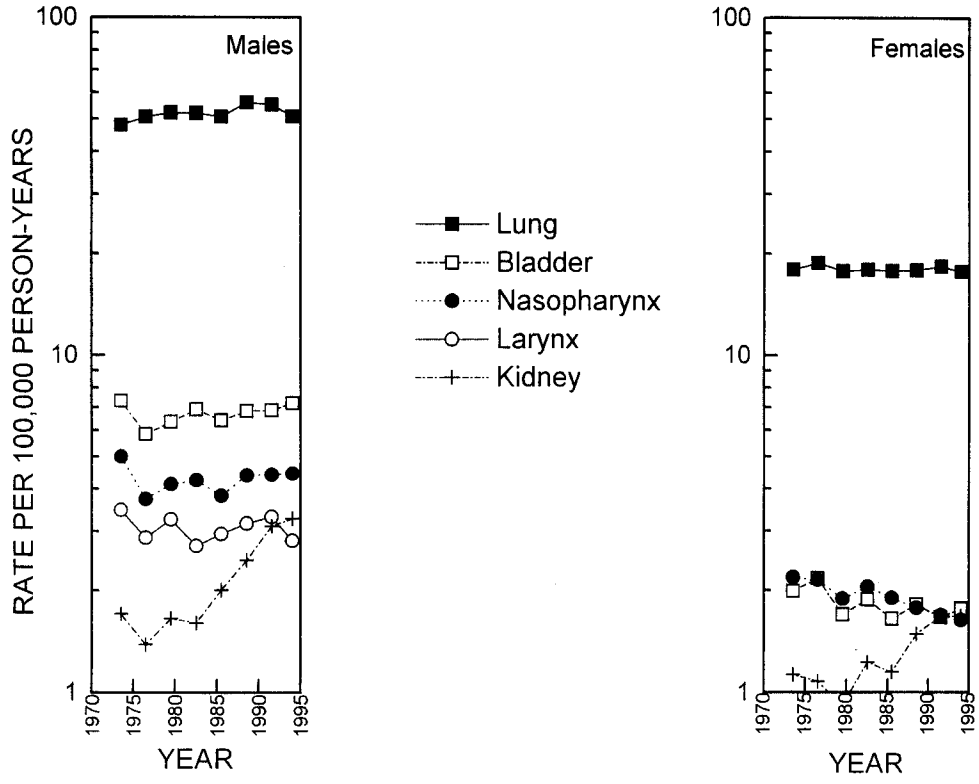

FIGURE 3 – Age-adjusted (world) incidence rates in urban Shanghai, 1972–1974 to 1993–1994: respiratory and urinary systems.

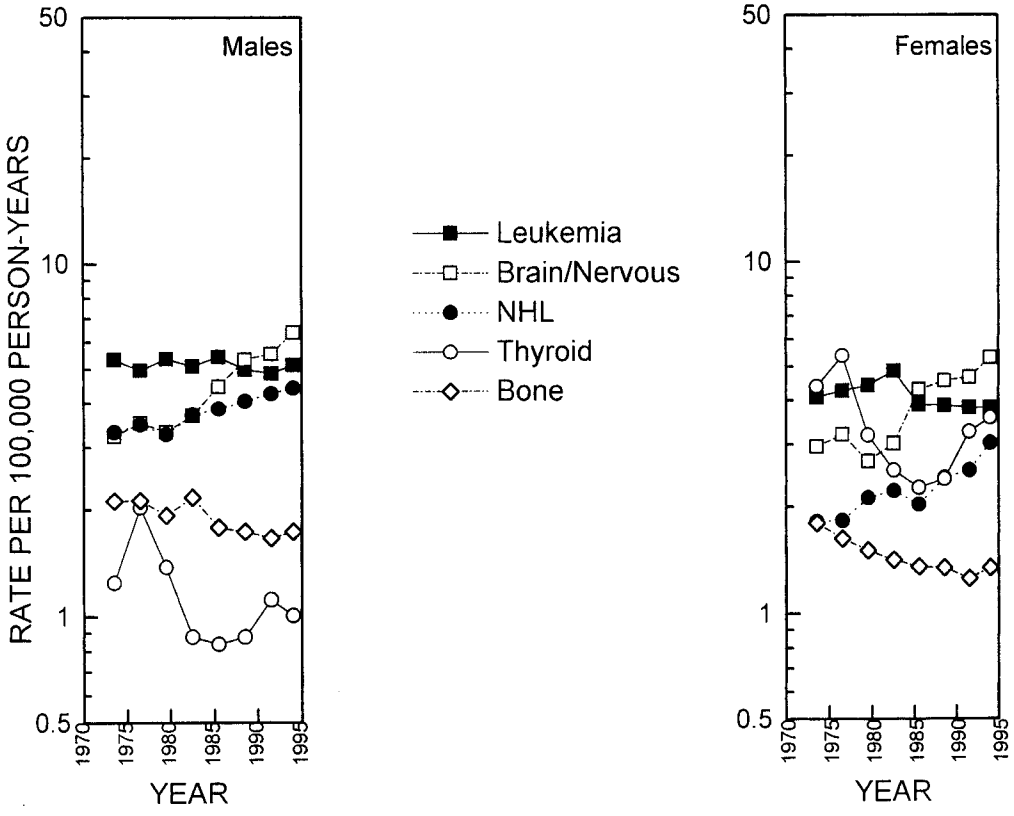

FIGURE 4 – Age-adjusted (world) incidence rates in urban Shanghai, 1972–1974 to 1993–1994: hematopoietic system and other miscellaneous sites.

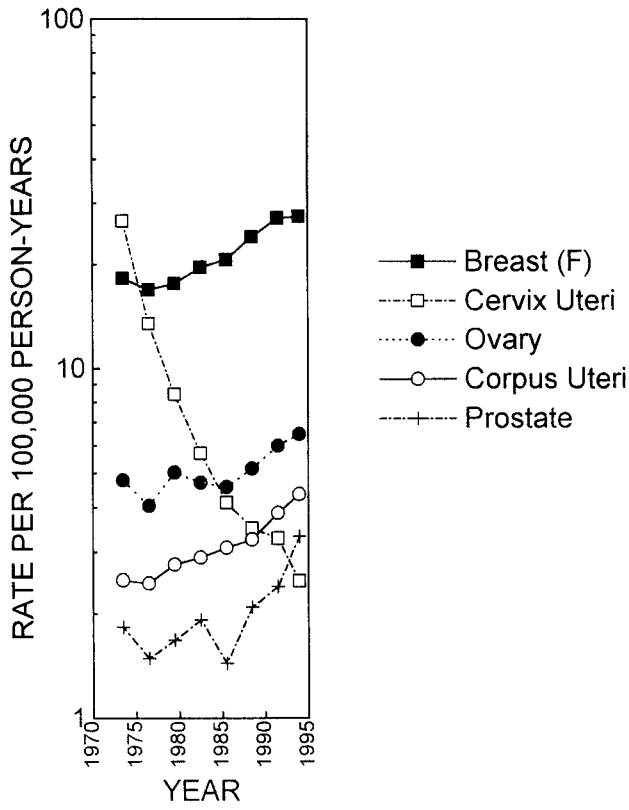

FIGURE 5 – Age-adjusted (world) incidence rates in urban Shanghai, 1972–1974 to 1993–1994: sex-specific sites.

cancer associated with an increase in breast self-examinations or mammography, since 12% or fewer of women in Shanghai recruited for a randomized trial of breast self-examination during 1989–1991 had availed themselves of a clinical breast examination during the previous year (Thomas *et al.*, 1997). Contrary to the relation between prostate cancer trends and widespread use of prostate-specific antigen (PSA) testing in the United States (Merrill *et al.*, 1996), PSA testing for prostate cancer is uncommon in Shanghai and unlikely to have contributed to the upward trend in recent years (Hsing *et al.*, 1998). In addition, diagnostic procedures for other major cancers, including the use of fecal occult blood testing and sigmoidoscopy for screening of colon cancer, have not changed appreciably, suggesting that the time trends observed for most cancers in Shanghai are related to changes in lifestyle factors or other exposures. Assessment of the incidence trends by stage of disease at diagnosis would help clarify to what extent earlier diagnosis may be involved, but stage data are not available.

Although lung cancer is one of the most common tumors in Shanghai, the incidence rates showed little change among men, ranging from 48 per 100,000 in 1972–1974 to 51 per 100,000 in 1993–1994, with a peak of 56/100,000 during 1987–1989. Rates can be expected to rise as a result of recent large increases in cigarette smoking, with the prevalence of smoking among males more than tripling in China from the early 1950s to the late 1980s and reaching 61% in Shanghai during the 1970s (Chen *et al.*, 1997). Rates have remained relatively low, at 18 per 100,000, among women, consistent with their lower prevalence of cigarette smoking (Gong *et al.*, 1995). Lung cancer risk among women in urban Shanghai has been linked not only to smoking but also to exposure to rapeseed oil vapors during high-temperature cooking (Gao, 1996). This type of exposure may have been reduced with improvements in kitchen ventilation and increases in the use of refined cooking oil. It is also possible that the trends in lung cancer have been attenuated by increasing intake of fruits and vegetables (Jin *et al.*, 1993) and by improvements in the work environment, with reduced exposure to occupational carcinogens.

With the rapid economic development in Shanghai over the past several decades, there have been substantial changes in dietary and other lifestyle exposures. The consumption of animal foods, mainly pork, poultry, eggs, and seafood, increased 50–160% in China between 1954 and 1979 (Yu *et al.*, 1991) and has continued since then (Shanghai Municipal Statistics Bureau, 1999). In addition, the proportion of dietary calories from fat has increased substantially, particularly among city dwellers (Popkin, 1994). Physical activity levels, however, have declined among urban residents of China (Popkin, 1994), resulting in rapid increases in the prevalence of obesity (Popkin *et al.*, 1995). Such changes probably have contributed to the increasing incidence trends for cancers of the colon, female breast, gallbladder, prostate, and renal parenchyma, tumors whose risks have been linked to high intake of animal foods and fat, to obesity, and/or to low physical activity (McTiernan *et al.*, 1998). Particularly revealing has been the increasing proportion of cholesterol *vs.* pigmented gallstones in China over time (Zhu *et al.*, 1995), since cholesterol stones have been strongly linked to gallbladder cancer (Fraumeni, Jr. *et al.*, 1996). The increase in corpus uteri cancer also may be related to trends in dietary fat intake and obesity (Shu *et al.*, 1992), although the role of diagnostic and reporting improvements is suggested by the decline in uterine tumors of unspecified site. In addition to obesity and smoking, the increasing prevalence of hypertension among Chinese (Wu *et al.*, 1995) may have contributed to the rising incidence of renal cell cancer (Chow *et al.*, 1995).

Other factors also may have influenced the secular cancer trends in China. The rising incidence of breast cancer may be related, in part, to the delay in age at first childbirth and the decline in the number of births (Hesketh and Zhu, 1997), which are well-established risk factors (Hulka, 1997). Estrogen use and hormone replacement therapy are known to increase the risk of corpus uteri cancer (Hulka, 1997) and may have contributed to the increases observed in recent years. However, in a population-based case-control study of endometrial cancer in Shanghai during 1988–1990, only 3 of 268 cases and none of 268 controls reported ever having used post-menopausal estrogens (Shu *et al.*, 1991).

On the other hand, the general improvements in living conditions and diet among Chinese have contributed to the decline in certain other cancers. In particular, the increased availability of fresh fruits and vegetables and the widespread use of refrigeration, reducing the need for salt and nitrate food preservation, likely account in part for the downward trend in cancers of the mouth, esophagus, and stomach, and possibly liver. Improvements in food storage and transportation also may have reduced exposure to aflatoxin, a hepatic carcinogen usually found in moldy grains (London and McGlynn, 1996). Hepatitis B virus is another hepatic carcinogen (London and McGlynn, 1996), but longitudinal data on the prevalence of these infections are sparse. The improved sanitary conditions in housing units may have reduced the prevalence of infection with *Helicobacter pylori*, which plays a key role in gastric carcinogenesis (Parsonnet, 1996). Unfortunately, the beneficial effects of improvement in diet and living conditions may be countered to some extent by the increasing prevalence of cigarette smoking, particularly among Chinese men (Chen *et al.*, 1997).

The increases observed for certain cancers, notably of the colon, female breast, gallbladder, prostate, corpus uteri, and ovary, have been so pronounced that dietary changes and diagnostic fashions in

Shanghai may not entirely explain all the upward trends. Also, reasons for the rising rates for kidney cancer and non-Hodgkin's lymphoma are not well understood. It would be valuable to analyze the incidence trends by cell type, but histologic data are not available in this registry. Nevertheless, substantial changes in cancer incidence are taking place in China, a nation in transition, providing remarkable opportunities for epidemiologic studies to identify risk factors and the means of cancer prevention.

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