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Review Article: Cancer Trends in Asia

Cancer Trends in Taiwan

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Cancer is becoming a more important health problem in Taiwan with aging of populations and changes in lifestyles. This indicates that a population-based cancer registration database is essential to providing informative data on cancer prevention and policy setting. The Taiwan Cancer Registry was launched in 1979 and all reporting hospitals were mandated to submit cancer data to the central cancer registry following the enactment of the Cancer Control Act in 2003. The National Health Insurance program in Taiwan has successfully provided quality health care, comprehensive benefits and convenient access to treatment. Most cancers had a rapidly increasing incidence after the initiation of the NHI program. However, cancer incidence rates of nasopharynx of both genders slightly decreased throughout the entire period and incidence of stomach cancer of both genders and cervical cancer of females declined beginning in 1995. For childhood cancers, the major types of leukemia, lymphomas, central nervous system neoplasms and other epithelial neoplasms for males and females accounted for nearly 55% of all types. This study presents for the first time the secular changes and age patterns in the incidence of childhood cancer using national cancer data.

Key words: Taiwan cancer registry – cancer trend – incidence – childhood cancer – screening

INTRODUCTION

With rapid aging of populations, cancer has become the first leading cause of death in Taiwan since 1982 (1). In order to provide informative data for cancer control and policy setting, a complete cancer registration database is required and necessary. In Taiwan, a population-based cancer registry was founded in 1979 and supported by a Grant-in-aid for the National Department of Health from Executive Yuan (2). Since then, the central cancer registry collected basic information, named the short-form system, on newly diagnosed cancer patients from hospitals with more than 50-bed capacity throughout the country. From 2002, a long-form system was established to collect more detailed information of cancer staging, treatment and follow-up data in hospitals with more than 500 new cancer cases annually for the six major cancers of the oral cavity and pharynx, colon and rectum, liver, lung, breast and cervix uteri. Following enactment of the Cancer Control Act in 2003 (3), all reporting hospitals were mandated to submit the cancer patient information to the central cancer registry. Additionally, a traceback procedure for the cancer registry system was implemented at the same time subsequently enhancing the quality of cancer registry data markedly (2).

The population-based cancer registry can not only provide cancer incidence data at the national level but also is the fundamental support in cancer prevention. In a related development, the National Health Insurance (NHI) program was launched in 1995 to provide health care for all residents (4). More than 99% of all Taiwan residents participate in the program, which provides health care of acceptable quality,

comprehensive benefits and convenient access to treatment. Accordingly, comparing the incidence trends of most adult and childhood cancers before and after the implementation of NHI in Taiwan is of worthwhile interest. In addition, changes in the stages of major cancers are also described for the long-form database.

PATIENTS AND METHODS

Data Source

The newly diagnosed cancer cases at all ages in central cancer registration database from 1980 to 2006 were used in this analysis. All information on the primary cancer site and histology was coded according to the version of the International Classification of Diseases for Oncology (ICD-O). Beginning with 2002 incidence data, ICD-O-3 (5) was used for a standard coding manual instead of ICD-O-FT. Therefore, all cancer types were coded or converted to ICD-O-3 for the analysis. Lymphoma and leukemia were grouped together in the hematological system and presented separately from each site. Some cancer sites were grouped and listed as follows: oral cavity and pharynx (C00–06, C09–10 and C12–14) and colon and rectum (C18–21).

Cancer cases with staging data from long-form database for the time period 2002–06 were used to estimate the secular changes of stage at diagnosis. The TNM staging system (6), which was derived from the American Joint Committee on Cancer (AJCC) and the International Union Against Cancer (UICC), was applied to six major cancers including oral cavity and pharynx, colon and rectum, liver, lung, breast and cervix uteri. Meanwhile, the FIGO staging was also required for cervical cancer in the long-form database.

With respect to childhood cancers, cases were restricted to children aged 0–19 years in the central cancer registration database from 1980 to 2006. The third edition of the International Classification of Childhood Cancer (ICCC-3) (7) based on ICD-O-3 is adopted for grouping tumors into 12 main diagnostic groups and 47 diagnostic subgroups. In this analysis, 12 ICCC-3 diagnostic groups were presented and abbreviated as follows: I, leukemias; II, lymphomas; III, central nervous system (CNS) neoplasms; IV, neuroblastomas; V, retinoblastoma; VI, renal tumors; VII, hepatic tumors; VIII, malignant bone tumors; IX, soft tissue sarcomas; X, germ cell neoplasms; XI, other epithelial neoplasms; and XII, other and unspecified neoplasms.

Statistical Analysis

The incidence cases (average per year) and percentage of 10 leading cancers between 1980–94 and 1995–2006 were estimated for both genders to show the relative change in rank between these two periods. For long-term cancer trend analyses, age-standardized incidence and mortality rates were calculated for all cancers from 1980 to 2006. Mortality data were derived from the national death database and were coded according to the ICD-9. Additionally, trends in age-standardized and age-specific incidence rates for different types of cancers were calculated for the time periods 1980–84, 1985–89, 1990–94, 1995–99 and 2000–06. Data on incidence rates refer to invasive cancers but not *in situ* cancers. Age standardization in all analyses was performed by the direct method based on the 2000 world standard population (8).

For childhood cancers, the incidence cases (average per year) and percentage of 12 ICCC-3 diagnostic groups between 1980–94 and 1995–2006 were estimated for both genders separately. Trends in age-standardized incidence rates for 12 main groups were also calculated for the time periods 1980–84, 1985–89, 1990–94, 1995–99 and 2000–06. Age-specific incidence rates were presented by two age groups: 0–14 and 15–19 years. All rates for childhood cancers were listed per million persons and were age-adjusted to the 2000 world standard population by the direct method using age groups of 0–4, 5–9, 10–14 and 15–19 years.

RESULTS

Quality Indicators of Taiwan Cancer Registry

The quality indicators included the percentage of morphologically verified cases (MV%), the mortality vs. incidence ratio (M/I%), and the percentage of death certificate only cases (DCO%) from 1980–84 to 2000–06 show steady improvement of the quality of Taiwan Cancer Registry. The MV% increased from 82.4% in 1980–84, 78.5% in 1985–89, 80.1% in 1990–94, 83.4% in 1995–99 to 87.0% in 2000–06. The M/I% decreased from 107.8% in 1980–84, 88.6% in 1985–89, 69.4% in 1990–94, 61.6% in 1995–99 to 53.4% in 2000–06. After 1985, the national death database started using the unique personal identification number assigned to all Taiwanese residents to link with cancer registration data for prognosis investigation. The DCO% decreased from 28.8% in 1985–89, 18.5% in 1990–94, 10.4% in 1995–99 to 2.8% in 2000–06.

Overall Cancer Trends

The number of newly diagnosed cancer cases in Taiwan from 1980 to 1994 was 12 911 for males and 9456 for females annually. The 10 leading cancers in this period were cancers of the liver (16.4%), lung (15.1%), stomach (11.2%) colon and rectum (11.1%), nasopharynx (6.1%), oral cavity and pharynx (6.0%), bladder (3.8%), esophagus (3.7%), prostate (2.9%) and non-Hodgkin lymphoma (2.6%) for males; and cancers of the cervix uteri (20.7%), breast (15.0%), colon and rectum (10.9%), lung (7.6%), stomach (6.2%), liver (5.2%), thyroid (3.4%), nasopharynx (3.2%), ovary (2.8%) and non-Hodgkin lymphoma (2.1%) for

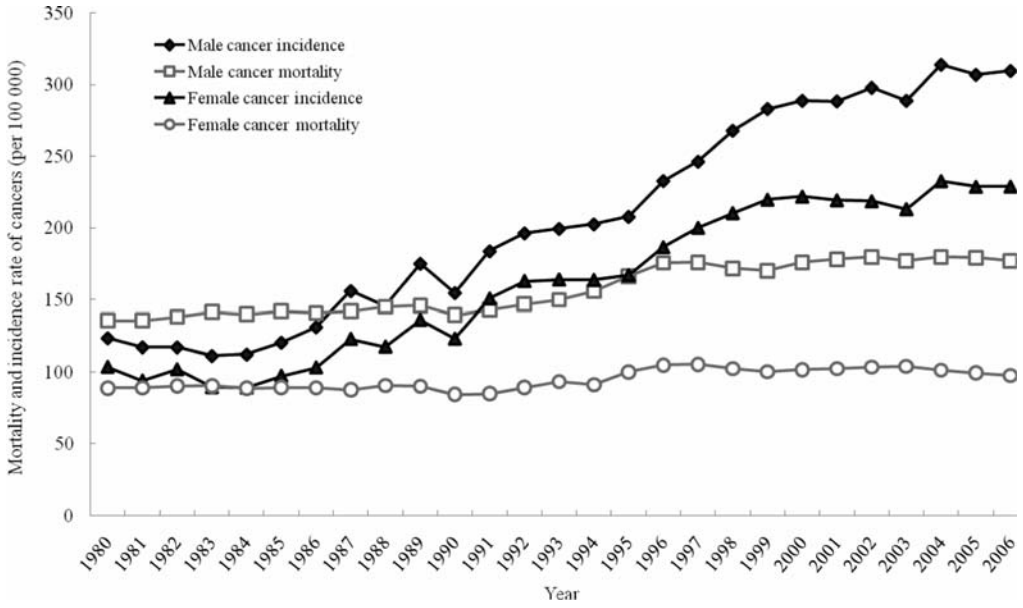

Figure 1. Secular trend of age-standardized incidence and mortality rates of all cancers for males and females in Taiwan, 1980–2006.

females. After implementation of the NHI program, there has been an obvious increase in the number of diagnosed cancer cases (33 167 for males and 24 589 for females annually between 1995 and 2006). Additionally, 10 leading cancers for males were liver (18.4%), lung (14.1%), colon and rectum (13.0%), oral cavity and pharynx (9.6%), stomach (6.7%), prostate (6.3%), bladder (3.7%), esophagus (3.3%), nasopharynx (3.2%) and non-melanoma of skin (2.5%), whereas cancers of the breast (19.4%), colon and rectum (13.2%), cervix uteri (10.1%), liver (9.3%), lung (8.8%), stomach (4.6%), thyroid (3.9%), ovary (3.0%), non-melanoma of skin (2.9%) and corpus uteri (2.8%) were 10 leading cancers for females.

Figure 1 shows a secular trend of age-standardized incidence and mortality rates for cancers of all sites combined in Taiwan from 1980 to 2006 for males and females. Despite an increasing trend in both genders, cancer incidence and mortality were more prominent in males than in females. The gender ratio of cancer incidence gradually increased from 1.2 in 1980 to 1.4 in 2006, whereas the gender ratio of cancer mortality increased from 1.5 in 1980 to 1.8 in 2006. In the early years of the national cancer registry, cancer mortality exceeded cancer incidence indicating the low coverage of cancer registration. After 1995, the incidence rate for cancer continuously increased, whereas the mortality rate remained steady. This finding may be attributed to the aging population in Taiwan and advances in cancer diagnosis and treatment.

Age-standardized incidence rates of most cancers in Taiwan from 1980 to 2006 for males and females are presented in Table 1. Most cancers had an increasing incidence, especially for the initiation of NHI. However, cancer incidence rates of nasopharynx of both genders slightly decreased throughout the entire period and incidences in stomach cancer of both genders and cervical cancer of females declined beginning in 1995.

The slight decline in nasopharyngeal cancer and gastric cancer rates may be attributed to reduced consumption of salt preserved foods. The control of *Helicobacter pylori* infection through proper treatment for gastric cancer may be responsible for part of the decline in incidence. In addition, NHI has provided free mass screening of cervical neoplasia since 1995. A recent study in Taiwan (9) demonstrates that the national screening program significantly reduced cervical cancer risk explaining the dramatic decline in invasive cancer incidence after 1996 and incidence of carcinoma *in situ* after 1999 (Fig. 2).

Age-specific incidence rates of major cancers in Taiwan from 1980 to 2006 for both genders were compared. Overall, the incidence rates increased gradually from 1980 to 2006 for all age groups for cancers of all sites combined, liver, lung and colon and rectum in both males and females; for cancers of the oral cavity and pharynx, prostate and bladder in males; and for cancers of the breast, ovary and corpus uteri in females. The age with peak incidence rates of cancers of all sites combined, lung and colon and rectum increased from 1980 to 2006. On the contrary, the age with peak incidence rates of cancer of the oral cavity and pharynx in males decreased from 1980–89 to 1990–2006. There was a decreasing trend of age-specific incidence rates of nasopharyngeal cancer and stomach cancer in both males and females; and cervical cancer in females from 1980 to 2006.

Cancer Stage in Major Cancers

Cancer staging data have been collected in the long-form system since 2002. The frequency distributions of stage at diagnosis for cancers of the cervix uteri, colon and rectum,

Table 1. Age-standardized incidence rates in Taiwan by primary cancer site, gender and diagnosed year, 1980–2006

Cancer site	1980–84			1985–89			1990–94			1995–99			2000–06		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
All sites	106.50	116.40	95.52	132.34	146.66	116.18	171.99	188.17	153.58	224.58	248.93	197.74	261.87	299.55	223.57
Oral cavity and pharynx															
Lip	0.12	0.17	0.07	0.20	0.31	0.09	0.29	0.48	0.09	0.52	0.88	0.15	0.64	1.13	0.16
Tongue	0.91	1.40	0.37	1.32	2.11	0.45	2.13	3.50	0.68	3.30	5.64	0.90	4.73	8.25	1.19
Mouth	1.51	2.32	0.57	2.21	3.62	0.65	3.43	5.88	0.78	5.57	9.97	1.02	7.72	14.30	1.13
Major salivary gland	0.42	0.47	0.37	0.38	0.40	0.37	0.53	0.58	0.48	0.58	0.68	0.48	0.71	0.78	0.63
Oropharynx	0.39	0.60	0.16	0.37	0.60	0.11	0.58	0.98	0.15	0.87	1.52	0.19	1.45	2.64	0.26
Nasopharynx	7.04	9.50	4.12	6.14	8.38	3.61	6.24	8.67	3.64	6.21	8.88	3.44	5.74	8.59	2.88
Hypopharynx	0.56	0.95	0.10	0.77	1.37	0.09	1.15	2.11	0.09	1.56	2.95	0.10	2.15	4.15	0.15
Pharynx and other oral cavity	0.05	0.06	0.03	0.07	0.10	0.04	0.09	0.13	0.05	0.13	0.24	0.02	0.19	0.35	0.03
Digestive system															
Esophagus	3.46	5.74	0.77	3.20	5.43	0.64	3.59	6.11	0.79	4.34	7.64	0.85	5.59	10.37	0.81
Stomach	11.61	16.03	6.43	13.30	18.18	7.75	14.34	18.78	9.38	15.18	19.55	10.43	13.85	18.05	9.56
Small intestine	0.31	0.32	0.29	0.50	0.57	0.44	0.60	0.69	0.51	0.80	0.93	0.67	1.01	1.20	0.82
Colon and rectum															
Colon	5.65	6.17	5.09	7.70	8.33	7.03	10.92	11.60	10.16	15.49	16.47	14.40	19.69	21.70	17.66
Rectum	5.00	5.73	4.19	6.72	7.52	5.82	9.48	10.41	8.41	12.48	14.15	10.66	15.06	17.73	12.38
Anus	0.19	0.20	0.17	0.21	0.22	0.20	0.30	0.30	0.30	0.36	0.39	0.33	0.34	0.28	0.39
Liver and intrahepatic bile ducts	9.96	15.60	3.26	15.69	24.53	5.62	21.76	32.20	10.36	32.32	46.53	17.45	38.99	55.80	22.22
Gallbladder	0.79	0.85	0.73	1.20	1.26	1.12	1.81	1.83	1.81	2.36	2.36	2.35	2.77	2.89	2.65
Pancreas	1.44	1.84	0.96	2.06	2.50	1.56	2.63	3.17	2.04	3.66	4.29	2.98	4.58	5.37	3.78
Respiratory system															
Nose, nasal cavity and middle ear	0.67	0.85	0.47	0.64	0.79	0.46	0.70	0.84	0.54	0.60	0.80	0.39	0.64	0.87	0.41
Larynx	1.45	2.49	0.20	1.66	2.88	0.23	1.70	3.02	0.20	1.98	3.60	0.23	2.12	4.01	0.21
Lung, bronchus and trachea	13.45	18.87	7.04	16.57	22.60	9.50	20.99	28.08	12.85	26.97	35.93	17.05	30.88	41.08	20.39
Pleura and other thoracic organs	0.27	0.30	0.23	0.47	0.59	0.34	0.65	0.79	0.49	0.81	1.00	0.61	0.94	1.14	0.74
Bones and joints	0.47	0.58	0.35	0.64	0.71	0.58	0.70	0.76	0.64	0.70	0.80	0.59	0.68	0.75	0.60
Skin															
Melanoma of skin	0.20	0.21	0.17	0.28	0.33	0.23	0.44	0.47	0.41	0.61	0.61	0.60	0.67	0.70	0.63
Non-melanoma of skin	1.95	2.43	1.46	2.72	3.04	2.37	3.91	4.13	3.67	5.81	5.98	5.61	7.30	7.81	6.78
Retroperitoneum and peritoneum	0.21	0.22	0.20	0.32	0.30	0.35	0.40	0.42	0.38	0.53	0.54	0.52	0.57	0.53	0.62
Soft tissue	0.56	0.69	0.42	0.80	0.94	0.65	0.99	1.07	0.90	1.36	1.47	1.24	1.61	1.82	1.39
Breast	5.94	0.09	12.75	7.84	0.10	16.47	11.39	0.17	23.45	16.45	0.19	33.34	22.31	0.30	44.45
Female genital system															
Cervix uteri	26.63	—	26.63	25.53	—	25.53	25.74	—	25.74	27.01	—	27.01	17.89	—	17.89
Corpus uteri	1.42	—	1.42	2.08	—	2.08	3.15	—	3.15	4.54	—	4.54	6.84	—	6.84
Uterus, NOS	0.38	—	0.38	0.51	—	0.51	0.36	—	0.36	0.09	—	0.09	0.04	—	0.04

Continued

Table 1. *Continued*

Cancer site	1980–84			1985–89			1990–94			1995–99			2000–06		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Ovary	2.15	—	2.15	3.06	—	3.06	4.35	—	4.35	5.72	—	5.72	6.75	—	6.75
Vagina, vulva and other female genital organs	1.02	—	1.02	0.89	—	0.89	1.17	—	1.17	1.23	—	1.23	1.15	—	1.15
Male genital system															
Prostate	2.54	2.54	—	4.66	4.66	—	7.58	7.58	—	13.95	13.95	—	19.30	19.30	—
Testis	0.37	0.37	—	0.42	0.42	—	0.58	0.58	—	0.67	0.67	—	1.04	1.04	—
Penis and other male genital organs	0.55	0.55	—	0.50	0.50	—	0.62	0.62	—	0.59	0.59	—	0.70	0.70	—
Urinary system															
Kidney	3.18	4.60	1.61	4.07	5.72	2.20	5.51	7.66	3.14	7.01	9.81	4.01	7.43	10.51	4.31
Bladder	0.67	0.80	0.50	1.16	1.45	0.82	1.71	2.11	1.25	2.41	2.92	1.87	2.68	3.43	1.92
Other urinary organs	0.83	0.92	0.74	1.24	1.42	1.04	2.06	2.10	2.03	3.10	3.02	3.20	4.13	3.81	4.46
Eye	0.24	0.24	0.24	0.21	0.23	0.18	0.28	0.28	0.27	0.24	0.24	0.24	0.25	0.29	0.21
Brain and nervous system															
Brain	1.36	1.58	1.09	1.74	1.96	1.48	2.29	2.67	1.89	2.47	2.85	2.07	2.54	2.87	2.20
Cranial nerves and other nervous system	0.15	0.18	0.12	0.18	0.18	0.18	0.24	0.27	0.21	0.22	0.21	0.23	0.28	0.29	0.27
Endocrine system															
Thyroid	1.44	0.80	2.19	2.01	0.90	3.23	3.42	1.60	5.37	4.45	1.82	7.21	5.68	2.68	8.74
Other endocrine organs	0.09	0.11	0.07	0.18	0.21	0.15	0.25	0.26	0.24	0.31	0.34	0.28	0.31	0.34	0.27
Lymphoma															
Hodgkin lymphoma	0.28	0.38	0.16	0.26	0.33	0.19	0.25	0.29	0.20	0.29	0.36	0.22	0.50	0.60	0.38
Non-Hodgkin lymphoma	2.29	2.65	1.88	2.86	3.54	2.14	4.00	4.78	3.16	5.26	6.15	4.30	6.50	7.46	5.52
Myeloma	0.37	0.45	0.28	0.53	0.68	0.37	0.77	0.98	0.55	0.99	1.23	0.74	1.33	1.60	1.06
Leukemia															
Lymphocytic leukemia															
Acute lymphocytic leukemia	0.80	0.91	0.69	0.75	0.84	0.66	0.90	0.94	0.87	1.09	1.21	0.97	1.25	1.36	1.13
Chronic lymphocytic leukemia	0.09	0.14	0.04	0.11	0.15	0.06	0.17	0.22	0.11	0.25	0.35	0.15	0.34	0.44	0.24
Other lymphocytic leukemia	0.06	0.07	0.05	0.07	0.07	0.07	0.08	0.10	0.05	0.06	0.08	0.04	0.04	0.05	0.03
Myeloid leukemia															
Acute myeloid leukemia	1.02	1.12	0.91	1.15	1.28	1.01	1.35	1.50	1.20	1.79	1.97	1.60	2.17	2.47	1.85
Chronic myeloid leukemia	0.36	0.48	0.23	0.38	0.46	0.29	0.49	0.60	0.36	0.53	0.62	0.44	0.72	0.88	0.55
Other myeloid leukemia	0.14	0.18	0.09	0.12	0.12	0.11	0.13	0.14	0.12	0.14	0.14	0.13	0.17	0.20	0.13
Other leukemia	0.08	0.09	0.06	0.15	0.16	0.13	0.19	0.24	0.13	0.22	0.22	0.23	0.24	0.27	0.20
Other and unknown sites	1.66	1.82	1.47	2.41	2.59	2.22	4.05	4.43	3.65	4.82	5.49	4.11	4.38	5.08	3.66

The data exclude non-invasive malignant neoplasms. Incidence rates are per 100 000 and are age-standardized to the 2000 world standard population.

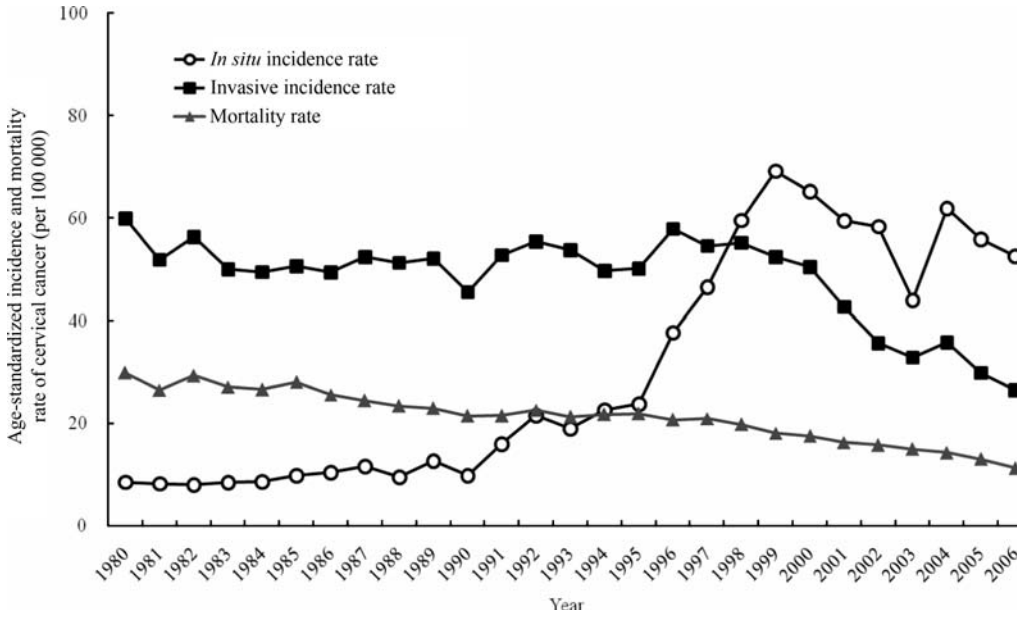

Figure 2. Secular trend of age-standardized incidence and mortality rates for cervical cancer among women with age 30+ years in Taiwan, 1980–2006.

female breast and oral cavity and pharynx, which were included in the screening program in Taiwan (Table 2), from 2002 to 2006 were examined. The percentages of Stages 0, 1, 2, 3 and 4 were 66.8%, 18.2%, 7.0%, 5.5% and 2.5% for cervical cancer; 4.2%, 15.7%, 27.6%, 30.1% and 22.4% for colon and rectum cancer; 9.7%, 27.4%, 40.5%, 17.7% and 4.7% for female breast cancer; and 0.5%, 21.0%, 18.7%, 15.1% and 44.7% for oral cavity and pharynx cancer. There was no significant change in the annual stage distribution of these cancers from 2002 to 2006.

Table 2. Cancer screening program in Taiwan

Cancer	Items	Start year	Age/interval	Screening rate in 2008
Cervix uteri	Pap smear	1995	≥30/3 years	56% (3 years)
Colon and rectum	Fecal occult blood test	1999	50–69/2 years	10% (2 years)
Female breast	Mammography	2002	50–69/2 years	12% (2 years)
Oral cavity and pharynx	Oral screening (smoker and betel quids chewer)	2004	≥18 /2 years	25% (2 years)

Childhood Cancer Trends

The number of childhood cancer cases newly diagnosed in Taiwan from 1980 to 1994 averaged 398 for males and 311 for females annually. The most common cancers in this period were leukemias (27.2%), CNS neoplasms (13.3%) and lymphomas (10.8%) for males; and leukemias (26.5%), CNS neoplasms (14.0%) and other epithelial neoplasms (13.7%) for females. Following the NHI program, the number of diagnosed cancer cases markedly increased (476 for males and 375 for females annually between 1995 and 2006). Moreover, the three leading cancers for males were leukemias (27.9%), lymphomas (13.7%) and CNS neoplasms (12.7%), whereas leukemias (27.1%), other epithelial neoplasms (14.6%) and CNS neoplasms (12.5%) were the three leading cancers for females. These four diseases for males and females accounted for nearly 55% of childhood cancers.

Figure 3a and b displays age-standardized incidence rates of childhood cancers according to the ICCC-3 group from 1980 to 2006 for both genders. Most childhood cancers had an increasing incidence rate in the period except for CNS neoplasms, other epithelial neoplasms, malignant bone tumors and other unspecified neoplasms in males; and hepatic tumors, renal tumors and other unspecified neoplasms in females. The dramatic decline of the incidence rate of other and unspecified neoplasms in both genders might be attributed to improvement in confirmation diagnosis and change in classification edition (ICD-O-FT used in 1980–2001 and ICD-O-3 used after 2002).

The age-specific incidence rates of childhood cancers according to the ICCC-3 group, gender and age from 2000 to 2006 were examined. Adolescents (aged 15–19 years) had higher incidence rates compared with those of children (aged 0–14 years) for other epithelial neoplasms (36.3 vs. 5.7 per million), lymphomas (23.1 vs. 13.4 per million), germ cell neoplasms (22.1 vs. 11.0 per million), soft tissue sarcomas (15.1 vs. 8.3 per million), malignant bone tumors (11.5 vs. 6.0 per million), hepatic tumors (5.1 vs. 4.2 per million) and other unspecified neoplasms (2.6 vs. 2.0 per million), whereas children had higher incidence rates of leukemias (42.0 vs. 30.2 per million), CNS neoplasms (17.7 vs. 14.4 per million), neuroblastomas (8.0 vs. 0.7 per million),

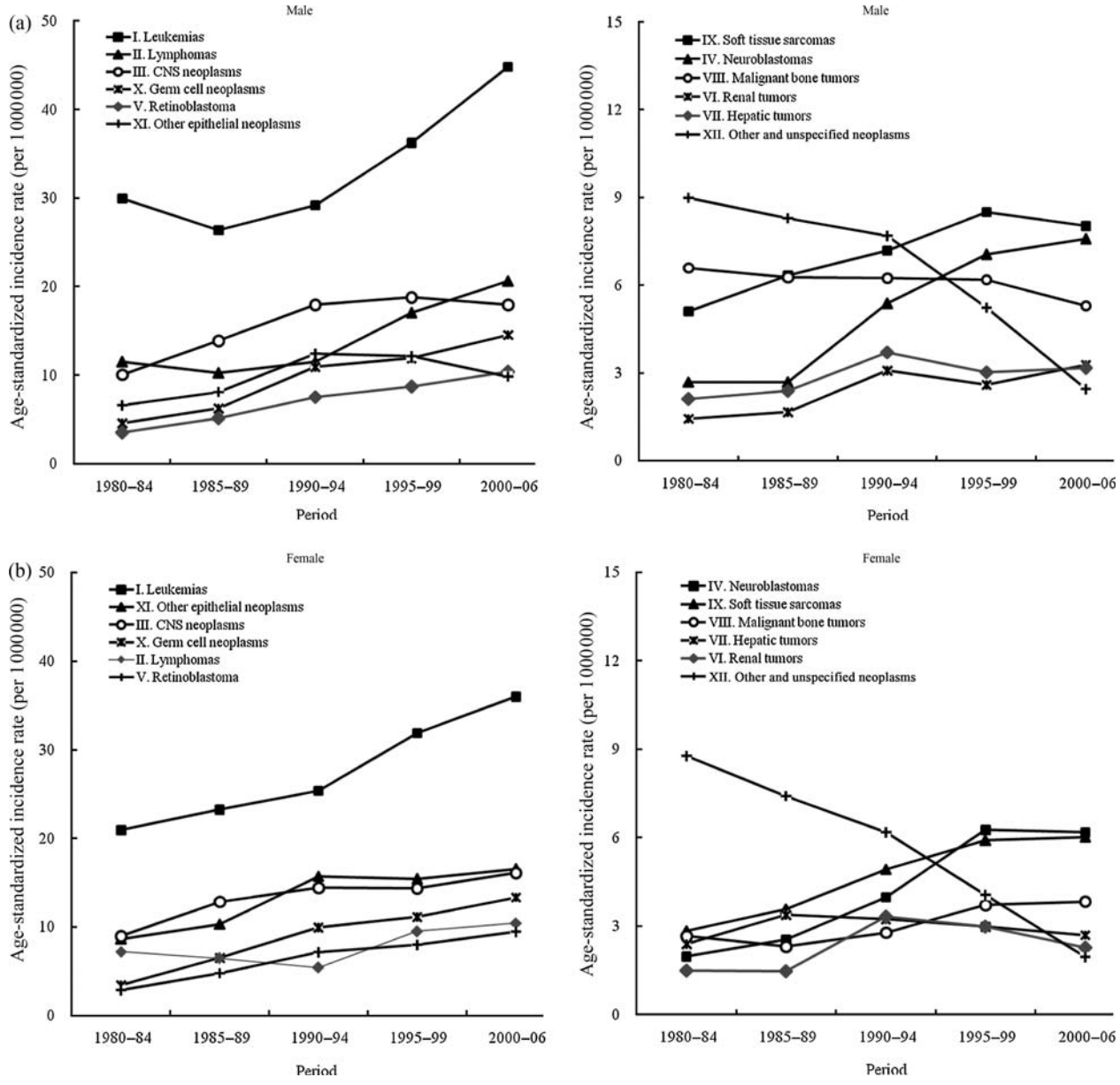

Figure 3. Secular trend of age-standardized incidence rates of childhood cancers by ICCC-3 group among males (a) and females (b) in Taiwan, 1980–2006.

renal tumors (3.3 vs. 0.8 per million) and retinoblastoma (3.2 vs. 0.0 per million) than adolescents. Additionally, childhood cancers among males had a higher incidence rate than those among females except for other epithelial neoplasms. These findings reveal the distinct differences in cancer incidence between children and adolescents.

DISCUSSION

The NHI program in Taiwan has successfully provided quality health care, comprehensive benefits and convenient access to treatment. Additionally, the data quality and timely reporting of the cancer registry were improved following enactment of the Cancer Control Act. Thus, the national cancer registry continues to ensure data quality and monitor cancer incidence. A long-form system will include cancer-specific factors and expand to more cancers reported in the near future.

In a related development, the Regulations for Cancer Care Quality Assurance Measures drafted according to the Cancer Control Act was promulgated in 2007 for long-form hospitals to promote cancer diagnosis and treatment quality and establish an accreditation criteria that largely included cancer prevention, screening, diagnosis, treatment, patient care, hospital care, and construction of a cancer diagnosis and treatment information database. In 2008, 22 medical center hospitals qualified for outstanding performance through the accreditation system. In addition to providing cancer patients with optimum care, these strategies also enhance data quality of the cancer registry database.

Primary and secondary prevention of major cancers, such as high-risk factor avoidance and periodical cancer screening, were implemented by the National Department of Health to reduce cancer incidence and mortality rates. Tobacco smoking, alcohol consumption and betel quids chewing are common habits in Taiwan. Following implementation of the Tobacco Hazards Prevention Act in 1997 and subsequent revision in 2007, historical data revealed that the smoking rates for adults aged 18 years are decreasing among males and steadily lower among females (9). Meanwhile, the control of betel quids chewing was implemented simultaneously in 1997. As a prioritized policy of betel quids control and oral cancer prevention in 2007, the Taiwan government has focused on lowering the rate of betel quids chewing. Chronic hepatitis B infection, a major risk factor for hepatocellular carcinoma, can be ~90% preventable with hepatitis B vaccination. The nationwide hepatitis B vaccination program has been successful in preventing acute and chronic liver disease in Taiwan since 1984. The universal immunization program among Taiwanese newborns has not only reduced the HBV infection rate but also prevented the incidence of childhood hepatocellular carcinoma (10). Additionally, cervical cancer screening program has appeared to be the most effective among all the screening services in Taiwan. It shows that success of the long-term promotion of Pap smear screening is related to the reduction of the cervical cancer incidence rate (11). The Taiwan government also established screening information system for major cancers of the cervix uteri, colon and rectum, female breast and oral cavity and pharynx. Both Taiwan Cancer Database and Cancer Screening Information System serve as the basis for planning of the cancer prevention and control program, as well as monitoring surveillance and academic research.

With advances in cancer diagnosis using genetic and pathological methodologies, several hematological diseases can be cured more effectively and patients' life expectancy prolonged. Moreover, the NHI program promoted convenient access to medical care and healthy services nationwide. To our knowledge, this study describes for the first time the secular changes and age patterns in the incidence of childhood cancer using national cancer data. In addition to contributing to research in genetic and environmental risk factors for childhood cancers, results of this study provide a valuable reference for governmental strategies to reduce childhood cancers.

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Conflict of interest statement

None declared.

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