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Incidence of Childhood Cancer in Osaka, Japan, 1971–1988: Reclassification of Registered Cases by Birch's Scheme Using Information on Clinical Diagnosis, Histology and Primary Site

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In 1971–1988, 4,021 malignant tumors occurring among children under 15 years of age were registered in the Osaka Cancer Registry, a population-based registry which covers Osaka Prefecture, Japan. These patients were reclassified into 12 diagnostic groups by Birch's scheme using information on clinical diagnosis, histology and primary site. The annual age-standardized incidence rate for childhood cancer per million children was 130.3 for males and 104.9 for females in 1971–88. Comparing the incidence rates for both sexes in 1981–88 with those in 1971–80 in Osaka, we observed a significant decrease of acute non-lymphocytic leukemia (ANLL) and a significant increase of all cancers, acute lymphocytic leukemia, non-Hodgkin lymphoma, sympathetic nervous system tumors, soft-tissue sarcomas, and gonadal and germ-cell tumors. Age-standardized incidence rates in around 1971–80 of the above-mentioned diagnostic groups were compared among 4 population-based registries; Osaka, Miyagi (Japan), SEER (U.S.), and the National Registry of Childhood Tumors (England and Wales). Rates for ANLL and gonadal and germ-cell tumors were higher and those for other diagnostic groups were lower in Osaka, especially for Hodgkin's disease. Thus, in 1980–88 in Osaka, rates for Hodgkin's disease remained low and rates for gonadal and germ-cell tumors increased, though rates for other cancers appeared to resemble the levels in caucasian populations. The incidence of childhood cancer in Japan was estimated according to the diagnostic groups in Birch's scheme.

Key words: Childhood neoplasm — Incidence — Time trend — Geographical variation — Population-based cancer registry

For children younger than 15 years of age, cancer is an important cause of mortality. In 1990 in Japan, 13.6% of deaths among children 1–14 years of age was attributed to malignant neoplasms, ranking second among causes of death.[1)]

Classification of childhood cancer by ICD rubrics may be insufficient to reveal their characteristics, since many childhood solid tumors can occur in different topologic sites and are thus classified as different cancers. A classification scheme including morphology data was proposed by Birch and Marsden, in order to facilitate investigations on the etiology of childhood cancer.[2)] In addition, it has been reported that the survival rate varied substantially according to the diagnostic group in Birch's classification.[3–8)] Thus, evaluation of the incidence of childhood cancer according to the new classification is desirable.

A worldwide study on the incidence of childhood cancer using the new classification scheme was conducted by the International Agency for Research on Cancer (IARC), using incidence data from 70 registries in 50 countries throughout the world. Three population-based registries in Japan, Osaka (1971–80), Miyagi (1971–79) and Kanagawa (1975–79), took part in the study.[9)] Differences in the incidence rates according to ethnic group were demonstrated in the study, though the reasons for these differences remain unclear. However, time trends in a definite registration area have never been investigated using the new classification method.

A nationwide childhood cancer data-bank (Japan Children's Cancer Registry; JCCR) has been operating in Japan with the support of the Japan Children's Cancer Association using a unique classification system closely resembling Birch's scheme. This data-bank functions, however, more as a central registry of department-based registries than as a population-based registry.[10)]

We reclassified the childhood cancer cases registered in the Osaka Cancer Registry according to the new scheme, and examined the time trends. Furthermore, the incidence of childhood cancer in Japan has been estimated according to the diagnostic groups of the new scheme, and compared with those reported by the JCCR. This is the first report on the descriptive epidemiology of childhood cancer in Japan based on Birch's classification using population-based registry data.

MATERIALS AND METHODS

Subjects Data for this analysis were obtained through the Osaka Cancer Registry (OCR), a population-based registry which covers all of Osaka Prefecture. It has been operating since 1962, though information on histological diagnosis has only been collected since 1966. Subjects in this study are those registered cancer cases under 15 years of age who were living in Osaka Prefecture at the date of diagnosis and were diagnosed in 1971–1988.

Background of the OCR Osaka Prefecture is the second smallest prefecture (1,882 km^2), with a population of 8,734,516 by the 1990 census. The population density is the highest among all the prefectures in Japan. Children account for 17.2% of the population. Surrounding Osaka City, the capital of the prefecture, there are 32 cities, 10 towns, and a village. There are 5 university hospitals, 1 cancer center, 2 children's hospitals, and about 600 general hospitals as of 1993.

Quality of data The proportion of cases registered by death certificate only (DCO), an inverse index of the completeness of registration, was 4.9% of the total cases under 15 years of age in 1971–88. The proportion of DCO was 6.5% in 1971–80, and it decreased year by year, reaching 2.8% in 1981–88. Through the whole period of this study, 76% of all childhood cancer cases were microscopically confirmed. The proportion increased from 71% in 1971–80 to 82% in 1981–88.

Classification Cancer cases were re-classified according to Birch's scheme into 12 diagnostic groups as shown in Table I, using information on clinical diagnosis, morphology (ICD-O-M) and topology (ICD-9) of disease.[2, 11, 12] The number of cases which could not be classified into the specified groups was only 117 (2.9% of the total). They were included in the category of "XII. Others." Histiocytosis X, which was included in the category of "II. Lymphomas and other reticuloendothelial neoplasms" in the original scheme, was excluded in this study, since it is now regarded as a reactive disease.

Population and calculation of rate The child population at risk was computed by linear interpolation from census data for every five years during the period of 1970–1990. The total person-years at risk amounted to 35.4 million years, and the annual average was 2 million. Rates per million children were calculated for age groups of 0, 1–4, 5–9, and 10–14. Age-standardized rates were obtained using the World Population.

Comparison with other populations The age-standadized incidence rates by diagnostic group in Osaka were compared with those presented from the Miyagi Tumor Registry, the Surveillance, Epidemiology and End Results (SEER) Program in the U.S. and the National Registry of Childhood Tumors in England and Wales.[9] Average annual populations under 15 years of age were 0.5, 4, and 11 million, respectively. The proportions of histologically verified cases were 67%, 97%, and 94%, respectively.[9] The proportion of DCO cases in childhood cancer was not mentioned in references 8 and 9, although Stiller and Bunch reported that it was less than 10% in England and Wales.[4] The proportions of DCO cases among all cancers in all ages were 25% in Osaka, 22% in Miyagi, and less than 5% in the SEER program.[13]

Test for significance The significance of differences in incidence rates between those in 1971–80 and in 1981–88 was tested using the standardized rate ratio. Statistical significance was judged at the 95% level using Smith's method.[14]

Estimation of incidence in Japan The Research Group for Population-based Cancer Registration in Japan has estimated the annual incidence of cancer in Japan.[15, 16] The aggregate incidence (number) in 1979–83 in each of the 3 age groups, 0–4, 5–9, and 10–14, was allocated according to the relative frequency of the cases by diagnostic group in Birch's scheme in Osaka for 1971–88.

RESULTS

In 1971–1988, 4,021 cases of childhood neoplasms (2,280 males and 1,741 females) were registered in the Osaka Cancer Registry, corresponding to an annual crude rate of 114.0 per million children. The annual age-standardized rate was 130.3 among males and 104.9 among females.

Table I presents the incidence of childhood cancer for both sexes by diagnostic group, as well as age-specific incidence rates, age-standardized rates, male-to-female ratios, and age-standardized rates for two periods, 1971–80 and 1981–88.

Relative frequency by diagnostic group Leukemias were most frequent (32.9%), followed by central nervous system (CNS) neoplasms (21.6%), lymphomas (9.3%), sympathetic nervous system (SNS) tumors (7.1%), and gonadal and germ-cell tumors (6.3%), as shown in Table I. Hepatic tumors (2.5%) and epithelial neoplasms (1.4%) were relatively minor.

Male-to-female ratio Childhood cancer was more common among males than females with a male-to-female ratio of 1.24 (Table I). This excess was mainly due to an excess of male cases in leukemias (1.23), lymphomas (1.57), and CNS neoplasms (1.27). Also, male excess was seen in renal tumors, soft-tissue sarcomas, and gonadal and germ-cell tumors. In contrast, a slight excess among females was observed only for epithelial neoplasms.

Age-specific incidence rates in four age groups The incidence rate of all cancers was high in the 0 and 1–4 year age groups (Table I). Leukemia showed a peak in the 1–4 year age group.

Table I. Incidence, Incidence Rates per Million Children and Their Time Trends of Childhood Cancer in Osaka, 1971–1988, Both Sexes

Diagnostic group	No. of cases	Age-specific rate				ASR[a]	M/F[b]	ASR[a] by period	
		0	1–4	5–9	10–14			1971–80	1981–88
I. Leukemias	1,323	27.1	56.0	37.4	24.7	38.7	1.23	33.9	39.9
Acute lymphocytic leukemia (ALL)	783	9.8	36.2	23.5	11.9	23.0	1.29	18.3	26.4
Other lymphocytic leukemia	7	0.0	0.2	0.2	0.2	0.2	0.41	0.2	0.1
Acute non-lymphocytic leukemia (ANLL)	308	5.3	10.3	8.7	8.2	8.8	1.17	9.1	7.3
Chronic myeloid leukemia	49	1.3	1.4	1.2	1.6	1.4	1.51	1.5	1.4
Other and unspecified leukemia	176	10.7	7.9	3.8	2.8	5.3	1.06	4.9	4.7
II. Lymphomas and other reticulo-endothelial neoplasms[c]	375	6.7	12.5	10.2	10.3	10.7	1.57	8.8	13.4*
Hodgkin's disease	27	0.0	0.3	0.9	1.1	0.7	1.53	0.8	0.7
Non-Hodgkin lymphoma (NHL)	183	2.2	6.1	5.0	5.3	5.2	1.86	4.0	6.9*
Burkitt's lymphoma	13	0.0	0.5	0.3	0.3	0.4	1.55	0.3	0.5
Unspecified lymphoma	103	2.2	3.1	3.2	2.6	2.9	1.68	2.8	3.0
Other reticuloendothelial neoplasms	49	2.2	2.5	0.7	0.9	1.5	0.81	1.0	2.3*
III. Central nervous system neoplasms	869	25.3	25.9	25.5	22.6	24.8	1.27	24.1	25.9
Ependymoma	44	0.4	2.5	1.0	0.6	1.3	0.95	1.1	1.6
Astrocytoma	115	0.4	3.2	3.2	3.9	3.2	0.98	2.4	4.3
Medulloblastoma	81	1.3	2.8	2.7	1.6	2.3	1.37	1.8	3.2*
Other glioma	47	0.4	1.2	1.5	1.5	1.3	0.96	0.9	1.8*
Other and unspecified	582	22.7	16.3	17.0	15.0	16.6	1.39	17.8	15.0
IV. Sympathetic nervous system tumors	286	20.5	18.3	4.4	1.3	9.0	1.23	8.1	10.7*
Neuroblastoma and ganglioneuroblastoma	284	20.5	18.2	4.4	1.2	9.0	1.23	8.0	10.7*
Other	2	0.0	0.1	0.0	0.1	0.1	1.24	0.0	0.1
V. Retinoblastoma	158	14.2	11.5	1.3	0.2	5.1	0.99	5.4	4.7
VI. Renal tumors	149	10.7	9.9	1.9	0.8	4.7	1.58	4.5	5.0
Wilms' tumor	128	9.8	8.4	1.7	0.6	4.1	1.45	3.8	4.5
Renal carcinoma	4	0.0	0.2	0.1	0.1	0.1	0.37	0.0	0.3
Other and unspecified	17	0.9	1.3	0.2	0.1	0.5	5.12	0.7	0.3
VII. Hepatic tumors	99	6.7	5.8	0.9	1.6	3.1	1.01	3.1	3.0
Hepatoblastoma	61	2.7	4.4	0.7	0.5	1.9	1.13	1.6	2.4
Hepatic carcinoma	9	0.0	0.1	0.0	0.7	0.2	1.99	0.2	0.3
Other and unspecified	29	4.0	1.4	0.2	0.3	0.9	0.67	1.2	0.4
VIII. Malignant bone tumors	145	0.9	1.1	3.2	8.1	3.8	0.97	3.5	4.3
Osteosarcoma	78	0.4	0.0	1.7	4.9	2.0	1.07	1.5	2.6*
Chondrosarcoma	4	0.0	0.1	0.2	0.1	0.1	3.28	0.1	0.2
Ewing's sarcoma	28	0.0	0.4	1.0	1.0	0.8	0.60	0.5	1.1
Other and unspecified	35	0.4	0.5	0.4	2.1	0.9	1.00	1.4	0.4
IX. Soft-tissue sarcomas	188	13.3	6.8	4.5	3.5	5.6	1.16	4.1	7.9*
Rhabdomyosarcoma	96	5.3	4.0	2.5	1.4	2.9	1.58	1.9	4.3*
Fibrosarcoma	30	1.8	0.7	0.8	0.8	0.9	0.57	0.6	1.2
Other and unspecified	62	6.2	2.0	1.2	1.3	1.9	1.02	1.5	2.3
X. Gonadal & germ-cell tumors	253	8.4	10.4	3.4	8.2	7.4	1.37	6.0	9.0
Non-gonadal germ-cell tumors	92	4.0	2.1	1.2	4.1	2.6	1.34	1.6	3.9*
Gonadal germ-cell tumors	102	2.2	6.1	1.2	2.2	3.1	1.77	3.0	3.0
Gonadal carcinoma	4	0.0	0.2	0.1	0.1	0.1	1.20	0.1	0.1
Other and unspecified	55	2.2	2.0	0.9	1.7	1.6	0.89	1.3	2.1
XI. Epithelial neoplasms	58	1.8	0.8	1.1	2.8	1.6	0.69	1.2	2.0
Adrenocortical carcinoma	1	0.4	0.0	0.0	0.0	0.0	0.00	0.0	0.1
Thyroid carcinoma	7	0.0	0.0	0.1	0.5	0.2	0.73	0.1	0.2
Nasopharyngeal carcinoma	4	0.0	0.0	0.1	0.3	0.1	2.66	0.0	0.2
Melanoma	10	0.0	0.5	0.2	0.3	0.3	0.23	0.2	0.4
Other carcinoma	36	1.3	0.3	0.7	1.8	1.0	0.84	0.8	1.2
XII. Others and unspecified	118	9.3	5.0	2.5	1.7	3.6	1.14	4.9	1.5
All neoplasms[c]	4,021	144.9	164.0	96.3	85.7	118.0	1.24	111.4	127.3*

Rates are expressed per million children.

a) ASR: Age-standardized rate standardized by the world population.

b) M/F: Male-to-female ratio.

c) Histiocytosis X is excluded in this study.

* represents a statistically significant increase of the ASR in 1981–88, compared with that in 1971–80 ($P<0.05$).

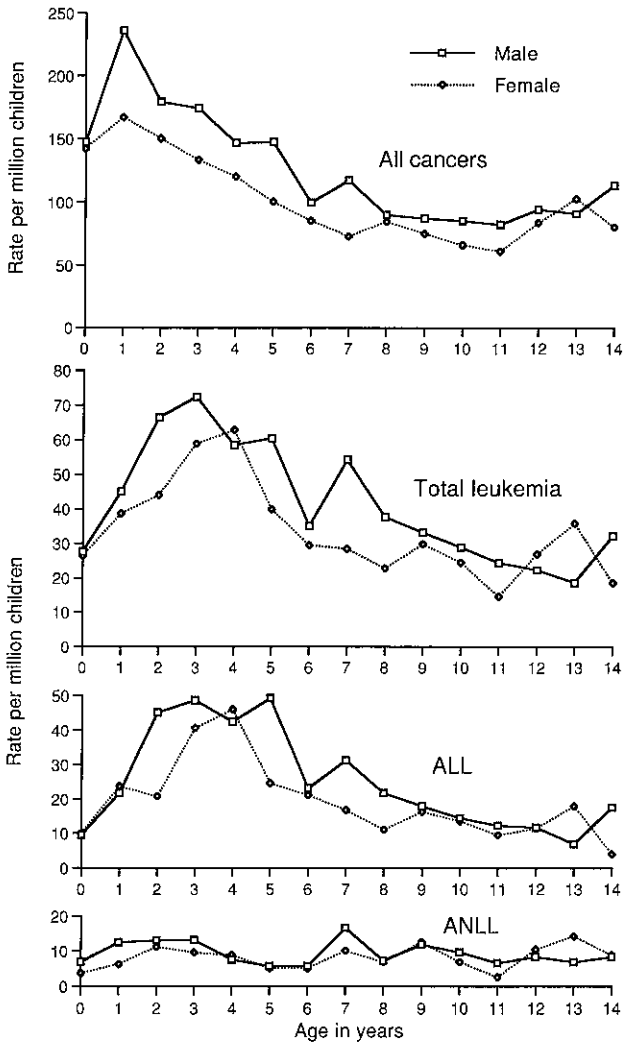

Fig. 1. Age-specific incidence rates of total malignancy and leukemia by sex in Osaka during 1971–1988.

Other diagnostic groups were divided into three groups according to their age-specific incidence rates: (1) groups with high incidence rates in 0 and 1–4 year age groups and low in the 5–14 year age groups (SNS tumors, retinoblastoma, renal tumors, hepatic tumors, soft-tissue sarcomas and others), (2) group showing an increasing trend of rates with age (malignant bone tumors), and (3) groups with relatively constant rates throughout 0–14 years of age (lymphomas, CNS neoplasms, gonadal and germ-cell tumors and epithelial neoplasms).

Age-specific incidence rates by sex The top chart of Fig. 1 shows age-specific incidence rates for all cancers in the 1-year age group during the period of 1971–88 by sex. They showed a peak in the second year of life for males and for females. Incidence rates among males were higher than those among females for almost all ages.

Incidence rates of total leukemias showed a peak at 3 years of age among males and at 4 years of age among females (Fig. 1, upper-middle). Acute lymphocytic leukemia (ALL) had high incidence rates during 2–5 years of age among males and females (Fig. 1, lower-middle). For acute non-lymphocytic leukemia (ANLL), rates were relatively constant throughout 0–14 years of age (Fig. 1, bottom).

Time trends Time-trends of incidence rates are shown in Table I for both sexes combined and in Table II for each sex in Osaka. Incidence rates for all cancers in 1981–88 were increased significantly among males and females compared with those in 1971–80. Among the main diagnostic groups, significant increases were observed in lymphomas, SNS tumors, soft-tissue sarcomas (for males and for females), and gonadal and germ-cell tumors (among females only).

The incidence rates for total leukemia were constant in these two periods among females and slightly increased among males (not significant). However, a significant increase was seen in ALL and a significant decrease in ANLL among males. Similar trends were also observed among females, although they were not statistically significant.

Comparison with other populations As shown in Table II, the incidence rate of all cancers was highest in the U.S., followed by Osaka in 1971–80, England and Wales, and Miyagi for both sexes. The difference in incidence rate between Osaka and the U.S. was rather small, compared with that for cancer at all ages: the ratio of incidence rate of all childhood cancer in Connecticut, U.S. to that in Osaka was 1.2 among males and 1.3 among females, while that for cancer in all ages was 1.5 and 1.9, respectively.[13]

Comparison of the incidence rates in Osaka by diagnostic group with those in the two white populations was made only for diagnostic groups showing a higher incidence rate than 10.0 in 1971–80 in Osaka as well as groups showing significant changes in incidence rates in 1981–88; groups I–IV, IX and X. The symbol ↑ or ↓ was attached to the figures in Table II when incidence rates both in the U.S. and in England and Wales were lower than −20% or higher than +20%, respectively, of that in Osaka in 1971–80.

The incidence rates of ANLL in both sexes and gonadal and germ-cell tumors in males were substantially higher in Osaka in 1971–80 than in the two white populations. On the other hand, the rates of ALL and Hodgkin's disease in males and in females were considerably lower in Osaka. Non-Hodgkin's lymphoma (NHL) and soft-tissue sarcomas seemed to be slightly less

Table II. Annual Age-standardized Incidence Rates per Million Children of Childhood Cancer in Selected Populations

Diagnostic group		Osaka 1971–80	Osaka 1981–88	Miyagi, Japan 1971–79	SEER (Whites) 1973–82	England and Wales 1971–80
I. Leukemias	M	41.1	44.5	40.3	47.8	41.8
	F	34.3	35.0	38.6	39.5	32.9
ALL	M	22.6↓	30.8*	17.3	35.9	33.7
	F	18.9↓	21.7	15.5	29.7	25.5
ANLL	M	10.7↑	7.5**	11.7	5.6	6.1
	F	8.5↑	7.2	10.1	6.5	5.7
II. Lymphomas	M	11.4↓	15.1*	4.8	19.9	14.5
	F	6.2	11.6*	2.6	11.3	6.6
Hodgkin's disease	M	0.8↓	1.0	0.4	6.5	5.6
	F	0.7↓	0.4	—	5.9	2.4
NHL	M	5.3↓	8.6*	1.8	6.9	7.9
	F	2.7	5.1*	—	2.8	3.4
III. CNS neoplasms	M	26.6	29.2	8.6	26.4	26.4
	F	21.4	22.4	10.4	23.3	22.4
IV. SNS tumors	M	8.7	12.1*	7.3	12.8	7.9
	F	7.3	9.4*	6.9	12.6	6.3
V. Retinoblastoma	M	5.8	3.8	5.3	3.7	3.4
	F	5.0	5.5	3.3	4.4	3.6
VI. Renal tumors	M	5.5	6.1	5.1	8.0	7.1
	F	3.5	3.8	3.2	10.0	7.7
VII. Hepatic tumors	M	3.3	2.6	4.9	2.1	0.9
	F	2.8	3.4	1.5	1.1	1.1
VIII. Malignant bone tumors	M	3.3	4.4	3.1	5.4	4.9
	F	3.7	4.2	5.1	5.6	4.2
IX. Soft-tissue sarcomas	M	4.3↓	8.6*	7.2	9.0	7.3
	F	3.8↓	7.1*	3.0	8.2	5.5
X. Gonadal and germ-cell tumors	M	7.7↑	9.3	6.6	4.3	2.5
	F	4.2	8.7*	5.9	4.1	2.6
XI. Epithelial neoplasms	M	1.0	1.5	2.3	3.2	2.0
	F	1.4	2.6	2.7	5.8	3.3
XII. Others	M	5.1	1.7	3.8	0.8	0.3
	F	4.6	1.4	2.1	0.7	0.2
All cancers	M	123.8	138.9*	99.3	143.5	118.9
	F	98.4	115.1*	85.3	126.7	96.3

Rates are standardized by the world population. Figures other than those in Osaka were obtained from reference 9.
Symbols * and ** represent a statistically significant increase or decrease in the incidence rates in 1981–88 in Osaka, respectively, compared with that in 1971–80.
Symbols ↑ and ↓ represent higher or lower incidence rates, respectively, in Osaka in 1971–80 than those in SEER as well as in England and Wales.

common in Osaka in 1971–80, but increased in 1981–88 to the same level as that found in the two white populations.

Incidence rate of all childhood cancer in Osaka was higher than that in Miyagi. The rates of total leukemia were similar in these two areas, while a higher rate of ALL and a lower rate of ANLL were observed in Osaka. Higher rates were observed in Osaka for lymphoma, CNS neoplasms, SNS tumors, and gonadal and germ-cell tumors.

Estimation of incidence in Japan by diagnostic group In Table III, the incidences (numbers of cases) in Japan by diagnostic group estimated in this study were compared with those registered in JCCR. The total number of childhood cancer cases in Japan was estimated to be 13,346 during 1979–83, around 2,700 per year, by the Research Group for Population-based Cancer Registration in Japan (RGPCR). The JCCR registered 6,780 cases during the same period.[10] So the ratio of the latter to the former was 50.8% for all childhood cancer.

Table III. Comparison of Estimated Incisence (Number) of Childhood Cancers in Japan with Those Registered in The Japan Children's Cancer Registry (JCCR) during 1979–83

Diagnostic group	Number in Japan		JCCR/ Estimates (%)
	Estimates	JCCR	
I. Leukemias	4,402	2,785	63.3
II. Lymphomas	1,251	636	50.9
III. CNS tumors	2,901	576	19.9
IV. SNS tumors	937	722	77.0
V. Retinoblastoma	514	533	103.6
VI. Renal tumors	487	288	59.1
VII. Hepatic tumors	324	158	48.7
VIII. Malignant bone tumors	487	116	23.8
IX. Soft-tissue sarcomas	623	170	27.3
XII. Others and unspecified	1,420	796	56.1
All cancers	13,346	6,780	50.8

JCCR: The Japan Children's Cancer Registry.
Estimates: Refer to the text ("Material and Methods").

The incidence for each diagnostic group in each of the three 5-year age groups was first estimated by allocating the total number of each age group according to the relative frequencies in each of the 5-year age groups in Osaka for 1971–88. Gonadal and germ-cell tumors and epithelial neoplasms were included in the group designated "other and unspecified," since these categories could not be identified in the classification form used by the JCCR. The ratio of the numbers by JCCR to our estimates varied by diagnostic group, from 104% for retinoblastoma to 20% for CNS neoplasms.

DISCUSSION

Childhood cancer is relatively uncommon but complicated in nature. Long-term observation in a large population is necessary to investigate its incidence rate by diagnostic group. To study trends of the incidence rate, 10 or more years of data are required even in Osaka, with a 2.0 million childhood population per year during the observation period in this study. These conditions make the epidemiological study of time trends difficult.

The Osaka Cancer Registry has one of the highest levels of registration among population-based registries in Japan.[16] Through the observation period, the proportion of cases registered by death certificate only was low for childhood cancer and the proportion of microscopically verified cases was high. However, these figures were better in the latter half of the observation period than in the former. Therefore, some degree of increase in incidence rates during the latter period might have been caused by improvements in the quality of registration. Furthermore, the age-standardized rate of cases classified into the "unspecified" group (included in diagnostic group XII) occupied only less than 1.7% for males and 1.4% for females in 1981–88, which were markedly lower than those in 1971–80. This also makes the incidence of groups I–XI in the latter period higher to some extent.

The international comparison of incidence rates of childhood cancer by diagnostic group was initially conducted by the IARC, to investigate geographical differences in cancers of certain diagnostic groups.[9, 17–20] However, these reports comprised only detailed description of the tendencies, without any etiological speculation. In observing trends of childhood cancer in Osaka, in addition to geographical comparison, we found siginificant increases of ALL, NHL, SNS tumors, soft-tissue sarcomas, and gonadal and germ-cell tumors, and a siginificant decrease of ANLL. The time trends and geographical differences of these diagnostic groups are discussed below.

IARC reported that the incidence rate for total leukemias, as well as for ALL, is high among white populations and low among East Asians.[9, 17, 18] In Japan, a high incidence of ANLL compensated for a low incidence of ALL, so that the incidence rate of total leukemias was similar to those in Europe. Similar trends were observed in this study: we found a high incidence rate of ANLL and low incidence rate of ALL in Osaka, compared with those in the U.S. and England and Wales, although the incidence rate of total leukemias was similar. Moreover, time trends in Osaka showed an increase of ALL and a decrease of ANLL among males and females. Parkin *et al.* suggested the possibility of selective under-diagnosis of the "common" subtype of ALL in populations with poor socioeconomic conditions, since the young age peak in the incidence of ALL is less marked in such populations.[17] However, this speculation does not apply to Osaka, as can be seen in Fig. 1.

Bessho reported that some cases diagnosed as ANLL before 1976 were reclassified into ALL after 1978 because of changes to the classification scheme as well as diagnostic methods.[21] However, the extent of the increase in the incidence rate of ALL was much larger than that of the decrease in ANLL in Osaka (Tables I and II). Furthermore, changes in females were less marked than those in males. These considerations suggested that most of the changes in Osaka were real, although a contribution by artificial factors can not be entirely excluded.

Hodgkin's disease is reported to be rare in East Asia, particularly in Japan.[9, 17] In this study, the incidence rate in Osaka was remarkably lower than those in the U.S. and England and Wales. The rate in Osaka remained constant throughout the observation period. On the other

hand, the incidence rate of NHL among males in Osaka in 1971–80 was lower than those in white populations. In 1981–88, however, it increased and became higher than those in the U.S. and England and Wales. These findings suggest that the low incidence of Hodgkin's disease might continue in Osaka and constitute a characteristic feature of the population.

The incidence rate of SNS tumors in Osaka in 1971–80 was lower than that in the U.S. and almost the same as that in England and Wales. The incidence rate in Osaka increased in 1981–88, to mid-way between those of the above populations. A nationwide mass screening program for neuroblastoma has been operating in Japan since 1986, and the increase in SNS tumors might be partly explained by this detection program.

The incidence rates of soft-tissue sarcomas were lower in Osaka for both sexes in 1971–80 than those in the two white populations. In 1981–88 in Osaka, it increased to the level of these populations.

IARC reported high incidence rates of gonadal and germ-cell tumors in East Asian countries.[9,17] In the present study, the rate in Osaka in 1971–80 was already higher than those in the white populations. It increased further in 1981–88 for both sexes, particularly for females. This tumor could become one of the characteristic cancers among children in Osaka in the future.

The above consideration of the various trends in Osaka and the geographical differences observed in this study suggests that most of the diagnostic groups, I, II, IV and IX, are approaching similar degrees of occurrence to those in white populations. Nevertheless, Hodgkin's disease and gonadal and germ-cell tumors exhibit, and may maintain, characteristic incidences in Osaka.

The incidence by diagnostic group in Japan was estimated in this study. However, the distribution of cases by diagnostic group might differ according to prefecture and calendar year. Further studies are required.

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