

## EPIDEMIOLOGIC CHARACTERISTICS OF MALIGNANT NEOPLASMS IN TAIWAN:

### I. ALL CANCER SITES

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Cancer mortality rates in Taiwan from 1954 to 1985 were analyzed in order to examine the secular trend, sex ratio, geographical distribution, international variation, and migrant difference of the disease. Cancer has become the leading cause of death in Taiwan since 1982. The age-adjusted cancer mortality increased significantly from 1957 to 1985 for both males and females, the sex ratio of age-adjusted cancer mortality also increased during this period. A J-shaped age curve indicating the exponential increase of cancer mortality from age of 15-19 to age of 80 or more was observed. Cumulative cancer mortality in Taiwan was the lowest for both males and females among the 16 developed countries compared. Males and females in Taiwan had lower cancer mortality rates by age than those in Singapore and Hong Kong. High age-adjusted cancer mortality rates for both males and females were found to cluster in the blackfoot disease endemic areas, metropolitan precincts of Keelung, Taipei, Tainan and Kaohsiung, townships of Ilan and Taipei counties as well as aboriginal townships. While cancers of the liver, lung, stomach, esophagus and nasopharynx were the five leading cancer deaths in males; cancers of the uterine cervix, lung, liver, stomach and breast were the top five in females. The sex ratio of age-adjusted mortality rate for ten leading cancers ranged from 1.20 for colon cancer to 5.41 for esophageal cancer. Leukemia and cancers of the nasopharynx, breast, cervix and liver had more proportion died before age of 65 than cancers of the lung, esophagus, stomach, colon, and bladder. With regards to its socioeconomic impact, cancer deaths caused a total of 116,595 work-years loss in 1985.

### Introduction

Disease pattern has changed drastically from conventional infectious diseases to chronic degenerative disorders and accidents in Taiwan since 1945. In recent decades, major causes of death have been replaced by cancers, cardiovascular diseases, chronic liver diseases and diabetes due to socioeconomic developments, public health improvements, and advances in biomedical sciences

and technology. Among these diseases, cancer has become the leading cause of death in Taiwan since 1982. It has brought tremendous impact to individuals, families and the whole society. In a comparison of the work-year loss resulted from cancers and cerebrovascular accidents in Taiwan, we found a total of 116,595 work-years loss due to cancers and 45,925 work-years loss due to cerebrovascular accidents in 1985. A com-

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prehensive analysis of cancer mortality and incidence was carried out to delineate epidemiologic characteristics of major malignant neoplasms, i.e., liver cancer, lung cancer, stomach cancer, nasopharyngeal cancer, cervical cancer and breast cancer, in Taiwan. The characteristics in study included age curve, sex ratio, secular trend, geographical variation, international comparison, and migrant study. This paper on the epidemiologic characteristics of mortality of all cancer sites in Taiwan is the first of a series of papers to be reported.

### Materials and Methods

**Sources of Data:** Data of cancer deaths in Taiwan area were obtained from the Taiwan Provincial Department of Health. As the death registration system was completely computerized in 1972, all the cancer death numbers by age and sex before 1972 were abstracted from the Vital Statistics in Taiwan[1]. Numbers of cancer death by age, sex and township from 1972 to 1985 were obtained from the Information Center of the Taiwan Provincial Department of Health. Cancer mortality rates of 15 selected countries and areas by age and sex in 1983 were abstracted from the Annual Vital Statistics published by the World Health Or-

ganization[2]. The age-sex-specific population data in Taiwan from 1954 to 1985 were abstracted from the Demographic Facts in Taiwan[3].

**Data Analysis:** As for the analysis of the secular trend, geographical variation, and migrant comparison, cancer mortality rates by sex and age were first calculated, then were age-adjusted by using world population in 1976[4], as the standard population. Cumulative mortality rates[4], over the age range from 0 to 84 years was used for international comparisons. Work-year loss of cancers by type was calculated by summing up the years lost from age at death up to age of 65 for each individual died from given cancers.

### Results

**Secular Trend:** The age-sex-adjusted total cancer mortality rates in Taiwan from 1957 to 1985 are shown in Table 1. Age-sex-adjusted cancer mortality rates increased significantly from 58.54 per 100,000 in 1957 to 106.89 per 100,000 in 1985 with an average annual increase of 1.73 per 100,000. Cancer was the seventh leading cause of death in 1957 and has become the first leading cause of death since 1982. The proportionate mortality from cancer also

TABLE 1. Secular Trend of Cancer Mortality in Taiwan, 1957-1985

Year	Death No.	Proportional mortality ratio (%)	Rank <sup>+</sup>	Crude mortality rate (per 100,000)	Age-sex-adjusted mortality* rate (per 100,000)
1957	3493	4.35	7	36.63	58.54
1962	4885	6.87	5	42.38	77.06
1967	6868	9.89	2	51.40	88.87
1972	8965	12.92	2	59.21	95.19
1977	11248	14.30	2	67.51	98.82
1982	14393	16.65	1	78.66	105.83
1985	16268	17.85	1	85.02	106.89

\* 1976 world population was used as the standard population

+ Rank among leading causes of death

increased in recent decades. Only 4.35% of total deaths in 1952 were due to cancers, while cancers accounted for 17.85% of total deaths in 1985.

**Sex Difference:** Table 2 presents the sex (male to female) ratios of age-adjusted cancer mortality rates in Taiwan from 1957 to 1985. Males had higher cancer mortality than females. In addition, sex ratios were found to increase in recent decades. The sex ratio for age-adjusted cancer mortality was 1.13 in 1957 and 1.58 in 1985, respectively. Cancer was the first leading cause of death for males, and the second for females in 1985.

**Age Distribution:** Age-specific cancer mortality rates in three consecutive periods, i.e., 1954-1963, 1964-1973 and 1974-1983, for males in Taiwan are depicted in Figure 1. A J-shaped age curve indicating an exponential increase of cancer mortality from age of 15-19 to age of 80 or more was observed. Cancer mortality rates also increased significantly from the period of 1954-1963 to the period of 1974-1983 for all age groups. The magnitude of the increase was greater in the first interval between periods of 1954-1963 and 1964-1973 than the second interval

between periods of 1964-1973 and 1974-1983. Age-specific cancer mortality rates for females in the three periods were shown in Figure 2. Cancer mortality rates in females also increased with age resulting in a J-shaped pattern. The rates increased from the period of 1954-1963 to the period of 1974-1983 for the age groups before 30 and after 50, while the rates remained unchanged for age groups between 30 and 49 during these periods.

**International Comparison:** The 1983 cumulative cancer mortality rates over the age range from 0 to 84 years in 16 countries and areas are compared in Table 3. Both males and females in Taiwan had the lowest cancer mortality among these countries and areas. The cumulative cancer mortality in Taiwan was 26.32% and 17.97% for males and females, respectively. The sex ratio of cumulative cancer mortality rate ranged from 1.2 to 1.8 in these 15 countries and areas, and the figure for Taiwan was 1.5.

**Migrant Comparison:** Age-specific cancer mortality rates of males in Hong Kong, Singapore and Taiwan are compared in Figure 3. Generally speaking, males in Taiwan had lower cancer mortality than those in Singapore and Hong Kong for most age

TABLE 2. Sex (Male to Female) Ratio of Cancer Mortality in Taiwan, 1957-1985

Year	Age-adjusted mortality rate (per 100,000)		Sex ratio	Rank <sup>+</sup>	
	Male	Female		Male	Female
1957	63.15	55.70	1.13	8	7
1962	89.93	65.64	1.37	7	5
1967	104.24	74.79	1.39	2	3
1972	113.11	77.86	1.45	2	3
1977	117.21	80.51	1.46	3	3
1982	127.12	82.85	1.53	1	2
1985	129.54	82.04	1.58	1	2

\* 1976 world population was used as the standard population

+ Rank among leading causes of death

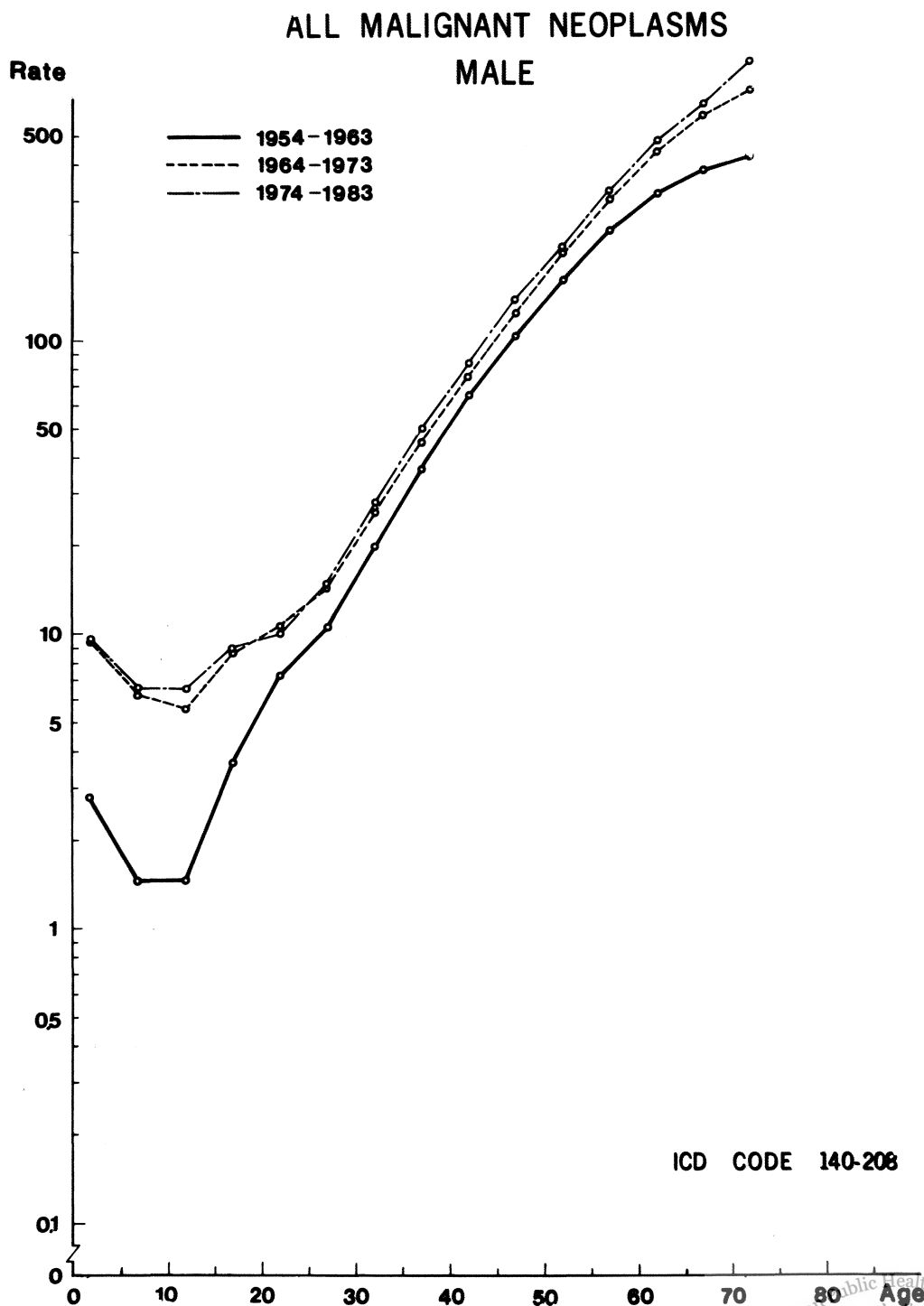
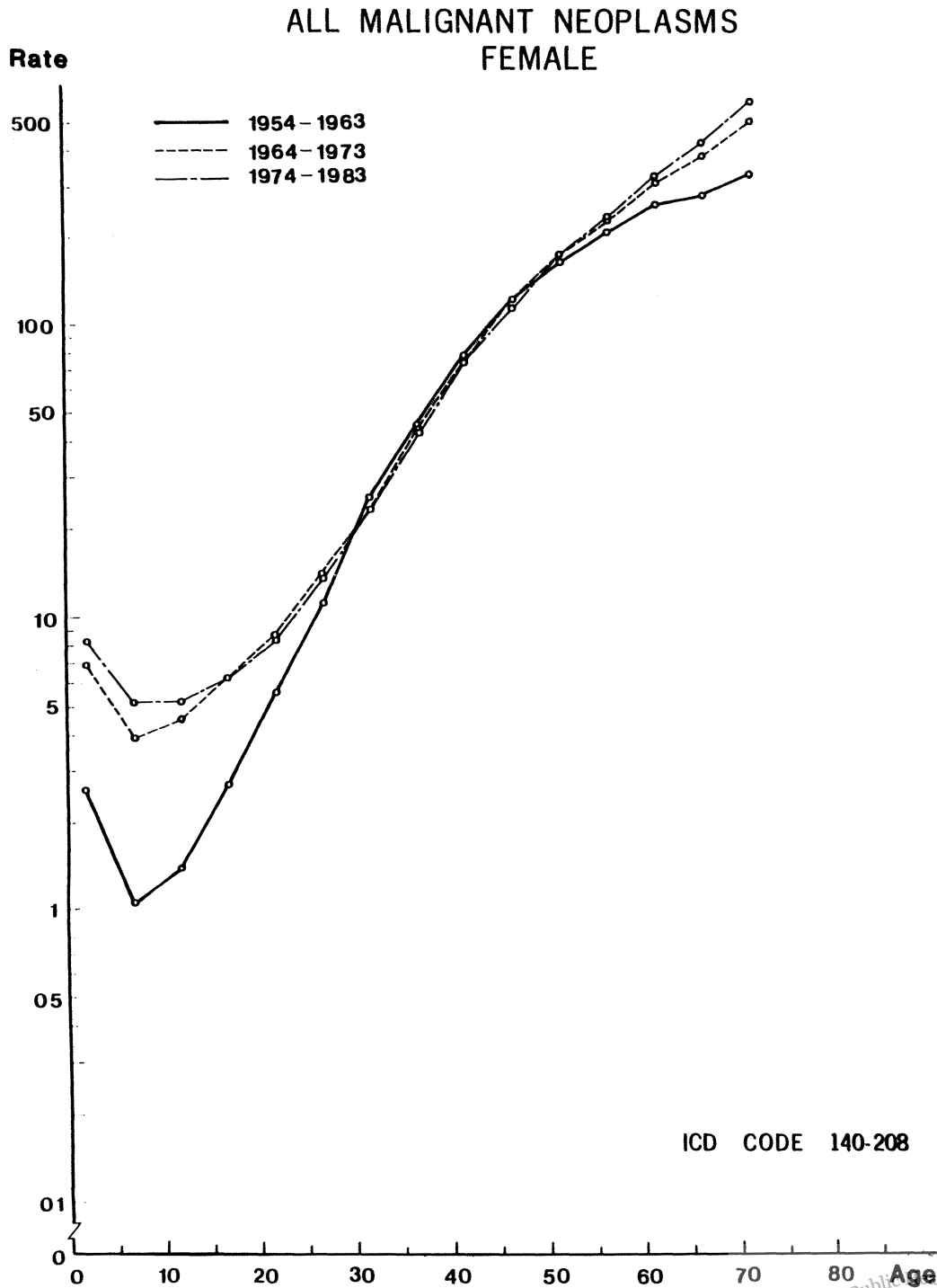
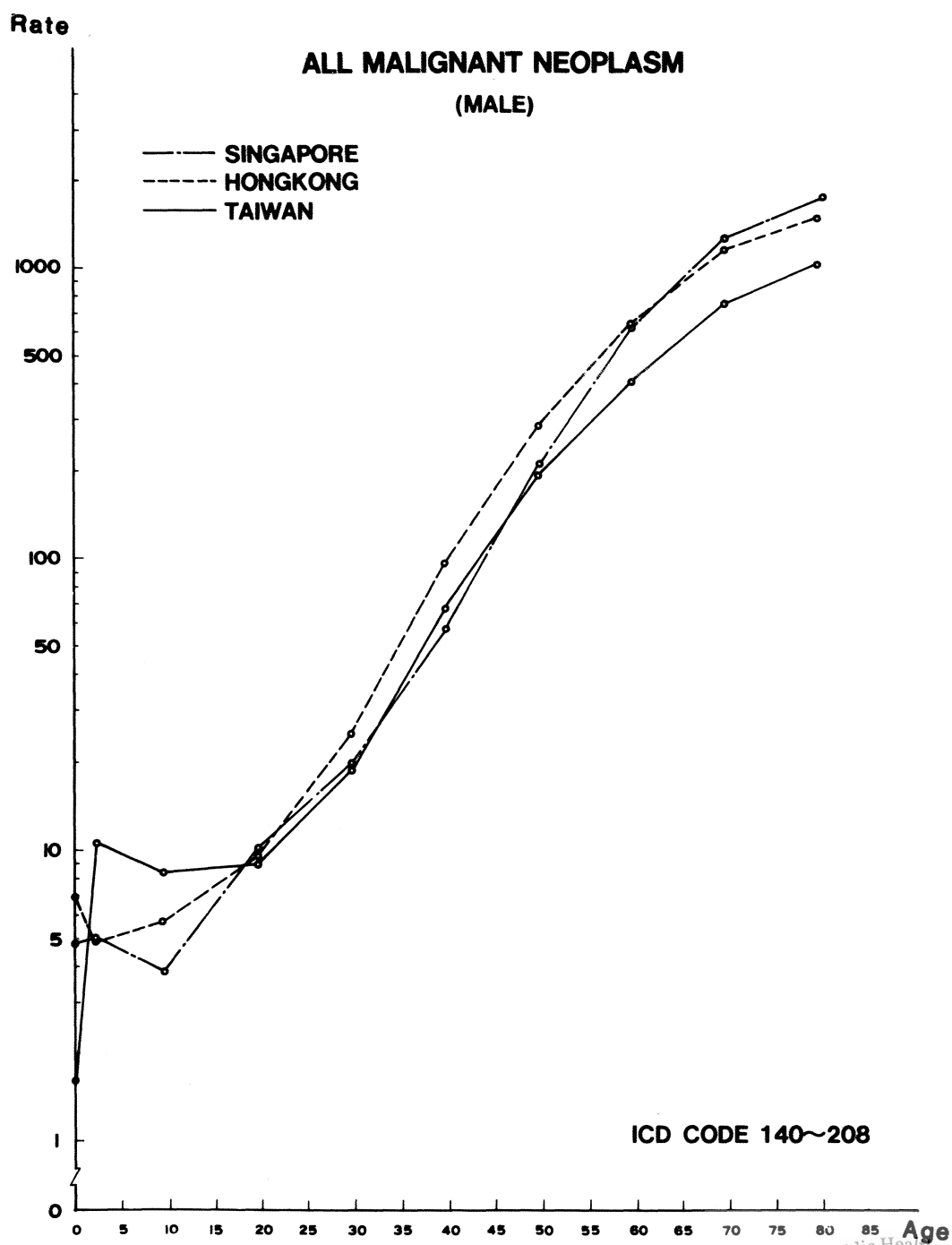


Fig.1. Age-specific cancer mortality rates per 100,000 for males in Taiwan, 1954-1983.



in Taiwan, 1954-1983.



**Fig.3. Age-specific cancer mortality rates per 100,000 for males in Singapore, Hong Kong and Taiwan, 1983.**

TABLE 3. International Comparison of Cumulative Mortality Rates (Per 100) of Cancer in 16 Selected Countries and Areas, 1983

Country	Male		Female		Sex Ratio
	CMR*	Rank	CMR	Rank	
Australia	38.72	9	23.56	13	1.7
Austria	43.67	4	27.76	4	1.6
Canada	38.82	8	24.63	10	1.6
Taiwan, China	26.32	16	17.97	16	1.5
England and wales	42.66	6	27.00	6	1.6
Hong Kong	36.36	13	20.27	14	1.8
Hungary	44.66	3	28.91	1	1.5
Ireland	38.49	11	27.30	5	1.4
Israel	32.28	15	25.66	9	1.2
Italy	38.50	10	22.85	13	1.7
Japan	34.60	14	20.14	15	1.7
Netherlands	47.12	1	26.45	8	1.8
Scotland	46.03	2	28.34	2	1.6
Singapore	39.13	7	24.00	11	1.6
U.S.A.	37.49	12	23.53	12	1.6
West Germany	42.78	5	28.04	3	1.5

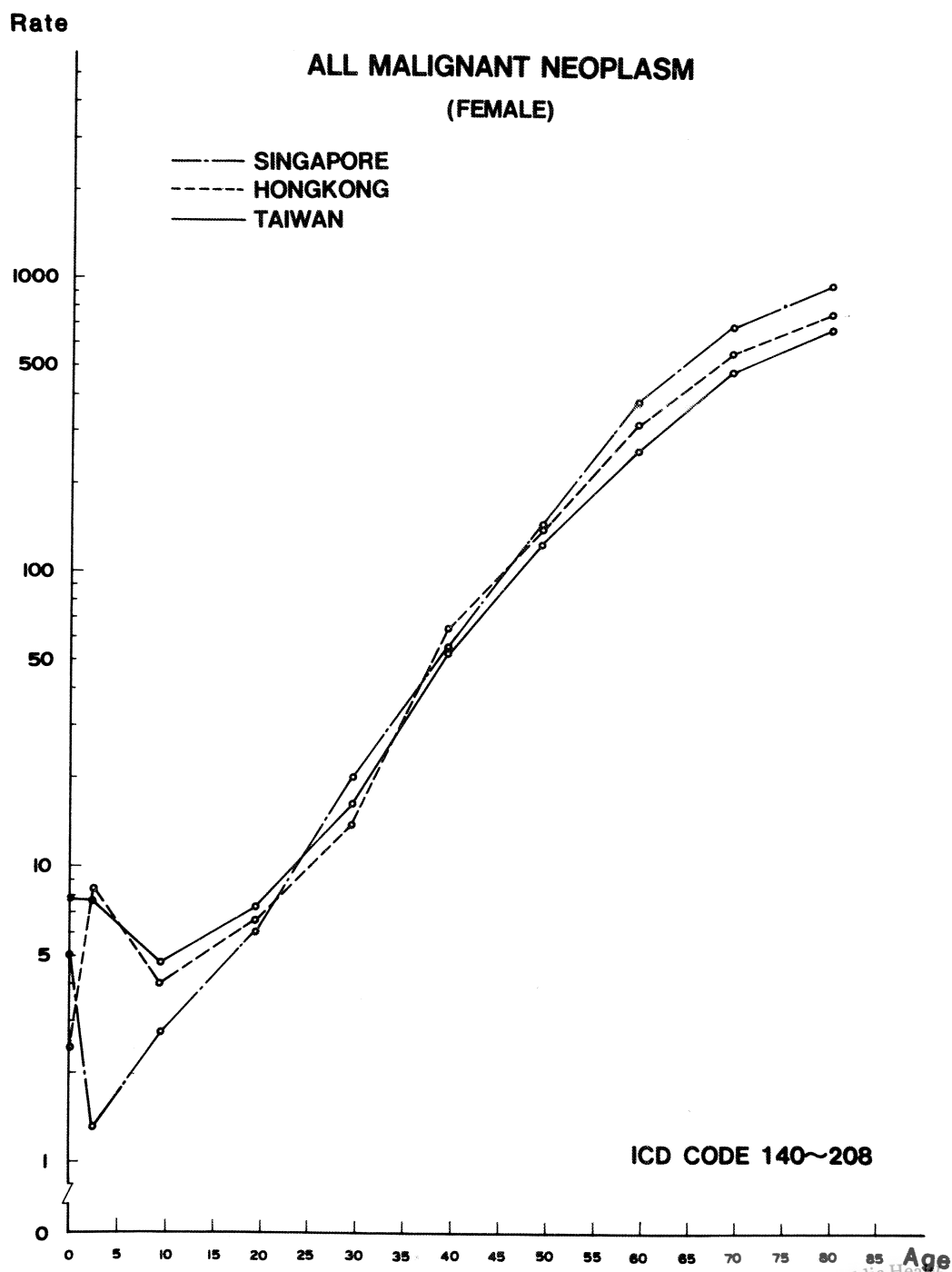
\* CMR Cumulative mortality rate over the age range from 0 to 84 years.

groups of greater than 20 years old. The rates were significantly higher among males in Hong Kong than those in Singapore for age groups between 30 and 59. Age-specific cancer mortality rates of females in Hong Kong, Singapore and Taiwan were compared in Figure 4. Females in Taiwan had lower cancer mortality than those in Singapore and Hong Kong, the higher the age, the greater the differences. Females in Taiwan, Hong Kong and Singapore had significantly lower cancer mortality than males in these areas. It is also of interest the higher the age, the greater the sex difference.

**Geographical Variation:** The geographical distribution of age-adjusted cancer mortality rates in 361 townships and metropolitan precincts is illustrated in Figures 5 and 6 for males and females, respectively. High age-adjusted cancer mortality rates for both males and females were found to cluster

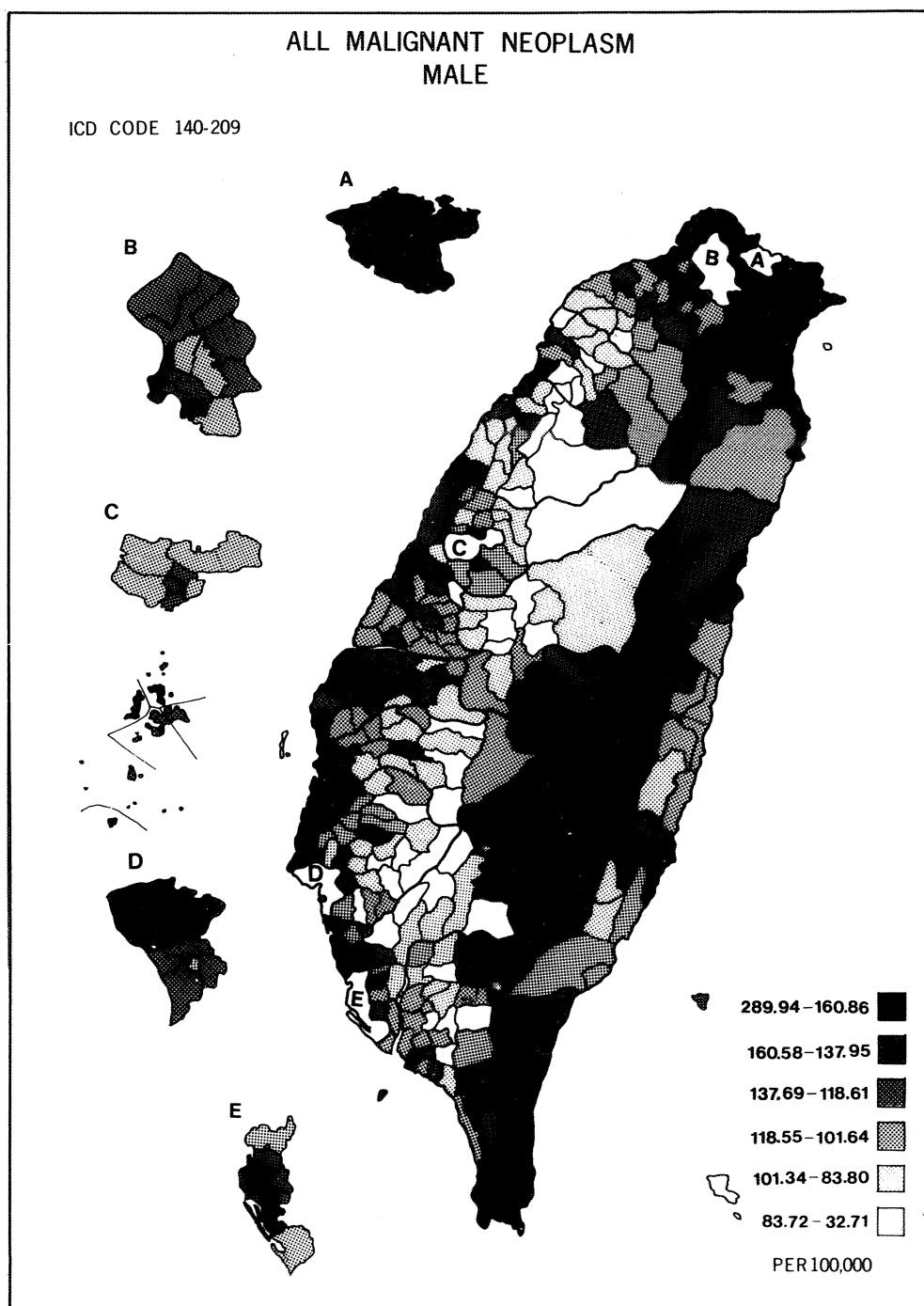
in blackfoot disease endemic areas, metropolitan areas of Keelung, Taipei, Tainan and Kaohsiung as well as northeastern and aboriginal townships. Low age-adjusted cancer mortality rates were observed in townships where the Hakka reside.

**Site Distribution:** The ten leading causes of cancer deaths by sex in Taiwan, for 1985 are shown in Table 4. While liver cancer, lung cancer, stomach cancer, esophageal cancer, and nasopharyngeal cancer were the five leading cancer deaths in males; cervical cancer, lung cancer, liver cancer, stomach cancer and breast cancer were the top five in females. The sex ratios of age-adjusted mortality rates ranged from 1.20 for colon cancer to 5.41 for esophageal cancer. Cancers of the esophagus, liver, nasopharynx, lung and stomach had sex ratio of age-adjusted mortality greater than 2.00. The proportion of deaths from certain

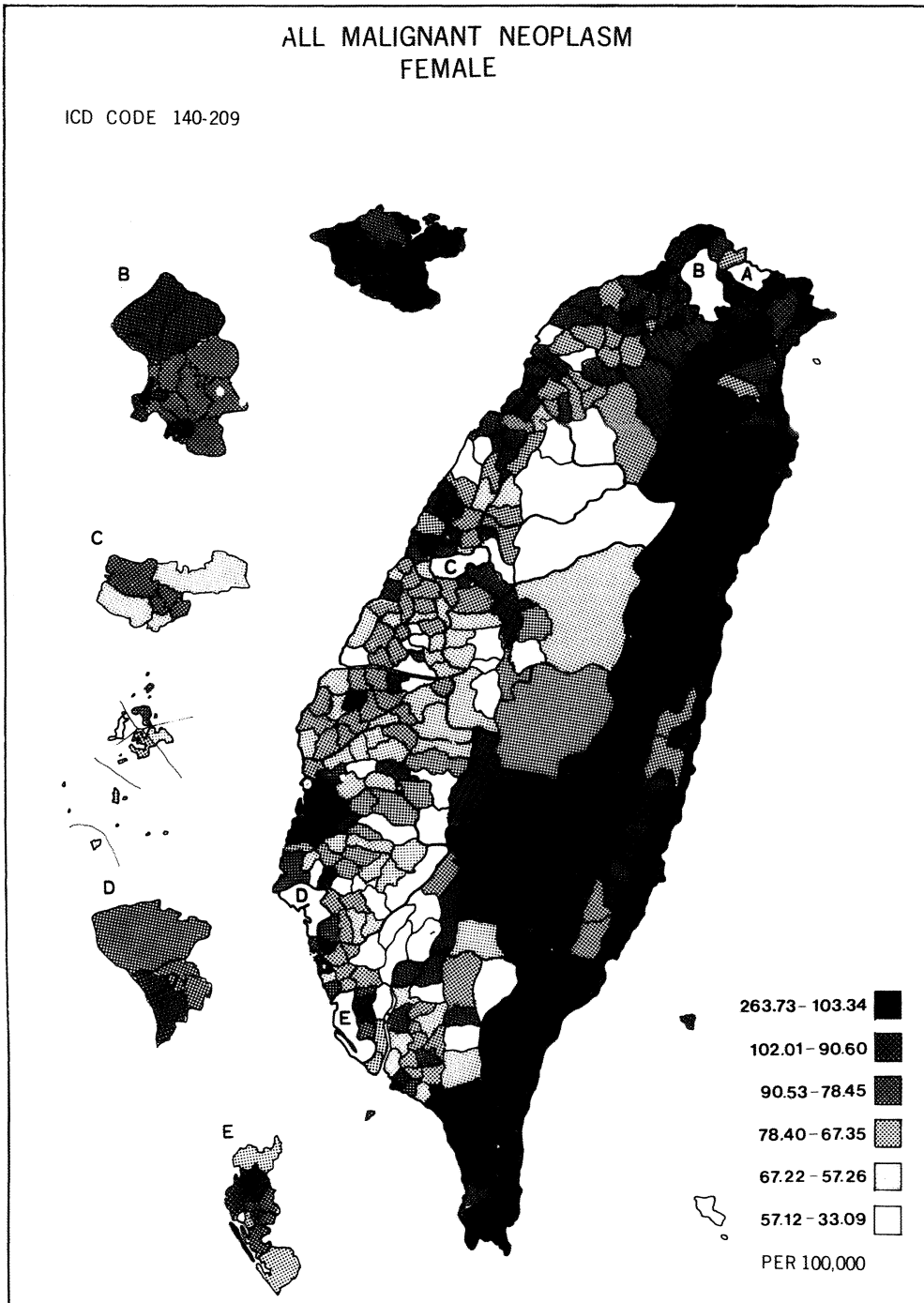


**Fig.4. Age-specific cancer mortality rates per 100,000 for females in Singapore, Hong Kong and Taiwan, 1983.**





**Fig.5. Age-adjusted cancer mortality rates per 100,000 for males in 361 townships and precincts of Taiwan, 1972-1983.**



**Fig.6. Age-adjusted cancer mortality rates per 100,000 for females in 361 townships and precincts of Taiwan, 1972-1983.**

TABLE 4. Ten Leading Causes of Cancer Deaths by Sex in Taiwan, 1985

Site (ICD code)	Rank <sup>+</sup>			Work-years loss	Proportion of deaths after age of 64 years (%)	Sex ratio
	Total	Male	Female			
Liver & intra-hepatic bile duct (155)	1	1	3	28,765	32.4	3.89
Trachea, bronchus & lung (162)	2	2	2	12,520	51.3	2.57
Stomach (151)	3	3	4	9,888	54.6	2.33
Cervix (179-180)	4	—	1	7,968	34.6	—
Colon (153)	5	6	6	5,140	49.6	1.20
Nasopharynx (147)	6	5	9	7,075	21.9	3.10
Leukemia (204-8)	7	7	7	7,233	15.0	1.41
Esophagus (150)	8	4	—	2,030	51.3	5.41
Breast (174)	9	—	5	5,370	24.6	—
Rectum, rectosigmoid junction & anus (154)	10	9	8	2,580	53.2	1.44
Pancreas (157)	11	10	10	2,183	42.3	1.63
Bladder (188)	12	8	12	1,063	64.2	1.91

+ Rank among leading cancers

types of cancer at age 65 and over to the deaths of all ages ranged from 15.0% for leukemia to 64.2% for bladder cancer. Leukemia and cancers of the nasopharynx, breast, cervix and liver had the proportion of deaths less than 40% for age groups of 65 or more. With regards to the work-year loss, leading cancers of the liver and lung caused 28,765 and 12,520 work-years loss, respectively.

### Discussion

Mortality data have been widely used to generate epidemiologic hypothesis, although there are limitations regarding the use of mortality data. The completeness and ac-

curacy of the death registration system should be evaluated before any conclusion based on mortality analysis is made. Causes of death may be misdiagnosed, misclassified and even miscoded. Issues had been raised regarding the determination of underlying cause of death, a typical example reported was the choice of the underlying causes between diabetes and coronary heart disease[5]. The bias might be solely resulted from different terminology used by physicians such as the preference of using chronic bronchitis in the United Kingdom and emphysema in the United States for the same clinical symptoms[6]. However, cancer had been reported to be one of the most complete and unequivocal causes of death[7-9]. As

it is mandatory to register death certificates in Taiwan, the death registration system is believed to be rather complete. The death registration has been improved and completely computerized since 1972. The number of deaths assigned to ill-defined causes of death has been significantly reduced in recent decade. As more than 99% of death certificates were issued by physicians, the diagnosis of cancer deaths were considered as reliable. As there might be some cancer patients who were not correctly diagnosed before they died, cancer mortality rates analyzed in this study might be underestimated. This limitation should be born in mind when comparisons and interpretations of the results are made. In this report, all epidemiologic characteristics except secular trend of cancer mortality were based on death data after 1972 in order to make more reliable descriptions.

The increasing secular trend of cancer mortality may be resulted from the following: 1) a decrease in other competing causes of death, 2) increased exposures to environmental pollution and/or occupational hazards, 3) improvements in diagnostic technology and medical care accessibility, 4) changes in dietary pattern and life styles, and 5) increased consumptions of alcohol and cigarette. It is interesting to notice that the secular trend of cancer mortality was different in males and females. The increased sex ratio in age-adjusted cancer mortality may imply the different impact of socio-economic changes on the cancer development in males and females. Further study is worthwhile to explore the possible explanations of this discrepancy. The increasing secular trend in cancer mortality was observed for all age groups in males, but only for younger or older age groups in females. The secular trend of mortality for various cancer sites by sex will be presented later.

Both international comparison and migrant study showed the lowest cancer mortality for Chinese in Taiwan among the 16 countries and areas compared. This may indicate that Chinese in Taiwan exposed to a

lower hazardous environment and/or experienced more healthful life styles and dietary patterns than other peoples. However, it is necessary to examine the international and intermigrant differences by various cancer sites before definite conclusions are made. The data will be shown in forthcoming reports regarding epidemiologic characteristics of specific cancers.

The high cancer mortality observed in metropolitan precincts may be explained by more advanced diagnostic technology, increased exposure to environmental hazards resulted from urbanization and industrialization, westernized life styles and dietary patterns, and reduced competing causes of death in urban than in rural areas. The high cancer mortality among residents in the blackfoot disease endemic area may be attributable to the high-arsenic artesian well water which has been used for more than 50 years. The high cancer mortality among aborigines in mountainous areas may be explained by their life styles including heavy alcohol drinking and special food preservation. The low cancer mortality among Hakka people deserves further investigation. Further scrutiny of geographical variation of various cancers may cast more important hints on their specific risk factors.

Different impact of hazard exposure, life style and dietary pattern on the development of various cancers between males and females may partly explain the different sex ratio among various cancers. The higher proportion of deaths before age of 65 for cancers of the liver, cervix, nasopharynx and breast as well as leukemia suggests that these types of cancer have an earlier onset age than other cancers. Interestingly, all these cancers except breast cancer have been suspected to be related to virus infections<sup>10</sup>. Further comparison of the age-specific mortality rates of various cancers will be consecutively reported in this series.

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## 台灣地區惡性腫瘤之流行病學特性：I. 全部癌症

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本研究分析1954年至1985年台灣地區的癌症死亡率，以期瞭解其長期趨勢、性比例、地理聚集、國際差異和移民變化。台灣地區男女性的癌症死亡率自1957年起，即呈明顯之增加趨勢，性比例也隨著年代而增高；而且自1982年起癌症即躍居十大死因之首位。癌症的年齡別死亡率係呈丁字型曲線，自15歲起即有明顯的等比增加，而在80歲以上達高峯。在與十五個國家地區的比較當中，台灣地區居民的男女性癌症累積死亡率均最低。就移民變化而言，台灣地區的年齡別癌症死亡率較香港、新加坡為低。偏高的年齡調整化死亡率，有明顯聚集在烏脚病流行地

區、都會區、北宜兩縣和東部山地鄉的現象，且男女皆然。在1985年，台灣地區男性的五大癌症死因是肝癌、肺癌、胃癌、食道癌和鼻咽癌，女性的五大癌症死因則是子宮頸癌、肺癌、肝癌、胃癌和乳癌。十大癌症的性比例，最低是結腸癌之1.2，而最高是食道癌的5.4。白血病、鼻咽癌、乳癌、子宮頸癌與肝癌的死亡年齡較肺癌、食道癌、胃癌、結腸癌和膀胱癌偏早。僅只1985年的癌症死亡所帶來的損失，即高達116,959工作人年，相當於150-200億的國民生產所得。有效控制癌症的危害是刻不容緩的衛生保健工作。

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