

EPIDEMIOLOGIC CHARACTERISTICS OF
MALIGNANT NEOPLASMS IN TAIWAN:

III. STOMACH CANCER

YU-CHUANG HUANG*, SHU-FANG TSAI**, SHIN-SHIN LEE***,
KUANG-HUNG HSU**, SAN-LIN YOU**, TONG-MING LIN*,
CHIEN-JEN CHEN*,**

Mortality rates from 1954 to 1983 and incidence rates from 1983 to 1985 of stomach cancer in Taiwan were analyzed to examine its secular trend, age curve, sex ratio, geographical clustering, international variation and migrant difference. Both mortality and incidence rates of stomach cancer increased with age in a log-linear relationship and peaked at the highest age group. The sex (male-to-female) ratio remained consistently around two-fold for age-specific mortality and incidence rates. The age-adjusted mortality has been decreasing since early 1970s for both males and females. Among 17 countries and areas compared, cumulative stomach cancer mortality in Taiwan ranked as the 11th and 13th, respectively, for males and females. High stomach cancer mortality rates were found to cluster in northeastern area and eastern aboriginal townships in Taiwan. Migrant study showed that Chinese in United States had much lower stomach cancer incidence than those in Shanghai, Singapore, Taipei and Hong Kong.

(Key words: *Stomach cancer, epidemiology, Taiwan.*)

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Introduction

Stomach cancer is one of the major cancers in Taiwan. Although the mortality of stomach cancer has been decreasing since early 1970s, the disease still ranked as the third leading cancer deaths for males and the second for females with crude mortality as high as 109.8 and 49.4 per 100,000, respec-

tively in 1985. The disease still has significant impact to the whole society in Taiwan. However, there has been quite few epidemiologic studies on stomach cancer in Taiwan. This study was carried out with the specific aim to examine the epidemiologic characteristics, including age curve, sex ratio, secular trend, geographical clustering, international variation and migrant difference of stomach

* Institute of Public Health, National Taiwan University College of Medicine;

** Institute of Biomedical Sciences, Academia Sinica;

*** Department of Industrial Hygiene, National Cheng-Kung University College of Medicine.

cancer in Taiwan.

Materials and Methods

Mortality data: The data of stomach cancer deaths by age, sex and townships were obtained from the Taiwan Provincial Department of Health. The death numbers of stomach cancer before 1972 were abstracted from the Vital Statistics in Taiwan[1]. For the years after 1972 when the death registration system was completely computerized, the death numbers of stomach cancer were obtained from the Information Center of the Taiwan Provincial Department of Health. The age-sex-specific population data in Taiwan from 1954 to 1985 were abstracted from the Demographic Facts in Taiwan[2]. The cancer mortality rates by age and sex of 16 selected countries and areas were abstracted from the Annual Vital Statistics published by the World Health Organization[3].

Incidence data: The incidence rates of stomach cancer by ethnic groups in San Francisco, Los Angeles, Hawaii, Hong Kong and Shanghai were abstracted from the Cancer Incidence in Five Continents published by the World Health Organization, 1983[4].

The incidence data of stomach cancer in Taiwan were obtained from the Cancer Registry Annual Report in Taiwan Area published by the Department of Health, Executive Yuan, Republic of China[5].

Analytical methods: The specific mortality rates by age and sex were *calculated* for the analysis of age curve and sex ratio. Age-adjusted mortality and incidence rates using world population in 1976 as standard population was utilized to examine the secular trend, geographical clustering and migrant difference. Cumulative mortality rates over the age range from 0 to 84 years were used for international comparison.

Results

Secular trend: The age-adjusted stomach cancer mortality rates by sex in Taiwan from 1954 to 1983 are shown in Table 1. The age-adjusted stomach cancer mortality rates for males increased from 1954 to 1973, and then a significant decreasing trend was observed. But for females, the age-adjusted mortality rates remained rather stable during the period of 1954-1969, and a decreasing trend was observed since 1969-1973. Males had higher

Table 1. Age-adjusted mortality rates from stomach cancer by sex in Taiwan, 1955-1983.

Year	Males	Females	Sex ratio (males/females)
1954-1955	23.4	12.5	1.9
1956-1957	24.4	13.3	1.8
1958-1959	21.7	11.9	1.8
1960-1961	22.9	12.1	1.9
1962-1963	24.0	11.8	2.0
1964-1968	24.3	12.7	1.9
1969-1973	25.1	11.1	2.3
1974-1978	22.0	10.8	2.0
1979-1983	20.0	9.8	2.0

age-adjusted mortality rates than females with a sex (male to female) ratio ranged from 1.82 to 2.55 during the study period.

Age curve and sex ratio: Age-specific mortality rates of stomach cancer in three consecutive periods, i.e. 1954-1963, 1964-1973 and 1974-1983, for males and females are depicted in Figures 1 and 2, respectively. The age-specific stomach cancer mortality rates were found to increase with age for both males and females with a peak at the eldest age in these periods. A decreasing mortality rate of stomach cancer was observed for age groups from 30 to 60 years of both males and females in recent decades. The decrease in age-specific mortality in the second interval between periods of 1964-1973 and 1974-1983 was

greater than that in the first interval between periods of 1954-1963 and 1964-1973. Also, the mortality rates of stomach cancer for age groups of greater than 60 years was found to increase in the first interval between periods of 1954-1963 and 1964-1973 and then to decline in the second interval between periods of 1964-1973 and 1974-1983. The secular change was different between younger and elder age groups.

International comparison: The cumulative mortality rates of stomach cancer in 17 selected countries and areas are compared in Table 2. The cumulative stomach cancer mortality in Taiwan was 5.14% for males and 2.44% for females. The rate was the highest in Japan and the lowest in the United

Table 2. Cumulative mortality rate (CMR) of stomach cancer stratified by sex in 17 selected countries and areas, 1983.

Country or Area	male		female		sex ratio
	CMR*	Rank	CMR*	Rank	
Australia	3.47	15	1.68	14	2.0
Austria	8.11	4	4.24	4	1.9
Canada	3.25	16	1.51	16	2.1
Chile	11.93	2	6.08	2	2.0
Taiwan	5.14	11	2.44	13	2.1
England and Wales	5.15	10	2.64	11	2.0
Hong Kong	4.30	13	1.62	15	2.7
Hungary	9.34	3	4.71	3	2.0
Ireland	5.30	9	2.87	9	1.8
Israel	3.88	14	2.24	12	1.7
Italy	6.68	7	3.61	7	1.9
Japan	13.32	1	6.50	1	2.0
Netherlands	5.95	8	2.68	10	2.2
Scotland	4.89	12	2.90	8	1.7
Singapore	7.45	5	3.73	6	2.0
U.S.A.	1.88	17	0.96	17	2.0
West Germany	6.87	6	3.99	5	1.7

* CMR: Cumulative mortality rate over the age from 0 to 84 years

States among selected countries and areas. The rate in Taiwan ranked as the 11th and 13th for males and females, respectively. The sex ratios of the cumulative mortality rates of stomach cancer in different countries and areas ranged from 1.7 to 2.2.

Geographical variation: The geographical variation of stomach cancer mortality rates in 361 townships of Taiwan for males and females are illustrated in Figures 3 and 4, respectively. Generally speaking, males and females had similar geographical variation of age-adjusted mortality rates in 361 townships and precincts. High mortality of stomach cancer was found to cluster in the northeastern area, eastern aboriginal townships and metropolitan Keelung and Taipei, while low mortality rate was observed in townships where the Hakka resides.

Age-specific incidence rate: The age-specific incidence rates of stomach cancer in 1983-1985 are shown in Figure 5. The incidence rates were quite similar to the age-specific mortality rates. The incidence rate increased with age for both males and females. A significant log-linear increase in incidence rate was observed after age of 50 years. The incidence rate of males was higher than that of females; and the higher the age, the greater the sex difference.

Migrant difference in incidence rate: The age-adjusted incidence rates of stomach cancer by sex and race in Taipei, Hong Kong, Singapore, San Francisco, Hawaii, Los Angeles and Shanghai are compared in Figure 6. The incidence rate was the highest in Shanghai for both males and females. There was a striking difference in age-adjusted stomach cancer mortality among Chinese in different areas. In general, Chinese in the United States had lower incidence rates than those in Shanghai, Singapore, Taipei and Hong Kong. Chinese had the highest stomach cancer incidence rate in Singapore as compared with Malays and Indians. Japanese, Blacks and Hawaiian had higher incidence rate than

Chinese in San Francisco, Los Angeles and Hawaii.

Discussion

Mortality and incidence rates of disease have been widely used to generate epidemiological hypothesis, although there exist limitations regarding the use of these data. Issues have frequently been raised on the completeness and accuracy of the death and disease registration system. As it is mandatory to register death events in Taiwan, its death registration system is believed to be complete. While causes of death may be misdiagnosed and misclassified, cancer has been considered as one of the most complete and unequivocal causes of death in the vital statistics. As cancer registration in Taiwan just started from 1979, the data of cancer incidence might not be complete and accurate in Taiwan area as a whole. Therefore, only incidence rate in Taipei City was studied because its registration system was believed to be satisfactory.

The age-adjusted mortality rate of stomach cancer was found to have been decreasing since early 1970s. The decline may be attributable to the improved living standard and socioeconomic status, the decreased use of nitrate and nitrite as food preservatives, the increased consumption of fresh vegetables and fruits, and the improved methods of food preservation[6]. However, the decrease in age-specific mortality rate of stomach cancer was observed only for age groups of less than 60 years. The elderly still had high mortality during the period from 1974 to 1983. The high mortality among elderly cohorts suggested they might have already exposed to large amount of environmental carcinogens during their long life span or they might still have the same dietary habits and life styles as before.

The male-to-female ratios for age-adjusted mortality and incidence rates of stomach cancer were around 2.0. Males might more

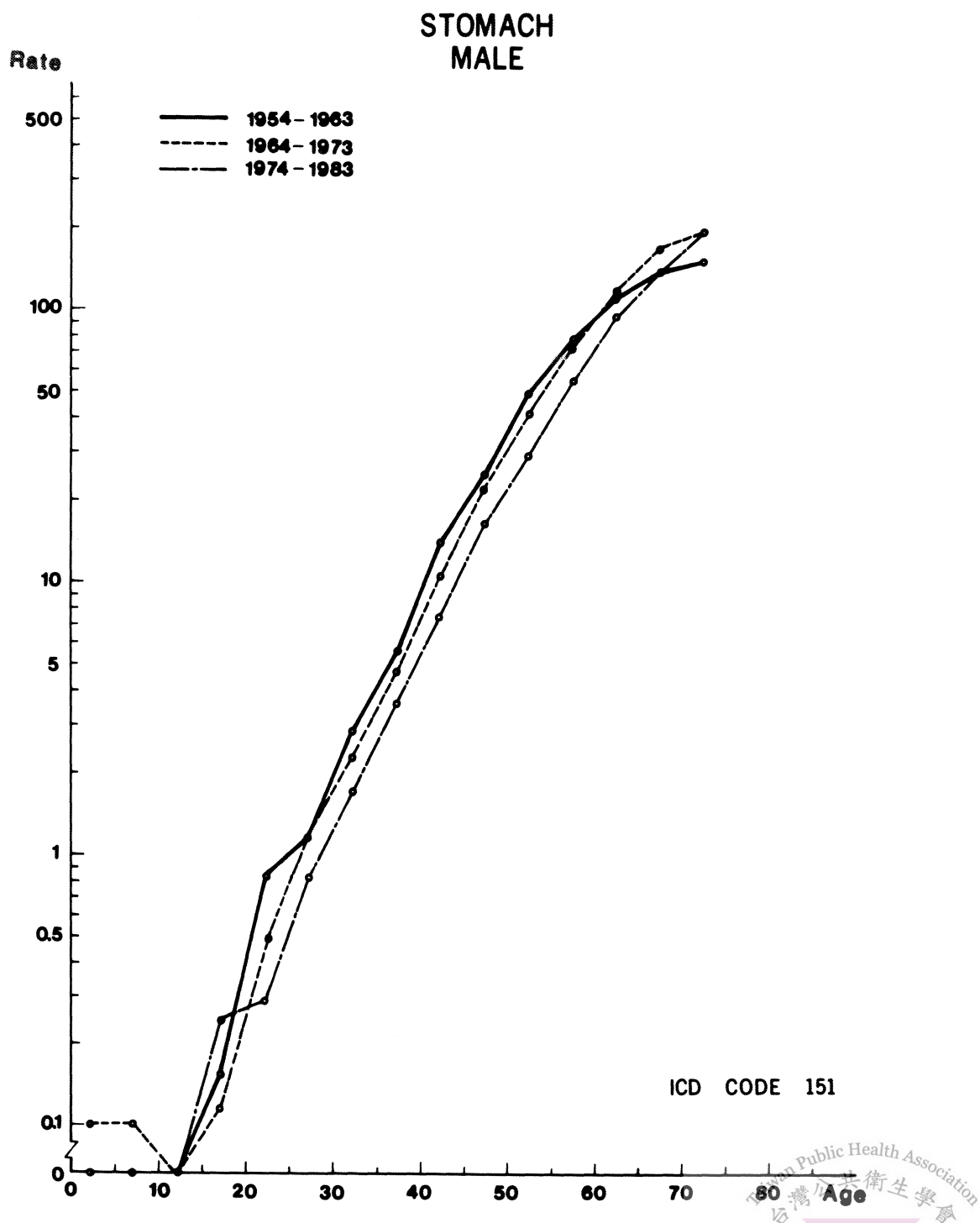


Fig. 1. Age-specific mortality rates of stomach cancer for males in Taiwan, 1954-1983.

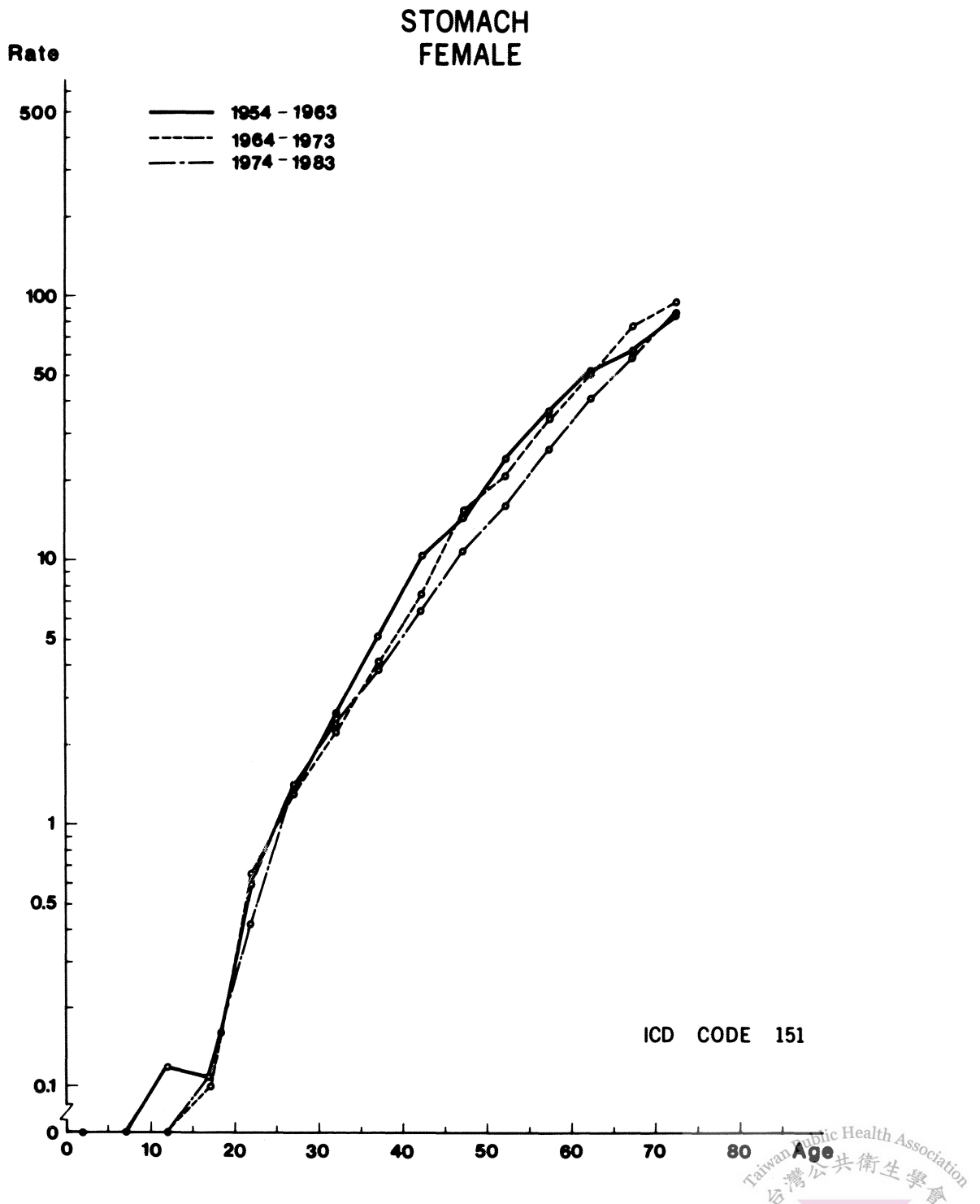


Fig. 2. Age-specific mortality rates of stomach cancer for females in Taiwan, 1954-1983.

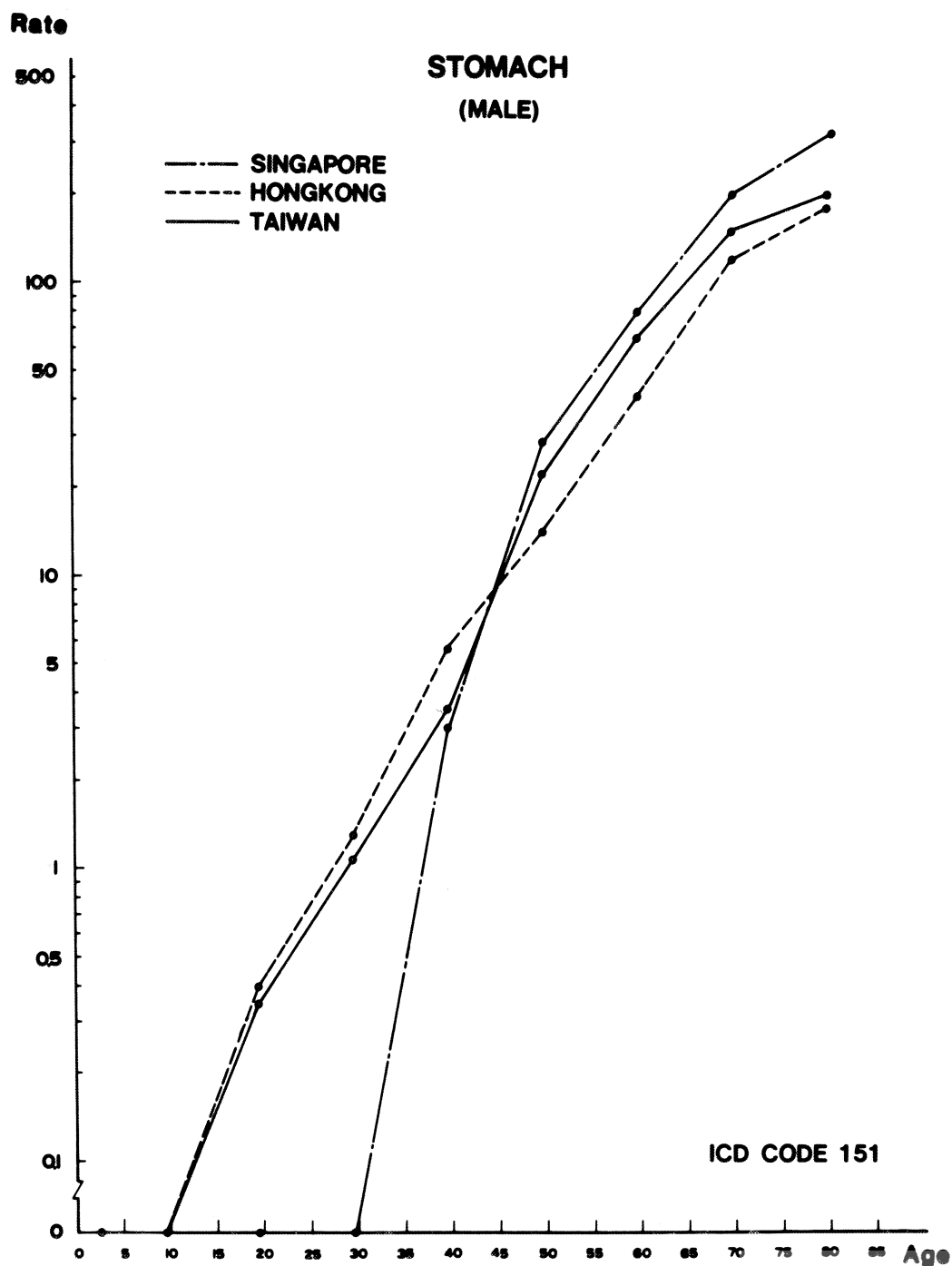


Fig. 3. Age-specific mortality rates of stomach cancer for males in Singapore, Hong Kong, Mainland China and Taiwan, 1983.

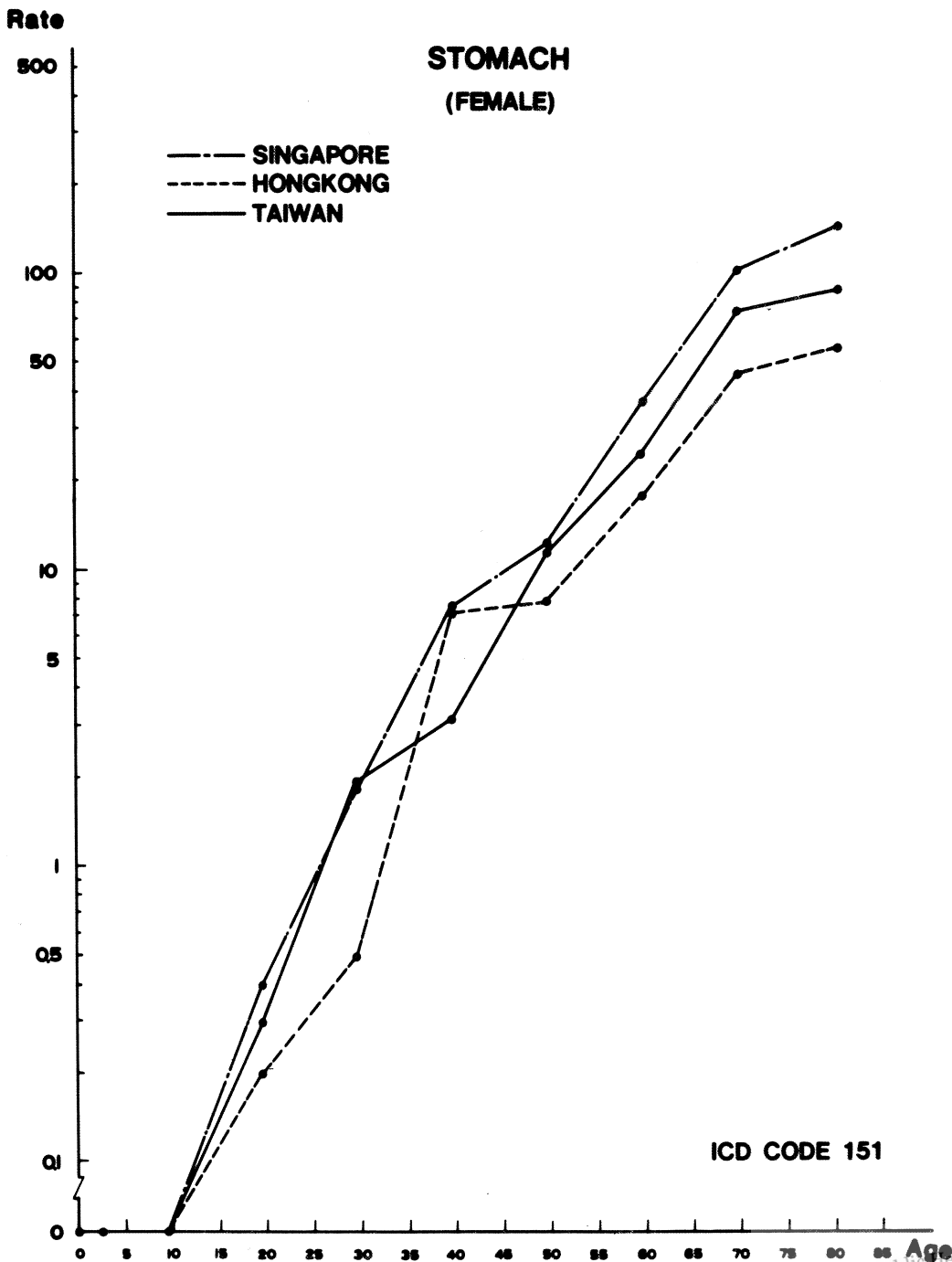


Fig. 4. Age-specific mortality rates of stomach cancer for females in Singapore, Hong Kong, Mainland China and Taiwan, 1983.

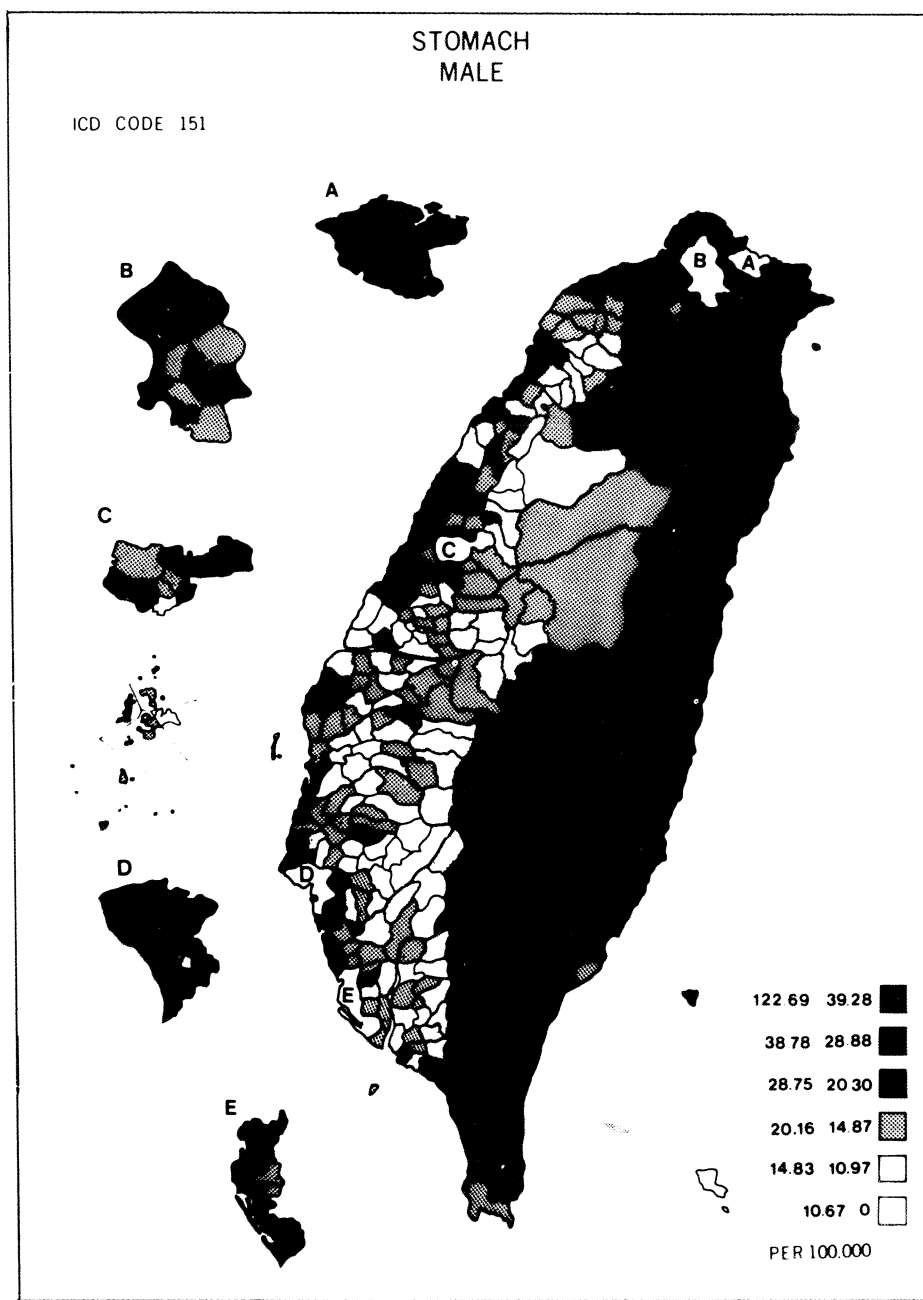


Fig. 5. Age-adjusted incidence rates of stomach cancer for males in 361 townships and precincts of Taiwan, 1972-1983.

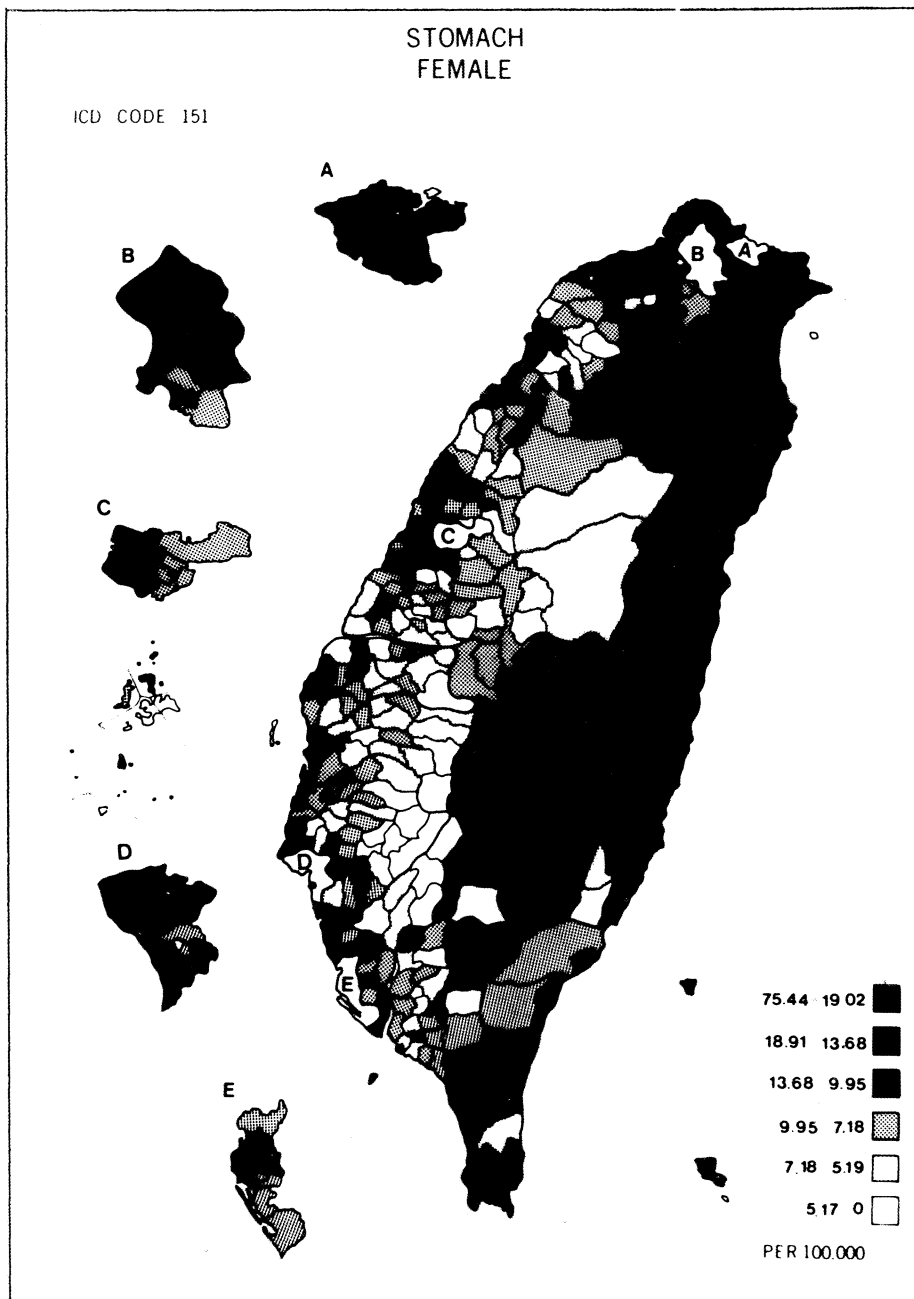


Fig. 6. Age-adjusted mortality rates of stomach cancer for females in 361 townships and precincts of Taiwan, 1972-1983.



Fig. 7. Age-specific incidence rates of stomach cancer by sex in Taipei, 1983-1985.

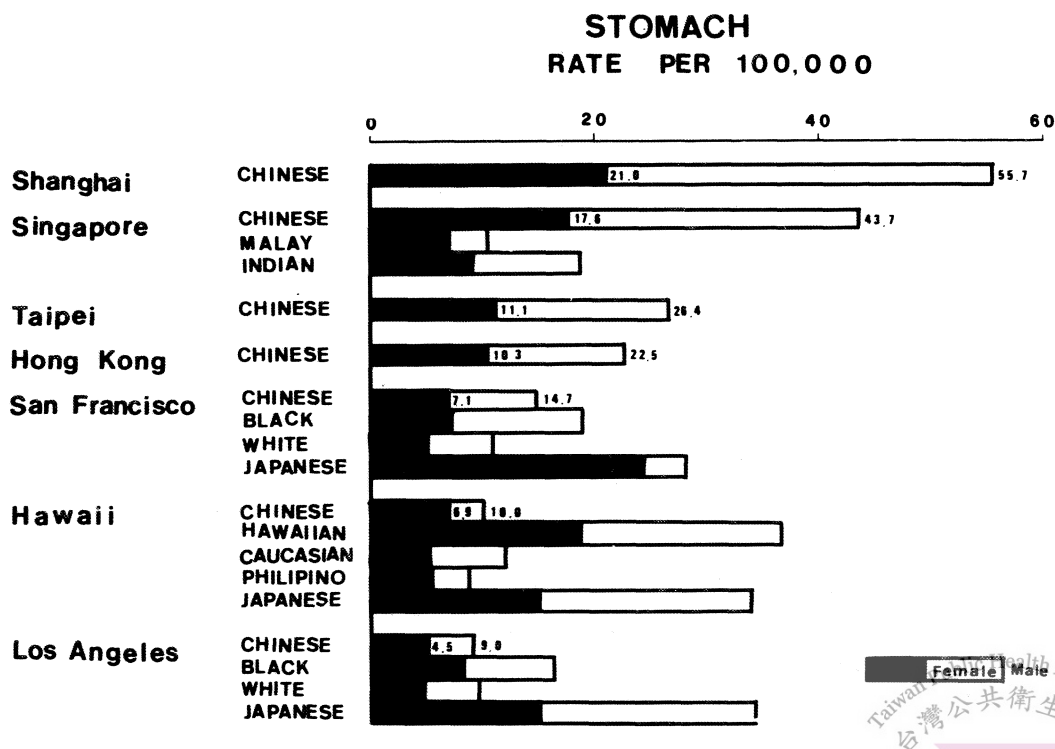


Fig. 8. Age-adjusted incidence rates of stomach cancer by sex in Taipei, Hong Kong, Singapore, San Francisco, Los Angeles, Hawaii and Shanghai.

likely be exposed to environmental risk factors than females, or females might have higher consumption of protective food such as fresh vegetables and fruits than males. Further exploration of possible risk factors responsible for the sex difference seems worthwhile. The sex ratios of age-adjusted mortality of stomach cancer have remained rather constant (around 2.0) since 1950s. It suggests the changes in the exposure to environmental risk factors might be quite parallel for both males and females.

The similar pattern of age-specific mortality and incidence rates of stomach cancer suggests the high fatality of the disease and the completeness of the cancer registry data. The log-linear increase of age-specific mortality and incidence rates of stomach cancer after age of 45 years indicates the cancer may have rather long induction period and continuous exposure to environmental risk factors may be necessary. These age curves were quite different from those of nasopharyngeal carcinoma, hepatocellular carcinoma, and cervical cancer which showed a striking increase after ages of 20-29 years. Virus-related cancers seem to have age curves different from those majorly induced by chemical carcinogenesis.

The clustering of high age-adjusted mortality rate of stomach cancer in northeastern area, eastern aboriginal townships and some metropolitan precincts deserves further exploration. While better diagnostic techniques may partly explain the high mortality of stomach cancer in metropolitan precincts, it may not explain the high mortality clustered in eastern aboriginal townships where medical

care services are inadequate. Heavy alcohol consumption and traditional dietary pattern may at least partly contribute to the high mortality of stomach cancer among aborigines.

Both the international variation and migrant difference observed in this study strongly suggest that environmental factors are much more important than genetic factors in the development of stomach cancers. Chinese in the United States had significantly lower age-adjusted incidence rate of stomach cancer than those in Shanghai, Singapore, Taipei and Hong Kong. The striking discrepancy suggests the changes from traditional Chinese to western life styles might reduce the probability of developing stomach cancer.

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台灣地區惡性贅瘤之流行病學特徵：Ⅲ. 胃癌

黃裕權* 蔡淑芳** 李心馨*** 許光宏**

游山林** 林東明* 陳建仁*、**

本研究以台灣地區 1954~1983 年胃癌死亡率及 1983~1985 年胃癌發生率資料，描述胃癌在台灣地區之長期趨勢，年齡，性比例及地理分佈特徵，並進行國際及移民比較。

台灣地區胃癌死亡率及發生率皆有隨年齡增加而呈現對數增加之趨勢，高年齡層之胃癌死亡率也最高。男性各年齡層之死亡率及發生率皆約為女性的 2 倍。自 1970 年代

開始，男、女性年齡標準化死亡率皆有逐漸下降之趨勢。

在 17 個國家及地區中，台灣男、女性胃癌，累積死亡率分別佔第 11 位及第 13 位。高死亡率地區大多集中在台灣東北部及東部及山地鄉鎮。移民比較發現，美國華人的胃癌發生率遠比上海、新加坡、台北及香港的華人為低。

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* 國立台灣大學醫學院公共衛生研究所

** 中央研究院生物醫學科學研究所

*** 國立成功大學醫學院工業衛生學系