Original

An Analysis of Death Rates in Tianjin, China, 1991-1996

Feng Yanru

Department of Public Health, Saitama Medical School, Moroyama, Iruma-gun, Saitama 350-0495, Japan

Background: In a previous study of the death rates in Tianjin in 1995, the author reported a high death rate from heart diseases and a low death rate from malignant neoplasms, compared with the corresponding rates recorded from other cities in China and Japan. Examination of the geographical variations of the death rates revealed clustering of deaths from cerebrovascular diseases and malignant neoplasms. The objective of the present study was to examine the mortality patterns in detail using data collected over the relatively long period of 1991-1996. **Methods:** The mortality statistics in Tianjin for the period of 1991-1996 were provided by the Department of Health, Tianjin, China. Population data were obtained from the censuses conducted in 1990 and 1995. The age-adjusted death rates, age-specific death rates and the standardized mortality ratios(SMRs) in the 18 districts of Tianjin were calculated for the three leading causes of death by sex. **Results:** The total number of deaths in Tianjin during the period 1991-1996 was 303,737. Of these, 63.7 % was attributed to the three leading causes of death. The age-adjusted death rates and age-specific death rates from heart diseases and malignant neoplasms decreased for both men and women during the study period. However, during the same period, the age-adjusted death rate, and for the most of part, the age-specific death rate from cerebrovascular diseases remained at a stable level in both sexes. Analysis of the geographical distribution of the death rates showed that the SMRs for heart diseases were high in the Northwest, the SMRs for cerebrovascular diseases were high in the eastern part of the urban area of Tianjin and in the eastern part of Tianjin, and those for malignant neoplasms were high in the urban and coastal areas. The geographical patterns of deaths from cerebrovascular diseases and malignant neoplasms were consistent with those indicated in the previous study. **Conclusion:** The present analysis determined the geographical patterns of deaths from the three leading causes of death within Tianjin, and a decreasing trend was apparent in the death rates from heart diseases and malignant neoplasms, while the death rate from cerebrovascular diseases remained stable during the study period. The results of the current study indicated that measures for the prevention and control of non-communicable chronic diseases in Tianjin, particularly of cerebrovascular diseases, were scarcely effective in the 1990s. The results also emphasize the need for special intervention in specific target districts of Tianjin.
Keywords: three leading causes of death, heart diseases, cerebrovascular diseases, malignant neoplasm, age-adjusted death rate, age-specific death rate, standardized mortality ratio (SMR)
J Saitama Med School 2003; 30: 113-120
(Received December 14, 2002)

Introduction:

Vital statistics have been widely used to monitor the health status of various populations, and are important for health planning and setting of priorities for disease prevention[1]. A system of death registration, which was based on the data collected from the local hospitals, health centers and police office, was founded in the late 1970 in Tianjin. In China, population census was started in 1982, after the Cultural Revolution, and it has been conducted every 5 years since 1990.

Since the 1990s, most studies on non-communicable chronic diseases in Tianjin have focused on comparison of the health status of populations between intervention and non-intervention areas. Analysis of the temporal trend and geographical variations of death rates is

considered to be important for the evaluation and improvement of interventional measures.

In a previous study of the death rates in Tianjin for the 1995, the author reported a high death rate from heart diseases and a low death rate from malignant neoplasms in Tianjin, compared with the corresponding rates in other cities of China and Japan. The analysis of geographical variations in the death rates revealed clustering of deaths from cerebrovascular diseases and malignant neoplasms within Tianjin[2]. The objective of the present study was to examine the mortality patterns in detail using the data for the relatively long period of 1991-1996.

Tianjin, located on the North China Plain, about 130 kilometers away from Beijing, is a modernized industrial city with a population of about 9 million. It has 18 administrative districts, and has been divided into four areas according to geographic characteristics: urban, suburban, rural, and coastal areas (Fig. 1). The urban area is the center of commerce, transportation, communication, health, education, and cultural facilities in Tianjin, and has six districts (Heping, Hedong, Hexi, Nankai, Hebei and Hongqiao). The two major demographic characteristics of the urban area of this city are a high population density and a high proportion of the elderly. The suburban area includes four districts (Dongli, Xiqing, Jinnan and Beichen), and has many

factories and some villages surrounded by farmlands. The rural area covers five agricultural districts (Ninghe, Wuqing, Jinghai, Baodi, and Jixian), and the coastal area, located along the West coast of the Bohai Gulf, has three districts (Tanggu, Hangu, and Dagang), and is a major chemical industrial base in northern China (Table 1).

According to the population censuses conducted on July 1, 1990, and October 1, 1995, in China, the age distribution of the population of Tianjin changed dramatically during the five-year period between the two censuses (Fig. 2). The population of people aged 38-51 years, and those aged 58 years or older increased among both men and women. The proportion of the elderly increased from 6.5 % in 1990 to 8.3 % in 1995. The population of people aged 19-29 years, and of children aged 0-5 years decreased for both the sexes. The proportion of children aged 0-5 years decreased from 9.7 % in 1990 to 5.6 % in 1995.

Since 1980, with the social reforms and economic liberalization, Tianjin has undergone enormous social and economic changes. The rapid improvement of the living standard of the residents of Tianjin may be expected to increase the life expectancy at birth and the proportion of the elderly in this city, which, in turn, can be expected to lead to the changes in the mortality patterns.

Materials and Methods:

Mortality statistics for the period of 1991-1996 in Tianjin, which was collected by a system of death registration covering 18 districts of Tianjin, was provided by the Department of Health, Tianjin, China. Causes of death were classified according to the codes of the Ninth Revision of the International Classification of Diseases (ICD-9). The ICD codes for the three leading causes of death are as follows: heart diseases; 393-398 and 410-429, cerebrovascular diseases; 430-438, and malignant neoplasms; 140-208. The population census has been conducted every 5 years in China since 1990, and the censuses conducted on July 1, 1990, and October 1, 1995 were used for this study[3]. The population for the years in which no census was conducted was determined by interpolation or extrapolation. The annual age-adjusted death rates were calculated using the sex- and age-specific population estimates determined in Tianjin on October 1, 1995 as the standard. The geographical variations of cause-specific death rates among men and women were explored using the six-year standardized
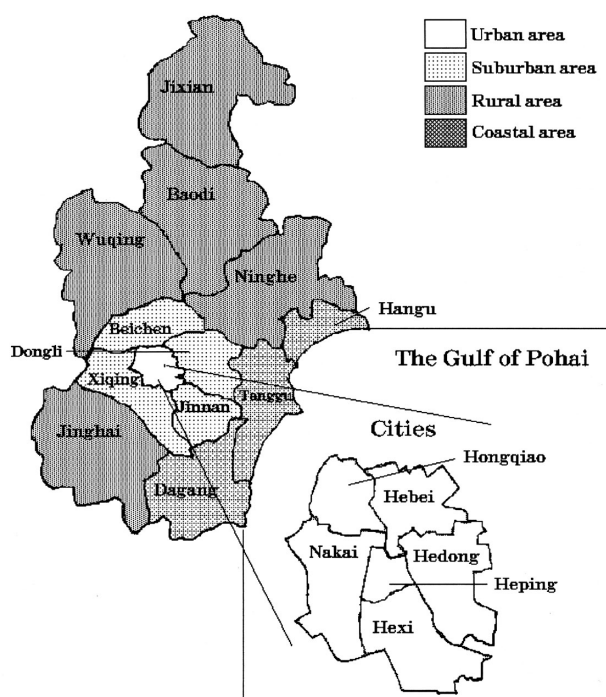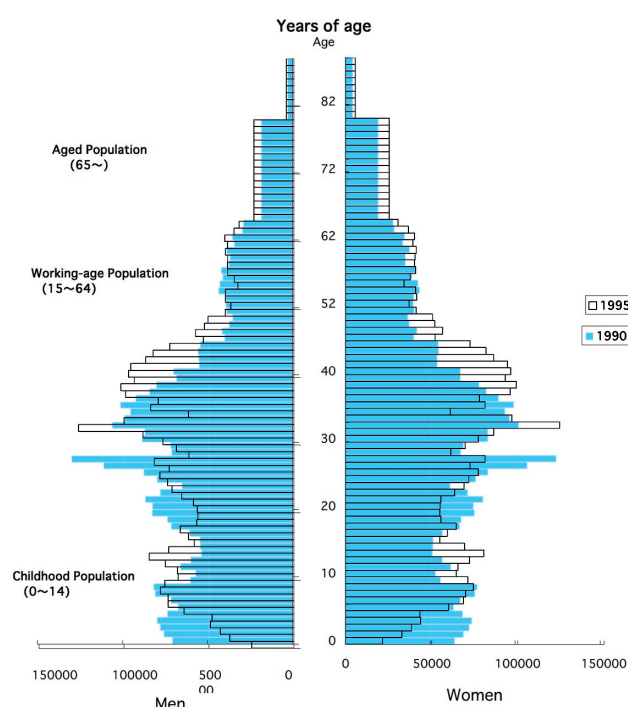

Fig. 1. Map of Tianjin, China.

Table 1. Population, elderly population and proportion of elderly population by district and sex in Tianjin, China, 1995

District	Population			Elderly Population			Proportion of Elderly Population (%)		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Tianjin	8,924,321	4,520,882	4,403,439	739,305	360,753	378,552	8.3	8.0	8.6
Urban area									
Heping	475,796	230,348	245,448	56,293	25,781	30,512	11.8	11.2	12.4
Hedong	618,301	312,675	305,626	55,405	27,448	27,957	9.0	8.8	9.1
Hexi	681,564	341,035	340,529	64,809	31,865	32,944	9.5	9.3	9.7
Nankai	719,521	365,664	353,857	70,555	34,167	36,388	9.8	9.3	10.3
Hebei	616,077	311,695	304,382	62,561	30,014	32,547	10.2	9.6	10.7
Hongqiao	575,822	291,024	284,798	57,237	27,264	29,973	9.9	9.4	10.5
Suburban area									
Dongli	297,106	149,890	147,216	18,871	9,672	9,199	6.4	6.5	6.2
Xiqing	302,335	151,498	150,837	19,412	9,840	9,572	6.4	6.5	6.3
Jinnan	362,281	181,462	180,819	22,866	11,370	11,496	6.3	6.3	6.4
Beichen	314,698	158,549	156,149	21,578	10,771	10,807	6.9	6.8	6.9
Rural area									
Ninghe	347,179	176,251	170,928	21,768	11,090	10,678	6.3	6.3	6.2
Wuqing	790,460	398,510	391,950	61,572	29,250	32,322	7.8	7.3	8.2
Jinghai	490,097	249,392	240,705	37,371	19,026	18,345	7.6	7.6	7.6
Baodi	633,677	321,350	312,327	50,647	23,887	26,760	8.0	7.4	8.6
Jixian	771,728	396,183	375,545	63,300	30,266	33,034	8.2	7.6	8.8
Coastal area									
Tanggu	448,228	233,470	214,758	29,667	15,369	14,298	6.6	6.6	6.7
Hangu	167,175	85,241	81,934	11,247	5,966	5,281	6.7	7.0	6.4
Dagang	312,276	166,645	145,631	14,146	7,707	6,439	4.5	4.6	4.4

Source; "Population Census of China, 1995", National Statistics Bureau
Elderly population; The population aged 65 years and over

Years of age
Aged Population (65~)
Working-age Population (15~64)
Childhood Population (0~14)

Source; Population Censas of China, 1995

Fig. 2. Population pyramid as of Oct.1.1990 and Oct.1.1995.

mortality ratio (SMR) in the 18 districts of Tianjin. The statistical significance of differences in the SMRs was examined using the Chi-square test, with P=0.05 as the significance level. Statistical analysis was carried out using the SAS software[4].

Results

During the period of 1991-1996, the total number of deaths in Tianjin was 303,737. Of these, 63.7 % was attributed to the three leading causes of death (24.4 % was due to heart diseases, 22.4 % due to cerebrovascular diseases, and 16.9 % due to malignant neoplasms) (Table 2).
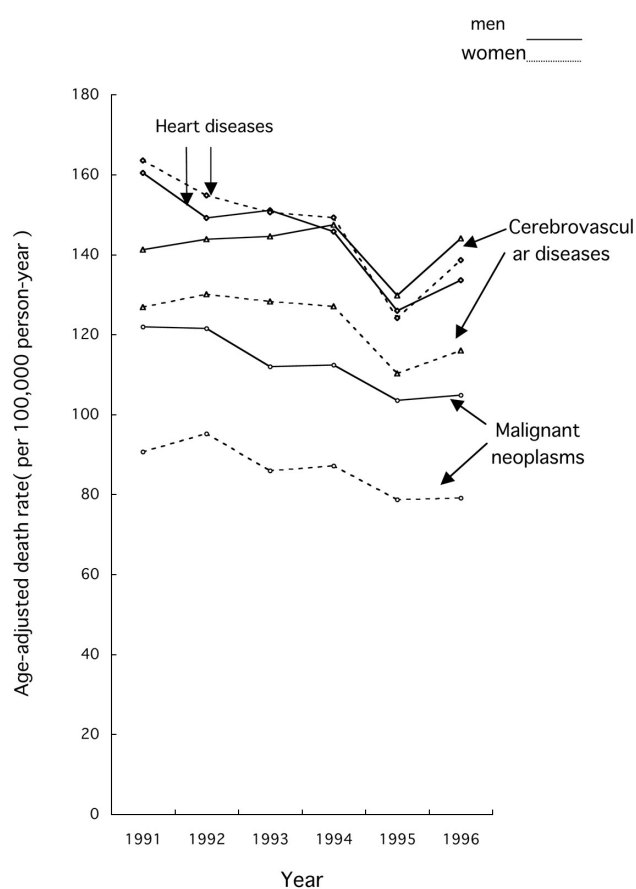
The age-adjusted death rate from the three leading causes of death for the period 1991-1996 are displayed by sex and cause of death in Fig. 3. The age-adjusted death rate from heart diseases and malignant neoplasms decreased during the period 1991-1996. The age-adjusted death rate from heart diseases decreased from 160.4 per 100,000 population in 1991 to 133.5 per 100,000 population in 1996 for men(16.7 % decrease), and from 163.5 per 100,000 in 1991 to 138.6 per 100,000 population in 1996 for women(15.2 % decrease). The

Table 2. The number of deaths and death rates by the three leading causes of death in Tianjin, China, in six years (1991-1996)

Cause of Death	Men			Women		
	Number of Deaths		Death Rate	Number of Deaths		Death Rate
		(%)	(per 100,000 person-year)		(%)	(per 100,000 person-year)
All Causes of Death	164,291	(100.0)	607.7	139,446	(100.0)	531.0
Heart Diseases	37,965	(23.8)	144.6	36,241	(26.0)	138.0
Cerebrovascular Diseases	37,559	(23.5)	143.0	30,477	(21.9)	116.1
Malignant Neoplasms	29,688	(18.6)	113.1	21,518	(15.4)	81.9

Source; "Vital Statistics, Tianjin, 1991-1996", Tianjin Municipal Health Bureau

age-adjusted death rate from malignant neoplasms decreased from 121.9 per 100,000 population in 1991 to 104.8 per 100,000 population in 1996 for men(14 % decrease), and from 90.6 per 100,000 population in 1991 to 79.1 per 100,000 population in 1996 for women(12.7 % decrease). During the same period, the age-adjusted death rate from cerebrovascular diseases remained at a stable level for both men (from 141.2 to 144.1 per 100,000 population) and women (from 126.8 to 116.0 per 100,000 population).

Fig. 3. The age-adjustd death rates for the three leading causes of death.

The age-specific death rates from the three leading causes of death for the period 1991-1996 are displayed by sex and cause of death in Fig. 4. The death rates from heart diseases and malignant neoplasms decreased for certain age groups among both men and women during the period 1991-1996. The death rates from heart diseases among women aged 35-44 years and 45-54 years showed a remarkable decrease, from 22.5 to 13.0 per 100,000 population (42.3 % decrease) and from 81.5 to 45.4 per 100,000 population (44.3 % decrease), respectively, for the two age groups. The sex difference in the death rate from heart diseases was greater among people aged 55-64 years, and diminished with increasing age. The death rates from malignant neoplasms decreased remarkably among men aged 55 years or older and also women aged 45 years or older during the study period. In particular, a marked decrease in the death rate was observed among men aged 55-64 years and women aged 45-54 years, with the death rates decreasing from 383.8 to 298.9 per 100,000 population(22.1 % decrease) and from 99.5 to 66.1 per 100,000 population(33.6 % decrease), respectively, in the two groups. On the other hand, during the same time period, the death rate from cerebrovascular diseases remained at a relatively stable level for both men and women in most age groups.

The SMRs for the three leading causes of death are presented in Table 3 and Fig. 5 by sex and region. The SMRs for heart diseases were high in the northwestern region of Tianjin(4)(SMR>100 and P<0.05) and low in the southwestern region(3)(SMR<100 and P <0.05). In the east of the urban area and the East of Tianjin(9), the SMRs for cerebrovascular diseases were high. The SMRs for malignant neoplasms were high in the urban and coastal areas(8), and low in rural areas(4). The geographic variations of death rates from cerebrovascular diseases and malignant neoplasms were consistent with the previous study results. The
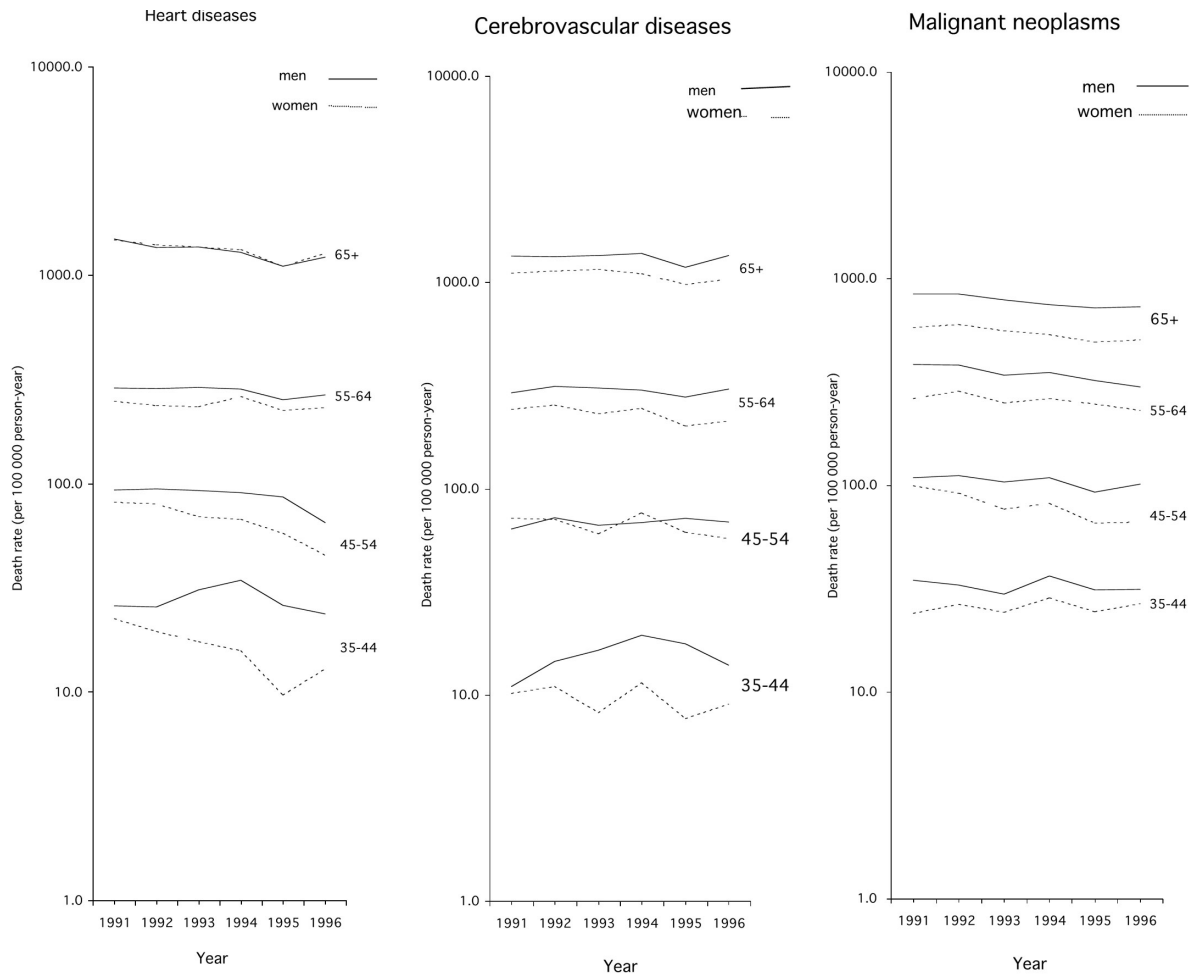
Fig. 4. The age-specific death rates for the three leading cases of death.

Table 3. The number of deaths, the standardized mortality ratio (SMR) of the three leading causes of death by district and sex, in Tianjin, China, in six years (1991-1996)

District	Heart disease				Cerebrovascular diseases				Malignant neoplasma			
	Men		Women		Men		Women		Men		Women	
	Number of death	SMR	Number of death	SMR	Number of death	SMR	Number of death	SMR	Number of death	SMR	Number of death	SMR
Tianjin	37,965	100	36,241	100	37,559	100	30,477	100	29,688	100	21,518	100
Urban area												
Heping	2,202	97.3	2,267	96.3	1,785	75.7 ###	1,578	75.4 ###	2,234	124.1 ***	1,808	125.3 ***
Hedong	2,305	95.2 #	2,183	97.1	3,092	121.7 ***	2,543	126.2 ***	2,949	141.9 ***	2,224	144.4 ***
Hexi	3,255	116.2 ***	3,045	115.7 ***	3,086	105.2 **	2,587	110.0 ***	3,024	127.4 ***	2,257	128.7 ***
Nankai	2,796	91.5 ###	2,789	96.1 #	3,287	103.1	2,602	100.7	3,004	117.9 ***	2,179	115.4 ***
Hebei	2,681	101.5	2,564	101.2	3,491	126.3 ***	2,770	122.2 ***	2,940	133.2 ***	2,091	125.5 ***
Hongqiao	3,458	139.9 ***	3,434	144.5 ***	2,957	115.0 ***	2,418	114.1 ***	2,586	127.0 ***	1,833	119.0 ***
Suburban area												
Dongli	802	88.3 ###	750	96.1	1,468	156.6 ***	1,082	155.2 ***	896	116.0 ***	680	123.8 ***
Xiqing	621	64.8 ###	587	71.6 ###	1,023	104.0	695	95.4	620	77.7 ###	404	72.8 ###
Jinnan	1,330	122.3 ***	1,200	124.8 ***	1,857	166.4 ***	1,283	149.8 ***	882	97.2	682	103.3
Beichen	1,176	112.5 ***	1,176	126.6 ***	1,728	161.4 ***	1,289	157.0 ***	1,008	116.5 ***	640	104.0
Rural area												
Ninghe	740	70.1 ###	698	78.8 ###	1,488	137.4 ***	1,153	147.1 ***	886	101.7	567	96.5
Wuqing	6,260	223.3 ***	6,032	223.7 ***	2,378	82.5 ###	2,593	109.4 ***	1,960	85.6 ###	1,535	92.7 ##
Jinghai	1,598	89.6 ###	1,379	93.1 #	1,809	98.5	1,320	100.9	1,058	73.1 ###	737	78.9 ###
Baodi	3,467	151.4 ***	3,154	140.3 ***	2,299	98.4	2,057	105.0 #	1,254	69.2 ###	1,005	75.6 ###
Jixian	2,811	97.4	2,618	95.4 #	2,816	95.8 #	2,343	98.0	1,218	53.7 ###	728	44.8 ###
Coastal area												
Tanggu	1,507	102.9	1,396	115.9 ***	1,719	113.7 ***	1,282	118.4 ***	1,800	140.9 ***	1,263	145.6 ***
Hangu	591	104.8	661	148.1 ***	804	138.1 ***	504	125.7 ***	670	139.2 ***	434	133.9 ***
Dagang	365	41.9 ###	308	47.1 ###	472	53.2 ###	378	65.2 ###	699	86.6 ###	451	92.4

Notes: The age-specific death rate by sex in 1995, Tianjin, is used as the standard
 *: SMR>100, P<0.05 **: SMR>100, P<0.01 ***: SMR>100, P<0.001
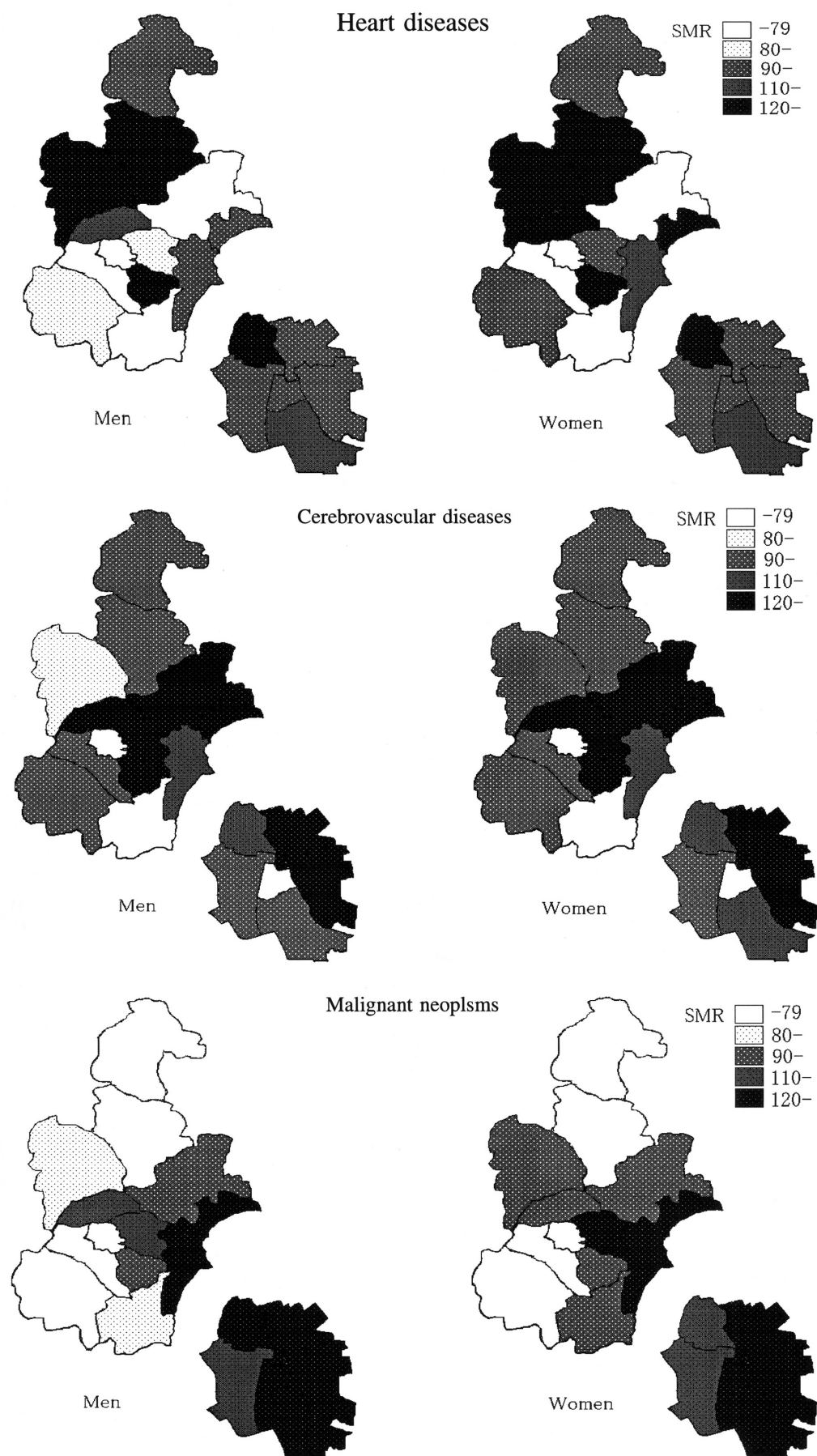 #: SMR<100, P<0.05 ##: SMR<100, P<0.01 ###: SMR<100, P<0.001

Fig. 5. The standardized mortality radio (SMR) of the three leading causes of death by district and sex, in Tianjin, China, 1991-1996.

geographical patterns variations of death rates from the three leading causes of death were similar between men and women each of the causes of death.

Discussion

In China, with economic liberalization and progressive aging of the population during the last twenty years, heart diseases, cerebrovascular diseases, malignant neoplasms, and other non-communicable chronic diseases(NCD) have now become the major causes of morbidity and mortality. In 1985, the Ministry of Tianjin sponsored a large-scale survey of non-communicable diseases to determine the prevalence of hypertension, cerebrovascular diseases, coronary heart disease and malignant neoplasms[5]. In 1989, a field intervention trial, which included health education and hypertension control, was launched in Tianjin[5].

Even though the death rates from heart diseases in both men and women showed a significant decrease during the years 1991-1996, heart diseases remain the leading cause of death in Tianjin. The decrease in death rates from heart diseases may however mean that individual behaviors and the living environment have considerably improved in the past ten years. A possible explanation for the apparent decrease in death rate among women aged 35-44 years and 45-54 years is that women in these age groups usually have easier access to health care management programs and more actively use health care services and seek help for symptoms than men and older women. Examination of the geographical distribution of death rates showed that death rates from heart diseases were high in the northwestern regions and low in the southwestern regions of Tianjin. The death rates in the northwestern regions determined in this study is higher than that in the previous study.

Death rates from cerebrovascular diseases, the second leading cause of death in Tianjin, showed a relatively stable trend among men and women during the study period. This observation indicates that the extent of exposure of the population to the major risk factor(s) of cerebrovascular diseases, such as a high-sodium diet and hypertension, showed no major changes during the period 1991-1996. Observation of the geographical distribution of the SMRs for cerebrovascular diseases showed that the death rates from this cause were high in the east of the urban areas of Tianjin and the East Tianjin. These results indicate that the populations living in these specific areas may have similar lifestyles, like a high-sodium diet, or have similar prevalence

rates of hypertension.

Death rates from malignant neoplasms decreased during the period 1991-1996, particularly for men aged 55 years or older and women aged 45 years or older. This may be attributed to the routine annual physical examination conducted in Tianjin since the early 1990s and the improvement of clinical techniques for the diagnosis of malignant neoplasms. In other words, early detection and prompt treatment may have led to the decrease of death rates from malignant neoplasms. Observation of the geographical variations of the SMRs showed that the death rates from malignant neoplasms were high in the urban and coastal areas of Tianjin, and low in the rural areas. Increasing exposure to environmental pollution is probably the major reason for the increase in death rates from malignant neoplasms. Air pollution from the large number of automobiles, heavy industries and smoke from burning coal has being a serious public health problem among the urban districts of Tianjin until now, and it is likely to worsen further with the rapid increase in the number of automobiles in the urban areas in the near future. Environmental pollution from chemical plants provides another possible explanation for increased death rates from malignant neoplasms in the coastal areas (Tanggu and Hangu), which are the major chemical industrial bases in northern China. These results emphasize that intensification of primary prevention measures in the specific target districts may be important for effective reduction of death rates from malignant neoplasms.

The study observed a decreasing trend of deaths from malignant neoplasms and a relatively stable trend of deaths from celebrovascular diseases in Tianjin during the period of 1991-1996. These changes are different from those observed in Japan[6]. Further detailed studies may help to explain these differences between Tianjin and Japan. Exposure assessment of risk factors in the population is a most important task for future studies, such as assessment of the prevalence of hypertension, as it will be very useful to formulate effective preventive measures.

Conclusion: The present analysis confirmed the results of the previous study on the geographical distribution of deaths from cerebrovascular diseases and malignant neoplasms in Tianjin, and showed that the death rates from heart diseases were high in the northwestern regions of Tianjin and low in the southwestern regions. Simultaneously, this study showed an apparent decreasing trend of death rates

from heart diseases and malignant neoplasms as well as a relatively stable trend of deaths from cerebrovascular diseases during the study period. The current study thus indicated that measures for the prevention and control of non-communicable chronic diseases in Tianjin, particularly for cerebrovascular diseases, was scarcely effective during the 1990s. The study results emphasize that special intervention in the specific target districts of Tianjin is necessary. The results of this study can be expected to help in increasing the awareness of the high prevalence of non-communicable chronic diseases among public health professionals and policy makers, and to identify interventional strategies.

Acknowledgments

References

1) Alderson MR. Mortality, Morbidity and Health Statistics. Basingstoke: Macmillan;1988. p.105-67.
2) Feng Yanru. The characteristics of mortality in Tianjin, China, 1995-An analysis of mortality rates from the three leading causes of death according to region, sex, and age. Journal of Saitama Medical School 2002; 29:187-96.
3) Cao Yaguang. The population register of Tianjin. Tianjin: The science technology publisher in Tianjin, 1998.
4) SAS Institute Inc, Japan. SAS Procedure Guide, Version 6. 3rd ed. Cary, NC: SAS Institute Inc; 1990.
5) TIANJIN COMMUNICABLE CHRONIC DISEASE COMMUNITY COMPREHENSIVE PREVENTION AND CONTROL PROJECT (1984-1998).
6) VITAL STATISTICS OF JAPAN. STATISTICS AND INFORMATION DEPARTMENT, MINISTER'S SECRETARIAT, MINISTRY OF HEALTH AND WELFARE, 1996.
7) Japan Epidemiological Association. Handbook of Epidemiology-Epidemiology and Prevention of Major Diseases. 1998.
8) Intersalt Cooperative Research Group. Intersalt: and intermational study of electrolyte excretion and bolld pressure. BMJ 1988;297-319.
9) Wu Yangfeng. Current status of major cardiovascular risk factors in Chinese populations and their trends in the past two decades. Chin J Cardiol, 2001; 29(2):7.
10) Vartiainen E, Du DJ, Marks JS, Korhonen H. Mortality, cardiovascular risk factors, and diet in China, Finland, and the United States. Public Health Rep 1991;106(1): 41-6.

1991-1996 年中国天津市の死亡状況の解析

馮　彦茹

前回，1995 年天津市の死亡状況について研究を行い，天津市の心疾患死亡率は中国都市地域，日本より高く，悪性心疾患の死亡率は中国都市地域，日本より低いことを明らかにした．また，市区の東部と天津市の東部地域は脳血管疾患の死亡率が高く，全市区と浜海区は悪性新生物の死亡率が高いことも明らかになった．

本研究では，1991 年から 1996 年の死亡資料を用いて，詳細に天津市の死亡状況を明らかにすることを目的とした．

今回の解析では，心疾患，脳血管疾患，悪性新生物の三大死因について，1991 年から 1996 年の各年次の性別の年齢調整死亡率，年齢階級別死亡率，18 地域別の標準化死亡比（SMR:Standardized mortality ratios）を算出し，比較した．

1991 年から 1996 年の 6 年間の死亡総数は 303,737 人で，そのうちの 63.7％を三大死因が占めている．その期間の心疾患と悪性新生物の年齢調整死亡率は年々減少したが，脳血管疾患の年齢調整死亡率は男女ともほぼ横ばいであった．また，脳血管疾患や悪性心疾患の SMR は地域格差が認められ，これは，前回報告した 1995 年の結果と同様であった．

今回の研究から，天津市の 90 年代の慢性非伝染病疾患の予防効果は特に脳血管疾患については，少なく，今後，死亡率の高い地域を中心とした介入が重要であると考えられた．また，今回の 6 年間の三大死因の死亡率の年次推移と地域格差の研究結果は，天津市の衛生施策の重要な資料となると考えられた．