Changes in Age-Sex Mortality Patterns and Causes of Death in the Republic of Korea

A characteristic of the mortality pattern of males in the Republic of Korea is that the mortality rate of those over 40 years of age is quite high compared with males of other ages and females of that age.

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The high population growth in many developing countries is caused by relatively low mortality and continuing high fertility. Under those circumstances, it is difficult to deny that reducing fertility is crucial for curbing rapid population

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growth. Nonetheless, because the health status of a population has an obvious bearing on mortality, its importance as a variable affecting the quality of the population has also been recognized (United Nations, 1973, p. 107). Therefore, while fertility reduction is an important factor for curbing population growth rates, mortality (or health) control is required for improving the quality of the population.

This study analyses the patterns of and changes in mortality in the Republic of Korea in order to enhance understanding of the mortality transition in that country. Also, it examines mortality differentials by the demographic and socio-economic characteristics of the population. Finally, it traces the characteristics of a healthy life based on an analysis of the causes of death.

Vital statistics since 1970 were used for the calculation of death rates by sex and age; the completeness of death registration data in the Republic of Korea since 1970 has enabled their use for the calculation of mortality indicators (Kim, 1990; Park, 1995). Population projections prepared in 2001 covered the period up to 2050 (Korea National Statistical Office (KNSO), 2001a). For the analysis of the reasons for the changes in the age-sex mortality pattern, the cause of death statistics that had been collected with death registration were used. Life tables have also been available since 1971 (KNSO, 2003).

For the analysis of mortality differentials, two demographic variables were included, sex and age, and two socio-economic ones, educational level and marital status, to determine the reasons for mortality changes.

Mortality trends and patterns

Age-sex pattern of mortality

The expectation of life at birth in 1971 for the Republic of Korea was 59.0 years for males and 66.1 years for females. People in the young age groups (up to around 30 years of age) have experienced very significant mortality declines compared with those in the older age groups throughout the whole reference period (see table 1). However, the mortality declines for the older age groups have increased recently and the differences in the mortality changes between the two groups have become smaller for both sexes in recent years. Although the decline in mortality was faster for females than for males, the death rates for males in all age groups declined faster in recent years, and the differences in the mortality changes between the sexes became smaller.

Although the mortality patterns by sex are different from each other because of the relatively high mortality rates after the age of 40 for males (see Kim, 1990),

changes in the mortality pattern of males can be expected when the differences in mortality decline between the sexes become smaller.

Table 1. Proportional decreases in age-specifi nortality rates, by sex, 1971-2001

Age group	Males (percentage)		Females (percentage)	
	1971-1985	1985-2001	1971-1985	1985-2001
Life expectancy at birth in each period (years)	59.0-64.5	64.5-73.3	66.1-72.8	72.8-80.2
0	50.8	70.0	52.7	70.8
1-4	50.7	70.9	52.7	74.2
5-9	57.4	72.5	59.1	77.0
10-14	58.7	68.7	64.7	69.2
15-19	44.9	65.0	59.1	68.1
20-24	49.3	59.9	69.2	63.9
25-29	31.5	59.2	66.4	61.8
30-34	27.5	55.5	57.2	58.7
35-39	7.8	50.5	48.4	54.5
40-44	11.6	51.8	39.5	58.6
45-49	17.0	47.5	36.7	56.3
50-54	25.5	44.1	33.2	54.6
55-59	28.5	43.0	30.4	51.6
60-64	23.0	42.1	26.3	48.1
65-69	19.0	40.8	13.2	44.9
70-74	8.8	34.4	5.0	36.7
75-79	11.0	29.2	9.7	26.0

Source: Korea National Statistical Office (2003). *2001 Life Tables for Korea* (Seoul, KNSO).

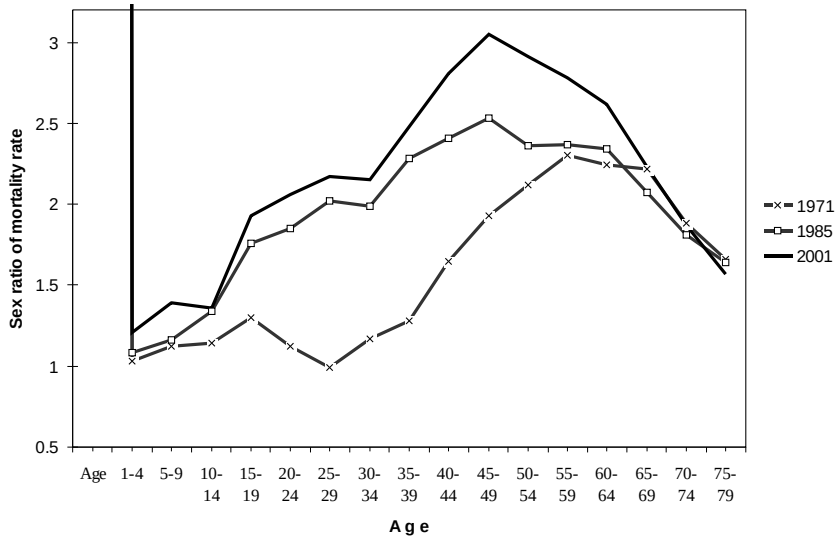
Although the increase in life expectancy at birth for females, i.e. 6.7 years, during the 14-year period between 1971 and 1985 exceeds that of males (5.5 years), the increase in life expectancy for males (8.8 years) for the 15 years after 1985 exceeded that of females (7.4 years) in that time period. The difference between the life expectancy of both sexes, i.e. 8.3 years, reached its peak in 1985 and then decreased slowly to 6.9 years in 2001 (Kim, 2004; KNSO, 2003), a pattern that is similar to that of most developed countries (OECD, 2004).

Mortality patterns and model life tables

A low sex ratio of mortality rates for the age group 5-9 years is generally found in societies traditionally having a strong son preference. Further, the low sex ratios of death rates for the age group 20-39 (a 10-year cohort) reflect high maternity mortality in societies with high fertility and poor medical services. However, those low sex ratios disappear when the fertility level becomes low and the standard of living improves.

The low sex ratios at ages 5-9 and 25-29 that existed in the Republic of Korea in 1971 disappeared over time with the decline in fertility and improvements in the quality of life (see figure 1). Subsequently, the low sex ratio of those two particular age groups has not been observed again since 1981. In the meantime, the sex ratio of the death rates of those in the age group 40-59 has increased, exceeding 3 in 2001. The death rates for males in those age groups were three times higher than those for females of corresponding ages. This is why the mortality pattern of males in the Republic of Korea belongs to the Far Eastern Pattern of mortality (United Nations, 1982).

The high death rates for males aged 40 and above in the Republic of Korea distinguished the life table of Korean males from the West Model of Coale and



Demeny (1983) that is generally regarded as the standard for the world. A study in

the early 1980s termed this type of pattern the "Far Eastern Pattern" of mortality (United Nations, 1982).

Figure 1. Sex ratios of age-specific mortality rates, 1971-2001

Source: Korea National Statistical Office (2003). *2001 Life Tables for Korea* (Seoul, KNSO).

Figure 2. Comparison of mortality pattern for Korean males and West Model of Coale and Demeny, 1971-1991

Source: Korea National Statistical Office (2003). *2001 Life Tables for Korea* (Seoul, KNSO); and Coale and Demeny (1983). *Regional Model Life Tables and Stable Populations* (New York, Academic Press).

Figure 2 summarizes the relative levels of West Model life tables compared with the death rates of Korean males by five-year age groups. The relative levels of West Model life tables in 1971 declined rapidly for those in age groups higher than 35-39 years, that is, although the mortality levels for those in the age groups from 10-14 years to 35-39 years were similar to those at 18-19 years of age, the levels for

those older than 40 years declined rapidly and reached the life table level of only 14.2 for those in their 50s. This pattern changed when overall mortality declined. The relative levels in 1991 at 50 years and older became higher and could be matched with the levels found in younger age groups. This means that the mortality pattern of Korean males is approaching the average patterns of developed societies experiencing mortality decline, although until around 1980 the Korean pattern belonged to the Far Eastern Pattern.

Mortality differentials

Mortality differentials by educational level and marital status

Mortality differentials are noticeable among various socio-economic subgroups: death rates appear to be higher within subgroups with a low level of education or in lower-grade occupations. Also, rural residents or unmarried people showed higher death rates than average (Benjamin, 1965; Antonovsky, 1967; Ruzicka, 1982; Kobayashi, 1984; United Nations, 1984; Yamamoto, 1985). Such mortality differentials are also found in the Republic of Korea (Kim, 1990).

The inverse relationships between mortality level and educational level among adults (aged 25-64 years) in the Republic of Korea are strong in all age groups (see Kim, 2004, p. 105, table 4-4), which is known as a general pattern (see Mathis, 1969; Kitagawa and Houser, 1973). For the 30 years from the period 1970-1972 to 2000, the difference in death risks by educational level showed a great change. The relative difference in the risks has increased over time, and the rate of increase is clear, especially in the younger age groups (25-34 and 35-44 years). This phenomenon shows that the gap narrows with age, but the mortality differentials increase with rises in education level.

The pattern of mortality differentials by marital status in the Republic of Korea shows a general picture (see Kim, 2004, p. 107, table 4-5). The mortality level of those married was definitely lower than that of the single population for both sexes and all age groups. The pattern of mortality differentials by marital status in the Republic of Korea has changed over the last 30 years. The difference in mortality level between those married and those never married is becoming smaller in all age groups and for both sexes. The difference in death rates of those married and those never married is lower in the age group 25-34 years for both sexes. Since the never-married rate for females is rising faster than that of males, the difference for females has become relatively smaller.

Educational level affects occupation, income and personal health. As the level of education increases, the level of mortality in all cases declines. Considering that the educational level of the single population, including those beyond marriageable age, is relatively low, it is assumed that the mortality differentials by marital status are related to a difference in educational level. The standardized death rates by marital status were estimated based on the proportion of deaths by sex and educational level in order to analyse mortality differentials by marital status, after the effects of the difference in educational level are controlled (see table 2).

Table 2. Mortality ratios of death rates and standardized death rates, by marital status and age, 2000

Sex and marital status	Ratio of death rates[a]	Ratio of standardized death rates[b]
Males (45-54 years)	**1.00**	**1.00**
Never married	4.10	3.31
Married	0.83	0.85
Others[c]	2.62	2.38
Females (45-54 years)	**1.00**	**1.00**
Never married	3.46	4.39
Married	0.92	0.86
Others[c]	1.85	1.50

Source: Korea National Statistical Office (2002). *2001 Vital Statistics* (Seoul, KNSO).

[a] Calculated directly from registration data.
[b] Calculated after standardizing death rates by marital status for the age group 45-54 years based on the population composition by educational level and sex.
[c] Including persons widowed, divorced or separated.

Standardized mortality ratios decreased for those who never married, other males and other females, while that of never-married females increased. Also, the educational level of never-married females in the age group 45-54 years appears to be relatively higher and that of others lower than those who were married. However, even though the effects of educational level are controlled, the death rates of those who never married and others (both sexes) are approximately two (other females) to four times (never-married males) higher than that of those who were married. Therefore, marital status, along with educational level, is a key factor that affects the mortality level directly in the Republic of Korea.

Effects of changes in composition by population characteristics on mortality

As mortality differentials change with educational level and marital status over time and since proportions of the population by educational level and marital status change with socio-economic development, the relationships between the changes in mortality levels and subpopulation proportions were analysed.

Using mortality ratios and population proportions by educational level and marital status, the mortality changes resulting from the changes in population composition between 1980 and 2000 were estimated from equations (1) and (2) below.

If the proportion of subpopulation *i* in 1980 is constant and the death rate of age group *j* in 2000, $R_{j(2000)}^{2000}$ is 1.0, the relative mortality ratio of age group *j* in 2000, $R_{j(80)}^{2000}$, may be estimated from equation (1).

$$R_{j(80)}^{2000} = \sum_i (W_{ij}^{80} \cdot r_{ij}^{2000}) \quad \text{..... (1)}$$

Where W_{ij}^{80} is the population proportion of characteristic *i* and age group *j* in 1980, r_{ij}^{2000} is the mortality ratio of characteristic *i* and age group *j* in 2000.

Since $R_{j(2000)}^{2000}$ = 1.0 the percentage change in mortality level P_j of age group *j* resulting from the change in population propor ɔn by characteristics from 1980 to 2000 is:

$$P_j = (1.0/R_{j(80)}^{2000} - 1) \cdot 100 \quad \text{..... (2)}$$

Therefore, the results of P_j reveal how much the change in population proportion by characteristics affects the mortality level and how different the effects are by age and sex.

Table 3. Relative mortality ratios and changes in mortality levels in 2000 as a result of the changing population composition since 1980, by age group

Age group (years)	Educational level[a]				Marital status[b]			
	Males		Females		Males		Females	
	Rj[c]	Pj[d](%)	Rj[c]	Pj[d](%)	Rj[c]	Pj[d](%)	Rj[c]	Pj[d](%)
25-34	2.521	-60.3	4.083	-75.5	0.879	13.8	0.910	9.9

35-44	2.203	-54.6	2.363	-57.7	0.781	28.0	0.952	5.0
45-54	1.550	-35.5	1.531	-34.7	0.897	11.5	1.019	-1.9
55-64	1.220	-18.0	1.082	-7.6	0.986	1.4	1.049	-4.7

Source: Korea National Statistical Office (2002). *2001 Vital Statistics* (Seoul, KNSO).

[a] Four classifications: never, elementary, middle and high school, and college and higher.

[b] Three classifications: never married, currently married and others.

[c] Relative mortality ratios by age in 2000, if the population composition by age in 2000 is the same as that in 1980 and the age-specific death rates in 2000 are 1.0.

[d] Proportional changes (percentage) of relative mortality ratio (1.0) of age-specific death rates in 2000 from the relative mortality ratio for age group *j* (R_j) resulting from the changing population composition since 1980.

The relative mortality ratios of the age group 25-34 years, based on population proportion by educational level, are 2.5 times higher for males and 4.1 times for females (see table 3). With age, the ratios plunge and reach approximately 1.1 to 1.2 times higher for both sexes. Therefore, the decreases in mortality levels (the difference between observed and estimated rates) for the age group 25-34 years, owing to improved educational levels from 1980 to 2000, were as significant as 60.3 per cent for males and 75.5 per cent for females. These decreasing percentages drop with age; those in the age group 45-54 years were as small as 35.5 per cent and 34.7 per cent for males and females, respectively. The considerable decline in the level of mortality in young age groups for both sexes (see table 1) means that the recent improvement in educational levels has strongly affected the decrease in mortality levels.

As opposed to the effects of educational change, the relative mortality ratios based on population proportions by marital status were less than 1.0 in all age groups for males and for the age group 25-44 years for females. The ratios increase slowly with age and reach about 1.0 at the highest age group for both sexes. Since the mortality level for those married is relatively lower than those in other subpopulations, the increase inthe never-married population proportions for both sexes tends to increase overall mortality rates.

Mortality by cause of death

Trends and patterns in causes of death

Early in the twentieth century, the leading causes of death in Korea were diseases related to the respiratory and digestive systems and communicable

diseases, including smallpox, pneumonia and tuberculosis (Lee, 1980, pp. 174-176). Kwon and Kim (1968) pointed out that infectious diseases such as cholera, smallpox and tuberculosis were the leading causes of death in Korea around 1920. The leading causes of death in the period 1938-1942 were those related to the digestive, respiratory and nervous systems and infectious and parasitic diseases (Kwon, 1968).

In 1966, the above-mentioned leading causes of death diminished, while deaths caused by neoplasms, diseases of the circulatory system, and injury and poisoning increased markedly. Those three newly emerging major groups of causes of death explained 50 per cent of the total deaths in the period 1980-1981, and more than 60 per cent of total deaths in 1990 and 2000 (Kim, 2004, pp. 113-114).

The changes in causes of death can be observed in the proportions of death caused by five leading factors. Table 4 lists the five leading causes of death between 1966 and 2000. It reveals that, of the leading causes of death in 1966, three of them were diseases of the respiratory and digestive systems and infectious diseases. In the period 1980-1981, all of the five most important causes of death were diseases of the circulatory system, neoplasms and injuries.

From 1990, the four most important causes of death were malignant neoplasms, cerebrovascular and heart diseases and traffic accidents. Such changes in the pattern of causes of death indicate that the dramatic decline in mortality levels since 1966 was mainly due to reductions in mortality from diseases of the respiratory system and infectious diseases such as pneumonia and tuberculosis.

Table 4. Changes in the five leading causes of death, 1966-2000

Rank	1966[a]	1980-1981[b]	1990[c]	2000[c]
1	Pneumonia	Malignant neoplasms	Malignant neoplasms	Malignant neoplasms
2	All forms of tuberculosis	Hypertensive diseases	Cerebrovascular diseases	Cerebrovascular diseases
3	Vascular lesions affecting central nervous system	Cerebrovascular disease	Heart disease (all forms)	Heart disease (all forms)
4	Malignant neoplasms	All accidents	Traffic accidents	Traffic accidents

5	Gastritis, duodenitis, enteristis and colitis	Heart disease (all forms)	Hypertensive diseases	Chronic liver diseases and cirrhosis

Sources: 1966: Economic Planning Board (1968). *1966 Vital Statistics* (Seoul, National Bureau of Statistics, Republic of Korea); 1980-1981: Economic Planning Board (1982). *1981 Cause of Death Statistics* (Seoul, National Bureau of Statistics, Republic of Korea); and 1990 and 2000: Korea National Statistical Office (2001b). *2000 Causes of Death* (Seoul, KNSO).

[a] Based on an abbreviated list of 50 causes of death in the *International Statistical Classification of Diseases, Injuries and Causes of Death*, seventh revision (Geneva, World Health Organization, 1957).

[b] Based on a special list of 55 causes of death in the *International Statistical Classification of Diseases, Injuries and Causes of Death*, ninth revision (Geneva, World Health Organization, 1977).

[c] Based on a special list of 56 causes of death in the 1995 Korean Standard Classification of Diseases, Korean National Statistical Office (2001). *2000 Causes of Death* (Seoul, KNSO).

Causes of adult deaths by age and sex

For the five-year age groups from age 35 years and older, mortality rates are high and the causes of death are substantially different between males and females (see Kim, 2004, p. 114, table 4-10). The first among the leading causes of death in 1981 was diseases of the circulatory system for both sexes and in all age groups. However, from 1990, the first such cause was neoplasms for those in younger age groups (35-64 years); diseases of the circulatory system became the leading cause of death for those at older ages. In 2000, the share of injury and poisoning in the causes of death was the greatest for males aged 35-54 years.

Although the general pattern of causes of death is similar for males and females, the sex differentials in the proportions of death caused by diseases of the digestive system are quite noticeable, particularly for those under 65 years of age (see Kim, 2004, pp. 114-115). Such differentials continued until 2000 owing to the persistence of a high rate of death caused by chronic liver disease for males, despite the reduction in death caused by diseases of the digestive system. The proportion of deaths caused by neoplasms for both sexes increased with the decline in overall mortality. However, it increased more rapidly for males than for females: neoplasms became a leading cause of death for people in the older age groups.

If the changes in death patterns continue, the leading causes of death for males and females aged 35-54 years will be injury and poisoning; for those in the older age groups, it will be neoplasms. Also, the proportions of death caused by diseases of the respiratory system will increase rapidly for those in the older age groups (especially 75 years and above). Together with neoplasms and diseases of

Table 5. Sex mortality ratios of cause-specific death rates by leading causes of higher mortality among males, by age group, 2000

Causes of death by age[a]	Cause-specific death rates[b]		Sex ratio of death rates (females:100)	Relative sex ratio (average sex ratio:1.00)
	Males	Females		
Ages 30-39 (total)	179.0	77.2	231.8	1.00
1. Malignant neoplasms	25.3	23.8	106.3	0.46
2. Chronic liver diseases and cirrhosis	16.4	2.1	780.9	3.37
3. Traffic accidents	32.7	8.2	398.8	1.72
4. Heart diseases (all forms)	10.7	3.4	314.7	1.36
5. Cerebrovascular diseases	7.8	3.8	205.2	0.88
Ages 40-49 (total)	441.0	148.7	296.6	1.00
1. Malignant neoplasms	98.2	57.1	171.9	0.58
2. Chronic liver diseases and cirrhosis	68.4	7.8	876.9	2.95
3. Traffic accidents	43.9	11.1	395.5	1.33
4. Heart diseases (all forms)	33.2	8.5	390.6	1.31
5. Cerebrovascular diseases	31.0	14.6	212.3	0.71
Ages 50-59 (total)	1,007.3	355.6	283.2	1.00
1. Malignant neoplasms	341.8	136.7	250.0	0.88
2. Chronic liver diseases and cirrhosis	117.3	19.1	614.1	2.17
3. Traffic accidents	61.1	19.2	318.2	1.12
4. Heart diseases (all forms)	76.8	23.9	321.3	1.13
5. Cerebrovascular diseases	99.7	53.1	187.7	0.66

Sources: Korea National Statistical Office (2001). *Population Projections for Korea: 2000-2050* (Seoul, KNSO); and KNSO (2001). *2000 Causes of Death* (Seoul, KNSO).

[a] Comparing the changes in the sex ratio of death rates by age group based on the five leading causes of death in males in the age group 40-49 years.

[b] Number of deaths per 100,000 persons, calculated from death registration data and the estimated population in 2000.

the circulatory system, diseases of the respiratory system will constitute the three leading causes of death for older persons (Kim, 2004, pp. 116-117).

The characteristic of the mortality pattern for males in the Republic of Korea is that the death rates for males over 40 years of age are relatively higher than those for younger males and for females. Table 5 shows the reasons for the sudden increase in the death rates of males over 40 years of age by comparing them with that of females. The five leading causes of death for males in the age group 40-49

years were selected and the death rates compared with those of males in the age group 30-59 and females in all age groups.

The death rate of males in the age group 40-49 years in 2000 was 441.1 per 100,000, which is approximately three times higher than that of females (148.7 per 100,000); and the mortality sex ratio is the highest among all age groups. In the age groups mentioned above, the five leading causes of death for males were malignant neoplasms, chronic liver diseases and cirrhosis, traffic accidents, heart diseases (all forms) and cerebrovascular diseases. Among them, the highest sex ratio was found in those who died of chronic liver diseases and cirrhosis (876.9 per 100,000). The ratios for those who died in traffic accidents (395.5 per 100,000) and heart diseases (all forms) (390.6 per 100,000) were also higher than the average (296.6 per 100,000). Similar patterns were found for those in the age group 30-59 years. However, because the death rates for both sexes were low in the age group 30-39 and the rate for females in the age group 50-59 also grew rapidly, the sex ratios of those who died in the age groups 30-39 years and 50-59 years were lower than that for those in the age group 40-49 years. Thus, it may be stated that the high sex ratios of those who died in the age group 40-49 were caused by the three above-mentioned causes of death.

If the sex ratio of death rates in the age group 40-49 is indexed as 1.0, the ratios of the above-mentioned causes of death were higher than 1.3; in particular, the ratio of chronic liver diseases was three times higher than the average ratio. However, these relative sex ratios became smaller than those of chronic liver diseases (4.17) and all accidents (2.81) for those in the age group 35-44 years in 1980-1981 (Kim, 1990, p. 80). This is one reason why the mortality pattern of males in the Republic of Korea has changed from the Far Eastern Pattern to the West Model, the average pattern globally, since the 1980s.

Summary and conclusion

The death rates of females aged 5-14 years and females aged 20-29 years were relatively higher than those of males in the Republic of Korea until the 1970s. However, this pattern has changed along with the decrease in overall mortality. That change is attributable to lowered fertility, which reduces the risk of death related to pregnancy. It is also related to a weakened preference for sons (Kong and others, 2000, p. 311).

The mortality patterns of males used to match the Far Eastern Pattern until the 1980s; it has been approaching the Western standard since then. Changes in mortality patterns in the Republic of Korea suggest that the Far Eastern Pattern is a

phenomenon of incomplete mortality transition that may be expected to disappear with further declines in mortality.

The mortality differentials by educational level have changed over the 30-year period from 1970 to 2000. The gap in mortality between persons with different levels of education has increased for both sexes. Mortality differentials by marital status are also quite significant, and the pattern has changed greatly over the aforementioned 30-year period. Mortality differentials between married and single people are becoming smaller in all age groups and for both sexes. When the educational effects were controlled, the death rates of those unmarried appeared to be approximately two to four times higher than the death rates of those married. Thus, mortality differentials by marital status, along with differentials by educational level, are the primary factors affecting mortality levels in the Republic of Korea. The analysis of the relationships between mortality levels and population composition revealed that mortality decreases with improvements in the educational levels of the population. By contrast, changes in the marital status composition of the population have resulted in increasing death rates because of the increase in the proportion of single people.

The specific causes of death have also changed in the process of the mortality transition. In 1966, pneumonia and tuberculosis were the most important causes of death. However, in 1980-1981, the major causes of death were malignant neoplasms and hypertensive diseases. In the 1990s, malignant neoplasms, cerebrovascular and heart diseases, and traffic accidents emerged as the major causes of death. Chronic liver diseases and cirrhosis ranked as one of the top five causes of death in 2000.

A characteristic of the mortality pattern of males in the Republic of Korea is that the mortality rate of those over 40 years of age is quite high compared with males of other ages and females of that age. Analysis of the causes of death for males aged 40-49 years reveals that the rates of death from chronic liver diseases, heart diseases and traffic accidents are particularly high. However, in recent years, the mortality pattern of males in the Republic of Korea has been changing to that of the West Model.

The main causes of mortality differentials by sex are the diseases related to behaviours such as smoking and drinking among males (Kim, 1990). Those include chronic liver disease, hypertensive disease and malignant neoplasms. In addition, while the overall death rates have declined rapidly along with the improvement in the educational levels of the population, there are still substantial differences in mortality by marital status. That situation calls for more research on

the mechanisms of mortality differentials as well as action programmes aimed at lowering the mortality level of the more vulnerable subpopulations.

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