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Korean Regional Mortality Differences According to Geographic Location

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CONTENTS

Ⅰ. Introduction

The health status of a nation can be measured in two different ways, namely the average approach and the distributive approach (WHO 2000). In the average approach, the health status of a nation can be measured with national indicators such as life expectancy or infant mortality rate generated by averaging individual levels. On the other hand, the distributive perspective attempts to measure the distribution of these average indicators between classes or geographic locations within a nation. Developed countries, which have already achieved sufficient levels of health status in the average concept, have become concerned about the health inequalities between classes or geographic locations and continue to formulate many policy efforts to reduce these inequalities (Acheson 1998). The "Healthy People 2010", which contains the fundamental contents of the current health policy of the United States, indicates that "reducing health inequalities between race, geographic locations, or classes", and "improving the quality of life and prolonging healthy life years", are the two major goals to achieve by 2010 (DHHS). "Healthy People

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2010" describes "gender", "race and ethnicity", "income and education", "disability", and "geographic location" as the five axes to explain the health inequalities (DHHS).

Among these five axes, the "geographic location" has slightly different meaning in the sense of health policy from the other four axes. Health and other public administrators are primarily interested in differences between areas, such as health regions and districts. This interest arises from their responsibility for the provision and distribution of services and resources. With information from research of geographic health inequality, they can base their decisions on more solid evidence. This aspect may also appeal to the health administrators under the current self-governing government that needs region-specific health policies instead of indistinctive uniform health policies. The information about regional differences of health status can also help to evaluate the efficiencies of regional health policies. The administrators can relate expenditures to the health status of each region and can compare the relative efficiencies. Moreover, the regional differences of health status can be indirect indicators of regional health needs which are the starting points for health policy (Britton 1990).

The information about regional differences of health status and the understanding of their causes can also make current health promotion strategies more elaborate. Although many earlier researches on health promotion have emphasized behavior change strategies rather than socio-environmentally focused interventions, the significance of "healthy surroundings", mainly the characteristics of residential locations, in supporting health promotion has been also highlighted in various health promotion settings (Scriven and Orme 1996). And it is difficult to understand or affect the health-promoting behaviour of individuals without an understanding of how the community within which the individual must carry out such behaviour act (Abelin et al 1987). The information from research of geographic health inequality can be a help to overcome these difficulties.

The developed countries, especially European countries with an egalitarian view of health policy, have strenuously investigated and studied health inequalities according to geographic locations for a long time (Britton 1990). Few studies, however, have been conducted in Korea. Therefore, in this study we examined regional differences of mortality in Korea and then examined the effects of geographic location on the risk for death.

Ⅱ. Methodology

1. Study data

The study subjects were all 232 basic administrative districts of Korea in 1998. The Korean basic administrative district consists of Si (city), Gun (county), and Gu (ward of large city). In this study we divided these administrative districts into three categories, "metropolis", "urban", and "rural", according to the geographic location. The "Gu's of Seoul and six other metropolitan cities (Busan, Daegu, Kwangju, Incheon, Daejun, and Ulsan) were categorized as "metropolis" and 69 subjects included. The 72 "Si's were categorized as "urban" and all 91 "Gun's were categorized as "rural". To measure the mortality status of each subject, we gathered raw data of the "Report on the cause of death statistics in 1998" from the Korean Statistical Office and Resident registration data from the Department of Administration and Home Affairs. The percentage of old (≥65 years old) population of each subject was calculated from resident registration data for both sexes. The following socioeconomic indicators of each subject, "number of privately owned cars per 100 population", "per capita production of manufacturing industries", and "number of hospitals and clinics per 1000 population", were also gathered from various sources (Table 1).

2. Analysis

1) Crude mortality rate

The crude mortality rate of each subject was calculated using the number of deaths

Table 1. Study data and its sources

	Data	Source	Publisher
Mortality status	Number of deaths	Report on the cause of death statistics (raw data)	Korean statistical office
	Number of population	Resident registration data	Department of administration and home affairs
Socioeconomic status	Elderly percent (≥65 years)	Resident registration data	Department of administration and home affairs
	Number of privately owned cars per 100 population	Yearbook of health and welfare statistics	Ministry of health and welfare
	Per capita production from manufacturing industries	Report on mining and manufacturing survey	Korean statistical office
	Number of hospitals and clinics per 1,000 population	Statistical yearbook of construction and transportation	Ministry of construction and transportation

from death statistics as the numerator and the population from resident registration as the denominator. In addition to the all-causes mortality, the crude mortality rates from the three major causes of death in Korea, cardiovascular disease, cancer and external causes (Korean Statistical Office 1999), were also calculated. According to the International Classification of Disease(ICD) 10th edition (WHO 1992), we defined the code from I00 to I99 as cardiovascular disease, from C00 to D48 as cancer, and from V01 to Y89 as external causes. These four kinds of crude mortality rates (all-causes, cardiovascular disease, cancer, and external causes) were recalculated for both sexes, so finally twelve kinds of crude mortality rates were calculated.

2) Standardized mortality ratio

The standardized mortality ratio (SMR) was calculated to increase the accuracy of the regional mortality status after correcting the difference of the age structure using the indirect standardization method. The expected deaths of each subject's 5 year-interval age groups were calculated using the reference mortality rate of the whole Korean population in 1998 of that age group and were then summarized to yield the expected deaths of each subject. The observed deaths of each subject were divided by these expected deaths to get the SMRs.

3) Multivariate analysis - Poisson regression

To calculate the risk ratios for death considering the age structure and socioeconomic status of each subject, multivariate analysis was done using Poisson regression method. The number of deaths of each subject were set as a response variable and the logarithmic values of the population for each were used as an offset in all the regression models. In the first model, only the geographic location variable (metropolis as baseline) was included to obtain the crude odds ratios. The percentage of old ($\geq$65 years old) population was added in the second model to correct the difference of the population structure. Various models, with or without the other three socioeconomic variables in addition to the previous two variables, were compared to find the model of best fit. In all the models, the Pearson chi-square value divided by the degree of freedom was specified as the scale parameter to correct the over-dispersion phenomenon in Poisson distribution. SAS (version 8.12) GENMOD procedure was used in all the multivariate analyses.

Ⅲ. Results & Discussion

1. General characteristics of study subjects

The general characteristics of all 232 subjects are shown in Table 2. As expected,

Table 2. General characteristics of study subjects in 1998

		Metropolis (n=69) mean ± S.D.	Urban (n=72) mean ± S.D.	Rural (n=91) mean ± S.D.	Total (n=232) mean ± S.D.
Population (persons)	Men	162,390 ± 70,302	129,079 ± 95,694	33,200 ± 15,565	101,379 ± 86,868
	Women	161,189 ± 70,382	127,700 ± 94,445	32,982 ± 14,889	100,508 ± 86,097
	Total	323,579 ± 140,641	256,779 ± 190,111	66,182 ± 30,429	201,887 ± 172,943
Elderly percent (%)	Men	3.65 ± 1.06	5.37 ± 2.23	9.98 ± 2.49	6.67 ± 3.44
	Women	6.56 ± 1.49	9.14 ± 3.13	15.72 ± 3.32	10.95 ± 4.87
	Total	5.21 ± 1.26	7.41 ± 2.71	13.11 ± 2.92	8.99 ± 4.22
Number of privately owned cars per 100 persons		16.36 ± 3.56	16.15 ± 2.89	11.49 ± 3.23	14.39 ± 3.97
Per capita production from manufacturing industries (million won)		8.61 ± 15.98	10.90 ± 11.94	7.21 ± 12.29	8.77 ± 13.42
Number of hospitals and clinics per 1,000 population		0.47 ± 0.27	0.35 ± 0.06	0.23 ± 0.07	0.34 ± 0.18

the metropolis region had the highest population and the lowest elderly percentage, whereas the urban region had the lowest population and the highest elderly percentage. The numbers of privately owned cars and hospitals and clinics were highest in the metropolis region and the per capita production from manufacturing industries was the highest in the urban region.

2. Crude mortality rate

The crude mortality rates by geographic location are shown in figures 1, 2 and 3. The rural region had the highest crude mortality rates in all four kinds of causes of death while the metropolis region had the lowest rates. These mortality differences were more prominent in men.

The "Resident registration data" used as the denominator has a limitation, and hence so does this study, in that it can not exactly reflect the actual status of residence. The census data exactly reflects the actual status of residence at the time of survey, but this data is generated at 5-year intervals and there was no data available for 1998. The data of death statistics used as the numerator is relatively accurate when it is used for overall death, but its accuracy is questionable when differentiating causes of death. According to the Korean Statistical Office, the percentage of deaths with classifiable causes has been continuously increasing from 77% in 1977 to 99% in 1998 (Korean Statistical Office 1999). Although there has been no empirical study to verify the accuracy of the reported cause of death in Korea, a recent study reported that the percentage of death certificates written by a physician had been continuously increasing from 44% in 1990 to 71.2% in 2000, and had almost reached 90% for deaths in the twenties to sixties (Khang et al 2002). Another sample study of the accuracy of the death certificate reported that the data in death certificates

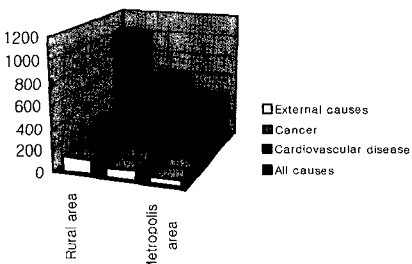

Figure 1. Crude mortality rates by geographic location, 1998
(unit: death per 100,000 persons)

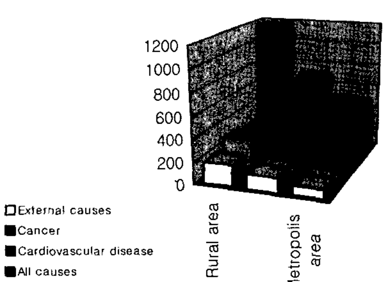

Figure 2. Crude mortality rates of men by geographic location, 1998
(unit: death per 100,000 persons)

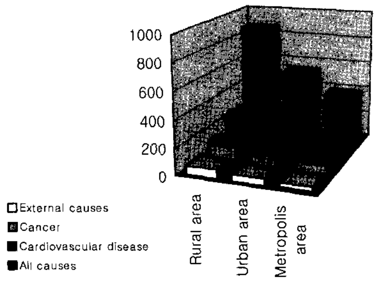

Figure 3. Crude mortality rates of women by geographic location, 1998
(unit: death per 100,000 persons)

were relatively reliable (Gong et al 1983). Considering these facts, we thought that the accuracy of cause of death would not seriously affect our results.

3. Standardized mortality ratio

The SMRs by geographic location are shown in figures 4 to 6. All kinds of death except from cardiovascular disease and cancer in women, showed a decreasing tendency for SMR in the movement from rural to metropolis region. This decreasing tendency was more prominent in men and there was a most significant difference between geographic locations in the case of death from external causes. In the deaths from cancer in women, on the contrary, the rural region had the lowest SMR.

A relatively similar tendency was also found in other studies (Chung 1991; Han 2001) although few previous studies have examined the regional mortality distribution in Korea. Chung (1991) reported the all-cause SMRs of "Si-Gun-Gu's using the data of 1985, and presented lower mortality ratios in the Capital area and higher mortality ratios in the rural areas of Jeonla and Gyeongsang provinces. Han (2001) reported SMRs of province level from five major causes of death in 1980, 1985, 1990, 1995, and 1999, so it was impossible to compare SMRs for each cause of death directly because in our study the data were calculated at the city and county levels. The data released by Korean statistical office (Korean Statistical Office 2000; 1999; 1998) also showed that the city area tended to have higher health status than the rural area.

4. Multivariate analysis

The results from Poisson regression analysis are shown in table 3 and figures 7-9. In model 1, which contains only the geographic location variable as the independent variable, all kinds of risk ratios for death increased significantly as the region moved to urban and rural regions, compared to baseline levels of metropolis. When the elderly percentages were added to the regression model in addition to the geographic location, the differences of risk ratios between geographic locations decreased, or even reversed, but the death from external causes still showed significant differences of death risk between geographic locations. In the final model, we included "the number of privately owned cars per 100 persons" and "per capital production from manufacturing industries", in addition to the variables included in model 2, after comparing the difference of deviance or log likelihood and its statistical significance for each model. The risk ratios for death from all causes significantly increased in both urban and rural regions, except for rural women. The risk of the rural region was slightly lower (OR=1.100) than that of the urban region (OR=1.111), but when we stratified by gender the men in the rural region showed a higher risk (OR=1.180) than the men in the urban region (OR=1.151). For cardiovascular disease, only women in the urban region showed a significant increase of risk (OR=1.062), and for cancer, rural women showed a significant decrease of risk (OR= 0.887), both compared to metropolis women. In the case of deaths from external causes, the risk ratios significantly increased in both urban and rural regions and the increasing tendency from metropolis to rural region was clearly observed in both sexes.

Although the differentiation between city and rural area is somewhat arbitrary, most of the foreign studies, mainly conducted in European countries, of the difference of health status between city and rural area have shown that the health status of the rural region is better than that of the urban region (Britton et al 1990; Carstairs and Morris 1991; Fox and Goldblatt 1982), while some studies

(Bentham 1984) have reported that the residents of outer cities or rural towns had the highest health status and the residents of deep rural or inner cities the lowest. Senior et al (2000) reported that when the geographic location was subdivided into more detail, such as deep rural, rural, rural town, small town, large town, and city, it was the deep rural and city which showed the highest health status, and the small and large towns which showed the lowest health status. Summarizing these results, the relationship between health status and urbanization may not seem to be linear (Bentham 1984). Such a nonlinear relationship indicates that the socioeconomic factors affecting the health status of residents operate with different mechanisms or degree according to the geographic locations (Shouls et al 1996). However, little knowledge is presently available about what factors affect the resident's health status and what mechanisms are involved. Curtis and Jones (1998) pointed out that the socioeconomic factors affecting the rural residents' health status could operate either positively or negatively, and that these factors did not show the same effects in all rural areas, so the characteristics of each region and the balance between positive and negative effects should be considered. Perhaps the different findings between existing studies conducted in European countries and several Korean studies, including this one may be due to the difference of this balance and the interactions among such factors. While we categorized all the districts into three (metropolis, urban, rural) categories, the possibility remains that districts with different characteristics and health status were categorized into the same category. Such a misclassification is another possible reason for the different findings between the European and Korean studies. A more precise comparison would have been possible if we had subdivided the districts more specifically with an indicator of urbanization reflecting the Korean sociocultural characteristics.

The mortality difference between regions showed different patterns according to sex, and causes of death. These different patterns give some clues and guidance for future research to elucidate the mechanisms by which the regional difference of health status are generated, and they are a potential base of evidence for future health policy in Korea. For example, if we examine the reason why deaths from external causes occur frequently in a specific rural or urban region, we can formulate, based on a stronger foundation of evidence, regional policy approaches to reduce the mortality from external causes in that region. As mentioned in introduction, such research will have greater value considering the current situation that requires region-specific health policies.

From 1990s, several researchers have been trying to divide the health determinants generating health disparity between geographic locations into two kinds of effects: compositional effect and contextual effect (McIntyre and Ellaway 2000). The former suggests that the disparity of health status between geographic locations is attributable to the difference of individual characteristics. Specifically, the health state of one location is worse than that of other because the people with many predisposing or risk factors for diseases are likely to move to and/or live together in that location. Meanwhile, the contextual effect suggests that the unique social and physical environments of the location itself influence the health status of residents living in the location by a contextual effect itself or by interacting with the compositional effect. That is to say, two people will have different health status if they reside in different places, even though they have the same individual characteristics, including genetic factors, lifestyle, and socioeconomic status. This differentiation has a very important implication for health policy. If the disparity of health status between geographic locations is mainly attributable to individual characteristics (compositional effects), a health policy focused on the individual in the residence should be planned and implemented. On the contrary, if contextual effect plays the key role in the disparity, other more macro approaches to health policy might be needed. Hence, in the future, further studies to differentiate the compositional and contextual effects are needed to clearly elucidate the health disparity mechanisms between geographic locations. It is essential that any policy approaches to reduce these disparities should be based closely and specifically on such research.

It is true that most of the health promotion strategies have focused their efforts on the individual behaviors (compositional effects), but, the idea of contextual effects is not new in the health promotion field (Peltomäki et al 2003; Janer et al 2002). This realization of contextual effects in the process of health promotion may give some meaningful suggestions to the current health promotion strategies. Contemporary health promotion emphasizes a community-based approach, but the evidence form the past 20 years indicates that many community-based programs have had only modest impact (Merzel and Joanna 2003). Although health promotion is usually of the behavior of individuals, the fact is that behaviour at the societal levels can also promote health and health promotion by individuals cannot be understood without an understanding of how the society affect the ability and the willingness of the individual to pursue health promotion (Abelin et al 1987). So, the integration of lifestyle modification, injury control, and environmental enhancement strategies of health promotion

Table 3. Risk ratios for death from selective causes according to geographic location[1]

Cause of death	Sex	Region	Model (1)[2]		Model (2)[3]		Model (3)[4]	
			O.R.	p-value	O.R.	p-value	O.R.	p-value
All causes	Total	Urban	1.315	<.0001	1.105	<.0001	1.111	<.0001
		Rural	2.487	<.0001	1.113	0.0022	1.100	0.0075
	Men	Urban	1.338	<.0001	1.138	<.0001	1.151	<.0001
		Rural	2.594	<.0001	1.197	<.0001	1.180	<.0001
	Women	Urban	1.285	<.0001	1.079	<.0001	1.083	<.0001
		Rural	2.355	<.0001	1.056	0.1099	1.053	0.1551
CVD	Total	Urban	1.242	<.0001	1.033	0.2346	1.049	0.0863
		Rural	2.373	<.0001	1.015	0.7688	1.013	0.7980
	Men	Urban	1.215	<.0001	1.029	0.3668	1.050	0.1207
		Rural	2.367	<.0001	1.072	0.2158	1.069	0.2345
	Women	Urban	1.270	<.0001	1.047	0.1055	1.062	0.0440
		Rural	2.379	<.0001	0.995	0.9233	0.996	0.9338
Cancer	Total	Urban	1.192	<.0001	0.996	0.8264	1.006	0.7700
		Rural	2.154	<.0001	0.939	0.0717	0.942	0.0961
	Men	Urban	1.220	<.0001	1.018	0.4435	1.039	0.1143
		Rural	2.381	<.0001	1.012	0.7718	1.020	0.6393
	Women	Urban	1.145	0.0002	0.984	0.4760	0.988	0.6185
		Rural	1.785	<.0001	0.884	0.0055	0.887	0.0112
External causes	Total	Urban	1.468	<.0001	1.317	<.0001	1.270	<.0001
		Rural	2.494	<.0001	1.481	<.0001	1.344	<.0001
	Men	Urban	1.478	<.0001	1.337	<.0001	1.302	<.0001
		Rural	2.557	<.0001	1.550	<.0001	1.415	<.0001
	Women	Urban	1.437	<.0001	1.293	<.0001	1.242	<.0001
		Rural	2.335	<.0001	1.407	<.0001	1.303	0.0005

1. Results from Poisson regression analysis with metropolis as baseline (O.R.=1.0)
2. Only the variable of geographic location was included in the model
3. "Elderly percent (≥65 years old)" was added to the model (1).
4. "Number of privately owned cars per 100 persons" and "per capita production from manufacturing industries" were added to the model (2).

are substantial (Slokols 1992). Through the incorporation of contextual effects into the health promotion strategies may broaden the strategic scope of health promotion from "strengthening individuals in disadvantaged circumstances" to "strengthening disadvantaged communities", "improving access to essential facilities and services", and "encouraging macro-economic and cultural change" (Picavet 2002). But, further studies to find the specific contextual effects of each geographic region that can be used as a component of the broadened health promotion strategies will be required.

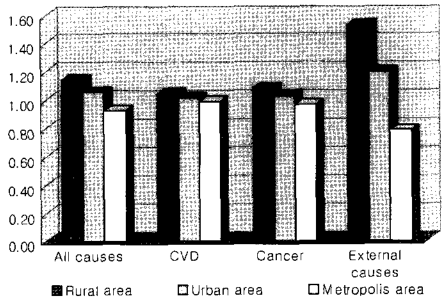

Figure 4. Standardized mortality ratios by geographic location, 1998

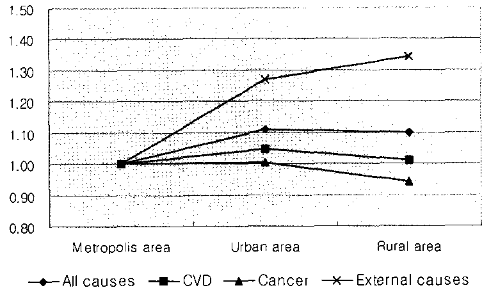

Figure 7. Risk ratios for death from selective causes by geographic location (Model 3)

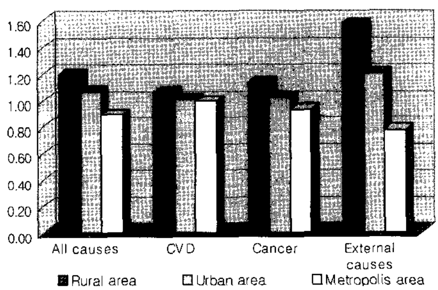

Figure 5. Standardized mortality ratios of men by geographic location, 1998

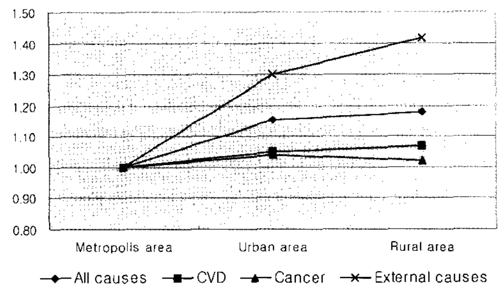

Figure 8. Risk ratios for male death from selective causes by geographic location (Model 3)

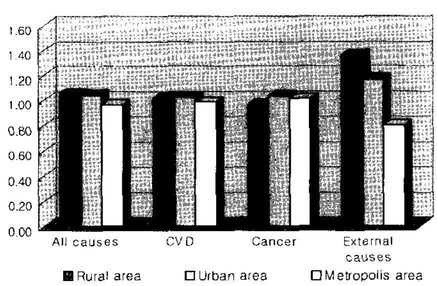

Figure 6. Standardized mortality ratios of women by geographic location, 1998

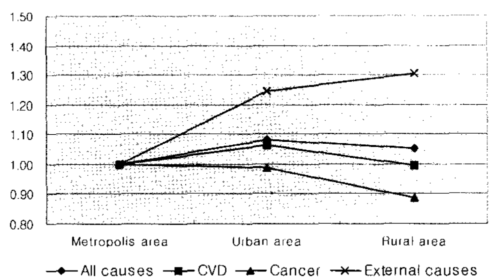

Figure 9. Risk ratios for female death from selective causes by geographic location (Model 3)

Ⅳ. Conclusion

From the above results, the following conclusions were made:

1. There are regional mortality differences according to the geographic location. The metropolis region had the highest health status in terms of mortality for all-cause death.
2. Men in the rural region and women in the urban region had the lowest health status in terms of mortality and there was no significant difference of risk of death between women in rural and metropolis regions for all-cause death.
3. For cardiovascular disease and cancer, significant differences were not found between geographic locations, except an increased risk in urban women for cardiovascular disease and a decreased risk in rural women for cancer, compared to metropolis women.
4. External causes of death may contributes considerably to the increased risk of death for urban and rural regions, especially the latter.
5. Further studies elucidating the causes of these differences and focused on the differentiation of compositional and contextual effects are needed.
6. The incorporation of contextual effects into the current health promotion strategies may broaden the strategic scope of health promotion.
7. Future policy approaches to reduce these mortality differences and to promote health should be considered based on the findings of current and future research.

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ABSTRACT

Objectives: To examine the regional mortality differences in The Republic of Korea according to geographic location.

Methods: All 232 administrative districts of the Republic of Korea in 1998 were studied according to their geographic locations by dividing each district into three categories; "metropolis," "urban," and "rural". Crude mortality rates for doth sexes from total deaths as well as the three major causes of death in Korea (cardiovascular disease, cancer, and external causes) were calculated with raw data from the "1998 report on the causes of death statistics" and resident registration data. Standardized mortality ratios (SMR) were calculated using the indirect standardization method. Poisson regression analyses were performed to examine the effects of geographic locations on the risk of death. To correct for the socioeconomic differences of each region, the percentage of old ($\geq$65 years old) population, the number of privately owned cars per 100 population, and per capita manufacturing production industries were included in the model.

Results: Most SMRs were the lowest in the metropolis and the highest in the rural areas. These differences were more prominent in men and in deaths from external causes. In deaths from cancer in women, the rural region showed the lowest SMR. In Poisson regression analysis after correcting for regional socioeconomic differences, the risk of death from all causes significantly increased in both urban (OR=1.111) and rural (OR=1.100) regions, except for rural women, compared to the metropolis region. In men, the rural region showed higher risk (OR=1.180) than the urban region (OR=1.151). For cardiovascular disease and cancer, significant differences were not found between geographic locations, except in urban women for cardiovascular disease (OR=1.151) and in rural women for cancer (OR=0.887), compared to metropolis women. In deaths from external causes, the risk ratios significantly increased in both urban and rural regions and an increasing tendency from the metropolis to the rural region was clearly observed in both sexes.

Conclusions: Regional mortality differences according to geographic location exist in The Republic of Korea and further research and policy approaches to reduce these differences are needed.

Key words : Mortality, Standardized mortality ratio, Geography, Health policy