

Original Article

Suicide Rate Differences by Sex, Age, and Urbanicity, and Related Regional Factors in Korea

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Objectives: Identify the characteristics related to the suicide rates in rural and urban areas of Korea and discover the factors that influence the suicide rate of the rural and urban areas.

Methods: Using the data on causes of death from 2006 to 2008, the suicide rates were calculated and compared after age-standardization based on gender, age group and urbanicity. And, in order to understand the factors that influence suicide rate, total 10 local characteristics in four domains - public service, social integration, residential environment, and economic status - were selected for multiple regression analysis.

Results: The suicide rates were higher in men than women, in rural areas than urban, and in older people than the younger. Generally, although there were variations according to age group and urbanicity, suicide rates were significantly related to residential environment and regional economic status but not related to regional welfare spending and social integration. In addition, the population over the age of 65 years, only regional economic status has significantly influence on their suicide rates.

Conclusions: The influence of characteristics of regions on suicide rate is various by age-group, gender, and urbanicity. Therefore, in order to lower suicide rate and reduce the gap between regions, various approaches must be adopted by taking into account the socioeconomic characteristics of the regions.

Key words: Suicide, Socioeconomic status, Korea
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INTRODUCTION

Out of all the Organisation for Economic Co-operation and Development OECD countries, the Republic of Korea has the highest suicide rate (28.4 out of 100 000 people, based on 2009 data), and the highest rate of increase in the suicide rate [1]. In particular, suicide was the most frequent cause of death at the population level among the age group with work productivity and who are able to participate in economic activity. Suicide is not only a public health problem, it is also a serious problem in the socioeconomic domain [2].

Given the unusually high suicide rate in Korea, relatively few studies examining the suicide rate in Korea have been performed. Research related to suicide has focused primarily on the national level [3-6] or individual level [7]. However, to understand the high suicide rate in Korea, it is important to understand the characteristics of the local communities in which the subjects of these studies resided. The local communities

where individuals reside affect their quality of health based on the physical environment, access to healthy environments at home and in the workplace, availability of public and private services for the residents, along with the social, economic, and cultural characteristics, and regional ethical rule [8]. Within this context, studies that determine which of these characteristics affect the differences in interregional suicide rates would be a meaningful contribution for addressing the problem. However, there have been very few studies in Korea that have examined suicide rates at the regional level.

It is widely accepted that suicide rates in general are influenced by the degree of urbanization and differ by sex; suicide rates are higher in rural areas than urban areas [6,9,10] and higher among males than females [11-14]. However, studies on suicide rates based on rural and urban areas mostly deal with changes in tendency over time [15], and many studies have been limited to only a few regions [9,10]. In addition, our review of the literature showed that a synthetic multilateral analysis of

Table 1. Age-standardized suicide rates (100 000)¹ by gender, age group, and urbanicity (2006-2008)

Gender	Age group	Mean (95% CI)			p-value
		Overall	Urban	Rural	
Total		23.7 (23.4, 23.9)	24.1 (23.4, 24.9)	30.5 (29.1, 32.0)	<0.001
Men	Total	33.2 (32.8, 33.6)	33.8 (32.6, 35.0)	43.3 (41.2, 45.7)	<0.001
	≤ 19	2.4 (2.1, 2.8)	2.6 (2.3, 2.9)	2.2 (1.4, 3.0)	0.25
	20 - 44	28.2 (27.0, 29.5)	25.3 (24.1, 26.4)	34.0 (31.5, 36.5)	<0.001
	45 - 64	56.3 (54.0, 58.7)	50.2 (48.1, 52.3)	68.3 (63.5, 73.1)	<0.001
	≥ 65	118.0 (112.6, 123.5)	111.6 (106.6, 116.7)	130.5 (118.2, 142.8)	0.002
	p-value for trend	<0.001	<0.001	<0.001	
Women	Total	15.8 (15.5, 16.0)	15.9 (15.4, 16.4)	18.8 (17.2, 20.4)	0.001
	≤ 19	2.3 (2.0, 2.7)	2.2 (1.9, 2.5)	2.5 (1.7, 3.4)	0.35
	20 - 44	19.0 (17.9, 20.0)	17.7 (17.0, 18.3)	21.5 (18.8, 24.2)	0.001
	45 - 64	18.1 (17.0, 19.2)	16.5 (15.5, 17.5)	21.2 (18.7, 23.8)	<0.001
	≥ 65	46.8 (44.2, 49.3)	46.0 (43.3, 48.8)	48.2 (42.9, 53.4)	0.54
	p-value for trend	<0.001	<0.001	<0.001	

CI, confidence interval.

¹ Direct standardization based on the 2005 census population.

the connection between the characteristics of urban and rural areas and suicide rates at the national level has been very rare. Moreover, to our knowledge, no national studies have been performed that have considered both sex and age as factors influencing suicide rates.

In this study we explained the factors that affect the differences in suicide rates among regions by stratifying the data according to urban versus rural residence, sex, and age, and its relationship to the multilateral regional indices. This method was used to narrow the gap in the regional differences in suicide rates, and provided basic data that should inform policies for decreasing the national suicide rate.

METHODS

I. Definition of Suicide and Application of Standardization

This study used 3 years of source data on cause of death from 2006 to 2008 obtained from Statistics Korea. In order to calculate the suicide rate, the sum of the mid-year population of the relevant regions over those three years was used as the denominator, and the number of suicide cases of the relevant regions over those three years was used as the numerator. We calculated the standardized suicide rate according to the direct age standardization method.

II. Classification of Region

To account for separated or merged cities, counties, and boroughs (si, gun, and gu), we divided all the regions of Korea into 248 cities, counties, and boroughs

in order to establish the regions to be used in our study. We classified the counties (gun) as rural areas (86 counties), and the cities (si) and boroughs (gu) as urban areas (162 cities and boroughs). Between the year 2005 and 2008, the regions that had changed administrative districts were the city of Cheonan and Jeju Island. In this study, Jeju Island was divided into the city of Jeju and the city of Seogwipo. The southeastern and northwestern boroughs of the city of Cheonan were merged into one city of Cheonan.

III. Regional Characteristics Variables

In order to calculate the relationship of indices to regional characteristics, we utilized the 2% sample source data and Almanac of District Financial Affairs of 2005 of the Ministry of Public Administration and Security. The regional characteristics were divided into four domains: public service, social integration, residential environment, and economic status. First, for public service we chose the ratio of the social welfare budget used for regional general accounting. Second, the relationship of the indices to social integration was calculated using the single household ratio, female householder ratio, and divorced or separated household ratio. Third, the relationship of the indices to the residential environment were calculated using the poor housing environment household ratio, ratio of households not in an apartment, and the excessively concentrated household ratio. Fourth, the study included economic status by analyzing the ratio of the population whose academic completion was less than high school, the ratio of households that are low income, and the ratio of households that do not own a vehicle [16].

Table 2. Means of the regional characteristics by urbanicity (2005)

Domains	Variables	Mean (95% CI)			p-value
		Overall	Urban	Rural	
Public service	Social welfare budget	16.9 (15.8, 18.0)	20.3 (18.9, 21.7)	10.5 (9.9, 11.1)	<0.001
	Social integration	22.5 (21.7, 23.2)	19.9 (19.1, 20.6)	27.3 (26.2, 28.4)	<0.001
Residential environment	Female householder	23.5 (22.9, 24.1)	22.1 (21.5, 22.7)	26.1 (25.0, 27.2)	<0.001
	Divorced or separated	30.0 (29.0, 31.1)	25.8 (24.9, 26.8)	38.0 (36.5, 39.4)	<0.001
	Poor household	35.3 (31.5, 39.0)	17.3 (14.6, 20.0)	69.2 (65.9, 72.6)	<0.001
	Housing in non-apartment	68.7 (66.0, 71.4)	57.7 (55.1, 60.4)	89.4 (87.0, 91.7)	<0.001
Economic status	Overcrowding	19.2 (18.7, 19.7)	18.8 (18.3, 19.3)	20.1 (18.9, 21.2)	0.046
	Lower education level	54.6 (52.9, 56.4)	46.4 (45.1, 47.8)	70.1 (68.4, 71.7)	<0.001
	Lower social class	71.5 (69.5, 73.4)	63.5 (61.5, 65.5)	86.6 (85.4, 87.8)	<0.001
	No car	48.3 (46.1, 50.5)	38.7 (37.0, 40.4)	66.4 (63.7, 69.1)	<0.001

CI, confidence interval.

IV. Statistical Analysis

A. Actual conditions and regional differences

We classified the subjects according to sex, age, and urban or rural residence, and ANOVA was performed for each group. Furthermore, the statistical significance of the differences between urban and rural areas was confirmed through a t-test.

B. Multiple regression analysis on factors that affect suicide

In order to understand the factors that affect the differences in regional suicide rates, multiple regression analysis was performed, and the subjects were stratified and analyzed according to ages less than 65 years and 65 years or above, urban and rural residence, and male and female. Independent variables were composed of the formerly-mentioned 10 variables concerning regional characteristics of the 4 domains. Before performing the multiple regression analysis, in order to confirm that each independent variable is in a linear relationship with log conversion value, we performed the Pearson correlation analysis for each independent variable and each quadratic term. As a result, we were able to find that each independent variable was in a linear relationship with the standardized suicide rate at a significance level of 0.05.

RESULT

I. Current Suicide Rate and Its Regional Differences

Table 1 shows the differences of suicide rates by sex, lifecycle, and urban versus rural residence. The age-standardized suicide rate was shown to be 23.7 per

100 000 peoples; the male and female rates were 33.2 and 15.8 per 100 000, respectively. The suicide rate had also increased as the subjects increased in age ($p < 0.001$). When comparing urban areas to rural areas, in males aged less than 19, there was no difference between the areas, but in males above 20 years old, the suicide rate in the rural areas was significantly higher than in the urban areas. In the case of females, there were no statistical differences between the aged 19 and below group and the 65 years or above group, but for the age group of those aged 20 to 64, the suicide rate in rural areas was statistically and significantly higher than urban areas.

II. Multiple Regression Analysis of Factors that Affect Suicide

Table 2 shows the average distribution of independent variables used in the regression analysis. From the regional general accounting data, the ratio of the social security budget was shown to be high in urban areas, and variables that showed the characteristics of the rest of the regions were all high in the rural areas ($p < 0.05$).

A. Age below 65

In the case of subjects aged less than 65 years old, the regression model showed an overall 56.1% suicide rate, the males' R square was high at 59.2% and the females' R square was low at 9.7% (Table 3). In terms of region, urban areas showed a very high R square of 60.4%, but rural areas had a very low R square. From all of the independent variables, lower social class, poor housing environment, and housing in a non-apartment had significant associations. In both male and female variables, lower social class was statistically significant. In urban areas for males, lower social class and poor housing environments were statistically significant. In urban areas for females, single household and no car

Table 3. Effects of the regional characters on suicide rates (under 65 years old)

Domains	Variables	Overall			Urban			Rural		
		Total	Men	Women	Total	Men	Women	Total	Men	Women
Public service	Social welfare budget	0.101	0.104	0.080	0.121	0.117*	0.098	-0.172	-0.041	-0.249
Social integration	Single household	0.031	-0.051	0.175	0.102	-0.006	0.269*	-0.203	-0.252	0.018
	Female householder	0.156	0.227	-0.045	0.170	0.161	0.212	0.233	0.682	-0.605
Residential environment	Divorced or separated	-0.220	-0.156	-0.274	0.124	0.121	-0.032	-0.033	-0.329	0.484
	Poor house environments	0.327*	0.215	0.408*	0.347**	0.348**	0.135	0.125	0.012	0.234
Economic status	Housing in non-apartment	0.253*	0.219*	0.217	0.071	0.012	0.181	0.236	0.356	-0.056
	Overcrowding	-0.046	-0.023	-0.091	-0.080	-0.069	-0.098	-0.044	0.014	-0.116
Adjusted R square	Lower education level	-0.031	0.046	-0.334	-0.257	-0.225	-0.261	0.347	0.633	-0.218
	Lower social class	0.530***	0.579***	0.311	0.550***	0.590***	0.354	0.015	-0.179	0.193
	No car	-0.148	-0.156	-0.082	-0.139	-0.006	-0.360*	-0.545	-0.634	-0.175
Adjusted R square		0.561	0.592	0.097	0.604	0.656	0.157	-0.002	0.025	0.018

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4. Effects of the regional characters on suicide rates (65 years old or more)

Domains	Variables	Overall			Urban			Rural		
		Total	Men	Women	Total	Men	Women	Total	Men	Women
Public service	Social welfare budget	0.031	0.067	-0.003	0.047	0.093	-0.007	-0.044	-0.076	0.045
Social integration	Single household	-0.187	-0.204	-0.164	-0.038	-0.090	0.021	-0.371	-0.300	-0.403
	Female householder	-0.152	-0.091	-0.030	-0.313*	-0.169	-0.321	-0.008	-0.046	0.226
Residential environment	Divorced or separated	-0.299	-0.126	-0.332	-0.243	-0.219	-0.162	0.049	0.293	-0.187
	Poor house environments	0.236	0.402*	-0.128	0.142	0.123	-0.018	0.092	0.188	-0.044
Economic status	Housing in non-apartment	0.215	0.124	0.199	0.013	-0.084	0.117	0.288	0.340	0.064
	Overcrowding	-0.093	-0.013	-0.152*	0.072	0.115	0.028	-0.225*	-0.126	-0.279**
Adjusted R square	Lower education level	0.087	-0.250	0.590*	0.295	0.153	0.545*	0.292	0.026	0.714*
	Lower social class	0.540***	0.655***	0.236	0.250	0.444**	-0.081	0.416	0.463*	0.303
	No car	-0.424***	-0.409***	-0.482**	-0.001	0.006	-0.135	-1.104**	-1.215**	-0.910*
Adjusted R square		0.260	0.221	0.169	0.296	0.269	0.238	0.306	0.266	0.176

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

were statistically significant. In the rural areas both males and females did not have statistically significant variables.

B. Age group 65 or above

In a multiple regression analysis based on the subjects who were in the 65 and above age group, the total model R square was 0.260, males were 0.221, and females were 0.169. The R square of urban areas was 0.296, and the R square of rural areas was 0.306. Compared to the below 65 age group, the R square of males and urban areas was lower, whereas, R square of females and rural areas that showed an increase (Table 4). Overall, there was a very strongly positive association with the lower social class, and there was a very strongly negative association with the no car variable. Males were statistically significant in the lower social class, no car, and poor housing environment variables, whereas, females were statistically significant in overcrowding, lower education level, and no car variables. In the urban areas, in case of males, lower social class was statistically significant, whereas, for urban areas and females, lower education level was statistically

significant. For the rural areas and males group, lower social class and no car were statistically significant. Finally, for the urban areas and females group, overcrowding, lower social class, and no car were statistically significant.

DISCUSSION

This is an ecological study on the factors that affect suicide rates based on the regional level, especially urban versus rural areas. However, due to the ecological fallacy, the characteristics of the relevant region's residents can be different from those of the victims of suicide. A limitation of this study was that the individual characteristics of victims of suicide were not analyzed. Nevertheless, because ecological studies have assisted in confirming the regions that need the public health support, and the studies are useful for influencing public health policies or plans [17,18]. Moreover, as we segmented the regions, the ecological fallacy showed a tendency to decrease [19], and this method is appropriate for understanding the effects of regional unit factors on

suicide [20].

Through this study, rather than seeing regional factors that showed coherent relevance to the suicide rate of regions, we were able to confirm that the suicide rate can be considerably different according to urban or rural areas, and to sex. The suicide rates for males is more than twice as high than for females [12,20-22]. Even in this study, the male suicide rate was twice as high as the female rate, and for the age group of 45 to 64, there was a three-fold difference. To explain these differences in suicide rates between the sexes, Suh [3] stated that although the suicide attempt rate is higher in females than in males, females tended to attempt suicide for the purpose of demonstration, whereas it has been reported that males attempt suicide with more certain methods. Furthermore, while females have greater resources to defend themselves from psychologically trauma, males receive greater psychological impact due to problems such as unemployment, retirement, and diseases [21,22]. We determined that the male suicide rate is higher than the female rate because there were also cases where the male victims of suicide had negative forms of behavior such as alcoholism, and because access to the instruments used for suicide is easier for males [12,23,24].

After comparing the subjects according to each age groups, the results showed that the suicide rate increased with age, and the suicide rate of those 65 and older was higher than any other age group. This result coincides with the existing studies [6,24,25], which have stated that the factors causing the elderly to commit suicide are due to physical diseases, being bereft of one's spouse, lack of income, and decrease in social activities, all of which are common in old age [26,27]. When comparing suicide rates in the age groups older than 20 in the rural and urban areas, every combination of age group and sex showed significance significantly higher rate in all rural areas except for the female group in 65 years or above. In discussing the reasons for the differences in suicide rates in rural and urban areas, Park et al. [28] stated that suicides using pesticides is the second most frequent method, especially because pesticides are poisonous and are easily accessible. Kim et al. [7] further claimed that because rural areas consist of an older population than urban areas, even when the age was standardized, the suicide rate in rural areas was higher. In addition, the fact that people have a bias against visiting psychiatric clinics for psychological symptoms such as depression is a problem, and the fact that there is a lack of awareness of psychological diseases can also be another reason the suicide rate of rural areas is higher [29]. Rural areas, lack

emergency medical facilities and those that exist are difficult to access for many people, and it is predicted that these reasons can also play a role in raising the suicide rate in rural areas; thus, future research is required.

According to the regression analysis, after having examined the relationship between the regional characteristics index and suicide rate, we found that the correlation between a region's social welfare expenditure level and the suicide rate was low. However, a study in the U.S. found that social welfare expenditures and suicide rates have a negative relationship [30,31]. Compared to the U.S., which is known for strong rural decentralization, Korea's social welfare policy has a very strong centralized authoritarian rule, which led us to assume that the relationship between the suicide rate and region's social welfare expenditures was not very significant. Park et al. [6] stated that, in comparison between countries, although social welfare expenditure level does not affect the absolute suicide rate, it does decrease the growth rate of suicide. In case of Korea, this implies that rather than regional level social welfare policies, national level policies can be more effective in decreasing the suicide rate, and it also implies that by consistently investing in social welfare policies, one can decrease the growth rate of suicide. Even then, the organization that actually carries out these social welfare policies is the local government; therefore, the role of local government cannot be overlooked.

Social integration has been shown to have a close relationship with suicide through various studies ever since Durkheim first suggested it [13,14,29,32], and, in general, those with a spouse shows low suicide rate compared to people who live alone because they are single, divorced, or bereaved [13,14,32]. However, this study showed that none of the three variables that measure social integration are related to the suicide rate. This demonstrates that the substitute index of social integration is inadequate or that factors such as social solidarity and so on that were not part of this study played a larger role in the suicide rate, all of which are parts that should be considered in future research.

It was shown that the residential environment and economic status of a region causes a clear effect overall, and showed a difference according to age group and regional differences.

Looking at the population under 65 years old, poor housing environment and lower social class had major effects on the suicide rate in urban areas, but they did not have any relevance to the suicide rate in rural areas. This phenomenon can be explained related to relative

deprivation. Currently, in Korea, compared to rural areas where the difference in the living environment is relatively low, the urban areas possess a huge difference in the living environment between the needy and the wealthy upper class, and there is growing anxiety regarding housing [33]. In this study, the fact that poor housing environment and lower social class showed a strong relationship with the suicide rate strongly implies that slum areas in the city or poverty-stricken areas where the living environment is poor and where lower class people are concentrated are where the suicide rate is high. Considering this point, we presume that when developing an intervention program for prevention of suicide for urban populations, focusing first on an area with many poor urban people will hugely contribute to lowering the suicide rate. Studies done by Rezaeian et al. [19] and Rehkoep et al. [34] support this point.

Overall, females less than 65 years old showed significantly low R square compared to males, and according to research on characteristics of adult suicide [35], suicide of adult males has to do with financial problems, and of females is highly related to psychological problems such as depression. However, in this study, because it did not take into account individual factors such as psychological problems, the R square could have been low. There needs to be further research on this point.

In populations 65 years and above, it appeared that the effect of the living environment disappeared and only the economic standard caused a significant effect on the suicide rate, and this is demonstrated to be similar in both urban and rural areas. In particular, there was almost no difference in regression model R square between urban and rural areas, and there was a relatively high R square even in females. This implies that, in order to reduce the suicide rate of the elderly population in Korea, economic support countermeasures that would solve the older population's poverty problem requires greater attention than any other serious problem.

To summarize thus far, there were differences in suicide rates between urban and rural areas, males and females, and between groups less than 65 years old and those 65 years and above, but all these findings could be condensed into one generalization--that the regional residential environment and economic status have significant impacts on the regional suicide rate. In other words, policies that reduce the regional economic status gap can also lead to an overall decrease in the suicide rate. Nevertheless, in populations less than 65 years old, there was a very low R square of regression model, and

this demonstrates that follow-up studies will be required considering other regional characteristics that could not be considered in this study.

Such are the limitations of this study. First, the regional classification standard of this research lacks the quality needed to apply the distinction of urban versus rural areas. For example, in cities that are made up of urban-rural areas, the characteristics of both urban and rural areas are consolidated, but it is classified as a city in this research. However, the regional classification code that would enable us to overcome the abovementioned problem was not provided by Statistics Korea. Second, this study obtained suicide rate data according to the city, county, or borough (si, gun, or gu) using cause of mortality source data provided by Statistics Korea. However, there have been criticisms that out of the fact that the suicide statistical data presented by Statistics Korea is different from the suicide statistical data distributed by the National Police Agency. In particular, having systematic errors, not random errors, from the suicide statistics data of either urban areas or rural areas could have had an impact on this study's results. Third, this study was not able to consider factors like the region's social bond, network, mental disease (such as depression) prevalence rate, or accessibility of medical services (such as psychological counseling or emergency medical aid) that can impact the suicide rate. In particular, the fact that these factors were not included in the source data of this research could be the reason why there is higher R square of the regression model in rural areas than urban, and more in females than males.

Despite these limitations, we were able to confirm that a region's living environment, economic standard, and so on, have significant effects on the regional suicide rate, and we were able to see that these effects are demonstrated differently according to sex, age, and rural versus urban residence. Therefore, in order to alleviate the high suicide rate in Korea and to reduce regional differences, multilateral intervention countermeasures that consider characteristics related to urban versus rural residence, sex, and age need to be prepared. Specifically, a suicide prevention campaign (based on regions concentrated with poverty-stricken classes) should be effective for the reduction of suicide in the non-elderly population in urban areas, and economic support among the elderly population should be helpful in reduction of their suicide rate. In conclusion, future research needs to include individual-level variables that were not included in this research, and comprehensive analysis that considers factors mentioned as the limitations.

CONFLICT OF INTEREST

The authors have no conflicts of interest with the material presented in this paper.

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