Trends in Educational Differentials in Suicide Mortality between 1993 - 2006 in Korea

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Purpose: This study aims to examine how inequalities in suicide by education changed during and after macroeconomic restructuring following the economic crisis of 1997 in South Korea. **Materials and Methods**: Using Korea's 1995, 2000, and 2005 census data aggregately linked to mortality data (1993 - 2006), relative and absolute differentials in suicide mortality by education were calculated by gender and age among Korean population aged 35 and over. **Results**: Average annual suicide mortality rates have steadily increased from 1993 - 1997 to 2003 - 2006 in almost all sociodemographic groups stratified by gender, age, and education. Based on the relative index of inequality (RII) and slope index of inequality (SII), educational differentials in suicide mortality generally increased over time in men and women aged 45 years +. Although RII did not increase with year among men and women aged 35 - 44 years, SII showed a significantly increasing trend in this age group. **Conclusion**: These worsening absolute inequalities in suicide mortality indicate that the governmental suicide prevention policy should be directed toward socially disadvantaged groups of the Korean population.

Key Words : Korea, socioeconomic factors, suicide, trends

INTRODUCTION

South Korea underwent a major economic structural reform after the financial crisis of late 1997, including market oriented restructuring in financial and corporative sectors and the enhancement of labor flexibility.[1,2] Although these neo-liberal structural reforms under the stewardship of the International Monetary Fund (IMF) were reported to be somewhat successful in terms of economic recovery, worsening socioeconomic inequality has been associated with these structural reforms.[3-5] The relative poverty rates (the proportion of households below the 50% median disposable income threshold) among urban households increased from 8.8 - 8.9% in 1996 - 1997 to 11.7 - 12.4% in 1998 - 1999, and remained 12.3 - 12.8% in 2004 - 2006.[6] The Gini coefficient for disposable income of urban households showed a trend similar to the relative poverty rate.[6]

Abrupt socioeconomic changes are known to be associated with upsurge in suicide mortality. For example, when Russia experienced huge socioeconomic changes due to the collapse of the Soviet Union in 1991 and the recent economic crisis in 1998, suicide mortality increased while life expectancy at birth declined.[7-9] Economic recession with rising rates of unemployment was associated with an

increase in suicide mortality in previous studies of US,[10] Japan,[11] German,[12] and Canada,[13] and Australia[14] although this was not true in Finland.[15] In Korea, several studies have reported that suicide mortality surged with the economic crisis of 1997.[16-18]

As seen in Fig. 1, on year by year, Korean suicide mortality rates have steadily increased in a nonlinear pattern in the study period (1993 to 2006). For both genders, interesting features of the trends of suicide mortality rates are that the rates surged in 1998 and rose again with a rapid pace after August 2001 when the redemption of all rescue loans from the IMF was completed and the Korean government declared the end of the economic crisis. As shown in Fig. 1, the features for both genders may result in the linear increasing pattern of average annual suicide rates of those periods: 1993 - 1997 (pre-economic crisis), 1998 - 2002 (economic crisis), 2003 - 2006 (post-economic crisis). According to Organization for Economic Co-operation and Development health data[19] on age-standardized suicide rates in 2006, suicide rates in Korea ranked the highest among the Organization for Economic Co-operation and Development (OECD) member countries in 2006.[19,20] Increased suicide mortality was reportedly observed in a low socioeconomic status (SES), measured by education attainment, occupational class, or material resources such as assets and household income.[21,22] Several studies conducted in Korea showed this inverse relationship between SES and suicide mortality,[23-27] and a previous study showed that relative inequalities in suicide mortality by area-based socioeconomic position (SEP) increased with the economic crisis in Korea.[28] However, these earlier Korean studies investigated relative aspects of socioeconomic inequalities in suicide mortality (i.e. risk ratio), but did not include absolute perspective of socioeconomic inequalities (i.e., risk difference). Except for a study,[28] time trends in socioeconomic differentials in suicide mortality have not been examined. In addition, these previous Korean studies did not include more recent patterns in suicide mortality. The aim of this study was to examine secular trends in relative and absolute socioeconomic differentials in suicide mortality during a relatively longer period (1993 - 2006), including before and after the recent economic crisis in Korea.

MATERIALS AND METHODS

Data sources and study subjects

The study period (1993 - 2006) was divided into three periods: 1993 - 1997 (pre-economic crisis), 1998 - 2002 (economic crisis), and 2003 - 2006 (post-economic crisis). Suicide records were obtained from 1993 - 2006 Death Certificate data of National Statistcal Office (NSO) of Korea.[29] Population denominators for suicide rates during each period were calculated from the 1995, 2000, and 2005 Korean census data. The census population was used as the common denominator in each period including census survey year. We employed an aggregate data matching method to link these suicide records to corresponding census records by the period. The matching variables were gender, age, residence, and education. Age groups were categorized as 35 - 44, 45 - 54, 55 - 64, and 65 +. Residential areas were categorized as city (si), county (gun), and ward (gu), and educational levels were grouped as no education or Elementary (6-years), Middle (3-years) or High (3-years), and College (3-years vocational year and 4-years university) or Graduate School was determined by the highest level of education completed.

The study subjects as a denominator for suicide rate constituted population aged 35 and over at the each census. Adults aged 25 - 34 years were not included due to the small number who did not complete elementary education, which resulted in unstable numbers of suicide deaths in
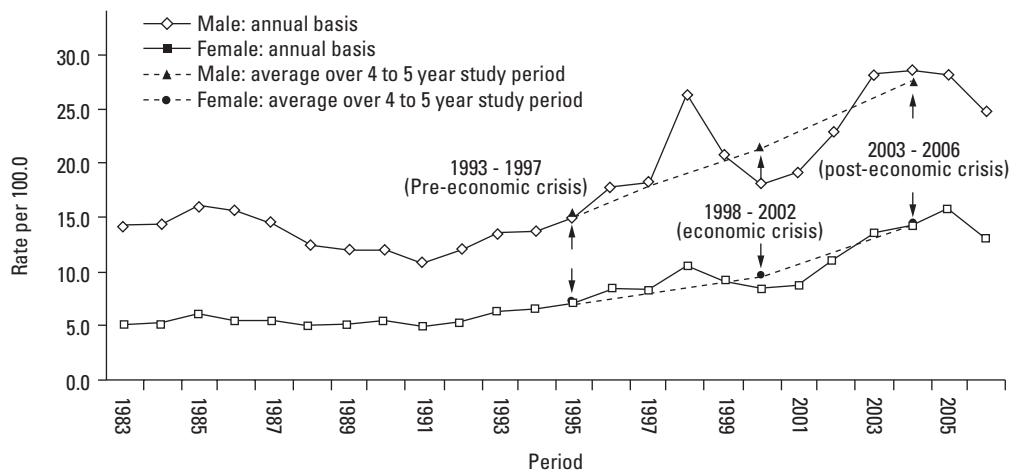

Fig. 1. The secular trends of Korean age standardized suicide rates (using 1995 Census population) in total population by gender during 1983 and 2006.

that group. The census data covered all residents of Korea, and Korean students and workers living abroad at the time of census were excluded in the survey. Foreigners were excluded from this analysis. The rate of refusal to answer education questions was quite low (0.01%, 0.02%, and 0.03% in 1995, 2000, and 2005 census, respectively). Census data are electronically accessible through the Korean Statistical Information System of NSO.[6]

The study subjects as a nominator for suicide rate constituted the deaths, aged 35 years and over, by suicide, which was coded as X60 - X84 (ICD-10) per the 10th revision of the International Classification of Disease (ICD-10) in 1993 - 2006 Death Certificates data. By law, all deaths of Korean must be registered on Death Certificates. The rate of failure to report the decedent's educational attainment on the death certificate was also low (0.27%, 0.18%, and 0.67% in 1993 - 1997, 1998 - 2002, and 2003 - 2006 period, respectively). Death Certificates data are available to the public from NSO. Thus, data were stratified into each combination of gender, age group, regional classification, educational level, and study periods with corresponding counts of suicide death and population.

Measurements and statistical method
Gender-, age- and education-specific suicide mortality rates (100,000 persons) in respective period, 1993 - 1997 (pre-economic crisis), 1998 - 2002 (economic crisis), and 2003 - 2006 (post-economic crisis), are the average annual numbers of suicides divided by the corresponding census population (in millions) within a socio-demographic group in the same period. To measure the magnitude of educational inequalities in suicide mortality, four measures were selected: rate ratio (RR), rate difference (RD), relative index of inequality (RII), and slope index of inequality (SII). Rate ratio and rate difference should be measured for grasping relative and absolute inequalities, respectively.[30,31] Both perspectives are important.[31] Although the rate ratios (relative inequality) of education for suicide mortality rates may remain unchanged or even fall over time, rate differences (absolute inequality) will be more widen the other way under increases in the average suicide mortality rates during the same time. In this case, rate differences may be more meaningful than rate ratios in the perspective of public health.

The RII and SII are measures of total impact that take into account not only the effect of lower education on suicide death, indices of effect such as RR and RD, but also the extent of inequalities in education within the population, e.g. by using information on population size of the groups with lower education. RII is rate ratio (RR) of hypothetically the lowest educated compared with hypothetically the highest educated (reference group) in the

population, assuming a linear association between education and suicide mortality. SII, the absolute measure equivalent to RII, expresses rate difference of hypothetically the lowest educated versus hypothetically the highest educated (reference group). There are two important advantages in using RII and SII. Firstly, because the population distribution of education groups changed over the study period, as shown in Table 1 and 2, the RII and SII will capture the impact of changing distribution of education groups as well as any changing disparities in suicide mortality by actual unit of educational level. Secondly, they are regression-based measures that make use of suicide mortality rate estimates for all three education groups, rather than just comparing two groups, RR and RD.

We used regression models based on Poisson distribution, which made reference to the statistical models for estimating the risk ratio and difference suggested by Leite et al.[32] and Spiegelman and Hertzmark.[33] As shown in equation (1), Poisson regression models using a logarithmic link function were used to compute education-specific rate ratios or RIIs in each study period and investigate association between rate ratio or RII and period. To compute education-specific rate differences or SIIs in each period and investigate association between rate difference or SII and period, Poisson regression models using a identity link function were applied as presented in the equation (2).[32,33] The following general models, stratified by gender and 10-year age group, were specified.

$$(1) \ \ln(d/p) = \beta_1 local + \beta_2 edu + \beta_3 period + \beta_4 edu^*period + \kappa$$
$$(2) \ rate/100{,}000 = \beta_1 local + \beta_2 edu + \beta_3 period + \beta_4 edu^*period + \kappa$$

Where d refers to the number of suicides, p refers to the corresponding denominator population, $\beta_1 \cdots \beta_4$ to the relevant regression coefficients (specified categorically), with κ as the constant. The "local" refers to residential areas categorized as si, gun, and gu residence, and "edu" refers to educational levels - no education or primary school education, middle or high school education, and college education or higher. β_2 in equation (1) represents rate ratio of those with middle or high school education or those with no education or elementary school education compared with those with college or higher education (reference group). β_2 in equation (2) represents rate difference of those with middle or high school education or those with no education or elementary school education vs. those with college or higher education (reference group). The "edu*period" term (β_4 in equations 1 and 2) refers to the interactions between period, 1993 - 1997 (pre-economic crisis), 1998 - 2002 (economic crisis), and 2003 - 2006 (post-

economic crisis), and education, and the statistical significance (*p* for trend) of the corresponding regression term is a test of the divergence or convergence in suicide rates by educational level over periods of the study in relative (rate ratios) and absolute (rate differences) terms

To compute RIIs and SIIs, "*edu*" in equations (1) and (2) was replaced by the mid-point of the cumulative proportion of the population in different educational groups on a scale for 0 to 1, instead of educational level. For example, for the lowest education level, which comprises 10% of the

population, those proportion ranges from 0 to 0.1, the average being 0.05. The hierarchical status of the lowest education group within a demographic population is positioned to be 0.05. The other variables are the same as computing rate ratios and rate differences. Thus, $\beta2$ in equations (1) and (2) is the estimate of RII and SII, respectively, and the *p*-value for $\beta2$ in equations (1) and (2) is the statistical significance (*p* for trend) for a linear association between RII or SII and period, respectively. Analyses were conducted with SAS 9.1 using PROC GENMOD.

Table 1. Number of Mid-Year Population and Average Annual Number of Suicides in Age Groups among Male Persons Aged 35 and over during the Study Period (1993 - 2006)*

	35 - 44			45 - 54			55 - 64			65 +		
	Element-ary or no edu-cation	High or Middle	College or higher	Element-ary or no edu-cation	High or Middle	College or higher	Element-ary or no edu-cation	High or Middle	College or higher	Element-ary or no edu-cation	High or Middle	College or higher
1993 - 1997												
No. of mid-yr pop. (%)	308,861 (8.4)	2,319,210 (63.0)	1,053,338 (28.6)	490,235 (21.4)	1,363,662 (59.6)	435,391 (19.0)	676,591 (42.3)	693,774 (43.3)	230,568 (14.4)	692,326 (71.3)	202,647 (20.9)	75,411 (7.8)
Average annual no. of suicides (%)	245.0 (33.5)	419.0 (57.4)	66.4 (9.1)	254.2 (44.8)	266.8 (47.1)	46.0 (8.1)	231.8 (54.9)	160.4 (38.0)	30.4 (7.2)	288.8 (74.9)	79.6 (20.7)	17.0 (4.4)
Suicide rates per 100,000	79.4	18.1	6.3	51.9	19.6	10.6	34.3	23.1	13.2	41.7	39.3	22.5
1998 - 2002												
No. of mid-yr pop. (%)	229,668 (5.5)	2,385,343 (57.5)	1,530,111 (36.9)	438,080 (16.3)	1,648,723 (61.5)	593,137 (22.1)	619,418 (34.5)	888,857 (49.5)	287,061 (16.0)	780,866 (60.7)	367,160 (28.5)	138,859 (10.8)
Average annual no. of suicides (%)	305.8 (24.9)	763.6 (62.2)	159.0 (12.9)	376.6 (38.5)	523.8 (53.5)	78.8 (8.0)	413.4 (49.1)	362.8 (43.1)	65.4 (7.8)	598.0 (73.1)	184.6 (22.6)	35.6 (4.4)
Suicide rates per 100,000	133.1	32.0	10.4	86.0	31.8	13.3	66.7	40.8	22.8	76.6	50.3.	25.6
2003 - 2006												
No. of mid-yr pop. (%)	100,510 (2.4)	2,083,134 (50.2)	1,964,451 (47.4)	335,406 (9.9)	2,034,956 (60.1)	1,018,094 (30.0)	509,035 (25.1)	1,131,499 (55.9)	905,199 (19.0)	889,627 (51.2)	612,747 (35.3)	233,972 (13.5)
Average annual no. of suicides (%)	188.5 (13.0)	961.0 (66.3)	300.3 (20.7)	455.3 (28.8)	953.0 (60.3)	173.0 (10.9)	585.3 (44.8)	609.5 (46.7)	111.3 (8.5)	984.4 (64.9)	439.4 (28.9)	94.0 (6.2)
Suicide rates per 100,000	187.5	46.1	15.3	135.7	46.8	17.0	115.0	53.9	29.0	138.3	89.6	50.2

* Percentages are row percentages.

RESULTS

As shown in Tables 1 and 2, education levels for both genders increased remarkably by age cohort, demonstrating profound social changes that occurred in the last 50 years. According to the 1995 census, while 42.3% of males aged 55 - 64 (born in 1931 - 1940) had elementary school or less education, only 8.4% of males aged 35 - 44 (born in 1951 - 1960) had no education or elementary

school education (Table 1). At the same time, for females, the proportion of those having no education or elementary school education was 76.9% among those aged 55 - 64, but decreased to 16.2% among females aged 35 - 44 (Table 2). Additionally, education levels for both genders increased rapidly with years within an age band. Among males aged 35 - 44, the proportion with no education or elementary school education decreased from 8.4% in 1995 to 2.4% in 2005. For females, the proportion decreased from 16.2% in 1995 to 3.2% in 2005. These remarkable

Table 2. Number of Mid-Year Population and Average Annual Number of Suicides in Age Groups among Female Persons Aged 35 and Over during the Study Period (1993 - 2006)*

	35 - 44			45 - 54			55 - 64			65 +		
	Element-ary or no edu-cation	High or Middle	College or higher	Element-ary or no edu-cation	High or Middle	College or higher	Element-ary or no edu-cation	High or Middle	College or higher	Element-ary or no edu-cation	High or Middle	College or higher
1993 - 1997												
No. of mid-yr pop. (%)	568,897 (16.2)	2,507,792 (71.2)	444,516 (12.6)	1,031,586 (46.1)	1,062,210 (47.5)	143,341 (6.4)	1,403,299 (76.9)	380,749 (20.9)	41,124 (2.3)	1,549,243 (93.8)	90,402 (5.5)	11,308 (0.7)
Average annual no. of suicides (%)	104.2 (37.9)	150.8 (54.8)	300.3 (7.3)	105.2 (60.4)	61.0 (35.0)	8.0 (4.6)	120.6 (82.8)	22.0 (15.1)	3.0 (2.1)	243.6 (94.8)	12.8 (5.0)	0.6 (0.2)
Suicide rates per 100,000	18.3	6.0	4.5	10.2	5.7	5.6	8.6	5.8	7.3	15.7	14.2	5.3
1998 - 2002												
No. of mid-yr pop. (%)	366,619 (9.1)	2,882,042 (71.4)	786,597 (19.5)	863,537 (33.0)	1,523,500 (58.1)	233,061 (8.9)	1,332,837 (68.0)	533,865 (28.3)	73,879 (3.8)	1,881,938 (90.3)	202,647 (8.7)	75,411 (1.0)
Average annual no. of suicides (%)	120.4 (27.7)	268.4 (61.8)	45.6 (10.5)	134.2 (50.8)	113.4 (42.9)	16.6 (6.3)	189.6 (75.5)	56.8 (22.6)	4.8 (1.9)	530.6 (93.9)	31.6 (5.6)	2.8 (0.5)
Suicide rates per 100,000	32.8	9.3	5.8	15.5	7.4	7.1	14.2	10.3	6.5	28.2	17.5	13.4
2003 - 2006												
No. of mid-yr pop. (%)	132,545 (3.2)	2,648,864 (64.8)	1,306,322 (32.0)	622,746 (18.5)	2,277,638 (67.6)	467,356 (13.9)	1,104,238 (51.5)	895,458 (41.8)	143,214 (6.7)	2,225,757 (84.7)	356,003 (13.5)	47,112 (1.8)
Average annual no. of suicides (%)	88.5 (14.3)	421.5 (68.1)	109.3 (17.6)	190.5 (39.3)	253.5 (52.3)	41.0 (8.5)	251.8 (66.6)	112.8 (29.8)	13.3 (3.5)	895.0 (92.5)	68.6 (7.1)	4.4 (0.5)
Suicide rates per 100,000	66.8	15.9	8.4	30.6	11.1	8.8	22.8	12.6	9.3	50.3	24.1	11.7

* Percentages are row percentages.

changes were found across all age groups and showed a relatively greater improvement in educational attainment in women than men.

As shown in Tables 1 and 2, suicide mortality rates (per 100,000) steadily increased for the study periods in all sub-groups, stratified by gender, age, and education. For females

Table 3. Differentials in Suicide Mortality by Age Group and Educational Level, with 95% Confidence Intervals and *p* Values for Trend during the Study Periods (1993 - 2006), among Males Aged 35 and Over

	Relative	Inequalities	Absolute inequalities (rate per 100,000)			
	RR*	RR[†]	RII[†]	RD[§]	RD[‖]	SII[¶]
	(95%CI)	(95%CI)	(95%CI)	(95%CI)	(95%CI)	(95%CI)
Age 35 - 44						
1993 - 1997	2.76	11.19	22.42	13	71	70
	(2.46 to 3.10)	(9.88 to 12.67)	(19.26 to 26.09)	(7 to 19)	(61 to 82)	(60 to 80)
1998 - 2002	2.95	11.47	21.5	22	121	119
	(2.73 to 3.18)	(10.51 to 12.51)	(19.14 to 24.36)	(14 to 30)	(108 to 132)	(106 to 132)
2003 - 2006	2.92	11.30	14.76	33	170	169
	(2.74 to 3.12)	(10.30 to 12.39)	(13.97 to 15.59)	(23 to 43)	(153 to 186)	(153 to 183)
p for trend**	0.563	0.994	< 0.001	< 0.001	< 0.001	< 0.001
Age 45 - 54						
1993 - 1997	1.80	4.42	6.99	7	37	42
	(1.56 to 2.07)	(3.83 to 5.11)	(5.98 to 8.16)	(1 to 14)	(27 to 46)	(32 to 52)
1998 - 2002	2.30	5.90	9.03	23	73	83
	(2.07 to 2.56)	(5.28 to 6.59)	(8.02 to 10.17)	(15 to 31)	(62 to 85)	(71 to 95)
2003 - 2006	2.70	7.57	12.64	29	115	122
	(2.49 to 2.92)	(6.93 to 8.28)	(11.33 to 14.11)	(20 to 39)	(101 to 129)	(108 to 136)
p for trend**	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Age 54 - 64						
1993 - 1997	1.74	2.54	2.85	11	21	30
	(1.47 to 2.08)	(2.14 to 3.03)	(2.39 to 3.40)	(4 to 18)	(14 to 29)	(19 to 41)
1998 - 2002	1.75	2.78	3.32	17	40	55
	(1.56 to 1.97)	(2.47 to 3.13)	(2.94 to 3.75)	(7 to 26)	(30 to 51)	(40 to 69)
2003 - 2006	1.84	3.92	5.79	23	80	99
	(1.67 to 2.04)	(3.53 to 4.35)	(5.18 to 15.59)	(12 to 33)	(66 to 94)	(83 to 115)
p for trend**	0.53	< 0.001	< 0.001	0.07	< 0.001	< 0.001
Aged 65 & over						
1993 - 1997	1.83	2.23	2.10	15	18	27
	(1.45 to 2.31)	(1.79 to 2.78)	(1.70 to 2.60)	(6 to 23)	(9 to 27)	(10 to 43)
1998 - 2002	2.03	3.36	4.02	21	48	77
	(1.73 to 2.38)	(2.881 to 3.91)	(3.49 to 4.65)	(11 to 31)	(36 to 60)	(57 to 6)
2003 - 2006	1.80	2.83	3.47	31	79	120
	(1.63 to 1.99)	(2.57 to 3.12)	(3.15 to 3.83)	(18 to 45)	(63 to 95)	(96 to 144)
p for trend**	0.778	0.046	0.064	0.06	< 0.001	< 0.001

CI, conficerce interval; RR, relative ratio; RII, relative index of inequality; RD, relative difference; SII, slope index of inequality.
*Rate ratios in those with middle or high school education compared to those with college or higher education, were driven from β_2 estimates (see equation 1).
[†] Rate ratios in those with no education or elementary school education compared to those with college or higher education, were driven from β_2 estimates (see equation 1).
[‡] Relative index of inequality is the relative rate for the expected mortality for the lowest educated compared with the highest educated (see method).
[§] Rate differences between those with middle or high school education and those with college or higher education, were driven from β_2 estimates (see equation 2).
[‖] Rate differences between those with no education or elementary school education and those with college or higher education, were driven from β_2 estimates (see equation 2).
[¶] Slope index of inequality is the expected rate difference of the lowest educated and the highest educated (see method).
**Represents linear increase across the study periods for each age group by inequality index, was driven from the period* edu interaction term (see method).

aged 55 - 64 and 65 +, suicide mortality did not show a linear rise, but the rates were recorded to be greater in 2003 - 2006 than in 1993 - 1997.

As shown in Table 3, significant educational inequalities in suicide mortality were found in males. This was true for age groups, study periods, and inequality measures (relative vs. absolute). However, the magnitude of inequalities differed with age, study periods, and inequality measures.

Table 4. Differentials in Suicide Mortality by Age Group and Educational Level, with 95% Confidence Intervals and *p* Values for Trend during the Study Periods (1993 - 2006), among Females Aged 35 and Over

	Relative	Inequalities	Absolute inequalities (rate per 100,000)			
	RR*	RR[†]	RII[‡]	RD[§]	RD[‖]	SII[¶]
	(95%CI)	(95%CI)	(95%CI)	(95%CI)	(95%CI)	(95%CI)
Age 35-44						
1993 - 1997	1.24	3.26	5.89	1	12	12
	(1.00 to 1.52)	(2.62 to 4.05)	(4.70 to 7.39)	(-3 to 5)	(6 to 17)	(6 to 17)
1998 - 2002	1.50	4.70	7.74	4	27	26
	(1.31 to 1.73)	(4.03 to 5.50)	(6.39 to 9.37)	(-1 to 9)	(19 to 34)	(19 to 33)
2003 - 2006	1.83	7.10	7.53	8	57	53
	(1.64 to 2.03)	(6.15 to 8.19)	(6.20 to 9.14)	(2 to 15)	(47 to 67)	(45 to 63)
p for trend**	0.001	< 0.001	0.130	0.037	< 0.001	< 0.001
Age 45 - 54						
1993 - 1997	0.99	1.58	2.38	1	5	6
	(0.71 to 1.38)	(1.14 to 2.19)	(1.79 to 3.15)	(-3 to 6)	(0 to 9)	(0 to 12)
1998 - 2002	0.98	1.82	3.02	4	9	11
	(0.78 to 1.23)	(1.44 to 2.30)	(2.42 to 3.76)	(-1 to 9)	(4 to 15)	(41 to 18)
2003 - 2006	1.22	3.13	5.65	3	21	22
	(1.03 to 1.43)	(2.64 to 3.72)	(4.69 to 6.81)	(-3 to 8)	(13 to 28)	(15 to 30)
p for trend**	0.142	< 0.001	< 0.001	0.653	< 0.001	< 0.001
Age 54 - 64						
1993 - 1997	0.79	1.16	1.98	-4	-1	3
	(0.46 to 1.36)	(0.69 to 1.94)	(1.33 to 2.94)	(-9 to 1)	(-6 to 5)	(-5 to 10)
1998 - 2002	1.54	2.02	1.90	3	5	6
	(1.02 to 2.34)	(1.34 to 3.04)	(1.46 to 2.48)	(-3 to 9)	(-1 to 11)	(-3 to 15)
2003 - 2006	1.30	2.16	2.95	3	11	15
	(0.98 to 1.72)	(1.64 to 2.86)	(2.36 to 3.67)	(-3 to 9)	(4 to 17)	(6 to 24)
p for trend**	0.256	< 0.05	< 0.05	0.07	< 0.05	0.09
Aged 65 & over						
1993 - 1997	2.72	3.35	1.78	5	5	3
	(0.85 to 8.66)	(1.08 to 10.42)	(1.08 to 2.93)	(-2 to 13)	(-3 to 13)	(-8 to 15)
1998 - 2002	1.31	2.21	2.99	3	11	18
	(0.76 to 2.26)	(1.301 to 3.73)	(0.16 to 4.08)	(-5 to 11)	(2 to 20)	(5 to 32)
2003 - 2006	2.05	4.30	5.05	13	35	56
	(1.33 to 3.15)	(2.82 to 6.53)	(4.07 to 6.28)	(4 to 22)	(26 to 45)	(39 to 72)
p for trend**	0.759	0.109	< 0.001	0.092	< 0.001	< 0.001

CI, confidence interval; RR, relative ratio; RII, relative index of inequality; RD, relative difference; SII, slope index of inequality.
*Rate ratios in those with middle or high school education compared to those with college or higher education, were driven from β_2 estimates (see equation 1).
[†]Rate ratios in those with no education or elementary school education compared to those with college or higher education, were driven from β_2 estimates (see equation 1).
[‡]Relative index of inequality is the relative rate for the expected mortality for the lowest educated compared with the highest educated (see method).
[§]Rate differences between those with middle or high school education and those with college or higher education, were driven from β_2 estimates (see equation 2).
[‖]Rate differences between those with no education or elementary school education and those with college or higher education, were driven from β_2 estimates (see equation 2).
[¶]Slope index of inequality is the expected rate difference of the lowest educated and the highest educated (see method).
**Represents linear increase across the study periods for each age group by inequality index, was deriven from the period* edu interaction term (see method).

First, based on the RII, educational differentials in suicide mortality generally decreased with age. For example, in the 2003 - 2006 period, RIIs for males were 14.76 (95% confidence interval 13.97 to 15.59), 12.64 (11.33 to 14.11), 5.79 (5.18 to 5.59), and 3.47 (3.15 to 3.83) among those aged 35 - 44, 45 - 54, 54 - 64, and 65 + years, respectively. However, this trend with age was not clear in SII. For example, in the same 2003 - 2006 period, SII for males aged 65 + was 120 (96 to 144), whereas SII for males aged 55 - 64 was 99 (83 to 115). Second, educational differentials in suicide mortality increased over time, with the exception of men aged 35 - 44. Among males aged 35 - 44, a rather decreasing trend in RII was observed (*p* for the trend < 0.001). However, in other age groups, increasing trends in relative (RII) and absolute (SII) measures for health inequalities were detected. For example, among men aged 45 - 54, RII was 6.99 (5.98 to 8.16) in 1993 - 1997, but increased to 9.03 (8.02 to 10.17) in 1998 - 2003, and has been subsequently recorded as 12.64 (11.33 to 14.11) in 2003 - 2006. SII for the same age group also showed an increasing trend: 42 per 100,000 (32 to 52) in 1993 - 1997, 83 (71 to 95) in 1998 - 2002, and 122 (108 to 136) in 2003 - 2006. The trends for these two summary measures were statistically significant (all *p* for trend < 0.001). These rising socioeconomic inequalities measured by relative and absolute measures were also clear in men aged 54 - 64. Especially, when the SIIs of 2003 - 2006 were compared with those of 1993 - 1997, absolute inequalities by education in suicide rates among men increased by 1.2 times (*p* for trend < 0.001) in ages 35 - 44, 1.9 times (*p* for trend < 0.001) in ages 45 - 54, 2.3 times (*p* for trend < 0.001) in ages 55 - 64, and 3.4 times (*p* for trend < 0.001) in ages 65 + respectively.

As shown in Table 4, educational differentials in suicide mortality were also found in females. However, the magnitude of educational inequality was smaller in females than males. The relatively weak relationships between education and suicide mortality were found in relative and absolute measures. For example, in those aged 45 - 54, RIIs for women were between 6.99 - 12.64, whereas RIIs for men were between 2.38 - 5.65. With the exception of RII in 2003 - 2006 among those aged 65 +, the magnitude of RIIs was greater in men than women. Additionally, SIIs examined here were greater in men than women without any exception.

In females, the magnitude of education inequalities in suicide mortality also differed with age, study periods and inequality measures. First of all, decreases with age in educational differentials in suicide mortality were found between the ages 35 and 64 for both summary measures (RII and SII), but were not clear among those aged 65 +. For example, in the 2003 - 2006 period, RIIs for females decreased from 7.53 (6.20 to 9.14) in ages 35 - 44 to 5.05 (4.07 to 6.28) in ages 65 +. Similar age-related patterns in RIIs and SIIs were found for different study periods. Second, educational differentials in suicide mortality increased over time as well. This was generally true for RII and SII and true for different age groups. For example, among women aged 45 - 54, RIIs were 2.38 (1.79 to 3.15) in 1993 - 1997 and 3.02 (2.42 to 3.76) in 1998 - 2002, however, increased to 5.65 (4.69 to 6.81) in 2003 - 2006 (*p* for trend < 0.001). SIIs for the same age group also indicate an increasing trend in socioeconomic inequality in suicide: 6 (0 to 12) in 1993 - 1997, 11 (4 to 18) in 1998 - 2002, and 22 (15 to 30) in 2003 - 2006 (*p* for trend < 0.001). Especially, when the SIIs of 2003 - 2006 were compared with those of 1993 - 1997, absolute inequalities by education in suicide rates among women increased by 3.4 times (*p* for trend < 0.001) in ages 35 - 44, 2.6 times in ages 45 - 54 (*p* for trend < 0.001), 4.0 times (*p* for trend = 0.09) in ages 55 - 64, and 17.7 times (*p* for trend < 0.001) in ages 65 +.

DISCUSSION

The results of this study showed that suicide mortality was concentrated in the lower education group. This was true for men and women and true for all age groups and study periods considered in this study. These inequalities in suicide mortality for both men and women were also shown in earlier studies in Korea[23,24] as well as in Japan,[34] US,[35] and Western European countries.[36] The influence of educational attainment on suicide risk may be explained by three different pathways. First, because those with a low educational attainment cannot seek a better job and accumulate material wealth, they may have a greater risk of suicide mortality because of the lower job security and association with poor monetary conditions (e.g., debt).[21,37,38] Second, education might have an independent effect on suicide, irrespective of occupation and income. Khang et al.[39] found that education, occupation, and income have independent effects on mortality in Korea, after simultaneously adjusting for these three major SES indicators. The highly educated are more receptive to health education messages and have a better informational access to health service.[40] This may make them to prevent or control proximal risk factors of suicide death such as alcohol abuse and depression.[41,42] Third, selection and recruitment into education might have an impact. Those with mental disorders and chronic severe illness as a proximal cause of suicide at younger ages might have left school with any qualification and might be less likely to get a chance of further education. This interpretation may be better suitable for educational differentials in suicide among younger

adults. However, this mechanism of social selection may not explain the observed suicide mortality inequalities found in older ages. In addition, the contribution of the selection mechanism to overall magnitude of suicide mortality inequalities would be small, given that education usually precedes health outcome in adults.

Results of this study also showed that educational differentials in suicide mortality, which were measured by RII and SII, generally increased from 1993 - 1998 to 2003 - 2006 among men and women aged 45 +. Although RII did not increase with year among men and women aged 35 - 44, SII showed a significantly increasing trend in this age group during the same time. Why did educational differentials in suicide mortality increased over time? The answer to this question may lie in the fact that the increase in these suicide mortality inequalities was accompanied by worsening gaps in terms of socioeconomic conditions during and after restructuring of Korean economy following the 1997 economic crisis. These worsening socioeconomic factors might modify the secular changes in proximally suicide risk factors (such as depression, alcohol misuse, hopelessness) with differentially affecting lower educational groups. Not mutually exclusive, three explanations may exist for these divergent patterns in suicide mortality by education.

First, the number of credit delinquents increased in 1998 and declined slightly in 1999 and 2000, and the number of those rose again in a rapid pace from 2002 to 2004 - to be called as the credit card crisis in Korea, and fell very slowly thereafter.[43] The sharp increase in credit delinquency since 2002 can largely be attributed to an economic policy that encouraged using credit cards to boost the stagnant economy in 2000 - 2001.[44] The credit delinquency, which caused social problems such as disintegration of family and suicides, happened much more often in low or middle income group than high income group.[43] Second, the increase of job instability (precarious employment) after and during the restructuring of Korean economy following the 1997 economic crisis, which was more likely to be concentrated among the low educated, might have contributed to this widening.[6] The proportion of precarious workers which was about 40% of all wage workers, before the 1997 crisis, reached 57% in after 2000.[45] A previous study in Korea[46] reported that, after adjusting for socioeconomic position (such as education, occupation class, and income), non-standard employment was associated significantly with liver disease, which was probably caused by binge alcohol drinking among men and mental disorders among women. Third, the highly persisting relative poverty rates since the 1997 crisis might have incurred much more frustrating or hopeless feeling to the poor, and in turn these feelings might have increased suicide potentials.[47-49] Third, however, these

interpretations should be considered with some cautions, because another aspects of social context such as culture (e.g., mass media and imitation theory), modernization (e.g., rampant materialism) and social integration (e.g., divorce, religion) which were suggested by Stack[21,22] were not considered in our above explanations. Future studies need to address detailed causal pathways between socioeconomic factors and suicide risks.

This study showed varying magnitude of suicide mortality inequalities by age and gender. The relative inequalities measured by RII tended to be enhanced in the relatively younger age groups, especially among males. This finding is consistent with the fact that relative socioeconomic inequalities in mortality from all causes and many specific causes decrease generally with age.[23] However, it should be noted that absolute inequalities in suicide mortality were not smaller in old ages than younger ages. The greater magnitude of suicide inequality found in men as compared with women is consistent with an earlier Korean study[23] as well as previous Western studies.[29,36,50] Lorant et al.[36] investigated socio-economic inequalities in suicide among 10 Western European countries and suggested that gender differences in the magnitude of suicide inequalities can be explained by gender differences in health-related and life-threatening behaviors, such as alcohol or drug misuse, which are known risk factors of suicide and are more prevalent among men and among lower socioeconomic groups.

There are several methodological considerations in interpreting the present results. It is possible that the number of suicides could have been underestimated because of a social stigma against suicide.[51] Many suicide deaths can be reported as accidental drowning, falls or some other causes.[52] However, whether the magnitude of under-reporting of suicide as a cause of death differs with socioeconomic position is uncertain. Some caution needs to be exercised when interpreting these finding, because they were controlled for the correlate of suicide such urban-rural residence area (si-gun-gu), but not for other correlates (e.g., divorce) in the present study. For example, a previous study[53] showed that the lower educational group has a higher risk of suicide mortality among the non-married (divorced or never married or widowed) than among the formally married in several Western European countries. However, the association between a low education and non-married status in Korea is not certain.

This study presents educational mortality inequalities in suicide and increasing trends in those inequalities. The most interesting finding of this study with regard to suicide preventive strategy, which was not demonstrated in previous Korean studies, would be increasing time trends of socioeconomic inequality in absolute suicide mortality rate.

Comparing the SIIs of the post economic crisis period (2003 - 2006) with those of the pre-economic crisis period (1993 - 1997), absolute inequalities in suicide mortality increased quite steeply among men and women in all age groups, especially those of females aged 65 + increasing by 17.7 times during the same time. These findings suggest that national suicide prevention efforts should be exercised to narrow the socioeconomic gaps in suicide mortality as well as reduce average suicide rate as a whole. From the view point of clinical implications, more attention should be paid to the psychiatric health service for those disadvantaged who suffered from a proximal risk factor of suicide such as depression.

In conclusion, we examined the trends in suicide mortality inequalities using Census and death certificate data, and found increasing educational inequalities in suicide mortality in both relative and absolute perspectives. However, we could not examine the mechanisms involved and the contribution of material, psychosocial, and behavioral factors to the increasing inequalities, because of paucity of the study variables in the Census and death certificate data. Future studies employing those variables may provide information on effective policy measure to decrease the absolute level of suicide mortality and socioeconomic differentials in suicide.

ACKNOWLEDGEMENTS

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