COMPARISON OF THE RISK FACTORS OF KOREAN ADOLESCENT SUICIDE RESIDING IN HIGH SUICIDAL REGIONS VERSUS THOSE IN LOW SUICIDAL REGIONS

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SUMMARY

Background: *The suicide rate of the youth in South Korea has been increasing, and suicide of the youth still has been the most common cause of death since 2007. We aimed to determine the trends and the regional risk factors of youth suicide in South Korea from 2001 to 2010.*

Subjects and Methods: *We used the data from the National Statistical Office to calculate the standardized suicide rates and various regional data including population census, employment, and labor. To calculate the effect of individual risk factors, we used the data from the fourth Korean Youth Risk Behavior Web-based Survey (KYRBWS-VI). Conditional autoregressive model for regional standardized mortality ratio (SMR) using inter-regional spatial information was fitted.*

Results: *Suicide rates of adolescents aged 12 to 18 was from 3.5 per 100,000 people in 2001 and 5.3 per 100,000 in 2010. There were no significant gender difference in suicide rates, however, the number of suicides among adolescents aged 15-18 accounted for four times than those of adolescents ages 12-14. High proportion of late adolescents, higher number of recipients of national basic livelihood, and higher number of adolescents who treated with depression were related to elevated suicide rate of adolescent. Total sleep time of adolescents and regional unemployment rate were negatively associated with the suicide risk of respective regions.*

Conclusions: *Age distribution, economic status, total sleep time, and the number of adolescent patients with depression were different between those in low and in high adolescent suicidal regions in Korea. Our findings suggest that preferential appliance of adolescent suicide prevention program for regions by considering those factors may be important steps to reduce adolescent suicide in Korea.*

Key words: *suicide – adolescent - risk factor – depression - sleep*

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INTRODUCTION

Suicide has been one of the most serious problems globally, while youth suicide rates vary widely from country to country (WHO 2017, Hawton et al. 2012). The suicide rate of individuals 9-24 years of age in South Korea was 7.7 deaths per 100,000 in 2017, which was higher than those in other OECD countries (WHO 2017, Korean National Statistical Office 2019). Youth suicide rates in South Korea have been increasing, especially among female adolescents, while rates among adolescents in other countries are decreasing (Kõlves & De Leo 2016). Suicide among adolescents in South Korea has been reported to be the most common cause of death since 2007 (Statistics Korea 2018).

The risk factors of youth suicide, which were identified by previous studies (Hawton et al. 2013, Jeon et al. 2013, Birmaher et al. 2007), can be categorized into sociodemographic factors, mental health factors and individual factors, and family factors. The risk factors of youth suicide are different from risk factors of adult and elderly suicide. In addition to individual factors such as depression, impulsivity, and low self-esteem, school factors (Yang et al. 2006, Hedeland et al. 2016) including school violence, problems of friendship, and academic stress, as well as family factors (Oprescu et al. 2017, Zainum & Cohen 2017, Sheftall et al. 2016) including family disruption, conflict with parents, and economic difficulties of family members, are known to be important risk factors of youth suicide.

In 2011-2012, a series of suicide events among adolescents in particular provinces of South Korea were reported by the media and, as a result, the entire country has been in shock from serial suicides among students. Student suicide has emerged as a serious social problem. It was required to investigate the presence of any vulnerability or risk factors in the particular areas which might be associated with the increased suicide events so that the government or the mental health organizations could develop and implement effective suicide prevention strategies for the respective region in South Korea.

Previous studies suggest that the regional differences in suicide rates are related to urbanity and regional economic status (Kõlves & De Leo 2016, Rehkopf & Buka 2006, Gartner et al. 2011, Sun et al. 2013, Page et al. 2007, Cha et al. 2014, Cheong et al. 2012, Phillips et al. 2002, Choi & Kim 2015, Levin & Leyland 2005). Some studies (Sun et al. 2013, Page et al. 2007, Levin & Leyland 2005) reported that the risk of suicide was higher in rural areas, but Gartner et al. (2011) reported the association between suicide risk and urbanity was less clear. In Korea, Cheong et al. reported that the suicide rates were higher in rural areas than urban areas, especially among elderly people, and this phenomenon was related to residential environments and regional economic status (Cheong et al. 2012). However, in a previous study that evaluated the trend of the suicide rate among Korean adolescents from 1997 to 2012 according to urbanity, Choi and Kim reported that the trend of suicide among adolescents significantly increased only in the urban area (Choi & Kim 2015). But, these studies did not consider individual-level factors associated with suicide. Still, little is known about the regional differences of suicide and different risk factors of regions between high suicide rates and low suicide rates among adolescents. Therefore, a comprehensive survey on youth suicide in South Korea is needed to plan and develop suicide prevention programs for each region. The aim of this study was to examine the trends of youth suicide and to analyze the differences between suicidal risk factors in high suicidal regions and low suicidal regions of adolescents in South Korea.

SUBJECTS AND METHODS

Definition of suicide and standardization of regional suicide rate

We used mortality data from the National Statistical Office of South Korea (NSO) from 2001 to 2010 (http;//www.kostat.go.kr/), and extracted data for individuals ages 12-18. The Intentional self-harm classification (X60–X84) and the sequel of intentional self-harm (Y870) based on the Korean Standard Classification of Disease-Version 5 (KCD-5) among causes of death were used to define suicide.

In order to identify the standardized suicide rates and to compare the regional standardized suicide rates, standardized mortality ratios (SMR) were calculated with regional observation frequency and ratio of expected degree for regional number of suicides of adolescents. For regional calculations of adolescent suicide rates from 2001 to 2010, we checked the administrative districts of the past 10 years. Final 241 unified administrative districts were included for this study.

We calculated the cumulative suicide rates per 100,000 people from 2001 to 2010. We also selected 25 regions with high SMR (over 90%) and 25 regions with low SMR (below 10%) for analyzing differences between each risk factor of suicide in these two groups.

Risk factors of suicide

We used the regional data from the NSO that was conducted in 2010. This data reflected the available and regional factors as socio-economic factors including the total number of recipients of national basic livelihood, the unemployment rate of people aged 15 and over, the number of single-parent households, and the number of head-of-households with low educational levels. These factors were selected through conducting a literature review and experts consultations on the common risk factors of adolescent suicide.

In addition, we used data from the 2010 annual report of the Korean Neuropsychiatric Association to estimate the number of regional psychiatrists and psychiatric hospitals in the area. We also obtained access to the claim data from the Korean Health Insurance Review & Assessment Service to estimate the number of adolescent patients with depressive disorders in the area. Each data set was recalculated according to regional population and is presented as the number per 100,000 people. The unemployment rates were shown as a percentage of the population.

To identify individual risk factors of suicide, we used the data from the Sixth Korean Youth Risk Behavior Web-based Survey (KYRBWS-VI) conducted in 2010. It is a web-based anonymous self-reported survey for adolescents between September and October 2010 (Korean Centers for Disease Control and Prevention, 2010) using a cross-sectional, stratified, multistage cluster method according to urbanicity, gender, and school type. Through conducting a literature review and consulting with experts we selected variables for analyzing individual risk factors. The Ethics Committee of the National Evidence based Healthcare Collaborating Agency (NECA) South Korea approved the study (NECAIRB12-014).

Statistical analysis

For data arrangement and basic analysis, we used SAS version 9.2 (SAS Institute Inc., Cary, NC, USA). T-tests were used to compare mean differences between socioeconomic risk factors of high SMR regions and low SMR regions. Rao-Scott chi-square tests, adjusted by considering regions and research design of each variable from KYRBW data, were used to explore differences between observed and expected frequencies of high SMR regions and low SMR regions.

To establish a model for prediction of regional SMR of adolescent suicides using inter-regional spatial information, we employed a conditional autoregressive model (CAR) which is a type of Bayesian spatial model using R.2.15.0, WinBUGS 14 software for calculating Hierarchical Bayes estimator of regional risk ratios. As a result of performing correlation analyses between the variables prior to model adjustment, a serious multicollinearity problem is incurred because inter-variable correlation coefficients of each variable from KYRBW

are close to 1. To solve this multi-co-linearity problem, we included sleep duration as risk factor, which was reported to affect adolescent suicides in South Korea23. Regarding the results of SMR model fitness, if a 95% confidence interval did not include 0 and most values were distributed within the sides less than 0, it could be determined that a regression coefficient was significant. And when a 95% confidence interval included 0 and posterior distribution of a regression coefficient was within the sides either more or less than 0, it could be interpreted that the regression coefficient was also significant.

RESULTS

A total of 2,167 adolescents ages 12 to 18 committed suicide from 2001 to 2010 in South Korea, and the cumulative number of suicide of adolescents ages 12 to 18 per 100,000 from 2001 to 2010 was 47.04. Suicide rates of adolescents ages 12 to 18 increased 1.5 times from 2001 to 2010, which was from 3.5 per 100,000 people in 2001 to 5.3 per 100,000 in 2010. Suicide rates of male adolescents were slightly higher than those of female adolescents (47.24 vs. 46.83 per 100,000), however, there were no significant gender difference in suicide rates. Regarding age, the number of suicides among adolescents ages 15-18 accounted for four times the number of suicides among adolescents ages 12-14. Regarding the method of suicide, 53.0% of suicides among Korean adolescents were jumping and, 30.5 % were hanging deaths. Table 1 shows the total number of age- and gender-specific suicide statuses and methods of suicide among Korean adolescents from 2001 to 2010.

The differences of socio-economic risk factors between in high suicidal regions and in low suicidal regions among Korean adolescents are presented in Table 2. In the high SMR regions, there was a significantly higher ratio of adolescents ages 15-18 versus adolescents ages 12-14 and higher number of single-parent households than those in the low SMR regions (respectively, t=4.24, p=0.0001; t=2.42, p=0.0194). There were significantly fewer recipients of national basic livelihood and fewer head-of-households with low educational levels in high SMR regions than those in low SMR regions (respectively, t=-2.27, p=0.0279; t=-2.63, p=0.0115).

Table 1. Age- and gender- specific suicide status and methods of suicide among Korean adolescents from 2001 to 2010

	Cumulative number of suicides	Cumulative number of suicides per 100,000	%
Total Number of Suicides	2167	47.04	
Ages 12-14	404	8.77	18.6
Ages 15-18	1763	38.27	81.4
Gender			
Male	1149	24.94	53.0
Female	1018	22.10	47.0
Methods of suicide			
Jumping from heights	1149	24.94	53.0
Hanging	660	14.33	30.5
Poisoning	203	4.41	9.3
Others	155	3.36	7.2

Table 2. Differences between socio-economic risk factors in high suicidal regions and low suicidal regions among Korean adolescents

| Variable	High suicidal regions Mean (SD)	Low suicidal regions Mean (SD)	t	p
Ratio of population ages 15-18	0.09 (0.01)	0.08 (0.01)	4.24	<0.001
Total number of recipients of national basic livelihood*	4184.5 (1424.0)	5049.1 (1267.0)	-2.27	0.028
Unemployment rates	0.40 (0.05)	0.38 (0.05)	1.43	0.159
Total number of single-parent households *	2583.6 (898.6)	2006.9 (783.0)	2.42	0.019
The number of head-of-households with low educational level*	11212.16 (4924.00)	14687.23 (4415.00)	-2.63	0.012
Number of adolescent patients with depressive disorders*	0.113 (0.018)	0.105 (0.016)	1.85	0.07
Number of psychiatric hospitals*	1.68 (1.25)	1.12 (1.28)	1.54	0.129
Number of psychiatrists	4.33 (5.14)	2.45 (3.84)	1.46	0.151

*number per 100,000 people

The differences between individual risk factors in high suicidal regions and low suicidal regions among Korean adolescents are presented in Table 3. The educational level of adolescents' mothers was significantly higher in the high SMR regions than in the low SMR regions. In addition, more adolescents who had gone on family trips more than once a year and the poor perceived general medical health were significantly higher in the high SMR regions than those in the low SMR regions.

Overall, the results of the conditional autoregression model with regional SMR using inter-regional spatial information based on final selection of risk factors are presented in Table 4 and Figure 1. Being a recipient of national basic livelihood and low unemployment rate predict high regional SMR. And more adolescent patients with depression and less total sleep time of adolescent were related to high regional SMR.

Table 3. Differences between individual factors in high suicidal groups and low suicidal groups using data from 2010 Korean Youth Risk Behavior Web-based Survey (KYRBW)

Variables		High SMR regions		Low SMR regions		P value
		Weighted frequency	%	Weighted frequency	%	
Age	Ages 12-14	182,362	19.68	150,026	16.19	0.479
	Ages 15-18	316,177	34.13	277,937	30.00	
Gender	Male	255,652	27.59	223,313	24.10	0.877
	Female	242,887	26.21	204,649	22.09	
Educational level						
of father	≥ high school graduate	465,414	50.23	401,427	43.33	0.381
	< high school graduate	33,125	3.58	26,536	2.86	
of mother	≥ high school graduate	465,407	50.23	403,766	43.58	0.037
	< high school graduate	33,132	3.58	24,197	2.61	
Perceived general medical health						
	≥ average	460,341	46.69	389,736	42.07	0.011
	< average	38,198	4.12	38,226	4.13	
Lifetime experience of smoking						
	Never smoked	368,717	39.80	320,289	34.57	0.575
	Ever smoked	129,822	14.01	107,674	11.62	
Lifetime experience of alcohol						
	Never used	224,193	24.20	190,366	20.55	0.727
	Ever used	274,346	29.61	237,596	25.64	
Adolescents who had gone on family trips						
	No experience	328,863	35.50	272,315	29.39	0.027
	more than once a year	169,676	18.31	155,647	16.80	

*SMR: standardized mortality ratio
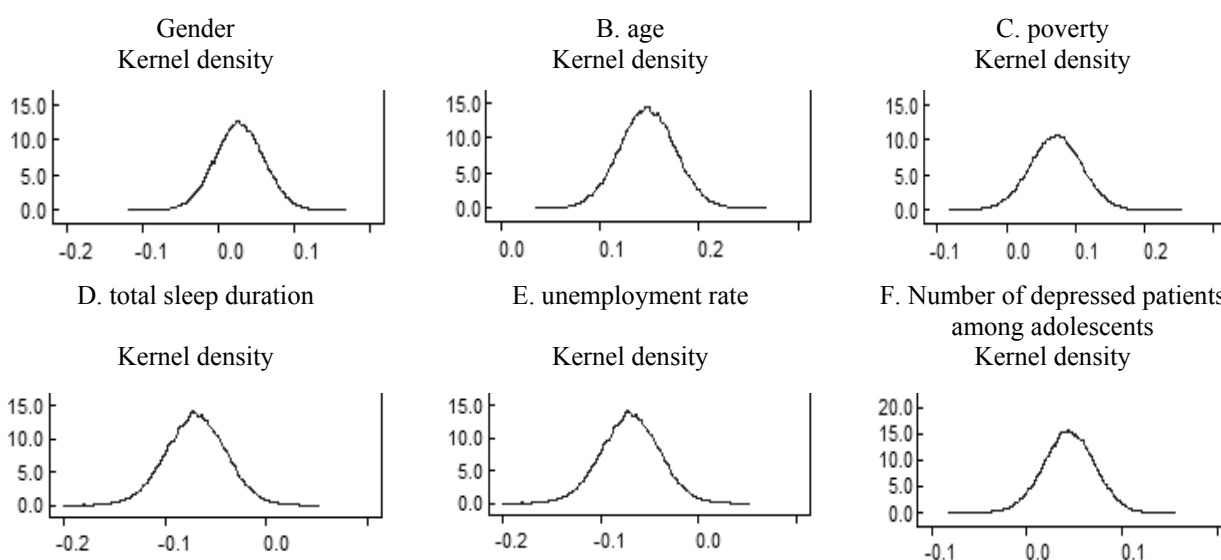
*chains 1:5 sample:50,000

Figure 1. Results of the conditional autoregression model with regional SMR using inter-regional spatial information based on final selection of risk factors

Table 4. Results of the conditional autoregression model with regional SMR using inter-regional spatial information based on final selection of risk factors

	Estimator	95% Confidence Interval
Gender	0.0273	(-0.03565, 0.09029)
Age	0.1278	(0.09227, 0.20280)
Poverty	0.0705	(-0.00367, 0.14370)
Total sleep duration	-0.0693	(-0.12820, -0.0116)
Unemployment rates	-0.1060	(-0.17440, -0.03710)
Numbers of depressed patients among adolescents	0.0442	(-0.00790, 0.09520)

DISCUSSION

We examined the regional SMRs and compared socio-economic and individual risk factors of suicide in high suicidal regions and those in low suicidal regions among Korean adolescents. The trends of adolescent suicide rates varied from country to country, and in general, suicide rates of male adolescents were higher than those of female adolescents and suicide methods among male adolescents were more lethal than those among female adolescents (Kõlves & De Leo 2016, Oprescu et al. 2017, Phillips et al. 2002, Park et al. 2016, Najafi et al. 2013, Redmore et al. 2016, Matthay et al. 2017. Laido et al. 2017). In this study, suicide rates of Korean adolescents increased 1.5 times from 2001 to 2010, and there was no significant gender difference in terms of suicide rates or in method of suicide. In a previous study, Park suggested that both male and female adolescents used similar methods of suicide in South Korea that may be associated with relatively higher suicide rates in female adolescents in Korea than in other countries (Park 2015). In other words, it is possible that the increase in the suicide rate of female adolescents affected the increase in the total suicide rate of adolescents.

In addition to gender similarity, another interesting finding of this study was that adolescents aged 15 -18 years old are at greater risk of suicide than younger adolescents aged 12-14 years old. In our previous study, we found that the peak age of suicide attempts of female adolescents was 13 years old and suicide rates decreased with age, although the prevalence of suicide ideation among adolescents in South Korea changed very little over the course of adolescence (Kang et al. 2015). Though suicide is a rare event in children ages 10-14 years, there is some possibility that high rates of suicidal behavior in female adolescents who are 13 years old may be connected with increasing risk of actual suicide after that age in South Korea. However, further studies are needed to investigate the temporal relevance of suicidal behavior and suicide among adolescents in South Korea.

The poor perceived general medical health among adolescents that was associated with suicidal idea and attempts was also one of the significant regional predictors of adolescent suicide in this study. As far as we know, this is the first report about the relationship between the perceived general medical health of adolescents and regional suicide rates. There were several studies about the correlation between perception of health and suicidal behaviors (Goodwin & Marusic 2011, Koenig et al. 2015, Husky et al. 2012, Barnes et al. 2010). As the result of this study, adolescent whose perceived their general medical health were poor could have more suicidal idea and attempts in high suicide regions than those in low suicide regions, so increasing accessibility to health service for assessing adolescent's general medical health would be important to prevent their suicidal acts.

In this study, we also focused on the issue of mental health service utilization in South Korea. Our results demonstrated that the number of adolescents who were treated for depression predicted elevated risks for regional suicide among adolescents. Several studies have reported low rates of mental health service utilization for suicidal ideation and behavior among adolescents across all racial/ethnic groups (Husky et al. 2012, Nestor et al. 2016, Michelmore & Hindley 2012, Borges et al. 2010). As a recent literature review by Hom et al., the prevalence of help-seeking in youth, which was 40% of older adults with suicide ideation, was only 28.3% of adolescents and young adults with suicide ideation, plans, and/or attempts (Hom et al. 2015). Recently, Lee et al. reported that only 8.8% of participants who reported depression or stress in South Korea had consulted a professional mental health service (Lee 2017). Interestingly enough, we found that the regional number of psychiatrists and the regional number of psychiatric hospitals were not significantly different between high suicidal regions and low suicidal regions, but more adolescents with depressive disorders resided in high suicidal regions. All things considered, Korean adolescents may have a tendency to feel depressed by having a poor perceived general medical health, and they may not seek out mental health specialists voluntarily. It is important to develop a standardized method of screening suicide risk for primary care physicians to detect depression and suicidal behaviors, and thus, to prevent suicide among adolescents. It is also suggested to make a collaborative system for mental health professionals in the consultation of adolescents with high risk of depression and suicide.

We also sought to find the regional differences of socio-economic risk factors associated with adolescent suicide. The region with a higher number of recipients of national basic livelihood was associated with higher risk of suicide. This result was similar to previous studies in the U.S. which reported a negative relationship with social welfare expenditures (Zimmerman 1987, Minoiu & Andres 2008). Recently, Lee et al. also reported in their retrospective cohort study from 2003 to 2013 in South Korea that Medicaid recipients had the highest suicide risk after adjusting for gender, age, and geographic location (Lee et al. 2017).

On the other hand, we found that the regions with lower unemployment rates were associated with higher suicide risk. In our analysis of individual differences between high suicidal regions and low suicidal regions, the results demonstrated that the number of adolescents who had gone on family trips more than once a year and the educational level of adolescents' mothers were significantly higher in high suicidal regions than in low suicidal regions. The association between family trip frequency and suicide was also found in a recent study using a representative sample of Lithuanian adolescents (Zaborskis et al. 2016). Although there are many controversies in socioeconomic risk factors of suicide, Rehkopf and Buka conducted a systematic review in which they found an inverse association between suicide rates and socioeconomic characteristics such as unemployment (Rehkopf & Buka 2006). In South Korea, Cheong et al. reported that regional economic status had significantly influenced the suicide rates of elderly citizens (ages 65 years old and older), but that suicide rates of younger adults and adolescents were unaffected by regional economic status (Cheong et al. 2012).

In terms of adolescent suicide in South Korea, we could interpret these findings as follows: after South Koreans experienced financial crisis in 1997, even including middle and high socio-economic groups, adolescent's and parent's worry about economic collapse of family, the increase in adult suicide rate, and the high correlation between education and economic position seem to contribute to increased suicide rates by increasing emotional overload and stress of adolescents in South Korea (Chang et al. 2009). However, According to Nordt et al., the relative risk of suicide associated with unemployment was elevated by about 20-30% after the 2008 economic crisis in 63 countries (Nordt et al. 2015). Chan et al. investigated the temporal associations of unemployment rates and suicide rates in South Korea from 2003 to 2011 and they reported that national unemployment rates were positively associated with suicide rates (Chan et al. 2014), but not including adolescent suicide rates. So, further extensive studies are needed to clarify the influences of national and regional socio-economic status on adolescent suicide in South Korea.

Finally, total sleep duration of adolescents was also an important predictor of regional adolescent suicide in South Korea. It is well known that sleep problems are associated with an increased risk of mental health problems and suicide risk after controlling for depressive symptoms (Lee et al. 2012a,b, Bernert et al. 2014, Liu 2004). Lee et al. reported that shorter weekday sleep durations ($\leq$7 hours) predicted higher suicidal ideation (Lee et al. 2012b) and Liu X reported that sleeping less than 8 hours at night was significantly associated with increased risk for suicide attempts (Liu 2004). In the results of our autoregressive analysis, total sleep duration less than 4 hours was the predictor of regional adolescent suicide in South Korea. These findings should suggest to government agencies and policymakers to try to build up an environment in which adolescents could sleep sufficiently at least more than 4 hours per night to prevent suicidal behaviors in South Korea.

Our study has some limitations. First, all the results of the analyses could not be included in the report due to the limitations of the currently available data in 2012. However, all data we used in our study were nation-representative data, organized by government, and we tried to consider including both individual risk factors and socio-economic data. Another limitation may be that this study is an ecological study from which no causal inference can be inferred. In this study, the regional differences between high and low SMR regions simply indicate the regional characteristics of high and low regions and do not mean that there is a difference between suicidal rates caused by these risk factors. Thus, we should be cautious of the interpretation of the results.

Despite these limitations, to the best of our knowledge, this study has value in that it is the first report of the regional differences in associations between risk factors among Korean adolescents.

CONCLUSIONS

We found that a high ratio of late adolescent population, a high number of recipients of national basic livelihood, a high number of adolescents treated for depression, sleep deprivation, and low unemployment rate were associated with suicide risk. Regarding the prevention of ever-increasing suicide problems among adolescents, multidisciplinary approaches considering age distribution of the participants, improving socioeconomic and family environments, and mental health including keeping enough sleep hours and proper treatment of depression, should be prepared.

Conflict of interest: *None to declare.*

Contribution of individual authors:

Gyung-Mee Kim: design of the study, literature searches, interpretation of data, first draft, approval of the final version.

Ji-Min Kim: statistical analyses, literature searches, approval of the final version.

Min Kyung Hyun: design of the study, interpretation of data, literature searches, approval of the final version.

Seong Mi Choi: statistical analyses, approval of the final version.

Jong-Min Woo: design of the study, interpretation of data, approval of the final version.

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