

Regional Exposure to Air Pollution and Health Behaviors as a Risk Factor for Suicide Attempt: The Seventh Korean National Health and Nutrition Examination Survey (KNHANES), 2016-2017, Korea Centers for Disease Control and Prevention

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Abstract

Background/Objectives: The purpose of this study is to identify the influencing factors of fine particle concentration level by region and health behaviors on suicide attempts.

Method/Statistical Analysis: This study used the 7th (2016-2017) primitive data disclosed by the National Health Nutrition Examination Survey. Considering the design features of the sample data, it is analyzed with a complex sampling method by reflecting stratas, clusters, and weight. The data were analyzed using logistic regression analysis of the complex samplings using the SPSS/WIN 18.0 program.

Findings: As a result of logistic regression analysis, the provability of suicide attempt was 12.32 times (95% CI 5.33-28.49, $p < .001$) higher in depression diagnosis group, 5.55 times (95% CI 1.87-16.46, $p = .002$) higher in 10 or more drinks in single session group, 2.48 times (95% CI 1.07-5.73, $p = .003$) higher in high perceived stress group, and 0.1 unit increase in Health-related Quality of life ($\beta = -2.35$, $p = .030$) resulted in 0.79 times factor on suicide attempt rate.

Improvements/Applications: This study can provide basic data to develop an intervention program that can reduce suicide attempt rate by analyzing environmental and health related factors affecting suicide attempts.

Keywords: *Air pollution, health behavior, suicide, depression, quality of life.*

Introduction

Korea's suicide rate was 24.3 per 100,000 in 2017^[1] and it is very high compared to 11.58 people per 100,000 population, which is the average suicide rate in OECD countries in 2015, second only to Lithuania^[2]. Suicide is an important indicator of the mental health of the general public and plays an important role in identifying the weaknesses of the nation's mental health system.

Suicide is caused by multiple causes, including various physical, mental, and sociocultural factors. Recently, some studies on environmental factors related to suicide-related behaviors were conducted^[3]. Among the various air pollution materials, ultrafine particle, due to its small size, affects the central nervous system and induces an inflammatory reaction, which is considered to be highly likely to have a neurobehavioral effect^[3]. In addition, when the concentration of fine particle PM10 increased by 1 $\mu\text{g}/\text{m}^3$, the probability of death due to suicide was significantly increased by 1.008 times compared to the probability of death by other factors^[4], and from 2002 to 2013, in the results of a long-term follow-up study of the National Health Insurance Corporation sample cohort data, the risk of suicide by region increased over a long period of air pollution exposure as suicide increased more than 4

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times according to air pollution in the highest level (4th quartile) from the lowest level (1st quartile)^[5]. Therefore, it is necessary to study how environmental factors such as air pollution are related to suicide attempts.¹

Other health behavior factors such as health-related quality of life, perceived stress, depression, and drinking have been reported to be related^[6-9]. It has been reported that the risk of suicidal thought is low when health-related quality of life is good^[6]. Depression is reported as the riskiest factor among suicide-related behaviors^[7-8]. In addition, studies on the relationship between environmental factors and suicide attempts among suicide-related factors have not been conducted. In recent years, the global environmental pollution problem has become serious and the damage to the health is expected, but the result is difficult to predict. Therefore, research on the relevance of health effects such as suicidal behavior of environmental factors is needed. Therefore, by analyzing the relevant data on the fine particle concentration by region of the Ministry of Environment and data from 2016 to 2017 out of the 7th National Health and Nutrition Examination Survey, the aim is to determine the effect of fine particle concentration by region and health behavior on suicide attempts.

Method

Subjects: This study used the 7th (2016-2017) primitive data disclosed by National Health and Nutrition Examination Survey^[9] and the annual air pollution level provided by the Ministry of Environment^[10]. The National Health and Nutrition Examination Survey used a two-stage stratified cluster sampling method, with each sample's enumeration district and household as primary and secondary sampling^[9]. In this study, a total of 16,277 people aged 19 and over were the final subjects for this study.

Instruments:

Suicidal attempt: The suicide attempt was determined by whether or not a suicide attempt was made in the last year^[9].

Regional exposure to air pollution: For the fine particle exposure, the average PM10 (fine particle) concentration data of the year was used for the annual air pollution level of the Air Korea's annual report^[10] on

air quality for the subject's residence area. In this study, the PM10 4th quartile of the year was calculated and analyzed.

Health behavior: Health behavior was measured by health-related quality of life, depression diagnosis, perceived stress, and amount of drinking. Health-related quality of life was measured by EQ-5D is calculated by multiplying each score in five dimensions by weight value, and closer to 1, the higher the health-related quality of life^[9]. Perceived stress is the stress perception rate, and the numerator were the number of respondents who felt stress "less" or "strongly" during their daily life^[9]. Depression diagnosis was measured by whether or not a depression was diagnosed^[9]. The amount of drinking was the average amount of alcohol consumed when drinking^[9].

Data collection: This data was surveyed from January to December 2016-2017^[9] and annual air pollution level change measurement data by region provided by the Ministry of Environment^[10].

Ethical consideration: As of 2015, the National Health and Nutrition Examination Survey conducted the research conducted by the state for public welfare without being reviewed by the Research Ethics Review Committee in accordance with the Bioethics Act and Enforcement Rules^[9].

Data analysis: In order to establish the representativeness of the sample to the population, the complex sampling method was used by reflecting strata, cluster, and weight in consideration of the sample design characteristics of the data^[9]. The data were analyzed using descriptive statistics of the complex sample and logistic regression using the SPSS/WIN 18.0 program.

Result and Discussion

General characteristics of subjects

The suicide attempter's mean health-related quality of life was 0.81 (± 2.69) and the mean health-related quality of life of non-suicide attempter was 0.95 (± 0.001), indicating that the suicide attempter had a low health-related quality of life. There was no significant difference in the proportion of suicide attempts according to the 4th quartile of PM10 concentration of fine particle ($F=0.36$, $p=.972$). The rate of suicide attempt was significantly

different according to depression diagnosis ($F=112.70$, $p<.001$), level of perceived stress ($F=33.19$, $p<.001$), and degree of amount of drinking ($F=18.50$, $p=.005$). Among the general characteristics, there was a significant

difference in the proportion of suicide attempts according to income level ($F=42.79$, $p<.001$) and economic activity ($F=37.94$, $p<.001$) [Table 1].

Table 1. General Characteristics and Difference of Suicidal attempt according to Characteristics N = 16,277

Characteristics	Categories	N	Suicidal attempt		Wald F or Chi-square (p)
			% or M±SD		
			No	Yes	
Age (years)			46.99±0.28	49.7±2.69	1.10(.294)
EQ-5D			0.95±0.001	0.81±0.024	34.06(<.001)
PM10	1Q	2339	99.4	0.6	0.36(.972)
	2Q	1968	99.3	0.7	
	3Q	4599	99.3	0.7	
	4Q	3223	99.3	0.7	
Income	Low	3004	98.5	1.5	42.79(<.001)
	Medium low	3039	99.5	0.5	
	Medium high	3013	99.7	0.3	
	High	3034	99.7	0.3	
Economic activity	No	4653	98.7	1.3	37.94(<.001)
	Yes	6946	99.7	0.3	
Depression diagnosis	No	11126	99.6	0.4	112.70(<.001)
	Yes	521	93.0	7.0	
Perceived stress	Low	8809	99.6	0.4	33.19(<.001)
	High	3306	98.6	1.4	
Amount of drinking (glasses)	Above 10	1081	98.7	1.3	18.50(.005)
	7-9	1250	98.7	1.3	
	5-6	1272	99.4	0.6	
	3-4	1845	99.7	0.3	
	1-2	8741	99.5	0.5	

Factors affecting suicidal attempt of subjects:

To identify exposure to fine particle concentrations and health behavior factors affecting suicide attempts, a logistic regression analysis was performed by adjusting the income level and economic activity, which differ in general characteristics. As a result of the analysis, there was no significant difference in suicide attempt according to the 4th quartile of fine particle concentration (PM10). Among health behaviors, factors affecting suicide

attempts were depression diagnosis ($\beta = 2.51$, $p<.001$), health-related quality of life($\beta = -2.35$, $p=.030$), amount of drinking ($\beta = 1.71$, $p=.002$), and perceived stress ($\beta = 0.91$, $p=.033$). The group diagnosed with depression was 12.32 times more likely (95% CI 5.33-28.49, $p<.001$) to undergo suicide attempt than the group not diagnosed with depression. Compared to the group with low perceived stress, the group with high perceived stress showed 2.48 times more susceptibility (95% CI

1.07-5.73, $p=.003$). In amount of drinking, compared with the group with 1 or 2 drinks, the group with 10 or more drinks was 5.55 times more likely to attempt suicide (95% CI 1.87-16.46, $p=.002$). In health-related quality of life ($\beta = -2.35$, $p=.030$), a 0.1-unit increase

equated to 0.79 times the suicide attempt rate. In other words, the suicide attempt rate increased by 1.11 times as the health-related quality of life decreased by 0.1 units [Table 2].

Table 2. Factors affecting suicidal attempt

Variables	Parameter estimate	OR	95% CI	p
Constant	-6.18			
PM10 (4Q)	-.26	0.76	0.25-2.33	.640
PM10 (3Q)	.72	2.07	0.77-5.55	.147
PM10 (2Q)	-.12	0.88	0.20-3.74	.862
PM10 (1Q)	Ref			
Depression diagnosis (yes)	2.51	12.32	5.33-28.49	<.001
Depression diagnosis (no)	Ref			
Perceived stress (high)	.911	2.48	1.07-5.73	.033
Perceived stress (low)	Ref			
Amount of drinking (Above 10)	1.71	5.55	1.87-16.46	.002
Amount of drinking (7-9)	1.07	2.92	0.94-9.08	.064
Amount of drinking (5-6)	0.42	1.52	0.36-6.32	.558
Amount of drinking (3-4)	-0.10	0.90	0.27-2.99	.864
Amount of drinking (1-2)	Ref			
Health-relatedQuality of life (EQ-5D)	-2.35	0.79	0.63-0.97	.030
Income (low)	1.11	3.03	1.11-8.27	.030
Income (medium low)	.14	1.15	0.36-3.68	.81
Income (medium high)	-.02	0.97	0.23-4.08	.97
Income (high)	Ref			
Economic activity (no)	1.52	4.61	1.92-11.04	.001
Economic activity (yes)	Ref			
Model Wald F=10.39, $p<.001$				

Discussion

In this study, to determine whether air pollution and health behavior affect suicide attempts, the National Health and Nutrition Examination Survey and the Ministry of Environment’s atmospheric environment concentration data were used. In Korea, a policy is in place to establish a national suicide prevention action plan since 2018, to eliminate suicide risk through active intervention and management of suicide, and reduce the suicide rate to 17 by 2022^[11]. Recently, on the basis of the results that systemic inflammatory marker (C-reactive

protein) has been changed due to environmental pollution, that this is related to suicide risk^[12], and in addition to the existing biological and socio-cultural causes, the relationship with environmental pollution as a cause of suicide has been raised. As a result of designing and analyzing the study based on the results of these previous studies, it was found in this study that it does not affect the suicide attempt according to the annual PM10 concentration exposure by region. This is similar to the result that there was no association between PM2.5 and 29,939 suicides in Japan^[13]. However, this is contrary

to the result that there is a correlation between suicide mortality rate and 5 pollutant concentrations during the week, and a reported result of a 3.2% increase in suicide mortality according to weekly PM10 concentration^[14], and the study of suicide deaths in Korea which found that the odds of deaths due to suicide increased 1.008 times as PM 10 concentration increased^[4]. In this study, the annual average observed concentration of fine particle concentration by region was applied, and various factors such as temperature that could affect fine particle concentration were not considered. Therefore, in the next study, it is necessary to make a model for predicting the atmospheric environment for pollutant concentration.

In this study, the factor that had the greatest influence on suicide attempts after adjusting income and economic activity was depression. Post-mortem investigations showed that almost all suicide attempters had mental health problems and high levels of depression^[15]. In a study in Taiwan, the risk of suicidal thought was 15.5 times higher compared to the group without depression^[7]. In this study, the group diagnosed with depression was 12.32 times higher in suicide attempt than the group not diagnosed with depression, which is similar to the results of the previous studies.

The second influencing factor was amount of drinking. In the risk factor analysis of suicide attempters, drinking status was 51.5% during suicide attempt, and drinking was found to be a risk factor affecting suicide attempts^[17]. In this study, people with a large amount of drinking were 5.55 times higher than those with a small amount of drinking^[17]. In a drinking state, it makes it difficult to control the negative emotions of people who have thoughts of suicide, and the ability to judge is also reduced by paralyzing rational thinking. This condition can easily lead to suicide attempts or suicide^[17].

The third influencing factor was perceived stress. Stress is shown to be a major influencing factor in suicide related behavior^[7, 17]. In this study, it was found that a person with a lot of stress is 2.48 times more likely to attempt suicide, and it is similar to the result that stress is a major influencing factor of suicide related behavior^[7], or the result that a person who has a lot of stress thinks suicide 3.5 times more than a person who feels less stress^[17]. People with suicide attempt experiences can lead to suicide related behaviors due to inability to address stress well.

The fourth influencing factor was health related quality of life. The health-related quality of life was 0.95 for those who did not attempt suicide, similar to the results for men and women in their 40s, which was 0.95 and 0.92 for 50s^[18], but suicide attempters were as low as average 0.81. This is because health-related quality of life is negatively correlated with suicidal thoughts^[19] and when health-related quality of life is low, suicidal thoughts are 2.5 times^[17] higher than in the high health-related quality of life group.

As a result of this study, air pollution concentration exposure level, which is an environmental factor among the risk factors of suicide attempt, did not appear as an influencing factor of suicide attempts. There should be contributions to reducing suicide attempts by mediating depression, amount of drinking, perceived stress, and health related quality of life which were found to be health behavior related factors affecting suicide attempts.

Conclusion

Factors influencing suicide attempts were depression, amount of drinking, perceived stress, and health related quality of life. Therefore, a program to mediate these factors should be developed and applied, and repetitive studies should be attempted to confirm the impact of environmental factors on suicide attempts. Therefore, in order to investigate the short-term and long-term effects of air pollution on suicide-related behaviors, a predictive modelling research on air pollution exposure should be conducted, and corresponding research on risk factors should be conducted.

Ethical Clearance: Not required

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Conflict of Interest: Nil

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