

Association between Smoking and Unintentional Injuries among Korean Adults

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Using a cross-sectional representative national survey, we evaluated the relationship between cigarette smoking and unintentional injuries among Korean adults. We used data from the 2009 Korean Community Health Survey. Smoking status was defined as never smokers, ex-smokers, and current smokers. Current smokers were categorized into light daily smokers (1-10 cigarettes/day), moderate daily smokers (11-20 cigarettes/day), or heavy daily smokers (≥ 21 cigarettes/day). We used the Poisson regression model with a robust variance estimation to estimate prevalence rate ratios (PRR) and corresponding 95% confidence interval (95% CI). After adjusting for demographic characteristics, socioeconomic variables, lifestyle variables, and health status variables, former smokers (PRR, 1.19, 95% CI 1.11-1.28), light daily smokers (PRR 1.22, 95% CI 1.13-1.32), moderate daily smokers (PRR 1.33, 95% CI 1.24-1.42), and heavy daily smokers (PRR 1.40, 95% CI 1.25-1.57) had an increased risk for unintentional injuries compared with non-smokers. In conclusion, cigarette smoking is associated with unintentional injuries in a dose-response manner in Korean adults. The findings suggest that community smoking cessation programs may reduce morbidity and mortality from unintentional injuries.

Key Words: Smoking; Health Surveys; Cross-Sectional Studies; Public Health

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INTRODUCTION

Unintentional injuries are a major public health problem worldwide. Unintentional injuries are typically classified according to the means of their occurrence and include road traffic accidents, poisoning, falls, fire, and drowning.¹ According to the World Health Organization, more than 14,000 people experience injuries daily. More than 5 million people die each year from injuries, and about a fifth of them die from unintentional injuries.² In Korea, the number of deaths from injuries in 2012 is lower than in 2010, but still higher than the OECD average.³ Unintentional injuries can affect physical, mental, and social health conditions and can affect quality of life.⁴ Identifying risk factors can help develop a strategy to reduce the burden of unintentional injuries in the population.

Smoking rates in Korea have been steadily declining over the last 20 years, but the smoking rate among men is

still around 40%. Furthermore, the smoking rate of Korean men is the seventh highest among OECD countries.⁵ Smoking is known to be not only associated with chronic diseases such as several types of cancer⁶⁻¹⁰ and cardiovascular disease,^{8,11,12} but also associated with injuries.¹³⁻¹⁶ Some epidemiological studies have reported that smoking is associated with injury and injury death.^{14,17-20} In addition, previous studies on unintentional injuries have mostly been conducted in children groups, and few studies have focused on adults. Furthermore, there has been no attempt to study the association between smoking and unintentional injuries in a large nationally representative sample of Korean adults.

Thus, we aimed to evaluate the relationship between smoking status and unintentional injuries in the adult Korean population. We also examined whether higher levels of smoking were associated with a higher prevalence of unintentional injuries.

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MATERIALS AND METHODS

1. Subjects

This study was conducted on subjects who participated in the 2009 KCHS (Korea Community Health Survey). The KCHS was a nationwide survey to investigate health and disease statistics at the city (Si), county (Gun), and district (Gu) levels since 2008.²¹ A total of 230,715 people participated in the study, and the final analysis included 214,621 people, excluding those who had some missing data.

2. Injury definition

A questionnaire survey was conducted on accidents and poisonings that were treated at medical institutions over the prior 12 months, and were classified into 8 categories according to the cause of the accident: traffic injuries, falls, collisions, stab injuries, burns, poisoning, animal bites and other injuries. Seeing as the focus of this study was unintentional, non-fatal injuries, defined as any injuries that were not deliberately caused by another person., intentional injuries by others was excluded from the analysis.

3. Smoking

Participants were classified as current, former, or non-smokers. Those who smoked less than 100 cigarettes in their lifetime were classified as non-smokers. Current smokers were categorized into the following categories: light daily smokers (1-10 cigarettes/day), moderate daily smokers (11-20 cigarettes/day), or heavy daily smokers (≥ 21 cigarettes/day).

4. Covariates

The height and weight were assessed by self-report and the BMI was defined as the body weight divided by the square of the height. Marital status was classified as married, never married or no spouse (divorced/widowed/separated). Household income was divided into 4 groups according to the average monthly income of household members. Regardless of whether they graduated or not, the level of education was divided into five categories according to the schools attended to the end; elementary school, junior high school, high school, college or higher. Alcohol intake was calculated by determining the weekly drinking amount according to the number of drinks and the amount drunk, and then it was classified into one or more per week or less than one week. Physical activity was categorized as the absence versus presence of vigorous or moderate physical activity more than once per week. Self-rated health was measured on a Likert scale and treated as a dichotomous variable between poor (very bad and bad) and good (fair, good, very good). Hypertension medication, diabetes medication, history of stroke, and history of coronary artery disease were assessed by self-report.

5. Statistical analysis

General characteristics of study participants across smoking status were compared using analysis of variance

for continuous variables and chi-square tests for categorical variables. We used the Poisson regression model with robust variance estimation to estimate prevalence rate ratios and corresponding 95% CIs with sample weights. Trend testing was also conducted to assess a dose-response relationship between the smoking categories. We stratified our analysis by age, sex, BMI, residence area, household income, education levels, alcohol consumption status, exercise and self-rated health. For stratified analysis, continuous variables or those had multiple categories such as age, BMI, household income and education levels were dichotomized. All analyses were performed using software Stata version 14 (StataCorp, College Station, Texas USA). A p -value < 0.05 was regarded as statistically significant.

6. Ethics statement

The study protocol of the KCHS was reviewed and approved by the Institutional Review Board of the Korean Centers for Disease Control and Prevention (2010-02-CON-22-P). All participants provided informed consent.

RESULTS

The characteristics of study participants according to their smoking habits are shown in Table 1. Of the subjects, 62.3% were non-smokers, 13.6% were former smokers, and 24.1% were current smokers. Never smokers were more likely to be women, less likely to be married, less educated, had a lower rate of alcohol consumption, and had a higher rate of exercise. Past smokers had high rates of not only medication for hypertension and diabetes, but also history of stroke and coronary artery disease and poor self-rated health. Current smokers had the highest BMI. Contrary to expectations, there was no difference in the prevalence of coronary artery disease and stroke among smokers according to the current smoking amounts. One reason for this result is that smokers may have quit after the cerebrovascular disease diagnosis.

Unintentional injuries risk increased monotonically with increasing levels of smoking. Compared with non-smokers, former smokers (PRR, 1.30, 95% confidence interval [CI] 1.23 to 1.37), light daily smokers (PRR 1.34, 95% CI 1.25-1.42), moderate daily smokers (PRR 1.47, 95% CI 1.39-1.55), and heavy daily smokers (PRR 1.58, 95% CI 1.42-1.75) had increased risk for unintentional injuries. This association was attenuated after adjusting for confounding variables, but statistically significant remained. PRR were for former smokers (PRR 1.18, 95% CI 1.10-1.26), light daily smokers (PRR 1.22, 95% CI 1.13-1.31), moderate daily smokers (PRR 1.30, 95% CI 1.21-1.40) and heavy daily smokers (PRR 1.36, 95% CI 1.21-1.52), respectively (Table 2).

Table 3 shows the results of the stratified analyses by potential confounders. The association between smoking and unintentional injuries was more evident in younger individuals than in older individuals (p for interaction < 0.001). However, the association was not different by sex, BMI, residence area, household income, education levels, alco-

TABLE 1. General characteristics of subjects according to smoking status

	Never smoker	Past smoker	Current smoker	p for trend	Current smoker (cigarettes per day)			p for trend
					1-10	11-20	≥21	
N	133,622 (62.3)	29,270 (13.6)	51,607 (24.1)		19,983 (38.7)	26,041 (50.5)	5,584 (10.8)	
Sex(male), %	25,992 (19.4)	27,518 (94.0)	47,545 (92.1)	<0.001	17,112 (85.6)	24,976 (95.9)	5,457 (97.7)	<0.001
Age, years	48.8±16.9	55.8±15.2	46.0±16.6	<0.001	45.4±17.0	46.0±13.3	48.0±11.1	<0.001
Body mass index, kg/m ²	22.7±3.0	22.5±2.9	23.3±3.0	<0.001	22.9±3.0	23.4±2.9	23.8±3.1	<0.001
Marital status, %				<0.001				<0.001
Married	21,097 (15.8)	1,891 (6.5)	11,076 (21.5)		5,342 (26.7)	5,074 (19.5)	660 (11.8)	
Never married	87,066 (65.2)	24,066 (82.2)	33,535 (65.0)		11,768 (58.9)	17,697 (68.0)	4,070 (72.9)	
Divorced/widowed/separated	25,459 (19.0)	3,313 (11.3)	6,996 (13.6)		2,873 (14.4)	3,270 (12.6)	853 (15.3)	
Household income (Korean won), %				0.953				<0.001
≤1.00 million	34,498 (25.8)	8,430 (28.8)	11,615 (22.5)		4,968 (24.9)	5,454 (20.9)	1,193 (21.4)	
1.01-2.00 million	31,361 (23.5)	6,719 (23.0)	13,931 (27.0)		5,115 (25.6)	7,214 (27.7)	1,602 (28.7)	
2.01-3.00 million	28,795 (21.5)	5,891 (20.1)	12,064 (23.4)		4,443 (22.2)	6,303 (24.2)	1,318 (23.6)	
≥3.01 million	38,968 (29.2)	8,230 (28.1)	13,997 (27.1)		5,457 (27.3)	7,070 (27.1)	1,470 (26.3)	
Education, %				<0.001				<0.001
Uneducated	17,915 (13.4)	2,625 (9.0)	3,142 (6.1)		1,650 (8.3)	1,196 (4.6)	296 (5.3)	
Elementary	22,835 (17.1)	5,448 (18.6)	6,206 (12.0)		2,293 (11.5)	3,073 (11.8)	840 (15.0)	
Middle school	15,235 (11.4)	4,275 (14.6)	6,523 (12.6)		2,025 (10.1)	3,540 (13.6)	958 (17.2)	
High school	44,712 (33.5)	9,488 (32.4)	21,878 (42.4)		7,924 (39.6)	11,573 (44.4)	2,381 (42.6)	
More than college	32,925 (24.6)	7,434 (25.4)	13,858 (26.8)		6,091 (30.5)	6,659 (25.6)	1,108 (19.8)	
Alcohol intake (≥1 drink/wk), %	38,206 (28.6)	17,443 (59.6)	37,837 (73.3)	<0.001	14,021 (70.2)	19,629 (75.4)	4,187 (75.0)	<0.001
Exercise (no), %	106,395 (79.6)	21,305 (72.8)	38,386 (74.4)	<0.001	15,200 (76.1)	19,164 (73.6)	4,022 (72.0)	<0.001
Self-rated health (bad), %	77,265 (57.8)	17,977 (61.4)	28,115 (54.5)	<0.001	10,475 (52.4)	14,258 (54.7)	3,382 (60.6)	<0.001
Hypertension medication, %	26,195 (19.6)	8,138 (27.8)	7,127 (13.8)	<0.001	2,753 (13.8)	3,499 (13.4)	875 (15.7)	0.029
Diabetes medication, %	8,707 (6.5)	3,193 (10.9)	3,277 (6.3)	<0.001	1,111 (5.56)	1,631 (6.3)	535 (9.6)	<0.001
History of stroke, %	2,370 (1.8)	1,214 (4.1)	718 (1.4)	0.897	320 (1.6)	336 (1.3)	62 (1.1)	0.001
History of coronary heart disease, %	1,217 (0.9)	675 (2.3)	469 (0.9)	<0.001	199 (1.0)	209 (0.8)	61 (1.1)	0.609
Rural residence, %	58,224 (43.6)	13,049 (44.6)	22,105 (42.8)	0.033	7,805 (39.0)	11,420 (43.8)	2,884 (51.7)	<0.001
Unintentional injury, %	5,400 (4.0)	1,538 (5.2)	2,983 (5.8)	<0.001	1,080 (5.4)	1,547 (5.9)	356 (6.4)	0.002

TABLE 2. Prevalence rate ratio for unintentional injuries according to smoking status

Daily cigarette amount	Crude model	Model 1	Model 2	Model 3
Non-smoker	reference	reference	reference	reference
Former smoker	1.30 (1.23-1.37)	1.22 (1.14-1.31)	1.20 (1.12-1.29)	1.19 (1.11-1.28)
Current smoker				
≤10 cigarettes per day	1.34 (1.25-1.42)	1.25 (1.16-1.35)	1.22 (1.14-1.32)	1.22 (1.13-1.32)
11-20 cigarettes per day	1.47 (1.39-1.55)	1.36 (1.27-1.46)	1.33 (1.24-1.42)	1.33 (1.24-1.42)
≥21 cigarettes per day	1.58 (1.42-1.75)	1.44 (1.29-1.61)	1.40 (1.25-1.57)	1.40 (1.25-1.57)
p for trend	<0.001	<0.001	<0.001	<0.001

Data are prevalence rate ratio (95% confidence intervals). Model 1 was adjusted for age, sex, household income, marital status, education and residence type. Model 2 was further adjusted for BMI, drinking and exercise. Model 3 was further adjusted for hypertension, diabetes, history of stroke, history of coronary heart disease and self-rated health.

TABLE 3. Stratified analyses by potential confounders

	Non-smoker	Former smoker	Current smoker (cigarettes per day)			p for interaction
			1-10	11-20	≥21	
Sex						0.687
Men	1.00	1.23 (1.14-1.33)	1.20 (1.11-1.31)	1.31 (1.21-1.41)	1.36 (1.21-1.54)	
Women	1.00	1.23 (1.01-1.50)	1.24 (1.06-1.45)	1.36 (1.07-1.72)	1.88 (1.07-3.32)	
Age						<0.001
19-49	1.00	1.20 (1.08-1.34)	1.29 (1.17-1.42)	1.39 (1.26-1.52)	1.46 (1.26-1.70)	
≥50	1.00	1.17 (1.07-1.29)	1.08 (0.96-1.22)	1.17 (1.05-1.31)	1.23 (1.03-1.47)	
Body mass index						0.742
<25	1.00	1.16 (1.07-1.26)	1.22 (1.12-1.33)	1.30 (1.19-1.41)	1.28 (1.11-1.48)	
≥25	1.00	1.22 (1.07-1.39)	1.17 (1.01-1.36)	1.30 (1.14-1.48)	1.51 (1.24-1.82)	
Residence area						0.068
Rural	1.00	1.16 (1.06-1.28)	1.21 (1.10-1.34)	1.39 (1.27-1.53)	1.39 (1.19-1.63)	
Urban	1.00	1.19 (1.07-1.32)	1.23 (1.09-1.38)	1.19 (1.07-1.33)	1.32 (1.12-1.55)	
Household income						0.200
Low	1.00	1.12 (1.02-1.23)	1.25 (1.13-1.38)	1.26 (1.14-1.39)	1.37 (1.18-1.60)	
High	1.00	1.25 (1.12-1.39)	1.19 (1.06-1.33)	1.36 (1.23-1.51)	1.34 (1.13-1.59)	
Education						0.361
Middle or less	1.00	1.16 (1.04-1.29)	1.14 (1.01-1.30)	1.22 (1.08-1.38)	1.25 (1.04-1.51)	
High or more	1.00	1.18 (1.08-1.30)	1.25 (1.14-1.38)	1.35 (1.24-1.48)	1.44 (1.25-1.67)	
Alcohol consumption						0.665
No	1.00	1.12 (1.01-1.24)	1.15 (1.01-1.30)	1.22 (1.08-1.38)	1.34 (1.08-1.66)	
Yes	1.00	1.25 (1.14-1.38)	1.26 (1.14-1.38)	1.37 (1.25-1.49)	1.41 (1.23-1.62)	
Exercise						0.689
No	1.00	1.21 (1.11-1.31)	1.22 (1.12-1.33)	1.31 (1.20-1.42)	1.40 (1.22-1.60)	
Yes	1.00	1.12 (0.97-1.28)	1.21 (1.04-1.40)	1.30 (1.13-1.49)	1.27 (1.02-1.59)	

hol consumption, or exercise.

DISCUSSION

In this large cross-sectional study of more than 200,000 adults, we examined the association between cigarette smoking and unintentional injuries. The major finding was that cigarette smoking was associated with the risk of unintentional injuries in a dose-response manner. This association persisted after adjusting for demographic characteristics, socioeconomic variables, lifestyle variables, and health status variables. In addition, the association between smoking and unintentional injuries was more evident in younger individuals than in older individuals. To our knowledge, this is the first study to assess the association between smoking habits and unintentional injuries in the general population.

Most studies evaluating the association between smoking habits and unintentional injuries have been conducted in specific groups such as youth, worker or military.²²⁻²⁵ A prospective study of 2,002 US army recruits demonstrated that cigarette smoking in the prior month was significantly associated with injury occurrence during their 8-week basic military training in both sexes.²⁵ In a meta-analysis of 18 studies conducted on military trainees, smoking was significantly associated with a lower-extremity overuse injury, with RR of 1.31 (95% CI 1.26-1.36). The relationship

between smoking and injuries showed a dose-response relationship, with a risk for injuries higher than in non-smokers by 1.27 times for low level smokers, 1.37 times for medium level smokers and 1.71 times for high level smokers.²² However, in a Finnish study of 8,219 adolescents aged 12-18, smoking was a significant risk factor for unintentional injuries in the univariate model, but its association disappeared when other health behaviors were adjusted.²⁶ So far, many studies have evaluated the association between smoking and injury death. In a Taiwan prospective study of 64,319 men, smokers had a significantly increased risk for all injury deaths (RR 1.69, 95% CI 1.39-2.05) compared to nonsmokers.²⁷ In a meta-analysis of four cohort studies showed that current smokers had a significantly higher accidental mortality rate and a relative risk ratio of 1.51 and 1.35 times greater than non-smokers, respectively.¹⁴ A meta-analysis of three randomized controlled trials reported that smoking cessation was borderline significantly associated with reduced unintentional injuries (RR 0.62, 95% CI 0.26-1.50), which might be limited by a relatively small sample size or rare outcomes.¹⁷

Although the underlying mechanism by which smoking contributes to unintended injuries is not yet clear, it can be explained by the following mechanisms. First, carelessness caused by smoking can increase the risk of injury. Distraction due to smoking and blurred vision due to smoke can cause injury.²⁷ In addition, current smokers are more

likely to have a car accident than non-smokers.^{28,29} Second, smoking decreases functions such as muscle strength, agility, and walking balance, increasing the risk of injury or reducing the likelihood of survival.^{13,29} Third, smoking is associated with other risk-taking behaviors, and smokers tend to behave more dangerously than non-smokers. Smokers have lower rates of use of driving safety belts,^{29,30} more traffic violations,³¹ and more drunk driving instances than non-smokers.^{20,32} In this study, we found that former smokers had a higher risk of unintentional injuries than non-smokers. These results suggest that the relationship between smoking and unintentional injuries may be influenced by the weakening of physiological function due to smoking and personal characteristics related to smoking habits, as well as the carelessness caused by smoking. In this study, the association between smoking and unintentional injuries appeared stronger in younger than in older individuals. This seems to be due to the greater tendency of young adults to engage in risk-taking behaviors as compared to older people.³³

The strength of this study is that it has been carried out in a large national representative sample. However, there are limitations. First, because this study is a cross-sectional study, it is difficult to assess the causal relationship between smoking and injury. Second, smoking assessment was based on self-reports and was not verified by other objective measures. In addition, unintentional injuries were reported by self-reports and not verified by medical records. It is possible that non-differential misclassification through self-report has attenuated true association.

In conclusion, cigarette smoking is associated with the risk of unintentional injuries in a dose-response manner. The relationship between smoking and injury is important not only for current smokers but also for nonsmokers who are exposed to environmental hazards such as respiratory diseases, cancer risks, and fires caused by exposure to tobacco smoke. If we reduce smoking rates through effective smoking cessation programs, we expect to reduce the burden of illness caused by injuries.

CONFLICT OF INTEREST STATEMENT

None declared.

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