



Electronic cigarette use among Korean adults

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Abstract

Objectives We investigated the prevalence and correlates of electronic cigarette (e-cigarette) use in a representative sample of Korean adults.

Methods This cross-sectional study used data from the Korean National Health and Nutrition Examination Survey of 2013. We analyzed 5338 subjects (≥ 19 years old) who provided data on e-cigarette use, sex, age, socioeconomic status, and health risk behaviors. Multivariate analyses were performed using logistic regression.

Results Using weighted samples, the prevalence of ever and current e-cigarette use were 6.6 and 1.1 %, respectively (11.2 and 2.0 % in men and 2.0 and 0.4 % in women). In multivariate analysis, the probability of ever e-cigarette use was highest in current smokers (OR 29.3, 95 % CI 15.5–55.3), former smokers (OR 6.1, 95 % CI 3.3–11.2), and daily heavy drinkers (OR 1.9, 95 % CI 1.1–3.4). Current e-cigarette use was associated with current smoking (OR 16.2, 95 % CI 4.7–55.4) and weekly heavy drinking (OR 2.7, 95 % CI 1.1–6.7).

Conclusions E-cigarette use was strongly associated with conventional cigarette use and with frequent heavy drinking. Dual use e-cigarettes and conventional cigarette use as well as the association between heavy alcohol use and e-cigarettes need further exploration.

Keywords Electronic cigarettes · E-cigarettes · Smoking · Heavy drinking

Introduction

The electronic cigarette (e-cigarette), also known as an electronic nicotine delivery system (ENDS), is a battery-powered device that aerosolizes liquid nicotine by heating a solution of nicotine, glycerol, and flavoring agents (Grana et al. 2013). Although e-cigarettes are often advertised as healthier alternatives to conventional cigarettes or smoking cessation aids, their safety, efficacy, and health effects remain controversial and poorly characterized.

Concerns about e-cigarettes include that harmful or potentially harmful components have been detected in e-cigarettes including formaldehyde, acetaldehyde, propylene glycol, and heavy metals, although the levels of these substances are lower than in conventional cigarettes (Kim and Shin 2013). Additionally, there are concerns that e-cigarettes may provide a bridge to smoking traditional cigarettes (Bunnell et al. 2015), they may undermine bans on smoking in public places (Crowley 2015), and bystanders may be exposed to nicotine in indoor environments (Colard et al. 2015). Although a recent clinical trial reported modest effects of e-cigarettes as smoking cessation aids, several limitations in the study design limited the interpretation of the data (Bullen et al. 2013).

The prevalence of e-cigarette use varies across countries and, despite concerns about public health, has significantly increased in some countries. In the United States (US), awareness of e-cigarettes has increased from 40.9 % in 2010 to 79.7 % in 2013, while e-cigarette use has increased from 3.3 to 8.5 % (King et al. 2015), a prevalence similar to that observed in the United Kingdom (UK) (Brown et al.

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2014). According to the 2011–2013 Global Adult Tobacco Survey, the prevalence of e-cigarette awareness was 10.9 % in Indonesia, 21.0 % in Malaysia, 49.0 % in Qatar, and 88.5 % in Greece. Across these four countries, almost 818,500 individuals are current e-cigarette users (Palipudi et al. 2015). All of these studies report a higher prevalence of e-cigarette use in current smokers than in non-smokers.

Since 2007, when e-cigarettes were introduced in Korea, they have rapidly become popular, primarily because of online marketing (Lee et al. 2011). According to ITC surveys conducted in 2010, the prevalence of awareness, trial use, and current use of e-cigarettes were 79, 11, and 7 %, respectively, among adult smokers in Korea (Gravely et al. 2014). However, the ITC study included smokers and former smokers only. Few studies have used nationally representative data, especially in East Asia, where the male smoking rate is high and few females smoke (Jung-Choi et al. 2012). Herein, we studied the prevalence of e-cigarette use and the characteristics of users in a nationally representative sample of individuals from South Korea.

Methods

Study population

This was a population-based cross-sectional study of the Korean National Health and Nutrition Examination Survey (KNHANES), which was conducted in 2013 by the Korean Centers for Disease Control and Prevention (KCDC 2014). A stratified multistage probability sampling design was applied with selections made using household registries from sampling units that were based on sex, age group, and geographical area. A total of 8018 people participated in the KNHANES 2013 survey (KCDC 2014). Among these participants, 6113 individuals who were at least 19 years old were initially selected and 775 subjects for whom questionnaire data about e-cigarette use was incomplete were excluded. A total of 5338 individuals were available for analysis.

Measures

Use of e-cigarettes

Ever use of e-cigarettes was assessed by the following question: “Have you ever tried e-cigarettes?” Current use of e-cigarettes was defined by a ‘yes’ response to the question, “In the past 30 days, have you used e-cigarettes?”

Smoking status

Current smokers were considered to be individuals who had a lifetime history of smoking more than 100 cigarettes

and were currently smoking “every day” or “some days.” Former smokers were considered to be individuals who had a lifetime history of smoking 100 cigarettes, but were “not at all” currently smoking. Never smokers were considered to be individuals who had a lifetime history of smoking less than 100 cigarettes.

Heavy drinking

Heavy drinking was assessed by asking subjects about their drinking behavior during the prior year. Our criteria for heavy drinking of 7 drinks for men and 5 drinks for women per day corresponds to WHO criteria, i.e., more than 60 g alcohol per day for men and more than 40 g alcohol per day for women (WHO 2000). The KNHANES questionnaire defines alcohol intake of “a drink” of spirits, beer, wine, or soju—a popular Korean traditional spirit. The following question was asked to evaluate heavy drinking, “How many times do you consume more than seven (men)/five (women) drinks of spirits or soju (6 cans of beer for men or 3 cans of beer for women—one beer can is 355 mL) in a single drinking day in the past year?: (1) never, (2) less than once a month, (3) approximately monthly, (4) approximately weekly, or (5) daily.

Other variables

Demographic data were obtained through direct interviews using standardized questionnaires, including region, marital status, household income, and educational level. Household income was the equivalent gross household income per month, calculated as the total household income per month/ $\sqrt{\text{number of family members}}$.

Statistical analysis

The complex sampling design was used for the KNHANES data considering stratification, clusters, and weights to represent the entire South Korean population. The number of subjects constituted the unweighted sample of individuals who actually participated in the KNHANES 2013 survey. The rates of demographic characteristics and the prevalence of ever and current e-cigarette use were presented as weighted percentages to describe nationally representative data. Chi-square tests were used to examine categorical variables. Odds ratios (OR) and 95 % confidence intervals (CI) were estimated multivariate logistic regression analyses undertaken to identify factors associated with ever and current e-cigarette use controlling for age, sex, socioeconomic status, and health risk behavior (such as smoking status and frequency of heavy drinking). A threshold for statistical significance was set at a two-tailed $P < 0.05$ level. All data were analyzed using SPSS version 21.0. (SPSS Statistics Inc, Chicago, IL, USA).

Results

Characteristics of study subjects

Table 1 describes the socio-demographic characteristics and health risk behaviors of the sample [49.0 % male;

mean (SE) age 45.7 (0.4) years]. The prevalence of current smoking was 42.1 % in men and 6.8 % in women. The prevalence of heavy drinking at least once a month for a year was 50.6 % (69.5 % of men and 32.4 % of women). The prevalence of daily heavy drinking was 4.0 % (7.0 % in men and 1.0 % in women).

Table 1 Selected characteristics of participants in the Korean National Health and Nutrition Examination Survey, 2013 ($n = 5338$)

	N	Weighted (%)		
		Total	Men	Women
Age (years)				
Mean (SE)		45.7 (0.4)		
19–29	701	19.5	21.3	17.7
30–39	938	19.5	19.9	19.1
40–49	1040	21.0	21.1	20.9
50–59	1014	19.1	19.2	19.0
≥60	1645	20.9	18.4	23.3
Sex				
Male	2255	49.0	NA	NA
Female	3083	51.0	NA	NA
Region				
Urban	4307	81.4	81.2	82.1
Rural	1031	18.4	18.8	17.9
Marital status				
Married, cohabited	4281	66.5	67.3	65.8
Single	2863	22.2	27.3	17.3
Separated, divorced, or widowed	829	11.3	5.5	16.8
Unknown	45	0.6		
Household income (quartile group)				
1st	1048	16.0	13.8	18.2
2nd	1401	26.2	25.7	26.6
3rd	1360	27.7	28.9	26.5
4th	1501	30.1	31.6	28.7
Unknown	28			
Educational level (years)				
<9	1256	17.5	11.1	23.7
9–11	545	9.2	9.2	9.1
12–15	1874	38.9	42.4	35.6
≥16	1660	34.4	37.3	31.6
Unknown	3			
Smoking status				
Never smoker	3246	56.7	24.3	87.8
Ex-smoker	1018	19.2	33.6	5.4
Current smoker	1073	24.1	42.1	6.8
Unknown	1			
Frequency of heavy drinking				
No or never drinking	2968	49.4	30.5	67.6
Monthly or less than once a month	1424	30.3	35.4	25.4
Weekly	747	16.3	27.1	5.9
Daily	193	4.0	7.0	1.0

E-cigarette use

In the weighted sample, the prevalence of ever and current e-cigarette use was 6.6 and 1.1 %, respectively (Table 2). The prevalence of ever and current e-cigarette use in men was 11.2 and 2.0 %, respectively, which was higher than in women (2.1 and 0.4 %). Table 2 describes the prevalence of e-cigarette use according to selected characteristics. Both the prevalence of ever and current e-cigarette use were significantly higher in younger adults, men, single

individuals, and current smokers ($P < 0.05$). Among e-cigarette users, 79.8 % of ever users and 86.9 % of current users were current smokers. Heavy drinkers (weekly or daily) reported a prevalence of ever use (19.4 %) and current use (2.9 %) of e-cigarettes, which was higher than that of non-heavy drinkers or never drinkers (3.0 % for ever e-cigarette use and 0.4 % for current e-cigarette use).

Table 3 shows the results of the multivariate logistic regression analysis for both ever and current use of e-cigarettes. Relative to never smokers, the odds ratios (ORs)

Table 2 Prevalence of ever and current e-cigarette use according to selected characteristics, Korean National Health and Nutrition Examination Survey, 2013 ($n = 5338$)

	Ever e-cigarette use		Current e-cigarette use	
	Weighted (%)	<i>P</i> value	Weighted (%)	<i>P</i> value
Total	6.6		1.1	
Age (years)				
19–29	8.5	<0.001	0.8	<0.001
30–39	9.4		1.7	
40–49	6.8		1.4	
50–59	4.9		1.4	
≥60	3.5		0.4	
Sex				
Male	11.2	<0.001	2.0	<0.001
Female	2.1		0.4	
Region				
Urban	6.7	0.552	1.0	0.404
Rural	6.0		1.4	
Marital status				
Married, cohabited	6.1	0.001	1.0	0.006
Single	9.2		1.4	
Separated, divorced, or widowed	3.9		1.1	
Household income (quartile group)				
1st	5.0	0.166	0.8	0.482
2nd	7.0		1.1	
3rd	7.8		1.3	
4th	6.0		1.2	
Educational level (year)				
<9	2.3	<0.001	0.5	<0.001
9–11	5.9		2.8	
12–15	9.1		1.2	
≥16	6.1		0.9	
Smoking status				
Never smoker	0.7	<0.001	0.2	<0.001
Ex-smoker	4.8		0.3	
Current smoker	21.8		4.0	
Frequency of heavy drinking				
No or never drinking	3.0	<0.001	0.4	<0.001
Monthly or less than once a month	7.6		1.0	
Weekly	12.4		3.1	
Daily	19.4		2.9	

Table 3 Odds ratios and 95 % confidence intervals from multivariate logistic regression analysis examining correlates of ever and current use of e-cigarettes, Korean National Health and Nutrition Examination Survey, 2013 ($n = 5338$)

	Ever use OR ^a (95 % CI)	Current use OR ^a (95 % CI)
Age (years)		
19–29	1 (reference)	1 (reference)
30–39	0.93 (0.58–1.47)	2.41 (0.78–7.39)
40–49	0.70 (0.42–1.67)	2.08 (0.73–5.95)
50–59	0.57 (0.32–1.01)	1.88 (0.53–6.26)
≥60	0.61 (0.34–1.10)	0.53 (0.12–2.30)
Sex		
Male	1 (reference)	1 (reference)
Female	0.82 (0.53–1.26)	0.72 (0.29–1.78)
Region		
Urban	1 (reference)	1 (reference)
Rural	0.85 (0.55–1.31)	1.35 (0.58–3.15)
Marital status		
Married, cohabited	1 (reference)	1 (reference)
Single	1.06 (0.70–1.61)	1.28 (0.46–3.56)
Separated, divorced, or widowed	0.85 (0.50–1.44)	1.56 (0.52–4.70)
Household income (quartile)		
1 st	1 (reference)	1 (reference)
2 nd	0.99 (0.59–1.68)	1.29 (0.42–3.91)
3 rd	1.08 (0.63–1.86)	1.71 (0.55–5.31)
4 th	0.89 (0.51–1.55)	1.87 (0.61–5.74)
Educational level (years)		
<9	1 (reference)	1 (reference)
9–11	1.76 (0.85–3.65)	3.27 (1.08–9.94)
12–15	2.14 (1.16–3.93)	0.99 (0.33–2.97)
≥16	1.54 (0.82–2.91)	0.82 (0.19–3.48)
Smoking status		
Never smoker	1 (reference)	1 (reference)
Ex-smoker	6.11 (3.34–11.19)	1.24 (0.20–7.66)
Current smoker	29.29 (15.53–55.25)	16.16 (4.71–55.40)
Frequency of heavy drinking		
No or never drinking	1 (reference)	1 (reference)
Monthly or less than once a month	1.21 (0.84–1.74)	1.51 (0.55–4.12)
Weekly	1.17 (0.76–1.80)	2.67 (1.07–6.66)
Daily	1.91 (1.06–3.42)	1.99 (0.44–8.92)

OR odds ratio, CI confidence interval

^a All odds ratios are adjusted for the other variables in the models

for ever and current use of e-cigarettes among current smokers were 29.29 (95 % CI 15.53–55.25) and 16.16 (95 % CI 4.71–55.40), respectively, after adjusting for age, sex, region, marital status, household income, educational level, and frequency of heavy drinking. Relative to never smokers, former cigarettes smokers showed a significantly increased OR for ever use of e-cigarettes (OR 6.11, 95 % CI 3.34–11.19). Daily heavy drinking was associated with ever use of e-cigarettes (OR 1.91, 95 % CI 1.06–3.42), but not current e-cigarette use (OR 1.99, 95 % CI 0.44–8.92).

Discussion

This study uses nationally representative data to report the prevalence and correlates of e-cigarette use among Korean adults. Although e-cigarette use has been described in Western adults (King et al. 2015; Brown et al. 2014), few studies have been conducted in East Asian countries where the male smoking prevalence is high, and women rarely smoke. In our study, ever and current e-cigarette use are prevalent among conventional cigarette smokers.

Additionally, ever use of e-cigarettes has been associated with an increased probability of daily heavy drinking in our study. Despite a markedly higher prevalence of e-cigarette use in men, sex was not associated with an increased risk for e-cigarette use after adjusting for age, socioeconomic status, smoking status, and frequency of heavy drinking.

The prevalence of e-cigarette use in Korea in 2103 was lower than that in the US or UK, despite e-cigarettes being available to consumers for similar time periods. According to a US online survey carried out from 2010 to 2013, ever use of e-cigarettes was 8.5 % and that of current use was 2.6 % (King et al. 2015)—slightly higher than the 6.6 and 1.1 % observed in our study. The prevalence of ever e-cigarette use in current smokers among UK adults is 36.5 % (Brown et al. 2014)—higher than the 21.8 % observed in this study. Differences in e-cigarette regulations across countries may underpin these differences. Korea regulates e-cigarettes as a tobacco product and levies both excise and ad valorem taxes on these devices. Advertisements for e-cigarettes in Korea are not permitted and e-cigarette use is prohibited in public places where cigarette smoking is banned. In contrast, e-cigarettes are promoted as smoking cessation aids in UK (Action on Smoking and Health 2014) and few regulations exist for e-cigarettes in US as of March 2014 (Grana et al. 2014). The prevalence of ever e-cigarette use among adult smokers in Korea was similar to that reported in the ITC study, but the prevalence of current use was lower (Gravelly et al. 2014), suggesting that e-cigarette use among smokers in Korea has not significantly increased in the last three years.

Consistent with previous reports (Brown et al. 2014; King et al. 2015; Li et al. 2015), current smoking status was strongly associated with both ever and current use of e-cigarettes. Additionally, the prevalence of e-cigarette use was highest among current smokers, followed by former smokers and individuals who never smoked. Current smokers use e-cigarettes as smoking cessation or reduction aids, and as substitutes for conventional cigarettes in nonsmoking places (Goniewicz et al. 2013; Kralikova et al. 2013).

Numerous studies across countries report that the prevalence of e-cigarette use is higher in young adults (ages 20–28) and adolescents (ages 12–19) than in adults older than age 45 (Carroll Chapman and Wu 2014). Ever use tripled among adolescents in New Zealand between 2012 and 2014 (White et al. 2015). In our study, although not significant, the prevalence of ever e-cigarette use was higher in adults less than age 40 years than in older age groups. In 2011, the prevalence of ever e-cigarette use was 9.4 % among Korean adolescents (Lee et al. 2014), which

was similar with that of Korean adults in this study. Thus, young adults and adolescents had a higher prevalence of e-cigarette use compared to older groups. It is possible that online marketing and sales of e-cigarettes targets and it is accessible to younger individuals to a great extent than older adults. In adolescents, sensation-seeking and the need for new and different experiences is associated with substance use, and may underpin e-cigarette experimentation (Carroll Chapman and Wu 2014; Crawford et al. 2003).

In this study, the prevalence of e-cigarette use was higher in men. In contrast, the prevalence of ever use was similar by sex in the US and New Zealand (King et al. 2015; Li et al. 2015). Sex differences in e-cigarette use in Korea may relate to sex differences in cigarette smoking, since sex was not significantly associated with e-cigarette use for multivariate analysis. Alternatively, they may relate to social repression of smoking among women who consequently under-report smoking (Jung-Choi et al. 2012).

Weekly and daily heavy drinking were associated with e-cigarette use in our study (although the association did not attain statistical significance for daily heavy drinking). An earlier study conducted in Northwest England reported that the use of e-cigarettes in teenagers was associated with both heavy drinking and drinking to get drunk (Hughes et al. 2015). Teenagers who use e-cigarettes may be more vulnerable to other forms of substance use and risk-taking behaviors. Several reasons could account for these trends. First, adults with e-cigarette experience might also exhibit other risk-taking behaviors, such as alcohol abuse. Second, heavy drinkers may be more likely to use e-cigarettes as an additional type of recreational substance. Third, heavy drinkers are more likely to smoke cigarettes and may have considerable difficulty quitting smoking (Hays et al. 1999; McKee et al. 2007). They might use e-cigarettes as smoking cessation aids or as substitutes for conventional cigarettes in indoor areas.

Limitations of this study include that because the design was cross-sectional, causal inference is limited. Self-reports of e-cigarette use, smoking, and drinking may have resulted in misclassification bias. This is particularly true for smoking behavior among women, which may have been under-reported (Jung-Choi et al. 2012). Finally, residual confounding related to unmeasured or inadequately measured factors may have existed.

Despite limitations, these data provide information of the prevalence and correlates of e-cigarette use in Korea. The finding that e-cigarette use is associated with heavy drinking will need confirmation in future studies. Moreover, if e-cigarette has a role for conventional cigarette use or heavy alcohol use among adults, we need to consider stronger regulation of e-cigarettes.

Compliance with ethical standards

Conflict of interest None.

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