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The price of tobacco and its effects on smoking behaviors in Korea: The 2015 Korea Community Health Survey

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ABSTRACT

This study investigated the effects of the price of tobacco on smoking behaviors in Korean adult smokers using a population-based survey. Current smokers or former smokers who quit smoking < 1 year prior to the survey were selected from the data of 2015 Korea Community Health Survey (N = 45,686). The effects of the price of tobacco on smoking behaviors were measured. The major effects were defined as quitting, reducing smoking and using electronic cigarettes (e-cigarettes). Chi-square tests and multiple logistic regression analyses were performed. After tobacco prices increased, 3.8%, 22.8% and 5.4% of subjects quit, reduced smoking and switched to e-cigarettes. The adjusted odds ratio (aOR) for reducing smoking was significantly higher in subjects with a lower household income and lower education level than in those with a greater income and higher education level among current smokers. Subjects who started smoking at an older age, who smoked a smaller number of cigarettes smoked per day and who had been exposed to anti-smoking campaigns and anti-smoking information were more likely to reduce smoking after the price of tobacco increased. Younger subjects were less likely to reduce smoking, but they were more likely to use e-cigarettes after the price of tobacco increased. Low-income subjects were sensitive to increases in the price of tobacco. Additional strategies are required to change the smoking behaviors of heavy smokers. Future studies should investigate the long-term effects of increasing the price of tobacco, especially on younger adults, on smoking behaviors.

1. Introduction

Smoking is a major health threat both worldwide and in Korea. The smoking burden is substantial in Korea (Zahra et al., 2016); additionally, the burden of exposure to secondhand smoke in Korea is the highest among high-income Asia Pacific group countries (Zahra et al., 2017).

The Korean government's tobacco control policies include smoke-free public places, public education on the harmful effects of tobacco, and inclusion of health warnings on cigarette packages (Cho, 2014). Although the prevalence of smoking decreased from 35.1% in 1998 to 23.3% in 2014 among Korean adults (from 66.3% to 42.3% in men, and from 6.5% to 5.1% in women), it is still high (Kang et al., 2017). Cigarette prices are the lowest among the Organization for Economic Cooperation and Development countries; there have been no increases in the cigarette tax since 2004 (Cho, 2014). In January 2015, the price of a pack of cigarettes increased by 80%, from 2500 won to 4500 won (from 2.3 US$ to 4.1 US$; 1 US dollar = 1100 Korean won), the biggest increase in Korean history (Hwang and Park, 2017). Electronic cigarettes (e-cigarettes) are considered a controversial smoking cession aid in Korea (Lee et al., 2011). The prevalence of e-cigarette use was reported to be 6.6% (ever) and 1.1% (current) in Korean adults (11.2% and 2.0% in men, respectively, and 2.0% and 0.4% in women, respectively), based on 2013 Korean National Health and Nutrition Examination Survey data. Additionally e-cigarette use has been strongly associated with conventional cigarette use (Lee et al., 2016a).

Pricing is an effective strategy to control smoking (Pierce et al., 2012), most studies have found that increasing the price of cigarettes through increased taxes is a highly effective intervention to reducing smoking among the youth, young adults, and persons of low socioeconomic status (Bader et al., 2011). This study investigated the effects of the price of tobacco on smoking behaviors, including e-cigarette use, in Korean adults using nationwide data.

2. Methods

2.1. Data source

Korea Centers for Disease Control and Prevention have annually used the Korea Community Health Survey (KCHS) to investigate both public health status and health behaviors at the community level since 2008. The sample areas were selected using stratified cluster sampling

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methods, and sample houses were selected using systematic sampling methods. All household members older than 19 years of age in a sample house were selected as members of the study population. A trained interviewer visited the sample houses and collected data using one-on-one interviews from August 15 to October 31 for the 2015 KCHS. Detailed information from the KCHS is available elsewhere (Kang et al., 2015).

A total of 228,558 subjects participated in the 2015 KCHS. Among them, there were 41,678 current smokers and 41,788 former smokers. Among the 41,788 former smokers, 4736 quit smoking < 1 year prior to the survey. In the 2015 KCHS, the effects of the price of tobacco and the type of effects on current smokers or former smokers who quit smoking within the past year were assessed (n = 46,414). Among these subjects, 27 were excluded because the effects of the price of tobacco were missing from the collected data. An additional 701 subjects were excluded due to missing covariate data. Finally, 45,686 individuals were selected as study subjects.

2.2. Measures

The following question was used to determine the effects of the price of tobacco on study participants: “Did the increase in the price of tobacco influence your smoking behaviors in January 2015?” The answers were either yes or no. If subjects answered ‘yes’, the types of effects were also ascertained with the following question: “How have you been affected on your current smoking by the increase of tobacco price? Please answer all following questions.” The types of effects were as follows: quit smoking, reduce smoking, smoke cheaper tobacco, use an e-cigarette, use another type of tobacco (not cigarettes or e-cigarettes), and other. For each type of effect, a participant could indicate whether an effect was applicable by answering yes or no. The types of effect can be answered ‘yes’ for 2 or more types.

Covariates were selected from previous studies addressing the change of smoking behavior and associated factors (Lee et al., 2016b; Luo et al., 2015; Tabuchi et al., 2016; Zawahir et al., 2013). Data on the age when someone first smoked (≤18, 19–29, or ≥30 years of age), and the number of cigarettes smoked per day (1–10, 11–20, or ≥21) were collected. Smokers in household, exposure to secondhand smoke in the workplace, and public places were also noted. Exposure to anti-smoking campaigns and information were also noted. Quit attempts and intention to quit smoking collected for current smokers. Quit attempts were assessed with the question “Have you ever attempted to stop smoking for more than a day (24 hours)?” The responses included: within the recent 1 year, before 1 year ago, and none. Intention to quit smoking was defined as a response to the question “Do you have any plan to quit smoking?” Response options included: within the next 6 months, someday but not in the next 6 months, and none. If current smokers answered they attempted to quit smoking (within the recent 1 year, before 1 year ago) and intended to quit smoking (within the next 6 months and someday but not in the next 6 months), the main reason to quit smoking was asked with the question “What is the main reason for quitting smoking? Please choose one answer” The main reason for quitting smoking was also asked with the same question for former smokers. The answers included: current health problems, concern about future health problems, for family health, to avoid harming other people (second-hand smoking), advice of surrounding people, due to tobacco price, exposure to anti-smoking campaign/warning sign on cigarette pack, difficulties in social activities (no place to smoke), and others. Gender, age (19–44, 45–64, or 65+ years), household income (≤1817, 1818–2726, 2727-3635, or ≥3636 US$; 1 US$ = 1100 won), education level (≤middle school, high school, or ≥college), type of family (living alone, live with only adults, or live with subjects younger than 19 years of age), drinking frequency (none, ≤1/week, or ≥2/week), and chronic diseases (no, yes) were also tabulated. Chronic diseases included hypertension, diabetes, hyperlipidemia, osteoarthritis, asthma, allergic rhinitis, and atopic dermatitis.

2.3. Analysis

SAS version 9.2 was used to analyze the data. The statistical analysis used the sampling weights to estimate descriptive statistics and regression models; the analysis also accounted for the complex, multistage sampling design of the KCHS. PROC SURVEYFREQ was used to estimate proportions and 95% confidence intervals (using the logit method). Multiple logistic regression models were estimated using PROC SURVEYLOGISTIC. All analyses were separated between current and former smokers because current smokers still smoked and former smokers stopped smoking around the price increase of tobacco. For current smokers, reducing smoking and use of e-cigarettes due to the price increase of tobacco were investigated by subjects' characteristics. For former smokers, quitting smoking and use of e-cigarettes due to price increase of tobacco were investigated. Finally, the main reason to quit smoking were described. All data except numbers are presented as weighted values. Statistical significance was at $P < 0.05$.

3. Results

Among the participants, 36.1% reported that their smoking behaviors were affected by the increase in the price of tobacco. The most common type of effect was a reduction in smoking (22.8%) and 5.4% reporting that they use e-cigarette. Smoking cheaper tobacco and quitting smoking were named by 4.0% and 3.8% of the respondents, respectively. Among current smokers, 25.3% reported that they reduced smoking amount and 39.0% former smokers reported that they quit smoking due to the increase of tobacco prices. Use an e-cigarette due to the price increase of tobacco was reported in 5.4% and 5.2% of current and former smokers, respectively (Table 1).

For current smokers, reducing smoking and the use of e-cigarettes

Table 1
Effects of the price of tobacco on smoking behavior, 2015 Korea Community Health Survey.

	Total (n = 45,686)	Current smoker (n = 41,055)	Former smokers (n = 4631)
Did the increase in the price of tobacco influence your smoking behaviors in January 2015?			
No	63.9 (63.4–64.5)	64.7 (64.1–65.3)	57.0 (55.8–58.3)
Yes	36.1 (35.5–36.6)	35.3 (34.7–35.9)	42.9 (41.7–44.2)
If yes, type of effect[a]			
Quit smoking	3.8 (3.6–4.0)	NA	39.0 (37.7–40.2)
Reduce smoking	22.8 (22.3–23.3)	25.3 (24.7–25.8)	NA
Smoke cheaper tobacco	4.0 (3.8–4.2)	4.4 (4.2–4.6)	NA
Use an electronic cigarettes (e-cigarettes)	5.4 (5.1–5.7)	5.4 (5.1–5.7)	5.2 (4.6–5.8)
Use another type of tobacco, except for cigarettes or e-cigarettes	0.6 (0.5–0.7)	0.6 (0.5–0.7)	0.6 (0.5–0.9)
Other	0.9 (0.8–1.0)	1.0 (0.8–1.1)	0.2 (0.1–0.3)

[a] Multiple responses. NA, not applicable. Data are expressed as % (95% CI).

due to price increase of tobacco were investigated. According to age, 23.6%, 24.9%, and 39.6% of the 19–44-, 45–65-, and 65 + -year age groups reduced smoking due to the price increase of tobacco. The aOR for reducing smoking was significantly higher in subjects older than 65 + years of age (aOR = 1.39, 95% CI = 1.24–1.56) compared to subjects between 19 and 44 years of age. A lower income level and lower education level were both associated with a higher aOR for reducing smoking than those who had higher incomes and higher education levels. Subjects who began smoking at an older age, and who smoked a smaller number of cigarettes per day were more likely to reduce smoking. Exposure to anti-smoking campaigns (aOR = 1.27, 95% CI = 1.15–1.39) and anti-smoking information (aOR = 1.27, 95% CI = 1.16–1.39) were associated with reducing smoking by multiple logistic regression analysis. Current smokers who attempted and intended to quit smoking were more likely to reduce smoking due to the price increase of tobacco. The use of e-cigarettes due to the price increase of tobacco was found in 7.2%, 3.3%, and 2.5% of those in the 19–44-, 45–64-, and 65 + -year age groups, respectively. The aOR for the use of e-cigarettes was significantly lower in subjects older than 65 years of age (aOR = 0.36, 95% CI = 0.26–0.51) compared to subjects between 19 and 44 years of age, and was significantly higher in subjects with chronic diseases (aOR = 1.19, 95% CI = 1.06–1.33) compared to subjects without chronic diseases (Table 2).

For current smokers who quit smoking within the past year, quitting smoking and use of e-cigarettes due to the price increase of tobacco were investigated. According to age, 37.3%, 41.5% and 38.6% of the 19–44-, 45–65-, and 65 + -year age groups reported they quit smoking due to the price increase of tobacco, respectively. Former smokers with low household income were more likely to report they quit smoking due to price increase of tobacco compared to subjects with high household income (aOR = 1.51, 95% CI = 1.27–1.79). Former smokers who started smoking at an older age and smoked a larger number of cigarettes per day were likely to respond that they quit smoking due to the price increase of tobacco. Younger former smokers were more likely to use e-cigarettes compared to older smokers (Table 3).

Overall, 81.3% and 67.7% of current and former smokers reported answered that they tried to quit or quit smoking due to the concern for their own and their family's health. Among current smokers who attempted and intended to quit smoking, 78.3% of those who were influenced by the price increase and 83.3% of those who were not influenced by it reported their own and their family's health as being their main reason to quit smoking. Among former smokers, 55.9% of those influenced by the price increase and 76.5% of those not influenced by it reported they quit smoking due to concerns for their own health and that of their family. Smokers whose smoking behavior was influenced by the price increase of tobacco were more likely to report that their reason for quitting smoking was due to tobacco price, as compared to smokers who were not influenced (Table 4).

4. Discussion

This study investigated the effects of the price of tobacco on smoking behaviors in Korea using 2015 KCHS data. Total 36.1% of subjects reported that they were affected by the tobacco price increase, and 3.8% and 22.8% of subjects quit or reduced smoking, respectively. The aOR for reducing smoking was significantly higher in subjects with a low household income compared to those with a higher income. This means that the increase of the price of tobacco might have disproportionately influenced smokers according to their economic status. Because the lowest household income group traditionally has a higher risk of smoking than the highest household income group in Korea (Yun et al., 2015), as in many countries, their smoking-related mortality rates are also higher (The World Bank, 1999). The price elasticity of cigarette consumption differed by income group, with lower-income Korean smokers more responsive to changes in the price of cigarettes; this group tended to reduce their cigarette consumption more frequently (Choi, 2016) and their corresponding economic burden may have decreased (The World Bank, 1999). These findings suggest that increasing the price of tobacco may result in the highest reductions in smoking among those who have the highest burden of tobacco use. However, smokers with a low income will be adversely affected if they continue to smoke after the increase of tobacco prices. This concern could be relieved if the revenues produced by the increase of tobacco price are assigned to tobacco control and health promotion efforts targeting the poor (Chaloupka et al., 2012).

Along with economic factors, current smokers who first smoked at an older age, and smoked fewer cigarettes per day were more likely to reduce smoking in this study. Heavy smokers reported that they were more likely to be persistent smokers despite the increase in the price of cigarettes compared with light smokers, according to the 2013 Korea Youth Risk Behavior Web-Based Survey (Lee et al., 2016b). The onset of smoking at an early age is a risk factor for nicotine dependence (Kendler et al., 2013), and smoking a high number of cigarettes per day is a feature of nicotine dependence (Aryal et al., 2015). Nicotine dependence is reported to hinder tobacco cessation (Tabuchi et al., 2016); therefore, in addition to the price of tobacco, an assessment of nicotine dependence and its treatment (e.g., pharmacotherapy) might be needed to help heavy smokers who first smoked at an early age quit or reduce smoking. Tax revenues raised from the tobacco price increase could be allocated to support access to smoking-cessation treatments/programs and expand early childhood education to reduce early smoking initiation (Vardavas et al., 2012; Wright et al., 2017).

In this study, subjects who were exposed to anti-smoking campaigns and information were more likely to reduce smoking. In previous studies, educational campaigns and smoking bans in public places were found to influence a smoker's intention to quit smoking (Luo et al., 2015; Zawahir et al., 2013). Similarly, in a study which investigated the impact of tobacco campaigns, smokers exposed to anti-smoking campaigns were more advanced in their thoughts about quitting (Borland and Balmford, 2003). Smoking in public places was banned, and this ban has gradually been expanded in Korea (Kwak et al., 2017). Such bans could contribute to the perception that smoking can affect public health via exposure to secondhand smoke. Although the rate of exposure to anti-smoking campaigns (88.1%) was relatively high among participants in this study, only 11.3% of subjects were exposed to other anti-smoking information.

The use of e-cigarettes (5.4%) was the second-most common type of effect of the increase in the price of tobacco in this study. The use of e-cigarettes is rapidly increasing due to social limitations on cigarette smoking in Korea (Lee et al., 2011). E-cigarettes are perceived as being less harmful than typical tobacco cigarettes (Baeza-Loya et al., 2014) and are used as smoking cessation aids (Meier et al., 2013). Preliminary evidence suggests that e-cigarettes help some smokers reduce or quit smoking (Meier et al., 2013), but e-cigarette-induced nicotine dependence has become an important concern, as some e-cigarettes may exceed the nicotine delivery of a tobacco cigarette and progression to higher-dose e-cigarettes may result (Cobb et al., 2015). Although the short-term use of e-cigarettes has not been considered a risk to health, there is a lack of standard methods for assessing risk from e-cigarette aerosols, and our knowledge about the health risk from e-cigarette use at the population level is limited (Knight-West and Bullen, 2016).

After the price of tobacco increased, younger subjects were less likely to reduce smoking compared to older adults, but they were more likely to use e-cigarettes in this study. It is generally known that younger smokers are more responsive to tobacco price policy changes compared to older smokers. This is based on the belief that older smokers are likely to be addicted to cigarettes and less able to reduce or quit their smoking consumption (Farrelly et al., 2001). However, smokers aged 45–64 and 65 + were more responsive than smokers aged 19–44 in our study. Similarly, a study of a middle-age Japanese population discovered that older age (being age 60–65 as opposed to age 50–54) was significantly associated with cessation (Tabuchi et al.,

Table 2
Reducing smoking and the use of e-cigarettes due to price increase of tobacco among current smokers, according to subjects' characteristics, 2015 Korea Community Health Survey.

		Reducing smoking due to price increase[a]		Use of e-cigarettes due to price increase[b]	
Characteristics	N	%	OR (95% CI)	%	OR (95% CI)
Total		25.3		5.4	
Gender					
Male	37,357	24.9	1.27 (1.14–1.43)	5.4	1.13 (0.89–1.43)
Female	3698	29.1	1.00	5.1	1.00
Age (years)					
19–44	17,920	23.6	1.00	7.2	1.00
45–64	17,333	24.9	1.10 (1.03–1.18)	3.3	0.48 (0.42–0.55)
65 +	5802	39.6	1.39 (1.24–1.56)	2.5	0.36 (0.26–0.51)
Income (US $)					
≤1817	13,563	33.0	1.63 (1.49–1.77)	5.1	1.13 (0.95–1.34)
1818–2726	8903	26.2	1.38 (1.26–1.50)	6.0	1.14 (0.97–1.33)
2727–3635	7529	23.1	1.15 (1.05–1.25)	5.4	1.01 (0.86–1.19)
≥3636	11,060	20.6	1.00	5.3	1.00
Education level					
≤Middle school	10,337	34.2	1.74 (1.57–1.92)	3.4	1.05 (0.83–1.31)
High school	17,801	26.0	1.31 (1.23–1.41)	6.2	1.20 (1.06–1.37)
≥College	12,917	21.0	1.00	5.2	1.00
Type of family					
Living alone	5425	25.7	1.00	5.3	1.00
Live with only adults	22,314	26.8	1.14 (1.04–1.25)	5.3	1.06 (0.88–1.27)
Live with subjects < 19 years	13,282	22.9	1.14 (1.03–1.25)	5.6	0.99 (0.81–1.21)
Drinking frequency					
None	5725	29.0	1.02 (0.93–1.12)	4.0	0.95 (0.77–1.18)
≤1/week	16,045	26.8	1.09 (1.02–1.16)	5.9	1.01 (0.90–1.13)
≥2/week	19,280	23.0	1.00	5.3	1.00
Chronic diseases					
No	24,380	24.4	1.00	5.2	1.00
Yes	16,675	26.6	0.98 (0.92–1.04)	5.7	1.19 (1.06–1.33)
Age when first smoked (years)					
≤18	13,601	23.1	1.00	6.9	1.00
19–29	24,675	25.8	1.14 (1.06–1.21)	4.7	0.79 (0.70–0.89)
≥30	2779	34.6	1.24 (1.08–1.42)	3.1	0.76 (0.52–1.11)
Number of cigarettes smoked per day					
1–10	18,551	30.9	2.85 (2.46–3.30)	5.7	1.05 (0.81–1.36)
11–20	19,529	21.1	1.85 (1.60–2.13)	5.3	1.15 (0.89–1.48)
≥21	2975	12.3	1.00	4.0	1.00
Smoker in household					
No	38,034	25.0	1.00	5.2	1.00
Yes	3020	27.8	1.15 (1.02–1.28)	7.4	1.26 (1.03–1.54)
Exposure to secondhand smoke in the workplace					
No	22,859	23.1	1.00	4.9	1.00
Yes	11,064	23.8	1.05 (0.98–1.12)	6.3	1.23 (1.09–1.39)
No job	7131	35.5	1.35 (1.24–1.47)	5.7	1.22 (1.03–1.45)
Exposure to secondhand smoke in public places					
No	8147	24.9	1.00	4.5	1.00
Yes	32,869	25.3	1.01 (0.94–1.09)	5.6	1.17 (1.01–1.36)
Exposure to anti-smoking campaigns					
No	4716	21.8	1.00	5.4	1.00
Yes	36,303	25.7	1.27 (1.15–1.39)	5.4	1.03 (0.87–1.23)
Exposure to anti-smoking information					
No	36,908	24.7	1.00	5.2	1.00
Yes	4140	29.5	1.27 (1.16–1.39)	7.3	1.18 (1.01–1.38)
Attempt to quit smoking					
Within the past 1 year	13,452	30.8	1.48 (1.37–1.59)	8.1	2.08 (1.77–2.44)
Before 1 year ago	14,045	24.6	1.20 (1.11–1.29)	4.4	1.22 (1.04–1.43)
None	13,557	19.5	1.00	3.3	1.00
Intention to quit smoking					
Within the next 6 months	7699	32.0	1.84 (1.68–2.01)	7.4	1.51 (1.27–1.81)
Someday but not in the next 6 months	20,305	26.4	1.54 (1.43–1.66)	5.7	1.42 (1.22–1.64)
None	13,033	18.3	1.00	3.4	1.00

CI, confidence interval; OR, odds ratio.
[a] Current smokers who reduced smoking in response to the price increase were coded as 1, while others were coded as 0.
[b] Current smokers who used e-cigarettes in response to the price increase were coded as 1, while others were coded as 0.

Table 3
Quitting smoking and the use of e-cigarettes due to price increase of tobacco among former smokers, according to subjects' characteristics, 2015 Korea Community Health Survey.

		Quitting due to price increase[a]		Use of e-cigarettes due to price increase[b]	
Characteristics	N	%	aOR (95% CI)	%	aOR (95% CI)
Total		39.0		5.2	
Gender					
Male	4316	39.4	1.31 (1.03–1.66)	5.2	1.28 (0.67–2.44)
Female	315	32.3	1.00	4.4	1.00
Age (years)					
19–44	1735	37.3	1.00	7.1	1.00
45–64	1797	41.5	1.01 (0.88–1.16)	3.7	0.50 (0.37–0.69)
65 +	1099	38.6	0.74 (0.61–0.91)	1.5	0.24 (0.11–0.48)
Income (US $)					
≤1817	1689	44.5	1.51 (1.27–1.79)	4.6	1.14 (0.75–1.74)
1818–2726	943	37.5	1.06 (0.90–1.24)	4.6	0.76 (0.50–1.15)
2727–3635	799	38.1	1.08 (0.94–1.25)	4.9	0.83 (0.56–1.23)
≥3636	1200	36.6	1.00	6.0	1.00
Education level					
≤Middle school	1414	43.0	1.18 (0.98–1.42)	1.4	0.44 (0.27–0.71)
High school	1725	39.2	1.06 (0.92–1.21)	6.9	1.56 (1.14–2.12)
≥College	1492	37.3	1.00	5.0	1.00
Type of family					
Living alone	496	40.1	1.00	4.4	1.00
Live with only adults	2790	39.6	1.09 (0.91–1.31)	5.0	1.18 (0.79–1.76)
Live with subjects < 19 years	1342	37.9	1.07 (0.87–1.31)	5.7	1.12 (0.73–1.70)
Drinking frequency					
None	833	35.8	0.69 (0.58–0.81)	3.2	0.75 (0.46–1.22)
≤1/week	1900	36.8	0.81 (0.72–0.90)	5.2	0.82 (0.59–1.13)
≥2/week	1898	42.5	1.00	5.7	1.00
Chronic diseases					
No	2451	39.7	1.00	6.2	1.00
Yes	2180	38.1	0.92 (0.82–1.03)	3.9	0.76 (0.57–1.01)
Age when first smoked (years)					
≤18	1611	36.5	1.00	5.8	1.00
19–29	2765	40.5	1.21 (1.08–1.35)	4.8	0.92 (0.67–1.24)
≥30	249	39.4	1.33 (1.01–1.78)	5.4	2.47 (1.19–5.09)
Number of cigarettes smoked per day					
1–10	1603	34.2	0.69 (0.58–0.83)	5.0	0.70 (0.43–1.13)
11–20	2464	41.6	0.92 (0.78–1.09)	5.3	0.88 (0.54–1.43)
≥ 21	564	44.2	1.00	4.9	1.00
Smoker in household					
No	4482	39.0	1.00	5.1	1.00
Yes	149	39.3	1.11 (0.86–1.43)	6.1	1.12 (0.53–2.37)
Exposure to secondhand smoke in the workplace					
No	2450	38.8	1.00	5.8	1.00
Yes	1158	39.1	1.00 (0.88–1.14)	4.3	0.69 (0.49–0.99)
No job	1022	39.2	1.00 (0.86–1.17)	4.7	0.92 (0.65–1.31)
Exposure to secondhand smoke in public places					
No	706	40.3	1.00	7.6	1.00
Yes	3922	38.8	0.94 (0.81–1.10)	4.9	0.58 (0.41–0.82)
Exposure to anti-smoking campaigns					
No	676	38.7	1.00	6.2	1.00
Yes	3954	39.0	1.02 (0.88–1.18)	5.0	0.80 (0.57–1.12)
Exposure to anti-smoking information					
No	4099	39.0	1.00	4.7	1.00
Yes	531	38.9	1.01 (0.86–1.20)	8.2	1.71 (1.23–2.39)

CI, confidence interval; OR, odds ratio.
[a] Former smokers who quit in response to the price increase were coded as 1, while others who quit for other reasons were coded as 0.
[b] Former smokers who used e-cigarettes in response to the price increase were coded as 1, while others were coded as 0.

2017). Responses to the price increase of tobacco can be interpreted as a combined effect of initiation prevention and cessation of smoking. Younger subjects are more likely to avoid smoking initiation because of price whereas older subjects are more likely to initiate cessation (DeCicca and McLeod, 2008). Since our study only included smokers who had already started smoking, older smokers were more responsive in this study. The dual use of conventional tobacco and e-cigarettes among younger adults has become an important health issue (Rath et al., 2012). Nicotine dependence from the use of e-cigarettes is a concern in younger people; it can hamper attempts to quit smoking and

Table 4
The main reason for quitting smoking according to the status of influence of tobacco price, 2015 KCHS.

What is the main reason for quitting smoking?	Did the increase in the price of tobacco influence your smoking behaviors in January 2015?		
	Total	Yes	No
Current smokers who attempted and intended to quit smoking	N = 21,835	N = 8826	N = 13,009
Current health problems	15.8	16.5	15.4
Concern about future health problems	50.3	47.4	52.2
For their family's health	15.2	14.4	15.7
To avoid harming other people (second-hand smoking)	7.8	7.0	8.3
Advice of surrounding people	2.1	1.9	2.3
Due to tobacco price	5.6	10.1	2.8
Anti-smoking campaign/warning sign on cigarette pack	0.1	0.2	0.1
Difficulties in social activities (no place to smoke)	1.5	1.5	1.5
Others	1.5	1.0	1.8
Former smokers who quit smoking within the past year	N = 4629	N = 2052	N = 2577
Current health problems	19.2	12.0	24.5
Concern about future health problems	32.4	31.5	33.1
For their family's health	16.1	12.4	18.8
To avoid harming other people (second-hand smoking)	7.8	6.7	8.7
Advice of surrounding people	5.0	4.2	5.6
Due to tobacco price	12.8	29.0	0.7
Anti-smoking campaign/warning sign on cigarette pack	0.1	0.1	0.2
Difficulties in social activities (no place to smoke)	2.1	1.4	2.6
Others	4.4	2.6	5.7

Data were expressed as %.

cause increased risks to human health (Siqueira, 2017; St Helen et al., 2016). In this study, subjects with chronic diseases were more likely to use e-cigarettes. Smoking cessation and health-related factors were identified as the primary reasons for e-cigarette use in previous studies (Patel et al., 2016). Therefore, appropriate health information and assessments are needed for subjects who use e-cigarettes, especially younger adults or subjects who smoke both conventional tobacco cigarettes as well as e-cigarettes.

E-cigarettes are categorized as tobacco products and are taxed by the volume of liquid nicotine they contain in Korea. Taxes on e-cigarettes were increased from 821 won to 1799 won per 1 ml (1.64 $/ml) in 2015. However, this led to selling concentrated nicotine solution and flavored liquid solutions separately to avoid the tax. Since solutions without nicotine are tax-free, reducing the taxable volume in e-cigarettes can cause a substantial portion of taxes to be avoided. Consequently, the price of e-cigarettes did not rise as much as the tax levied on them, and uses of e-cigarettes substantially increased (World Bank Group, 2018). Aside from tax avoidance, the mixing of the two solutions by users puts them at risk, as the levels of nicotine concentration in products are often inaccurately labelled, and being exposed to the high nicotine solution can be life-threatening (Davis et al., 2015; Goniewicz et al., 2015).

The evaluation of the effects of the price of tobacco on smoking behaviors using the KCHS had some limitations. First, the KCHS collected data using one-on-one interviews. A social desirability bias might have affected participants' responses regarding smoking-related behaviors. Second, it is difficult to determine the long-term effects of the increase in the price of tobacco on smoking behaviors because the KCHS was conducted between August and October of 2015, only 8 to 10 months after the price increase. Further follow-up studies would be needed to assess the long-term outcomes of this tax policy. Third, the data on smoking behavior influenced by the price increase of tobacco was based on a self-attributed questionnaire assessed only in one session using a cross-sectional design, as opposed to using a longitudinal design with a before and after survey. Therefore, decreased smoking behavior could be assessed differently between individuals, which might lead to misclassification. Therefore, assessing the effect of the price increase with quantitative measures such as number of smoking days and cigarettes smoked is recommended. Fourth, the retrospective nature of this study might have led to recall bias. Smokers who attempted to quit smoking might be more likely to recall trying to quit or reducing the amount they smoked in response to the price increase, as compared to smokers who did not attempt to quit. Similarly, current smokers who have a plan to quit in the near future might have different recall of their behavior in response to the tax increase than those who do not intend to quit (Reed et al., 2008). Therefore, attempts and intention to quit smoking were included in the models to control for the biased recall in this study and prospective study design could be tailored to avoid this problem.

5. Conclusion

The increase in the price of tobacco in 2015 had a substantial impact on smoking behaviors in Korean adults. Smoking reduction was significantly higher in subjects with a lower socioeconomic status and those exposed to public anti-smoking policies, as compared to those with a higher socioeconomic status and those who were not exposed to such policies. Heavy smokers were less likely to reduce smoking, and younger subjects were more likely to use e-cigarettes. These results suggest that additional strategies for smoking cession, especially in heavy smokers and younger subjects, are needed. Further studies are needed to investigate the long-term effects of the price of tobacco on smoking behaviors.

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Declaration of conflicting interests

The author declares no conflicts of interest.

References

Aryal, U.R., Bhatta, D.N., Shrestha, N., Gautam, A., 2015. Assessment of nicotine dependence among smokers in Nepal: a community based cross-sectional study. Tob. Induc. Dis. 13, 26. https://doi.org/10.1186/s12971-015-0053-8.

Bader, P., Boisclair, D., Ferrence, R., 2011. Effects of tobacco taxation and pricing on smoking behavior in high risk populations: a knowledge synthesis. Int. J. Environ. Res. Public Health 8, 4118–4139. https://doi.org/10.3390/ijerph8114118.

Baeza-Loya, S., Viswanath, H., Carter, A., Molfese, D.L., Velasquez, K.M., Baldwin, P.R.,

Thompson-Lake, D.G., Sharp, C., Fowler, J.C., et al., 2014. Perceptions about e-cigarette safety may lead to e-smoking during pregnancy. Bull. Menn. Clin. 78, 243–252. https://doi.org/10.1521/bumc.2014.78.3.243.
Borland, R., Balmford, J., 2003. Understanding how mass media campaigns impact on smokers. Tob. Control. 12 (Suppl. 2), ii45–52.
Chaloupka, F.J., Yurekli, A., Fong, G.T., 2012. Tobacco taxes as a tobacco control strategy. Tob. Control. 21, 172–180. https://doi.org/10.1136/tobaccocontrol-2011-050417.
Cho, H.J., 2014. The status and future challenges of tobacco control policy in Korea. J. Prev. Med. Public Health 47, 129–135. https://doi.org/10.3961/jpmph.2014.47.3.129.
Choi, S.E., 2016. Are lower income smokers more price sensitive?: the evidence from Korean cigarette tax increases. Tob. Control. 25, 141–146. https://doi.org/10.1136/tobaccocontrol-2014-051680.
Cobb, C.O., Hendricks, P.S., Eissenberg, T., 2015. Electronic cigarettes and nicotine dependence: evolving products, evolving problems. BMC Med. 13, 119. https://doi.org/10.1186/s12916-015-0355-y.
Davis, B., Dang, M., Kim, J., Talbot, P., 2015. Nicotine concentrations in electronic cigarette refill and do-it-yourself fluids. Nicotine Tob. Res. 17, 134–141. https://doi.org/10.1093/ntr/ntu080.
DeCicca, P., McLeod, L., 2008. Cigarette taxes and older adult smoking: evidence from recent large tax increases. J. Health Econ. 27, 918–929. https://doi.org/10.1016/j.jhealeco.2007.11.005.
Farrelly, M.C., Bray, J.W., Pechacek, T., Woollery, T., 2001. Response by adults to increases in cigarette prices by sociodemographic characteristics. South. Econ. J. 156–165.
Goniewicz, M.L., Gupta, R., Lee, Y.H., Reinhardt, S., Kim, S., Kim, B., Kosmider, L., Sobczak, A., 2015. Nicotine levels in electronic cigarette refill solutions: a comparative analysis of products from the U.S., Korea, and Poland. Int. J. Drug Policy 26, 583–588. https://doi.org/10.1016/j.drugpo.2015.01.020.
Hwang, J.H., Park, S.W., 2017. Is there differential responsiveness to a future cigarette price increase depending on adolescents' source of cigarette access? Medicine (Baltimore) 96, e7311. https://doi.org/10.1097/md.0000000000007311.
Kang, Y.W., Ko, Y.S., Kim, Y.J., Sung, K.M., Kim, H.J., Choi, H.Y., Sung, C., Jeong, E., 2015. Korea community health survey data profiles. Osong Public Health Res. Perspect. 6, 211–217. https://doi.org/10.1016/j.phrp.2015.05.003.
Kang, E., Lee, J.A., Cho, H.J., 2017. Characteristics of hardcore smokers in South Korea from 2007 to 2013. BMC Public Health 17, 521. https://doi.org/10.1186/s12889-017-4452-z.
Kendler, K.S., Myers, J., Damaj, M.I., Chen, X., 2013. Early smoking onset and risk for subsequent nicotine dependence: a monozygotic co-twin control study. Am. J. Psychiatry 170, 408–413. https://doi.org/10.1176/appi.ajp.2012.12030321.
Knight-West, O., Bullen, C., 2016. E-cigarettes for the management of nicotine addiction. Subst. Abus. Rehabil. 7, 111–118. https://doi.org/10.2147/sar.S94264.
Kwak, J., Jeong, H., Chun, S., Bahk, J.H., Park, M., Byun, Y., Lee, J., Yim, H.W., 2017. Effectiveness of government anti-smoking policy on non-smoking youth in Korea: a 4-year trend analysis of national survey data. BMJ Open 7, e013984. https://doi.org/10.1136/bmjopen-2016-013984.
Lee, S., Kimm, H., Yun, J.E., Jee, S.H., 2011. Public health challenges of electronic cigarettes in South Korea. J. Prev. Med. Public Health 44, 235–241. https://doi.org/10.3961/jpmph.2011.44.6.235.
Lee, J.A., Kim, S.H., Cho, H.J., 2016a. Electronic cigarette use among Korean adults. Int. J. Public Health 61, 151–157. https://doi.org/10.1007/s00038-015-0763-y.
Lee, Y.S., Kim, H.S., Kim, H.D., Yoo, K.B., Jang, S.I., Park, E.C., 2016b. Is a Price increase policy enough for adolescent smokers?: factors affecting the effectiveness of increasing cigarette prices among Korean adolescent smokers. Nicotine Tob. Res. 18, 2013–2019. https://doi.org/10.1093/ntr/ntw122.
Luo, B., Wan, L., Liang, L., Li, T., 2015. The effects of educational campaigns and smoking bans in public places on Smokers' intention to quit smoking: findings from 17 cities in China. Biomed. Res. Int. 2015, 853418. https://doi.org/10.1155/2015/853418.
Meier, E., Tackett, A.P., Wagener, T.L., 2013. Effectiveness of electronic aids for smoking cessation. Curr. Cardiovasc. Risk Rep. 7. https://doi.org/10.1007/s12170-013-0343-8.
Patel, D., Davis, K.C., Cox, S., Bradfield, B., King, B.A., Shafer, P., Caraballo, R., Bunnell, R., 2016. Reasons for current E-cigarette use among U.S. adults. Prev. Med. 93, 14–20. https://doi.org/10.1016/j.ypmed.2016.09.011.
Pierce, J.P., White, V.M., Emery, S.L., 2012. What public health strategies are needed to reduce smoking initiation? Tob. Control. 21, 258–264. https://doi.org/10.1136/tobaccocontrol-2011-050359.
Rath, J.M., Villanti, A.C., Abrams, D.B., Vallone, D.M., 2012. Patterns of tobacco use and dual use in US young adults: the missing link between youth prevention and adult cessation. J. Environ. Public Health 2012, 679134. https://doi.org/10.1155/2012/679134.
Reed, M.B., Anderson, C.M., Vaughn, J.W., Burns, D.M., 2008. The effect of cigarette price increases on smoking cessation in California. Prev. Sci. 9, 47–54. https://doi.org/10.1007/s11121-008-0081-1.
Siqueira, L.M., 2017. Nicotine and tobacco as substances of abuse in children and adolescents. Pediatrics 139. https://doi.org/10.1542/peds.2016-3436.
St Helen, G., Havel, C., Dempsey, D.A., Jacob 3rd, P., Benowitz, N.L., 2016. Nicotine delivery, retention and pharmacokinetics from various electronic cigarettes. Addiction 111, 535–544. https://doi.org/10.1111/add.13183.
Tabuchi, T., Nakamura, M., Nakayama, T., Miyashiro, I., Mori, J., Tsukuma, H., 2016. Tobacco price increase and smoking cessation in Japan, a developed country with affordable tobacco: a National Population-Based Observational Study. J. Epidemiol. 26, 14–21. https://doi.org/10.2188/jea.JE20140183.
Tabuchi, T., Fujiwara, T., Shinozaki, T., 2017. Tobacco price increase and smoking behaviour changes in various subgroups: a nationwide longitudinal 7-year follow-up study among a middle-aged Japanese population. Tob. Control. 26, 69–77. https://doi.org/10.1136/tobaccocontrol-2015-052804.
The World Bank, 1999. Curbing the epidemic: governments and the economics of tobacco control. The World Bank. Tob. Control. 8, 196–201.
Vardavas, C.I., Filippidis, F.T., Agaku, I., Mytaras, V., Bertic, M., Connolly, G.N., Tountas, Y., Behrakis, P., 2012. Tobacco taxation: the importance of earmarking the revenue to health care and tobacco control. Tob. Induc. Dis. 10, 21. https://doi.org/10.1186/1617-9625-10-21.
World Bank Group, 2018. Reducing Tobacco Use Through Taxation: the Experience of the Republic of Korea, Washington.
Wright, A., Smith, K.E., Hellowell, M., 2017. Policy lessons from health taxes: a systematic review of empirical studies. BMC Public Health 17, 583. https://doi.org/10.1186/s12889-017-4497-z.
Yun, W.J., Rhee, J.A., Kim, S.A., Kweon, S.S., Lee, Y.H., Ryu, S.Y., Park, S.W., Kim, D.H., Shin, M.H., 2015. Household and area income levels are associated with smoking status in the Korean adult population. BMC Public Health 15, 39. https://doi.org/10.1186/s12889-015-1365-6.
Zahra, A., Cheong, H.K., Lee, E.W., Park, J.H., 2016. Burden of disease attributable to secondhand smoking in Korea. Asia Pac. J. Public Health 28, 737–750. https://doi.org/10.1177/1010539516667779.
Zahra, A., Cheong, H.K., Park, J.H., 2017. Burden of disease attributable to smoking in Korea. Asia Pac. J. Public Health 29, 47–59. https://doi.org/10.1177/1010539516675696.
Zawahir, S., Omar, M., Awang, R., Yong, H.H., Borland, R., Sirirassamee, B., Fong, G.T., Hammond, D., 2013. Effectiveness of antismoking media messages and education among adolescents in Malaysia and Thailand: findings from the international tobacco control southeast Asia project. Nicotine Tob. Res. 15, 482–491. https://doi.org/10.1093/ntr/nts161.