

Effects of an 80% cigarette price increase on quit attempts, successful quitting and smoking intensity among Korean adult smokers: results from nationally representative longitudinal panel data

Boram Lee, Dong-Chul Seo 

Department of Applied Health Science, Indiana University School of Public Health—Bloomington, Bloomington, Indiana, USA

Correspondence to

Dr Dong-Chul Seo, Department of Applied Health Science, Indiana University School of Public Health—Bloomington, Bloomington, IN 47405, USA; seo@indiana.edu

Received 20 November 2019

Revised 18 February 2020

Accepted 11 March 2020

ABSTRACT

Objectives South Korea implemented an unprecedented cigarette tax increase in 2015, raising its cigarette price by 80%. This study evaluated the extent to which the 2015 cigarette tax increase affected Korean adult smokers in terms of quit attempts, successful quitting and smoking intensity.

Methods Data were drawn from a nationally representative longitudinal study, the Korean Welfare Panel Study (waves 9–12, 2014–2017). Korean adults who smoked before the 2015 cigarette tax increase comprised the sample (n=2114). We used the multiple logistic regressions to examine factors of quit attempts and successful quitting and the generalised estimating equations to estimate changes in smoking intensity among continued smokers.

Results After the cigarette tax increase, 60.9% (n=1334) of baseline smokers attempted to quit and 34.7% of the attempters succeeded in quitting. The smokers aged ≥ 65 years and light smokers both attempted more ($p < 0.01$) and succeeded more ($p < 0.05$) in quitting than smokers aged 35–44 years and heavy smokers, respectively. The successful quitting was not significantly associated with income levels. Depressive symptoms, first cigarette use before age 19 and smoking a pack or more a day at baseline were associated with failures in quitting. Smoking intensity among continued smokers decreased after the cigarette tax increase ($p < 0.001$), but such a decrease was not observed in light smokers, young smokers and high-income smokers.

Conclusion The current study findings imply that the Korean government may consider implementing periodic increases in cigarette tax which should reflect the rate of inflation and income growth. Smoking cessation programmes need to address depressive symptoms.

INTRODUCTION

Smoking has been one of the major health threats in South Korea with the adult male smoking prevalence at 38.1% in 2017.^{1,2} Partly triggered by one of the highest adult male smoking prevalences (43.2% in 2014) and the lowest retail price of a 20-cigarette pack among the 34 members of the Organization for Economic Cooperation and Development, the Korean government raised a cigarette tax by 114% (from 1550 won to 3318 won) on 1 January 2015, about 10 years after the previous cigarette tax increase.³ It resulted in an increase in cigarette price by 80%, from 2500 won (approximately US\$2.35) to 4500 won (approximately US\$4.23) per pack on

average. This cigarette price increase was four times greater than the last cigarette price increase on 30 December 2004. The purpose of this study was to evaluate how the unprecedented large cigarette tax hike in 2015 disproportionately affected quit attempts, successful quitting and smoking intensity of Korean adult smokers.

Although it is well documented that a cigarette tax increase is one of the most effective measures to control tobacco use,⁴ there has been a heated debate regarding the Korean government's decision to impose such a cigarette tax hike.^{3,5} The centre of the debate was a disagreement about the notion that low-income smokers would benefit from a large cigarette tax increase. Some experts argued the 2015 tax increase would reduce not only overall smoking prevalence but also socioeconomic disparities in smoking.^{3,6} This argument was based on previous findings that low-income smokers were more sensitive to changes in cigarette price than middle-income or high-income smokers.^{7–9} By contrast, given the pertinacious addictiveness of nicotine and high smoking prevalence in low-income populations in Korea, others were concerned about the regressivity of cigarette taxes, that is, low-income people relatively bear greater financial burden than high-income people.^{4,6}

Previous literature indicates that income, educational attainment and nicotine addiction are significant predictors for responsiveness to cigarette tax increases.^{7–9} Prior studies also suggest that smokers who are older than 60 years are more sensitive to cigarette tax increases than their counterparts.^{10,11} However, most previous studies were based on either cross-sectional data^{6,12,13} or aggregated data.¹⁴ Besides, few studies examined effects of a cigarette tax increase on successful quitting separately from quit attempts.¹⁵ The present study attempted to evaluate the extent to which the 2015 cigarette tax increase affected Korean adult smokers in terms of quit attempts, successful quitting and smoking intensity using 4 years of longitudinal panel data (2014 to 2017) of a nationally representative sample of Korean adults.

Additionally, this research can provide empirical evidence on effects of a large cigarette tax increase in Asia.^{16,17} Most previous findings investigated effects of either small increases in cigarette prices or cigarette taxations in western developed countries.^{7,8} The 2015 cigarette tax increase in Korea was implemented in a context where 43.2% of male



© Author(s) (or their employer(s)) 2020. No commercial re-use. See rights and permissions. Published by BMJ.

To cite: Lee B, Seo D-C. *Tob Control* Epub ahead of print: [please include Day Month Year]. doi:10.1136/tobaccocontrol-2019-055518

adults and 5.7% of female adults were current smokers; 91% of male adult current smokers were daily smokers; and 4.4% of male adults and 0.1% of female adults were current electronic cigarette (e-cigarette) users in 2014.¹ Considering that many low-income and middle-income countries experience similar high male smoking prevalence, this evaluation research on the 2015 cigarette tax increase in Korea may provide important policy implications for other countries.^{3 18}

METHODS

Data

We analysed data from an ongoing nationally representative panel study, the Korean Welfare Panel Study (KOWEPS). KOWEPS is the second largest longitudinal panel in South Korea who were sampled by two-stage stratified cluster sampling with oversampling of low-income households.¹⁹ The retention rate for wave 12 was 62.2%. Details can be found elsewhere (www.KOWEPS.re.kr). For this study, we extracted data from wave 9 (collected in March to August of 2014) to wave 12 (collected in February to May of 2017) to evaluate the latest cigarette tax increase which has been effective since 1 January 2015. We treated wave 9 as the baseline and followed the sample up to wave 12. Korean adults who were 19 years old or older and smoked cigarettes before the 2015 cigarette tax increase comprised the initial sample of the study (n=2593). We excluded 479 respondents who did not answer to any of the follow-up surveys, reducing the analysis sample to 2114. The dropout respondents were more likely to be unmarried and younger than those who remained in the analysis sample, but their differences were non-significant in terms of sex, income level, educational attainment, smoking quantity, initial smoking age and depressive symptoms.

Measures

Three outcomes were examined: quit attempts, successful quitting and smoking intensity. Quit attempts were coded dichotomously (yes/no). Those who reported quitting more than 24 hours in the past 12 months measured at wave 11 or wave 12 were coded as yes to quit attempts. Those who reported quitting attempts at wave 10 were not counted as yes because their quit attempts might have happened before the tax increase, considering that wave 10 data were collected from March to June of 2015 and the cigarette tax hike occurred in January 2015. Those who reported non-current smoking in any of the follow-up waves (ie, waves 10–12) were also coded as yes. Considering the sample of this study were all current smokers at baseline, reporting non-current smoking at follow-up waves implies quit attempts after the tax increase. Successful quitting was defined as abstinence at wave 10 or wave 11 and continued abstinence at all the subsequent waves. For example, if a respondent reported abstinence at wave 10 and consistently reported abstinence at wave 11 and wave 12, we coded the respondent as a successful quitter. However, if a respondent reported abstinence at wave 10 but current smoking at wave 11 or wave 12, the respondent was not a successful quitter. Successful quitters were defined only from those who made quit attempts. Those who reported current smoking in all the three follow-up waves (ie, waves 10–12) were defined as continued smokers. We assessed changes in their smoking intensity using a self-reported average number of cigarettes smoked per day.

We included in the analysis model sociodemographic characteristics that have shown associations with smoking behaviours, such as age groups (19–24, 25–34, 35–44, 45–54, 55–64 and 65 or more), sex (male, female), marital status (married,

unmarried), educational attainment (less than high school, high school, some college or more) and income levels.^{10 20} Individual income levels were measured based on equivalised disposable income which was calculated by dividing the reported disposable household income by the square root of the number of household members.²¹ This method has been used to assess individual purchasing power accounting for the size and composition of household.²² Then, the equivalised disposable income was divided into quintile levels according to the four cut-off values drawn from the Korean Statistical Information Service.

Smoking quantity at baseline, age of first cigarette use and having a plan to quit at baseline were also included in the model as they are covariates that may affect the outcomes of the present study.^{12 23 24} We categorised smoking quantity at baseline into (1) light (less than 10 cigarettes per day), (2) moderate (10–19 cigarettes per day) and (3) heavy (20 cigarettes or more per day). Age of first cigarette use was dichotomised based on the minimum legal age for tobacco purchase in South Korea (ie, <19 years or ≥19 years). Having a plan to quit at baseline was also coded dichotomously (yes/no).

Depressive symptoms and self-rated health were also included as they are related to smoking behaviour.^{25 26} Depressive symptoms were measured with the Korean version of the Center for Epidemiological Studies Depression scale (CES-D-11) which is a validated short-form of the original CES-D.²⁷ The CES-D-11 contains 11 items rated on a 4-point Likert scale about depressive symptoms in the past week. A higher score indicates more depressive symptoms. Self-rated health was dichotomised as poor (fair, poor or very poor health) or good (good or very good).

Analysis

After we examined descriptive statistics of each variable at baseline (wave 9) to understand the characteristics of the sample as well as variable distributions, we compared frequencies and percentages of categorical covariates and mean values of continuous covariates between quit attempters and non-attempters and then between successful quitters and non-successful quitters. We performed multiple logistic regressions to examine ORs of different levels of covariates for both quit attempts and successful quitting. We also estimated if the 2015 cigarette tax increase was associated with smoking intensity among continued smokers using the generalised estimating equations (GEEs) with unstructured correlation structure. The GEE models took into account autocorrelations in error terms among the within-person repeated measures.²⁸ In addition, we examined multiplicative interaction terms of the cigarette tax increase with socio-demographic characteristics, smoking-related characteristics, depressive symptoms and self-rated health in separate models. All parameter estimates were weighted based on the KOWEPS complex survey sampling scheme to obtain nationally representative estimates. We used Stata V.15.1 for all statistical analyses.

RESULTS

Table 1 presents descriptive statistics of the adult cigarette smokers who comprised the sample of this study at baseline (n=2114). About 94% of the smokers were male, which reflects the disproportionately higher smoking prevalence in men (38.1% in 2017) than in women (6.0% in 2017) in South Korea.¹ Most smokers (69.7%) began smoking after the age of 19 and half of the smokers were heavy smokers, smoking at least one pack of cigarettes a day.

Out of 2114 smokers at baseline, 1334 smokers (60.9% in weighted percentage) attempted to quit but only 481 smokers

Table 1 Descriptive statistics of the adult cigarette smokers at baseline (wave 9) (N=2114)

	n	Weighted %
Age (years)		
19–24	62	4.1
25–34	272	18.3
35–44	559	28.0
45–54	469	26.6
55–64	326	14.6
65 or older	426	8.4
Sex		
Male	1935	94.1
Female	179	5.9
Marital status		
Married	1381	65.3
Unmarried	733	34.7
Educational attainment		
Less than high school	666	19.7
High school	771	37.3
Some college or more	677	43.0
Income level		
First quintile (bottom 20%)	480	13.3
Second quintile	424	17.4
Third quintile	471	23.5
Fourth quintile	431	25.7
Fifth quintile (top 20%)	308	20.1
Depressive symptoms (mean, SD)	5.87, 8.02	
Self-rated health		
Good	1388	75.19
Poor	726	24.81
Age of first cigarette use		
Before 19 years	617	30.3
19 years or later	1497	69.7
Smoking quantity		
Light	331	14.8
Moderate	744	36.1
Heavy	1039	49.1
Having a plan to quit		
No	1289	58.2
Yes	825	41.8

(21.1% of the sample, 34.7% of the attempters in weighted percentages) succeeded in quitting during the study period. Smokers were more likely to attempt to quit if smokers were 65 years of age or older (adjusted OR (AOR)=1.72, 95% CI=1.10 to 2.68), light smokers (AOR=1.73, 95% CI=1.18 to 2.53) or moderate smokers (AOR=1.49, 95% CI=1.13 to 1.95) compared with their counterparts, controlling for other covariates (table 2). Marital status, educational attainment, depressive symptoms, self-rated health and the age of first cigarette use were not associated with quit attempts.

Being female (AOR=2.29, 95% CI=1.36 to 3.86), earning the highest quintile of income (AOR=1.69, 95% CI=1.14 to 2.50) or having a plan to quit (AOR=1.82, 95% CI=1.41 to 2.36) at baseline were also associated with more quit attempts but not successful quitting. Smokers who were 45 years of age or older and light smokers (AOR=1.74, 95% CI=1.14 to 2.67) showed significantly higher odds of successful quitting than their counterparts. Quit attempters with depressive symptoms (AOR=0.98, 95% CI=0.95 to 0.99), and who started smoking

before age 19 (AOR=0.66, 95% CI=0.45 to 0.96) were less likely to successfully quit than their counterparts. Marital status, educational attainment and self-rated health were not associated with successful quitting.

Table 3 shows the results of GEE models of smoking intensity among continued smokers. As indicated in model 1, the smoking intensity significantly decreased after the cigarette tax increase ($p<0.001$), controlling for other variables. When we entered sequentially interaction terms between the cigarette tax increase and each of the independent variables, the decrease in smoking intensity after the tax increase differed by smokers' age, marital status, income level and smoking quantity at baseline (figures 1 and 2). Figure 1 shows different effects of the cigarette tax increase on smoking intensity by equalised disposable income and figure 2 by smoking quantity among continued smokers. Smoking intensity did not significantly decrease among continued smokers aged 19–34 years, unmarried or with the highest income level (ie, fifth quintile). Interestingly, smoking intensity significantly increased among light and moderate smokers ($p<0.001$), whereas the number of cigarettes smoked per day among heavy smokers declined from 22.49 to 19.24 after the tax increase ($p<0.001$) (figure 2).

DISCUSSION

Quit behaviours and reduced smoking intensity in elderly smokers

This study evaluated the extent to which an 80% cigarette price increase in Korea disproportionately affected quit attempts, successful quitting and smoking intensity across different groups of Korean adult smokers, using 4 years of prospective data in a nationally representative sample of Korean adults. The large cigarette price increase affected elderly smokers most as they showed both high rates of quit attempts and successful quitting as well as a large decrease in smoking intensity after the tax hike in the adjusted model. Although the high responsiveness to cigarette taxation among Korean elderly smokers was observed in another study with a different nationally representative data set,¹⁰ it may seem to conflict with the generally known belief that young generations are more sensitive than old generations to a cigarette price change.^{26 29} A possible explanation for this may have to do partly with differences in the sample and outcomes between the present study and previous studies supporting the conventional belief. Most prior studies supporting the high responsiveness to cigarette taxation in young populations evaluated both smoking initiation and smoking intensity using samples of the general population including non-smokers.^{8 13} However, the sample of the present study was adult current smokers who were followed up prospectively on quitting and smoking intensity. Indeed, previous findings focusing on smoking cessation of current smokers indicate that older adult smokers are more likely to quit after a cigarette tax increase than young adult smokers.¹¹

Given that the age group disparity in the cigarette tax responsiveness was above and beyond the effect of other variables in the model, including income level and smoking quantity, this finding implies that some factors other than income and nicotine addiction may help drive elderly smokers more responsive to the cigarette price increase. Although it is speculative, elderly adults may be more sensitive to the price changes than younger counterparts due to a concern about limited or stagnant future income flow and a revived concern about tobacco-induced health harm triggered by the price increase.³⁰ When we compared the income growth over the study period among different age groups, the smallest income growth was found in the elderly smokers aged 65 or older. As there

Table 2 Quit attempts and successful quitting among adult smokers after the 2015 cigarette tax increase in South Korea, 2014–2017

At baseline (2014)	Quit attempts (n=1334)		Successful quitting (n=481)	
	% or mean	AOR (95% CI)	% or mean	AOR (95% CI)
Age (years)				
19–24	69.6	1.79 (0.82 to 3.92)	33.9	1.26 (0.51 to 3.11)
25–34	58.1	0.99 (0.64 to 1.52)	35.1	1.44 (0.84 to 2.46)
35–44	59.7	Ref	26.3	Ref
45–54	57.7	1.14 (0.83 to 1.60)	38.8	1.81 (1.15 to 2.86)
55–64	64.2	1.33 (0.88 to 2.01)	34.0	1.76 (1.05 to 2.96)
65 or older	71.1	1.72 (1.10 to 2.68)	48.2	3.64 (1.93 to 5.97)
Sex				
Male	59.8	Ref	34.1	Ref
Female	78.7	2.29 (1.36 to 3.86)	42.1	1.33 (0.73 to 2.43)
Marital status				
Married	60.9	1.12 (0.83 to 1.49)	34.4	0.89 (0.61 to 1.30)
Unmarried	60.9	Ref	35.3	Ref
Educational attainment				
Less than high school	63.1	0.91 (0.63 to 1.31)	35.2	0.77 (0.49 to 1.22)
High school	60.3	Ref	34.0	Ref
Some college or more	60.4	0.90 (0.67 to 1.22)	35.1	0.97 (0.65 to 1.43)
Income level				
First quintile (bottom 20%)	67.1	1.41 (0.90 to 2.21)	37.4	1.17 (0.68 to 2.03)
Second quintile	56.3	1.01 (0.70 to 1.44)	28.3	0.87 (0.53 to 1.45)
Third quintile	55.1	Ref	30.6	Ref
Fourth quintile	62.2	1.31 (0.92 to 1.87)	38.6	1.24 (0.80 to 1.95)
Fifth quintile (top 20%)	67.8	1.69 (1.14 to 2.50)	38.1	1.27 (0.77 to 2.08)
Depressive symptoms	5.81 to 5.98*	0.99 (0.97 to 1.01)	5.12 to 6.17†	0.98 (0.95 to 0.99)
Self-rated health				
Good	59.2	Ref	35.9	
Poor	66.0	1.28 (0.94 to 1.75)	31.5	0.76 (0.52 to 1.12)
Age of first cigarette use				
Before 19 years	58.7	1.00 (0.77 to 1.31)	27.8	0.66 (0.45 to 0.96)
19 years or later	61.9	Ref	37.5	Ref
Smoking quantity				
Light	71.9	1.73 (1.18 to 2.53)	44.2	1.74 (1.14 to 2.67)
Moderate	65.4	1.49 (1.13 to 1.95)	35.2	1.19 (0.83 to 1.69)
Heavy	54.3	Ref	30.5	Ref
Having a plan to quit				
No	55.0	Ref	34.1	Ref
Yes	69.2	1.82 (1.41 to 2.36)	35.3	0.92 (0.66 to 1.26)

Reference groups of categorical variables were chosen based on categories of interest and adequate cell sizes. Bolded values indicate statistical significance at the 0.05 level.

*Mean scores of attempters and non-attempters.

†Mean scores of successful quitters and non-successful quitters.

AOR, adjusted OR; Ref, reference group.

is a paucity of data on this area, future research is warranted to investigate the determinants that drive elderly smokers responsive to a cigarette price increase.

Income differential in impacts of cigarette taxation

A noteworthy finding was that low-income smokers were not more likely to succeed in quitting than middle-income smokers in the adjusted model despite the high quit attempt rate among low-income smokers. The decrease in smoking intensity after the tax increase among low-income smokers was only about one cigarette. These results do not support the expectation of the Korean government that an increase in cigarette tax would lead to a decrease in socioeconomic disparities in tobacco use by inducing quitting more in low-income smokers than in middle-income or high-income smokers based on prior study findings.^{8 31} Indeed, a large body

of evidence supports that low-income smokers are more responsive to a cigarette tax increase than others.^{7 8 17 32} To the contrary, however, the results of the present study support a concern about the regressivity of cigarette taxes. Wilson and Thomson (2005) underlined the unintended consequence of cigarette taxation that may impose greater financial burden on low-income smokers who do not want to or cannot quit.³³ To alleviate these concerns, the increased revenues generated by cigarette taxes should be allocated to health promotion programmes, including smoking cessation programmes, for low-income smokers.⁴

There is another important factor that should be considered in examining the effect of a cigarette tax increase on reducing socioeconomic disparities in tobacco use. Literature reports that any positive effects of cigarette taxation can dwindle if the cigarette tax is not raised commensurately with inflation and income growth.²⁹

Table 3 Smoking intensity among continued smokers over 4 years (2014–2017) using the generalised estimating equations (n=1361)

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coef.	P value	Coef.	P value	Coef.	P value	Coef.	P value	Coef.	P value	Coef.	P value
2015 tax increase	-0.82	<0.001	-0.82	<0.001	-1.35	<0.001	0.12	0.694	-1.08	0.005	-3.14	<0.001
Age at baseline (years)												
19–24			-1.41	0.005	-3.30	<0.001	-1.68	0.001	-1.74	0.001	-1.68	0.001
25–34			-0.06	0.908	-1.58	0.002	-0.14	0.781	-0.16	0.761	-0.15	0.769
35–44			Ref									
45–54			0.51	0.184	0.15	0.754	0.49	0.212	0.49	0.209	0.51	0.196
55–64			-0.07	0.923	0.09	0.901	0.13	0.846	0.16	0.818	0.16	0.822
65 or older			-1.44	0.008	-0.87	0.161	-1.28	0.022	-1.26	0.024	-1.29	0.021
Married (vs unmarried)			-0.56	0.128	-0.62	0.087	0.25	0.508	-0.58	0.104	-0.58	0.111
Income level												
First quintile (bottom 20%)			-0.39	0.325	-0.51	0.216	-0.49	0.234	-0.42	0.410	-0.47	0.250
Second quintile			0.21	0.497	-0.22	.476	-0.21	0.504	-0.43	0.323	-0.22	0.460
Third quintile			Ref									
Fourth quintile			0.19	0.545	0.31	0.335	0.29	0.359	0.02	0.972	0.32	0.312
Fifth quintile (top 20%)			0.34	0.374	0.37	0.344	0.34	0.375	-0.69	0.217	0.45	0.240
Smoking quantity												
Light			-12.63	<0.001	-12.48	<0.001	-12.49	<0.001	-12.46	<0.001	-16.92	<0.001
Moderate			-8.34	<0.001	-8.20	<0.001	-8.20	<0.001	-8.18	<0.001	-11.07	<0.001
Heavy			Ref									
Age*tax												
19–24*tax					2.52	0.004						
25–34*tax					2.28	<0.001						
35–44*tax					Ref							
45–54*tax					0.58	0.300						
55–64*tax					0.08	0.906						
65 or older*tax					-0.65	0.293						
Married*tax							-1.27	0.002				
Income*tax												
First quintile*tax									-0.20	0.753		
Second quintile*tax									0.22	0.687		
Third quintile*tax									Ref			
Fourth quintile*tax									0.36	0.522		
Fifth quintile*tax									1.37	0.031		
Smoking quantity*tax												
Light*tax											7.22	<0.001
Moderate*tax											4.67	<0.001
Heavy*tax											Ref	
Intercept	16.62	<0.001	21.44	<0.001	21.52	<0.001	20.55	<0.001	21.40	<0.001	22.59	<0.001

Model 1 regressed smoking intensity on the 2015 cigarette tax increase. Model 2 added individual sociodemographic characteristics, smoking characteristics, depressive symptoms and self-rated health to model 1. Models 3–6 added interaction terms of the 2015 tax increase with age group, marital status, income level and smoking quantity, respectively. All the regression models were adjusted for sex, educational attainment, depressive symptoms, age of first cigarette use and having a plan to quit in addition to age group, marital status, income level and smoking quantity across models 2–6. Coef., coefficient; Ref, reference group; tax, the 2015 cigarette tax increase.

Even though the Korean cigarette price was remarkably increased by 80% as a result of the 114% cigarette tax hike in 2015, the cigarette price in Korea is still one of the lowest in the world when gross domestic product per capita is considered.³⁴ This is mainly because the cigarette price in Korea did not change for 10 years from 2005 to 2014. Actually, cigarettes in Korea even after the 80% price increase were more affordable to purchase in 2015 compared with 10 years ago in terms of consumers' purchasing power where per capita income and inflation were considered during the same period.³⁵ Taken together, the amount of cigarette price increase generated by the 2015 tax increase may not be large enough to lead smokers, especially low-income smokers, to quit or reduce tobacco consumption. A cigarette price increase lagging inflation

and income growth may not be impactful. It calls for additional and periodic increases in cigarette tax to keep pace with the rate of inflation and consumer income growth.⁴

Quit attempts versus successful quitting

Another finding that deserves mention is that predictors for successful quitting were different from predictors for quit attempts while both might have been triggered partly by the cigarette tax hike. Whereas quit attempts are considered as a key process leading to smoking cessation, most quit attempts fail.^{15 36} Thus, it is important to understand what differentiates successful quitters from unsuccessful quitting attempters.¹⁵ The results of the present study indicate that early onset of cigarette use, heavy

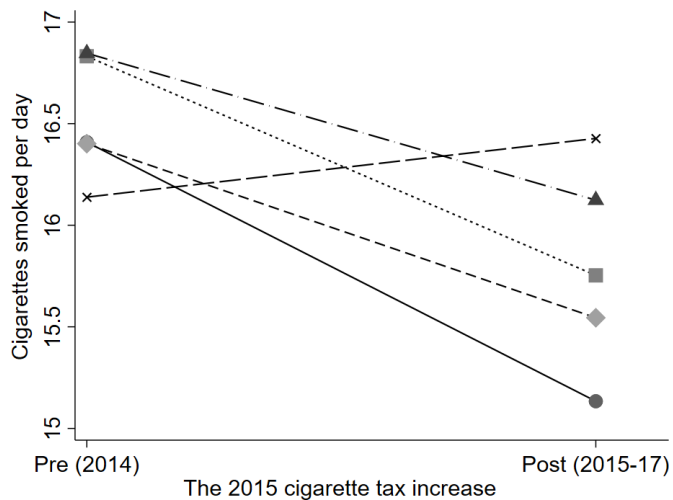


Figure 1 Different effects of the 2015 cigarette tax increase on smoking intensity by equivalised disposable income among continued smokers. ●— First quintile, —◇— second quintile, —■— third quintile, —▲— fourth quintile and —×— fifth quintile.

smoking and depressive symptoms may be risk factors for unsuccessful quitting among Korean smokers, whereas early-onset and depressive symptoms may not be risk factors against quit attempts. This means that motivations to quit may not be that different among smokers regardless of early-onset and depressive symptoms. However, when it comes to successful quitting, early-onset and depressive symptoms appear to make a difference. Early initiation of smoking and heavy smoking are closely related to nicotine dependence,^{37 38} which is a strong predictor for relapse.³⁹ Thus, such smokers may not succeed more in long-term cessation compared with those relatively less addicted to nicotine. Although the exact mechanism by which depressive smokers have an increased difficulty quitting is unclear, literature is robust that smokers with depressive symptoms experience more difficulties in long-term cessation than non-depressed smokers even if their desire to quit is similar or even greater than non-depressed smokers.^{25 40 41} A potential explanation may be related to low self-efficacy, strong withdrawal symptoms,

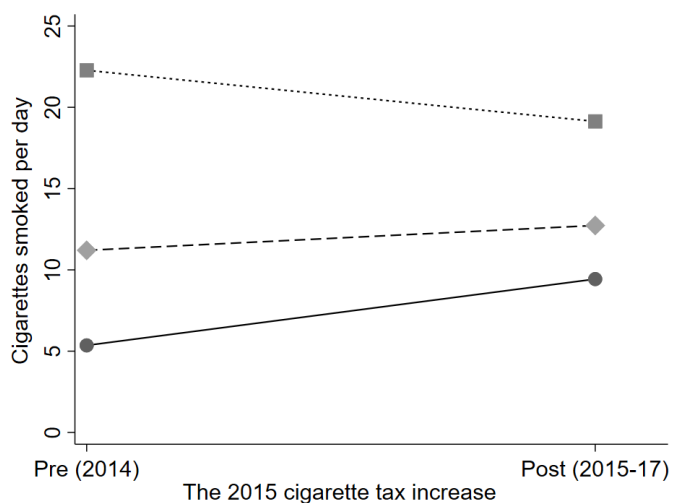


Figure 2 Different effects of the 2015 cigarette tax increase on smoking intensity by smoking quantity at baseline among continued smokers. ●— Less than 10 cigarettes per day, —◇— 10-19 cigarettes per day and —■— 20 cigarettes or more per day.

ineffective coping behaviours and distorted perception about quitting among depressed smokers.⁴²⁻⁴⁴ These findings support the need for smoking cessation interventions tailored to mental health condition of the participants and warrant future research on the interplay between depression and quitting including identification of moderators and mediators affecting the relation.

Heavy smokers versus light smokers

A finding of note was that heavy smokers who smoked 20 cigarettes or more before the tax increase showed the greatest reduction in cigarette consumption although they did not succeed more in quitting than light smokers. As reduced amount of cigarette consumption is likely translated into reduced harm to the smokers' health, this responsiveness is a positive result of the cigarette tax increase, alleviating or possibly offsetting part of the regressive effect of the cigarette tax. This positive effect of the cigarette tax increase was observed in other studies too.^{17 24 45} On the other hand, contrary to popular belief, light smokers who smoked less than 10 cigarettes a day before the tax increase showed an increase in smoking intensity while, on the average, they attempted more and succeeded more in quitting. This could be due to some light smokers who were already on the trajectory of increasing cigarette consumption or who perceived little impact of the cigarette price increase on their budget given their small number of cigarettes smoked a day. This interpretation is only speculative and warrants further research to characterise this group of light smokers.

This study has limitations. First, we could not consider the use of other tobacco products such as e-cigarettes because of unavailability of such variables in the secondary data. E-cigarette use may have been affected by the cigarette tax increase. Prior studies showed that interests and actual use of e-cigarettes increased within a year after the 2015 tax increase.^{1 10 46} Although such an increase might have coincided with the secular trend of e-cigarette use popularity, it warrants further research that investigates possible cross-over effects between the cigarette price increase and e-cigarette use for a better understanding of the overall effects of the 2015 cigarette taxation.^{10 47} Second, our findings on young adult smokers aged 19 to 24 years need a cautious interpretation because of the small cell size ($n=62$). Such a small cell size may lead to unstable parameter estimates and may have confounded study findings. Third, measurement issues such as reporting bias and recall bias might have confounded findings due to self-reported responses. Fourth, it is possible that other tobacco control policies and programmes implemented in South Korea during the same time period might have confounded our study findings. Fifth, unmeasured confounding factors might have influenced the prospective associations between the cigarette price increase and the three major outcomes of the present study.

Despite the limitations, the present research contributes to the literature by providing valuable data on the effect of an 80% cigarette price increase on adult smokers' quit attempts, successful quitting and smoking intensity in a non-western country where more than 40% of male adults smoked cigarettes at the time of the cigarette price increase. Considering many low-income and middle-income countries experience similar high male smoking prevalence, the present study may provide important policy implications for such.^{3 18} Our findings indicate that the large cigarette tax increase helped elderly smokers and light smokers quit but did not effectively lead low-income smokers to quit. One of the main implications is that a cigarette price increase lagging inflation and income growth may not be as impactful as

it should. It is recommended that cigarette prices be periodically evaluated and raised to keep pace with the rate of inflation and consumer income growth.

What this paper adds

What is already known on this subject

- ▶ A cigarette tax increase is one of the most effective measures to control tobacco use. The Korean government raised a cigarette tax by 114% in 2015 to reduce smoking prevalence and socioeconomic disparities in smoking.

What important gaps in knowledge exist on this topic

- ▶ Given the high cigarette tax hike in a country where more than 40% of male adults were current smokers, there is a need for evaluating the effect of such a tax hike on quitting behaviour and a possible influence on socioeconomic disparities in smoking.

What this paper adds

- ▶ This study addresses the knowledge gap by investigating the impact of the recent cigarette tax hike on adult smokers' quit attempts, successful quitting, and smoking intensity, using a nationally representative longitudinal panel of Korean adults (2014–2017). The large tax increase helped elderly smokers and light smokers quit but did not effectively lead low-income smokers to quit. A main implication is that a cigarette tax increase that falls short of inflation and income growth may not be as impactful as it should.

Contributors BL conducted data analysis and drafted the manuscript. D-CC contributed to the conceptualisation of this study, supervised data analysis, interpreted findings and provided critical revisions. Both authors approved the final version.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository. This study used wave 9 to wave 12 data of the KOWEPS. KOWEPS is the second largest longitudinal panel in South Korea who were sampled by two-stage stratified cluster sampling with oversampling of low-income households. Data can be requested by visiting www.KOWEPS.re.kr.

ORCID iD

Dong-Chul Seo <http://orcid.org/0000-0002-1972-6237>

REFERENCES

- 1 Korea Centers for Disease Control and Prevention (KCDC). Korea National health and nutrition examination survey (KNHANES) 2014–2017. Available: http://kosis.kr/statisticsList/statisticsListIndex.do?menuId=M_01_01&vwcd=MT_ZTITLE&parmTabld=M_01_01#SelectStatsBoxDiv [Accessed 19 Nov 2019].
- 2 Zahra A, Cheong H-K, Park J-H. Burden of disease attributable to smoking in Korea. *Asia Pac J Public Health* 2017;29:47–59.
- 3 Cherukupalli R. Korea's 2015 cigarette Tax increases. *Tob Control* 2016;25:123–4.
- 4 Chaloupka FJ, Yurekli A, Fong GT. Tobacco taxes as a tobacco control strategy. *Tob Control* 2012;21:172–80.
- 5 Choi SE. Impact of 2015 Korean cigarette Tax increase on lower income people. *J Addict Res Ther* 2017;8:306–7.
- 6 Choi SE. Are lower income smokers more price sensitive?: the evidence from Korean cigarette Tax increases. *Tob Control* 2016;25:141–6.
- 7 Bader P, Boisclair D, Ferrence R. Effects of tobacco taxation and pricing on smoking behavior in high risk populations: a knowledge synthesis. *Int J Environ Res Public Health* 2011;8:4118–39.
- 8 Thomas S, Fayter D, Misso K, et al. Population tobacco control interventions and their effects on social inequalities in smoking: systematic review. *Tob Control* 2008;17:230–7.
- 9 Frieden TR, Mostashari F, Kerker BD, et al. Adult tobacco use levels after intensive tobacco control measures: new York City, 2002–2003. *Am J Public Health* 2005;95:1016–23.
- 10 Han MA. The price of tobacco and its effects on smoking behaviors in Korea: the 2015 Korea community health survey. *Prev Med* 2019;120:71–7.
- 11 Tabuchi T, Fujiwara T, Shinozaki T. 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* 2017;26:69–77.
- 12 Boyle RG, Stanton CA, Sharma E, et al. Examining quit attempts and successful quitting after recent cigarette Tax increases. *Prev Med* 2019;118:226–31.
- 13 van Hasselt M, Kruger J, Han B, et al. The relation between tobacco taxes and youth and young adult smoking: what happened following the 2009 U.S. federal Tax increase on cigarettes? *Addict Behav* 2015;45:104–9.
- 14 Gallus S, Schiaffino A, La Vecchia C, et al. Price and cigarette consumption in Europe. *Tob Control* 2006;15:114–9.
- 15 Rafful C, García-Rodríguez O, Wang S, et al. Predictors of quit attempts and successful quit attempts in a nationally representative sample of smokers. *Addict Behav* 2013;38:1920–3.
- 16 Huang J, Zheng R, Chaloupka FJ, et al. Differential responsiveness to cigarette price by education and income among adult urban Chinese smokers: findings from the ITC China survey. *Tob Control* 2015;24 Suppl 3:iii76–82.
- 17 Lee J-M. Effect of a large increase in cigarette tax on cigarette consumption: an empirical analysis of cross-sectional survey data. *Public Health* 2008;122:1061–7.
- 18 Goodchild M, Perucic A-M, Nargis N. Modelling the impact of raising tobacco taxes on public health and finance. *Bull World Health Organ* 2016;94:250–7.
- 19 Korea Institute for Health and Social Affairs. *Users' guide: Korea welfare panel study. social welfare research Institute of Seoul National University*. Seoul: Korean Institute of Social and Health Affairs, Social Welfare Research Institute of Seoul National University, 2018.
- 20 Yao T, Ong MK, Max W, et al. Responsiveness to cigarette prices by different racial/ethnic groups of US adults. *Tob Control* 2018;27:301–9.
- 21 Organization for Economic Cooperation and Development (OECD). Divided we stand: why inequality keeps rising, 2011. Available: <https://www.oecd.org/els/soc/dividedwestandwhyinequalitykeepsrising.htm> [Accessed 10 Oct 2019].
- 22 Kinge JM, Vallejo-Torres L, Morris S. Income related inequalities in avoidable mortality in Norway: a population-based study using data from 1994–2011. *Health Policy* 2015;119:889–98.
- 23 Piñero B, López-Durán A, Del Río EF, et al. Motivation to quit as a predictor of smoking cessation and abstinence maintenance among treated Spanish smokers. *Addict Behav* 2016;53:40–5.
- 24 Saenz-de-Miera B, Thrasher JF, Chaloupka FJ, et al. Self-Reported price of cigarettes, consumption and compensatory behaviours in a cohort of Mexican smokers before and after a cigarette Tax increase. *Tob Control* 2010;19:481–7.
- 25 Cooper J, Borland R, McKee SA, et al. Depression motivates quit attempts but predicts relapse: differential findings for gender from the International tobacco control study. *Addiction* 2016;111:1438–47.
- 26 Wang Q. The relation between cigarette taxes and older adult smoking in Zhejiang and Gansu: what happened following the 2009 Chinese Tax adjustments? *Environ Health Prev Med* 2017;22:21.
- 27 Hoe M, Park B, Bae S. Testing measurement invariance of the 11-item Korean version CES-D scale. *Mental Health and Social Work* 2015;43:313–39.
- 28 Hanley JA, Negassa A, Edwardes MD, et al. Statistical analysis of correlated data using generalized estimating equations: an orientation. *Am J Epidemiol* 2003;157:364–75.
- 29 Levy DT, Tam J, Kuo C, et al. The impact of implementing tobacco control policies: the 2017 tobacco control policy Scorecard. *J Public Health Manag Pract* 2018;24:448–57.
- 30 DeCicca P, McLeod L. Cigarette taxes and older adult smoking: evidence from recent large Tax increases. *J Health Econ* 2008;27:918–29.
- 31 Cho H-J. The status and future challenges of tobacco control policy in Korea. *J Prev Med Public Health* 2014;47:129–35.
- 32 Blakely T, Cobiac LJ, Cleghorn CL, et al. Health, health inequality, and cost impacts of annual increases in tobacco tax: multistate life table modeling in New Zealand. *PLoS Med* 2015;12:e1001856.
- 33 Wilson N, Thomson G. Tobacco taxation and public health: ethical problems, policy responses. *Soc Sci Med* 2005;61:649–59.
- 34 World Health Organization. *Who report on the global tobacco epidemic, 2017: monitoring tobacco use and prevention policies*. Geneva: World Health Organization, 2017. https://www.who.int/tobacco/global_report/2017/en/
- 35 World Bank Group. *Reducing tobacco use through taxation: the experience of the Republic of Korea*. Washington, DC: World Bank, 2018. <https://openknowledge.worldbank.org/handle/10986/30020>
- 36 DiClemente CC, Prochaska JO, Fairhurst SK, et al. The process of smoking cessation: an analysis of precontemplation, contemplation, and preparation stages of change. *J Consult Clin Psychol* 1991;59:295–304.
- 37 Donny EC, Griffin KM, Shiffman S, et al. The relationship between cigarette use, nicotine dependence, and craving in laboratory volunteers. *Nicotine Tob Res* 2008;10:447–55.

- 38 Kendler KS, Myers J, Damaj MI, *et al.* Early smoking onset and risk for subsequent nicotine dependence: a monozygotic co-twin control study. *Am J Psychiatry* 2013;170:408–13.
- 39 Vangeli E, Stapleton J, Smit ES, *et al.* Predictors of attempts to stop smoking and their success in adult general population samples: a systematic review. *Addiction* 2011;106:2110–21.
- 40 Lawrence D, Mitrou F, Zubrick SR. Non-Specific psychological distress, smoking status and smoking cessation: United States National health interview survey 2005. *BMC Public Health* 2011;11:256.
- 41 Wilhelm K, Wedgwood L, Niven H, *et al.* Smoking cessation and depression: current knowledge and future directions. *Drug Alcohol Rev* 2006;25:97–107.
- 42 Haukkala A, Uutela A, Vartiainen E, *et al.* Depression and smoking cessation: the role of motivation and self-efficacy. *Addict Behav* 2000;25:311–6.
- 43 Reid HH, Ledgerwood DM. Depressive symptoms affect changes in nicotine withdrawal and smoking urges throughout smoking cessation treatment: preliminary results. *Addict Res Theory* 2016;24:48–53.
- 44 Kahler CW, Brown RA, Strong DR, *et al.* History of major depressive disorder among smokers in cessation treatment: associations with dysfunctional attitudes and coping. *Addict Behav* 2003;28:1033–47.
- 45 Cavazos-Rehg PA, Krauss MJ, Spitznagel EL, *et al.* Differential effects of cigarette price changes on adult smoking behaviours. *Tob Control* 2014;23:113–8.
- 46 Kim SH, Chun S, Shin DW. Cigarette taxation and the searching popularity of electronic cigarettes. *Journal of the Korean Society for Research on Nicotine and Tobacco* 2018;9:86–9.
- 47 Grace RC, Kivell BM, Laugesen M. Estimating cross-price elasticity of e-cigarettes using a simulated demand procedure. *Nicotine Tob Res* 2015;17:592–8.