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Electronic Cigarette Use Among Korean Adolescents: A Cross-Sectional Study of Market Penetration, Dual Use, and Relationship to Quit Attempts and Former Smoking

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Abstract

Purpose

As elsewhere, in South Korea electronic cigarettes (e-cigarettes) are marketed, in part, as a smoking cessation aid. We assessed the prevalence of e-cigarette use among Korean adolescents and the relationship between e-cigarette use and current (past 30-day) smoking, cigarettes/day, attempts to quit conventional cigarettes, and ceasing to use cigarettes.

Methods

Data from the 2011 Korean Youth Risk Behavior Web-based Survey of 75,643 students aged 13–18 years were analyzed with logistic regression.

Results

A total of 9.4% (8.0% ever–dual users who were concurrently using e-cigarettes and smoking conventional cigarettes and 1.4% ever–e-cigarette only users) of Korean adolescents have ever used e-cigarettes and 4.7% were current (past 30-day) e-cigarette users (3.6% dual users and 1.1% e-cigarettes only). After adjusting for demographics, current cigarette smokers were much more likely to use e-cigarettes than were nonsmokers. Among current cigarette smokers, those who smoked more frequently were more likely to be current e-cigarette users. The

an e-cigarette user were 1.58 times (95% confidence interval, 1.39–1.79) higher among students who had made an attempt to quit than for those who had not. It was rare for students no longer using cigarettes to be among current e-cigarette users (odds ratio, .10; confidence interval, .09–.12).

Conclusions

Some Korean adolescents may be responding to advertising claims that e-cigarettes are a cessation aid: those who had made an attempt to quit were more likely to use e-cigarettes but less likely to no longer use cigarettes. E-cigarette use was strongly associated with current and heavier cigarette smoking.

Keywords

[Electronic cigarettes](#) • [Smoking cessation](#) • [Adolescents](#) • [Smoking](#) • [Tobacco](#) • [Electronic nicotine delivery systems](#) • [Dual use](#)

Implications and Contribution

E-cigarettes are marketed as a cigarette alternative and smoking cessation aid. In contrast, most Korean adolescent e-cigarette users are dual users with cigarettes. Adolescents who tried to quit smoking are more likely to use e-cigarettes but less likely to no longer smoke, which suggests that e-cigarettes inhibit rather than promote cessation.

E-cigarettes (electronic nicotine delivery system) are battery-powered devices that look like cigarettes and deliver nicotine vapor [1, 2, 3]. E-cigarettes are marketed as safer alternatives to cigarettes and smoking cessation aids [1, 2, 3, 4, 5]. This has been true in Korea [6] (Figures A-1 to A-5 are supplemental materials that can be found in the online version of this article) since 2007, where the volume of e-cigarette use tripled between 2008 and mid-2011 [1].

Data collected in 2008 a year after e-cigarettes were introduced in Korea showed that 10.2% of and high school students were aware of e-cigarettes, but only .5% had used them [7]. In survey of 228 United States (US) male adolescents (age 11–19 years), the



a high awareness of e-cigarettes (67%); yet <1% of students tried them [\[\[8\]\]](#). Findings from a nationally representative sample of Polish high school and university students revealed higher e-cigarette use among high school students (age 15–19 years; 8.2%) than young adults (age 20–24 years; 5.9%) [\[\[9\]\]](#). Results of a national study of US middle and high school students demonstrated that e-cigarette use doubled from 2011 to 2012, with prevalence of ever-use increasing from 3.3% to 6.8% and current use increasing from 1.1% to 2.1% [\[\[10\]\]](#). That study also found high levels of dual use, with 80.5% of current high school e-cigarette users concurrently smoking conventional cigarettes. Analyses of a national US adult dataset (age ≥18 years) revealed that e-cigarette awareness doubled from 16.4% to 32.2% between 2009 and 2010 and ever-use increased from .6% to 2.7% [\[\[11\]\]](#). In a 2010 nationally representative sample of US adults, 40.2% had heard of e-cigarettes, with the highest awareness among current cigarette smokers (11.4%), compared with the total population (3.4%) [\[\[12\]\]](#). Longitudinal data from Canada, the US, the United Kingdom, and Australia [\[\[12\]\]](#) collected in 2010 and 2011 revealed that although 85.1% of e-cigarette users reported using e-cigarettes as a cessation aid, there was no difference in rates of successful quitting between e-cigarette users and nonusers [\[\[13\]\]](#). Another study of Quitline callers in six US states found e-cigarette users were significantly less likely to quit after 7 months, compared with participants who never tried e-cigarettes (30-day point prevalence quit rates: 21.7% and 16.6% vs. 31.3%; $p < .001$) [\[\[14\]\]](#).

The Korean Youth Risk Behaviour Web-based Survey (KYRBWS) is an annual nationally representative survey investigating health risk behaviors. This study used the 2011 KYRBWS to assess the prevalence of e-cigarette use after the market was more established, as well as the relationship between e-cigarette use and current cigarette smoking, cigarettes/day, attempts to quit conventional cigarettes, and stopping smoking cigarettes.

Methods

Data

The KYRBWS is an anonymous, Internet-based, self-administered questionnaire administered in class to a nationally representative cross-section of middle and high school students [\[\[15\]\]](#). The 2011 sample consisted of 79,202 students age 13–18 years in 2,400 classrooms (secondary sampling units), consisting of all students in three classes from each of 400 middle and 400 high schools (primary sampling units) from 129 strata identified using a stratified multistage cluster sampling method. The first question in the system asked the students about their willingness to participate. If students did not want to participate, they could leave the computer room.

Participants who completed the survey received a small gift. The response rate was 95.5%, and 75,643 completed surveys. Our analysis is based on the public use dataset.



from the Korea Centers for Disease Control, which is described in detail and available at <http://www.yhs.cdc.go.kr>, including sampling weights for all Korean adolescents [[15]].

Measures

E-cigarette use questions were: “Have you ever used e-cigarettes?” (yes/no) and “Have you used e-cigarettes in the past 30 days?” (yes/no).

Cigarette smoking questions were: “Have you ever smoked, even one puff in your life?” (yes/no) and “How many days did you smoke, even one puff, in the past 30 days?” Response options were “None,” “1–2 days,” “3–5 days,” “6–9 days,” “10–19 days,” “20–29 days,” and “Every day.” We re-categorized responses to “None,” “1–9 days,” “10–29 days,” and “Every day,” to obtain about the same number of respondents in each of the non-daily categories. Current (past 30-day) cigarette smokers were asked: “How many cigarettes did you smoke a day on average in the past 30 days?” Response options were “Less than one stick per day,” “One stick per day,” “Two to five sticks per day,” “Six to nine sticks per day,” “Ten to 19 sticks per day,” and “Twenty or more sticks per day.” Current smokers were also asked, “Have you ever attempted to quit smoking in the past 12 months?” (yes/no).

We define “former smoker” as a respondent who had ever smoked one puff, but had not smoked in the past 30 days.

Other questions

We included several demographic variables because these variables could be associated with smoking and e-cigarette use: age, gender, grade, location, and the amount of spending money that students had (using the question, “How much allowance do you get a week?”). Sixteen response options ranged from “None” to “150,000 won” (equivalent to US \$150; 1,000 won = US \$1), recoded into four categories: “None to 9,999 won,” “10,000 to 49,999 won,” “50,000 to 99,999 won,” and “>100,000 won.”

Students were also asked, “Have you participated in school-based smoking prevention or cessation programs in the past 12 months?” (yes/no), which permitted us to control for the impact of these smoking prevention programs.

Statistical analysis

We used weights, strata, and primary sampling unit information provided in the public use dataset to compute descriptive statistics, and logistic regressions to account for the complex survey design. Ordinal variables (grade, weekly allowance, and range of days smoked during the month) were entered into the logistic regressions, coded as 0, 1, 2, and so forth. The associated odds ratios represented the odds of the dependent variable e-

cigarette use or smoking conventional cigarettes) occurring for each step-up in the ordinal scale. Computations were done with Stata version 12.1 (StataCorp, College Station, TX).

Results

Sample demographics appear in [Table 1](#).

Table 1 Sociodemographic characteristics of participants

Factor	Category	Unweighted, %	Weighted, %	n
Sex	Boy	50.1	52.7	37,873
	Girl	49.9	47.3	37,770
Location ^a	Province	13.0	6.2	9,856
	Metropolitan city	45.9	45.0	34,692
	City	41.1	48.8	31,095
Grade	7	16.8	16.0	12,728
	8	17.1	16.7	12,903
	9	17.0	16.9	12,843
	10	16.6	17.2	12,569
	11	16.5	16.7	12,508

Data were collected from South Korean youth in Grades 7 through 12 (aged 13–18 years) in 2011 (N = 75,643).

metropolitan cities and cities.

b KRW is South Korea's currency, the won (1,000 KRW = US \$1).

[Open table in a new tab](#)

A total of 85.5% of seventh-grade students (age 13 years) were never-users of conventional cigarettes or e-cigarettes, compared with 66.5% of 12th-grade students ([Table 2](#)). Among 12th graders, 16.9% currently smoked cigarettes (past 30 days) and 5.9% currently used e-cigarettes, including 5.0% who were currently dual users of conventional cigarettes and e-cigarettes.

Table 2 Prevalence of cigarette and e-cigarette use among Korean adolescents (weighted %)

Grade	All	7	8	9	10	11
n	75,643	12,728	12,903	12,843	12,569	12,508
Never-user (no cigarettes or e-cigarettes)	72.4	85.5	77.7	72.5	66.4	66.4
Ever-cigarette-only user	18.3	10.2	15.4	18.5	20.9	22.0
Ever-e-cigarette-only user	1.4	1.5	1.4	1.5	1.5	1.1
Ever-dual user (cigarette and e-cigarette)	8.0	2.7	6.0	7.5	11.3	10.5

Current cigarette smokers are students who answered “yes” to both questions, “Have you ever smoked, even one puff in your life?” and “How many days did you smoke, even one puff in the past 30 days?” Current e-cigarette users are students who answered “yes” to both questions, “Have you ever used e-cigarettes?” and “Have you used e-cigarette in the past 30 days?” For both cigarette and e-cigarette use, former users are students who answered “yes” to ever-use and “no” to past 30-day use. The prevalence of ever–e-cigarette user (9.4%) among all participants, is the sum of ever–e-cigarette-only user (1.4%) and ever–dual user (8.0%). The prevalence of current e-cigarette user (4.7%) is the sum of current e-cigarette–only user (1.1%) and current dual user (3.6%). Results in this table are summarized from the detailed results in [Table A-1](#).

[Open table in a new tab](#)

E-cigarette use was significantly higher for boys (7.8% vs. 1.8% for girls; $p < .001$), older students (6.2% among 12th graders vs. 2.0% among seventh graders; $p < .001$ for trend), those with larger weekly allowances ($p < .001$), and those had not participated in school-based smoking prevention programs in the past 12 months (5.1% vs. 4.7%; $p = .043$) ([Table 3](#)). Current cigarette smokers were significantly more likely than never or former cigarette smokers to use e-cigarettes ($p < .001$). Students who had smoked every day in the past 30 days had the highest rate of current e-cigarette use (50.8%), compared with .6% among those who not currently smoking cigarettes ($p < .001$). Among current cigarette smokers, those who tried quitting in the past 12 months were significantly more likely to use e-cigarettes than those who had not (40.0% vs. 29.1%; $p < .001$).

Table 3 Univariate association between current e-cigarette use (vs. never–e-cigarette use) and sociodemographic characteristics and smoking behavior^a



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b *p* values were computed using logistic regression to allow for the complex survey design.

d Trend tested using logistic regression with the independent variable treated as an ordinal variable (coded 0, 1, 2, etc.).

e KRW is South Korea's currency, the won (1,000 KRW = US \$1); N = 72,282 owing to three missing values for allowance.

f “Former smokers” includes students who reported smoking at least one puff of a cigarette and not reporting any smoking in the past 30 days, which includes experimenters and students who became regular smokers, then quit.

Among current smokers (n = 8,988) current e-cigarette use was associated with higher levels of cigarette consumption ($p < .001$) ([Figure 1](#)).

Figure thumbnail gr1

Figure 1 Among current smokers, current e-cigarette (e-cig) users smoke more conventional cigarettes than former e-cigarette users or never–e-cigarette users ($p < .0001$).

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Multivariable logistic regression analysis confirmed that current cigarette smokers were much more likely to currently use e-cigarettes than were nonsmokers (odds ratio [OR], 66.46; 95% confidence interval [CI], 57.83–76.37), adjusting for demographics ([Table 4](#)). (Including former e-cigarette in the “non-current” e-cigarette users did not materially affect the results. The adjusted OR for being a current e-cigarette user among current smokers was 49.10 [95% CI, 42.75–56.38].) The odds of being a current e-cigarette user was 1.58 (95% CI, 1.39–1.79) among students who had made an attempt to quit in the previous 12 months compared to those who had not ([Table 4](#)). (Including former e-cigarette users in the reference group did not materially change the odds of a quit attempt among current smokers (OR, 1.50; 95% CI, 1.34–1.69).

Table 4 Multivariable predictors of current and former e-cigarette use

Factor	Category	Current versus never e-cigarette use (N = 72,282 ^a)	Current versus never e-cigarette use (among current cigarette smokers) (N = 7,302 ^a)	Former versus current e-cigarette use (N = 6,669)	Former versus never e-cigarette use (N = 72,329)
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Cigarette use	Never	Reference		Reference	Reference
	Former ^b	6.91 (5.88–8.12)		1.08 (.90–1.29)	7.89 (7.04–8.85)
	Current	66.46 (57.83–76.37)		.33 (.29–.39)	24.48 (21.80–27.49)
Attempted to quit	No		Reference		
	Yes		1.58 (1.39–1.79)		

All odds ratios are adjusted for other variables in the models.

CI = confidence interval; OR = odds ratio.

a Excludes 3,358 former e-cigarette users.

b “Former smokers” includes students who reported smoking at least one puff of a cigarette and not reporting any smoking in the past 30 days, which includes experimenters and students who became regular smokers, then quit.

c A metropolitan city is larger than a city. Depending on the number of residents, financial independence rate of local governments, geographical location, and so forth, cities are divided into metropolitan cities and cities.

d KRW is South Korea's currency, the won (1,000 won = US \$1).

* $p < .05$.

** $p < .001$.



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As elsewhere, the e-cigarette industry in Korea advertises and sells its products as a smoking cessation aid [1, 6]. (Despite the government's acknowledgment that e-cigarettes have not been proven safe or effective for smoking cessation, e-cigarettes that contain a solution without nicotine are regulated under the Korea Food and Drug Administration as an “electronic smoking desire reducer,” whereas e-cigarettes with nicotine are regulated as a tobacco product under the Ministry of Finance [[6]].) Some Korean adolescents appear to be responding to this marketing: Current smokers who had attempted to quit smoking in the past 12 months had higher odds of using e-cigarettes (Table 4), and e-cigarette users among current smokers had higher odds of attempting to quit smoking (Table 5). Although attempt to quit smoking conventional cigarettes was associated with current e-cigarette use, current e-cigarette users were much less likely to be no longer using cigarettes (OR, .10; 95% CI, .09–.12) (Table 5).

Table 5 Multivariable association of e-cigarette use with cigarette smoking status and attempts to quit among Korean adolescents



Factor	Category	Current versus never cigarette smoking among all participants except former cigarette smokers (N = 64,930)	Attempts to quit versus no attempts to quit cigarette smoking among current cigarette smokers (N = 8,988)	Former ^a versus current cigarette smoking among ever cigarette smokers (N = 19,698)
		OR (95% CI)	OR (95% CI)	OR (95% CI)
E-cigarette use	Never	Reference	Reference	Reference
	Former	23.76 (21.14–26.71)	1.48 (1.29–1.71)	.32 (.29–.36)
	Current	64.94 (56.55–74.58)	1.67 (1.48–1.90)	.10 (.09–.12)
Sex	Boy	Reference	Reference	Reference
	Girl	.44 (.40–.48)	1.14 (1.01–1.29)*	1.30 (1.19–1.41)
	Province	Reference	Reference	Reference

All odds ratios are adjusted for other variables in the models.

CI = confidence interval; OR = odds ratio.

a Former smoker: participant who has ever smoked even one puff, but has not smoked in the past 30 days.

b A metropolitan city is larger than a city. Depending on the number of residents, financial independence rate of local governments, geographical location, and so forth, cities are divided into metropolitan cities and cities.

c KRW is South Korea's currency, the won (1,000 won = US \$1).

* $p < .05$.

** $p < .001$.

[Open table in a new tab](#)

Discussion

The findings of high dual use of cigarettes and e-cigarettes show that e-cigarettes are not being used as a substitute for cigarettes among Korean adolescents. Furthermore, the significant association between current e-cigarette use and higher levels of cigarette consumption compared with ever- and never-e-cigarette users suggests that e-cigarettes do not have a role in reducing harm among these teens, and in fact may be increasing harm.

Although e-cigarettes have rapidly become widely available, there has not been a consistent policy response to them [\[\[16\]\]](#). There is limited published research on e-cigarettes regarding safety, efficacy, regulations, and public health impact [\[6, 9, 17, 18, 19, 20, 21, 22\]](#). The US Food and Drug Administration announced its intent to regulate e-cigarettes [\[\[23\]\]](#), but as of October 2013, it had not done so.

A total of 9.4% of Korean adolescents have tried e-cigarettes, and 4.7% were current e-cigarette users. Tenth graders had the highest e-cigarette use, whereas 12th graders had the highest conventional cigarette use. Compared with a previous study [\[\[7\]\]](#) that showed that .5% of Korean adolescents had ever used e-cigarettes in 2008, ever-use increased almost 20-fold in just 3 years. In addition, 1.4% of Korean adolescents initiated nicotine use with e-cigarettes (i.e., those who never smoke regular cigarettes and are traditionally considered to be a low-risk group), which means that e-cigarettes represent a new pathway for young people to become addicted to nicotine.

Rather than being used as an alternative to conventional cigarettes, most e-cigarette users are dual users with cigarettes. Among ever e-cigarette users, 85% were dual users of tobacco cigarettes and e-cigarettes and among current e-cigarette users, more than 75% were dual users. These results are consistent with findings from previous US youth and adult studies showing that 81% [\[\[10\]\]](#) (high school students), 84% [\[\[12\]\]](#), and 55% [\[\[11\]\]](#) (adults) of e-cigarette users were also current cigarette smokers. In addition, a cohort study of US adults found roughly equal levels of cigarette consumption among cigarette-only and dual users [\[\[24\]\]](#) (used cigarettes and another tobacco product, such as chewing tobacco or e-cigarettes), which indicates that among US adults, other tobacco products did not replace cigarette smoking or decrease the frequency of smoking. This dual use may have negative implications for individual and public health because even low levels of cigarette smoking confer nearly the same risk of cardiovascular disease as heavier smoking [\[\[25\]\]](#), and duration of smoking (as well as intensity) determines the risk of lung cancer [\[\[26\]\]](#).

The high rates of dual use of e-cigarettes and conventional cigarettes in our study and others [\[24\]](#) have implications for laws governing the marketing and promotion of e-cigarettes. Marketing that encourages dual use could be banned under Article 13.2 of the World Health Organization Framework Convention on Tobacco Control.

Organization Framework Convention on Tobacco Control, because “tobacco advertising and promotion” is defined as “any form of commercial communication, recommendation, or action with the aim, effect, or likely effect of promoting a tobacco product or tobacco use either directly or indirectly” [\[\[16\]\]](#).

Our finding that Korean student smokers who had made an attempt to quit were more likely to be e-cigarette users is similar to the finding that US adult smokers who used e-cigarettes were more likely to have made an attempt to quit and less likely to be former smokers than were current smokers [\[\[12\]\]](#), as well as the finding that adult e-cigarette use was not significantly related to attempt to quit or successfully quitting cigarettes [\[\[11\]\]](#). One longitudinal analysis from four countries also found no significant difference in quitting successfully between e-cigarette users and nonusers [\[\[13\]\]](#), and another longitudinal study of US Quitline users found that e-cigarette use was associated with lower levels of quitting compared to those who never used an e-cigarette [\[\[14\]\]](#). A nationally representative cross-sectional study in the US found that e-cigarette use was associated with unsuccessful attempts to quit, but not successful attempts [\[\[27\]\]](#). These results from large population-based studies, together with the results from the current study, stand in contrast to studies using convenience samples and published commentaries arguing that e-cigarettes are an effective cessation tool [\[28, 29, 30, 31\]](#). The one randomized, controlled, clinical trial [\[\[32\]\]](#) of e-cigarettes compared with medicinal nicotine replacement therapy among adult smokers in Auckland, New Zealand found no statistically significant differences in biochemically confirmed (breath carbon monoxide) self-reported continuous abstinence from the day of quitting to 6-month follow-up between nicotine e-cigarettes (7.3%), nicotine patches (5.8%), and non-nicotine e-cigarettes (4.1%). The findings of the current study as well as from national population highlight the wisdom in the World Health Organization's statement on e-cigarettes, which cautions that they are not a proven cessation aid and could derail effective cessation attempts [\[\[33\]\]](#). Until and unless there are convincing longitudinal studies demonstrating that e-cigarettes as currently used are an effective cessation aid, authorities should prohibit any advertising claims, explicit or implicit, that e-cigarettes are an effective cessation aid.

Limitations

Because the KYRBWS used cross-sectional data, the directionality of our findings cannot be established. In addition, data might have various biases, including underreporting of smoking behavior, which is common among younger youth. However, concern for underreporting is balanced by the anonymous data collection, large sample size, and response rate of over 90%.

Because the KYRBWS did not ask whether students had smoked 100 cigarettes in their lifetime, we could not use the common definition of a “former smoker” as someone who had smoked 100 cigarettes in their lifetime but had not smoked in the past 30 days. Rather, we had

“former smoker” as someone who had smoked a single puff and who had not smoked in the past 30 days, which combines former 100 cigarette smokers with former experimenters who may only have used cigarettes briefly.

Although we found that students who were trying to quit smoking were more likely to use e-cigarettes—a behavior consistent with the messages used to market e-cigarettes—the KYRBWS did not include questions asking students why they used e-cigarettes, so we do not know to what extent students were consciously choosing to use e-cigarettes as a smoking cessation aid. In addition, the KRYBWS asked only whether students had used e-cigarettes in the past 30 days, not the number of days on which they used them or the number of e-cigarettes consumed.

Finally, these results were collected from one country, and thus may have limited generalizability to other countries.

Despite the e-cigarette industry's claims that it markets only to adults, e-cigarettes have achieved substantial penetration into the youth market. As elsewhere with youth [\[\[10\]\]](#) and adults [\[8, 9, 11, 12\]](#), most Korean adolescent e-cigarette users are dual users with conventional cigarettes. They are more likely to have tried quitting smoking, which suggests that, consistent with e-cigarette marketing messages ([Figures A-1 through A-5](#)), some youth may be using e-cigarettes as a smoking cessation aid. However, former cigarette smokers were rare among current e-cigarette users. Use of e-cigarettes is associated with heavier use of conventional cigarettes, which raises the likelihood that, like smokeless tobacco [\[\[34\]\]](#), actual use of e-cigarettes may increase harm by creating a new pathway for youth to become addicted to nicotine and by reducing the odds that an adolescent will stop smoking conventional cigarettes.

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Supplementary Material

PDF



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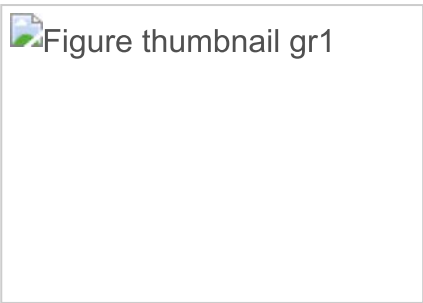


Figure 1 Among current s...

Tables

Table 1: Sociodemographic characteristics of participants

Table 2: Prevalence of cigarette and e-cigarette use among Korean adolescents (weighted %)

Table 3: Univariate association between current e-cigarette use (vs. never–e-cigarette use) and sociodemographic characteristics and smoking behavior^a

Table 4: Multivariable predictors of current and former e-cigarette use

Table 5: Multivariable association of e-cigarette use with cigarette smoking status and attempts among Korean adolescents



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