

The relation between tobacco taxes and youth and young adult smoking: What happened following the 2009 U.S. federal tax increase on cigarettes?

By: [Martijn van Hasselt](#), Judy Kruger, Beth Han, Ralph S. Caraballo, Michael A. Penne, Brett Loomis, Joseph C. Gfroerer

Van Hasselt, M., Kruger, J., Han, B., Caraballo, R. S., Penne, M. A., Loomis, B., & Gfroerer, J.C. (2015). The relation between tobacco taxes and youth and young adult smoking: what happened following the 2009 U.S. federal tax increase on cigarettes? *Addictive Behaviors*, 45, 104-109. DOI: 10.1016/j.addbeh.2015.01.023.

Made available courtesy of Elsevier: <https://doi.org/10.1016/j.addbeh.2015.01.023>



This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](#).

Abstract:

Background

On April 1, 2009, the federal government raised cigarette taxes from \$0.39 to \$1.01 per pack. This study examines the impact of this increase on a range of smoking behaviors among youth aged 12 to 17 and young adults aged 18 to 25.

Methods

Data from the 2002–2011 National Survey on Drug Use and Health (NSDUH) were used to estimate the impact of the tax increase on five smoking outcomes: (1) past year smoking initiation, (2) past-month smoking, (3) past year smoking cessation, (4) number of days cigarettes were smoked during the past month, and (5) average number of cigarettes smoked per day. Each model included individual and state-level covariates and other tobacco control policies that coincided with the tax increase. We examined the impact overall and by race and gender.

Results

The odds of smoking initiation decreased for youth after the tax increase (odds ratio (OR) = 0.83, $p < 0.0001$). The odds of past-month smoking also decreased (youth: OR = 0.83, $p < 0.0001$; young adults: OR = 0.92, $p < 0.0001$), but the odds of smoking cessation remained unchanged. Current smokers smoked on fewer days (youth: coefficient = -0.97 , $p = 0.0001$; young adults: coefficient = -0.84 , $p < 0.0001$) and smoked fewer cigarettes per day after the tax increase (youth: coefficient = -1.02 , $p = 0.0011$; young adults: coefficient = -0.92 , $p < 0.0001$).

Conclusions

The 2009 federal cigarette tax increase was associated with a substantial reduction in smoking among youths and young adults. The impact of the tax increase varied across male, female, white and black subpopulations.

Keywords: Tobacco | Youth smoking | Young adult smoking | Tax

Article:

1. Introduction

Tobacco use remains the leading preventable cause of death and disease in the United States (US DHHS, 2014). Data from the National Survey on Drug Use and Health (NSDUH) show that among youths aged 12 to 17 who had not smoked cigarettes prior to the past year (i.e., youths at risk for initiation), the incidence rate in 2012 was 4.8%. The prevalence of current cigarette smoking was 31.8% among young adults aged 18 to 25 (SAMHSA, 2013a). Both the rate of youth initiation to cigarette smoking and the prevalence of current smoking among young adults are well above the goals set by the U.S. Department of Health and Human Services in its Healthy People 2020 objectives (US DHHS, 2012a).

One of the most effective policies for reducing tobacco use is to increase the price of tobacco products, which is most commonly achieved by increasing state and federal excise taxes (Guide to Community Preventive Services, 2012). Several recent systematic reviews have found that higher cigarette prices lead to a reduction in smoking prevalence and intensity among youth and young adults (Bader et al., 2011, Chaloupka et al., 2011, International Agency for Research on Cancer (IARC), 2011, Rice et al., 2009). Tauras (2005) found that, among young adults, an increase in the price of cigarettes led to transitions from daily smoking to no smoking, from moderate daily to light daily smoking, and from heavy daily smoking to moderate daily smoking. Several studies also conclude that higher prices resulting from higher taxes increased the number of quit attempts and the probability of successful cessation among youth and young adults (DeCicca et al., 2008, Tauras, 2004, Tauras and Chaloupka, 2001, U.S. Department of Health and Human Services (US DHHS), 2012b, Zhang et al., 2006). Evidence suggests that youth and young adults are more sensitive to cigarette price and tax increases than adults (Chaloupka, 2001, Chaloupka et al., 2011, Chaloupka and Wechsler, 1997, Farrelly and Bray, 1998, U.S. Department of Health and Human Services (US DHHS), 2012b). While higher taxes and prices may not altogether prevent young adolescents from experimenting with cigarettes, regular uptake of smoking typically also occurs at younger ages. Higher taxes therefore do have the potential to reduce smoking rates in the longer term (Ross & Chaloupka, 2003).

This is the first study to examine changes in youth and young adult smoking behavior before and after the passage of the Children's Health Insurance Program Reauthorization Act of 2009, which raised the federal excise tax on a pack of cigarettes from \$0.39 to \$1.01 per pack, an increase of 158% (GPO, 2009). This represented the largest increase in U.S. federal excise taxes to date. As a result, cigarette prices jumped by 9.4% between March and April of 2009 (U.S. Department of Labor, 2009). The federal tax increase was also the only major tobacco control policy that affected smokers across the U.S. between 2008 and 2009. During this period, average state-level excise taxes on cigarettes remained more or less the same (CDC, 2009), and no other tobacco control policies were implemented uniformly across states.

The objective of our study was to estimate the effect of the federal cigarette tax increase on a wide range of smoking behaviors, including: (1) cigarette smoking initiation, (2) the prevalence of current cigarette use, (3) the number of days cigarettes were smoked among current smokers, (4) the average number of cigarettes smoked per day among current smokers, and (5) smoking

cessation. We estimated the effect of the tax on youths aged 12–17 and young adults aged 18–25, by sex and race/ethnicity.

2. Methods

2.1. Sample

The National Survey on Drug Use and Health (NSDUH) was used to examine the smoking behavior of youth and young adults from 2002 to 2011. NSDUH is an annual cross-sectional, national- and state-based survey on the use of tobacco products, alcohol, illicit drugs, and mental health status among the U.S. civilian, non-institutionalized population aged 12 or older (SAMHSA, 2013a). The survey has been conducted since 1971 and collects data quarterly through face-to-face interviews. NSDUH employs a state-based design with an independent probability sample within each state and the District of Columbia. This study used data from the 2002–2011 NSDUH. Data prior to 2002 were not used because of the methodological changes introduced to the survey design in 2002, which affected respondent reporting of substance use (Kennet & Gfroerer, 2005). Annual sample sizes are around 3600 for each of the eight states with the largest populations and around 900 for each of the remaining states and the District of Columbia. Youth and young adults were oversampled to achieve roughly equal numbers of respondents aged 12 to 17, 18 to 25, and 26 or older each year. This corresponds to annual sample sizes of about 1200 for each age group in large states and 300 per age group in small states. The percentage of eligible households that completed the initial screening was 90.7% in 2002 and declined to 87.0% in 2011. Interview response rates among youth and young adults were 90.0% and 85.2%, respectively, in 2002, and declined somewhat to 85.0% and 80.5%, respectively, in 2011. The 2002–2011 study sample contained data on 226,315 youths and 226,228 young adults.

2.2. Smoking measures

Cigarette smoking was assessed using five NSDUH indicators. The first indicator was initiation of cigarette smoking which is defined as having smoked the first lifetime cigarette during the 12 months before the survey interview. The measure is not defined for those who had a first lifetime cigarette more than 12 months before the survey interview. The second indicator was past-month cigarette smoking which is defined as having smoked all or part of a cigarette during the 30 days before the interview. This measure is defined for all respondents. The third indicator was smoking cessation which is defined as ever having smoked daily and smoked during the period 13 to 24 months ago, but not having smoked during the past 12 months. This measure is defined only for those who reported having been a daily smoker (i.e., having smoked 30 consecutive days) at some point in their lifetime and who reported smoking during the 13 to 24 months before the survey interview. The fourth indicator was a quantity measure among past-month smokers, in terms of the number of days smoked during the past month. The fifth indicator was the number of cigarettes smoked among past-month smokers on a typical day during the past month.

2.3. Individual and state-level characteristics

In the statistical models for youth and young adults we controlled for the following set of respondent characteristics: sex, race/ethnicity, age, presence of parents in the household, birthplace (U.S. or not), household income, county type (e.g., metropolitan), religious service attendance, importance of religion, school enrollment, privacy during the survey interview, attitudes toward risky behavior, frequency of seatbelt use, and having moved 2 or more times during the past 5 years. In the models for youth, we also included two control variables measuring the perception of parents' attitude toward smoking one or more packs of cigarettes per day and perceived risk of smoking. In the models for young adults we included control variables for pregnancy, education, employment status, and health insurance status.

Several state-level covariates were used to account for differences in tobacco control policies and antismoking sentiment across states. State excise taxes on a pack of 20 cigarettes were obtained from the Tax Burden on Tobacco (Orzechowski & Walker, 2012), which contains annual averages that were converted to quarterly numbers through linear interpolation. Quarterly indices for the presence of a smoke-free law in bars, restaurants, and private workplaces as covariates were also included. These were collected from the ImpacTeen project (ImpacTeen, 2013) and CDC's State Tobacco Activities Tracking and Evaluation (STATE) system (CDC, 2013). The values that each index assumed were “no restrictions,” “some restrictions,” and “complete smoking ban.”

An annual measure of the lack of compliance with laws prohibiting the sale of tobacco products to individuals younger than 18 was also included. Following the Synar Amendment of 1992, states were required to enact and enforce such laws and conduct annual, unannounced inspections of tobacco sales outlets (Substance Abuse and Mental Health Services Administration (SAMHSA), 2011a, U.S. Department of Health and Human Services (US DHHS), 2012b). The variable used in the analysis is the percentage of retailers that violate youth tobacco access laws, as reported by each state (SAMHSA, 2013b). The violation rate is expected to have limited explanatory power, because sale restrictions do not apply to young adults, and youth also rely on social sources (e.g., friends and family) to obtain cigarettes (Altman et al., 1999, DiFranza and Coleman, 2001, Forster et al., 1998). However, we included the variable as a proxy for antismoking sentiment in a state.

We included quarterly per capita tobacco control funding, obtained from CDC's STATE system. To account for potential delayed effects of this funding, we calculated a discounted cumulative amount of funding for each quarter, which included the current quarter and the previous seven quarters, where past funding amounts were discounted at a quarterly rate of 25% (Farrelly, Pechacek, Thomas, & Nelson, 2008). The final state-level covariate used in the model is a NSDUH estimate of smoking prevalence by quarter. This allowed us to control for the general downward trend in smoking that may have affected smoking among youth and young adults independently of the tax change. Additionally, this variable helped account for differences between states in general attitudes toward smoking. We used the smoking prevalence among 18- to 25-year-olds in the models for youth and the smoking prevalence among 26- to 49-year-olds in the models for young adults.

Before the analysis could proceed, appropriate values of the state-level variables had to be assigned to or linked with each individual record in NSDUH. Because the smoking measures

relate to different time periods (e.g., past month, past 12 months), the assignment mechanism varied across the different outcome analyses. For the initiation indicator, we distinguished between those who initiated and those who did not. For those who initiated smoking, the month and year of initiation were known, so that we could assign values of the state-level covariates from the corresponding quarter. For individuals who did not initiate smoking, we calculated a “look-back date” of 45 days prior to the survey interview and assigned values of state-level variables from the quarter that contained the look-back date. Thus, for those not initiating, values were chosen from either the interview quarter or one quarter prior.

A similar approach was followed for the cessation outcome. For respondents who quit smoking 13 to 24 months before the interview date, the month and quarter of quitting were known and we assigned values of the state-level variables from the corresponding quarter. For respondents who did not quit smoking, we calculated a look-back date of 410 days ($= 365 + 45$) before the survey interview and assigned values of the state-level variables from the quarter that contained the look-back date. Finally, the past-month smoking indicator and smoking intensity outcomes (days and cigarettes per day) refer to the 30 days before the survey interview. For these outcomes, we assigned to these individuals the values of the state-level covariates from the quarter that contained the majority of that 30-day period. Thus, in these analyses we assigned values of state-level covariates from either the interview quarter or one quarter prior (if the interview date fell within 15 days of the start of a quarter).

2.4. Statistical analysis

Data were analyzed using SAS-Callable SUDAAN® (RTI International, 2012) to account for NSDUH's complex survey design and sampling weights. Smoking behavior was analyzed separately for youth and young adults, and the male, female, black and white populations within those age groups to examine potential differences in the response to the increase in the federal excise tax. Before estimation, all explanatory variables measured in dollars were adjusted for inflation using the Bureau of Labor Statistics' Consumer Price Index (U.S. Department of Labor, 2013). To adjust for missing data, an ‘unknown’ category was added for unordered, categorical variables. Missing values of ordered or continuous variables were imputed (SAMHSA, 2011b). Regression coefficients and odds ratios (ORs) were estimated using Generalized Estimating Equations with Taylor linearization to calculate standard errors and confidence intervals (CIs).

The statistical models used to estimate the impact of the April 1, 2009, federal tax increase on each of the examined outcomes were pre-post regression models. They included as covariates the individual and state-level characteristics discussed before, as well as a post-period indicator (equal to 0 before April 1, 2009, and equal to 1 thereafter). The value of the indicator, corresponding to the reference period of the smoking outcome, was linked to the NSDUH record following the same procedure described above. For the binary outcomes (smoking initiation, current smoking, and cessation), we used a logistic regression model. For the smoking intensity outcomes (smoking days and cigarettes per day) of current smokers, we used a linear regression model. The analysis for smoking days was based on the sample of all current smokers, whereas the analysis for cigarettes per day was conducted separately for daily and nondaily smokers.

3. Results

3.1. Descriptive statistics

Table 1 contains the average rates of smoking initiation, past-month smoking and smoking cessation before and after the April 1, 2009 federal tax increase. Rates are shown separately for youth aged 12–17, young adults aged 18–25, and four subgroups. Table 1 also shows, for current smokers, the number of days smoked during the past month and the number of cigarettes consumed per day of smoking.

Table 1. Rates of smoking initiation, past-month smoking, smoking cessation, and (for current smokers only) the average number of days smoked and the number of cigarettes per day, before and after the April 1, 2009 federal tax increase; 2002–2011 NSDUH.

Age	Outcome	Period	All	Male	Female	White	Black
12–17	Initiation (%)	Before	6.7	6.2	7.2	7.5	4.4
		After	5.1	5.0	5.3	5.5	3.5
	Past-month use (%)	Before	10.9	10.7	11.2	13.2	6.1
		After	8.3	8.7	8.0	9.9	4.8
	Cessation (%)	Before	3.6	4.1	3.1	3.3	4.8
		After	2.8	2.9	2.8	2.5	N/A
	Days smoked	Before	14.6	14.9	14.3	15.7	11.6
		After	13.4	13.3	13.5	14.6	N/A
	Cigarettes per day	Before	4.8	5.1	4.4	5.3	3.0
		After	3.9	4.0	3.9	4.5	N/A
18–25	Initiation (%)	Before	8.1	9.2	7.2	9.6	5.2
		After	7.0	7.8	6.4	8.0	4.7
	Past-month use (%)	Before	38.5	42.5	34.5	43.9	27.7
		After	34.2	38.3	30.0	38.8	26.0
	Cessation (%)	Before	3.6	3.0	4.3	3.6	3.2
		After	3.8	3.7	4.0	3.4	4.4
	Days smoked	Before	20.4	20.2	20.8	21.6	19.3
		After	19.2	18.8	19.6	20.5	18.4
	Cigarettes per day	Before	8.5	9.0	7.9	9.7	6.0
		After	7.1	7.4	6.7	8.2	5.2

Notes: entries labeled “N/A” were suppressed because (unweighted) sample sizes were less than 500.

Smoking initiation rates among youth and young adults were lower after the April 1 2009 tax increase compared to before the federal tax increase. The same was true for past-month cigarette use. The cessation rate among youth was lower after the tax increase, compared to before, whereas for young adults the rate was slightly higher. Among youth and young adult current smokers, the number of days smoked (during the past month) and the number of cigarettes smoked per day were lower after the tax increase, but compared to the averages before the tax increase, the reductions were marginal.

3.2. Initiation, past-month use and cessation

Table 2 shows the odds ratios (ORs) for the post-period indicator, estimated from the logistic regression models for smoking initiation, past-month cigarette use and smoking cessation. The OR represents the odds of the outcome occurring after April 1, 2009 relative to the odds of it occurring before April 1, 2009. ORs less than one indicate that, the outcome was less likely after compared to before the federal tax increase, controlling for individual and state-level characteristics.

Table 2. Odds ratio estimates from the logistic regression models for smoking initiation, past-month cigarette use and cessation, comparing the odds of the outcome after and before the April 1, 2009 tax increase.

Age	Population	Smoking initiation OR (p-value)	Past-month use OR (p-value)	Smoking cessation OR (p-value)
12-17	All	0.83 (<0.0001)	0.83 (<0.0001)	0.84 (0.4684)
	Male	0.87 (0.0140)	0.92 (0.0253)	0.87 (0.6849)
	Female	0.79 (<0.0001)	0.75 (<0.0001)	0.86 (0.6355)
	White	0.79 (<0.0001)	0.80 (<0.0001)	0.90 (0.6857)
	Black	0.88 (0.2364)	0.86 (0.0778)	N/A
18-25	All	0.91 (0.0532)	0.92 (<0.0001)	1.00 (0.9949)
	Male	0.92 (0.2143)	0.96 (0.0651)	1.12 (0.4198)
	Female	0.91 (0.1601)	0.87 (<0.0001)	0.91 (0.4560)
	White	0.88 (0.0268)	0.89 (<0.0001)	0.85 (0.1670)
	Black	0.92 (0.5253)	1.03 (0.6184)	1.41 (0.3216)

Notes: OR = odds ratio. The odds ratio is the odds of a given smoking outcome after April 1, 2009, divided by the odds before April 1, 2009. Two-sided p-values are given in parentheses.

N/A: Due to the small sample size, the odds ratio could not be calculated.

For youth, the tax increase was associated with a reduction in the odds of smoking initiation (OR = 0.83, $p < 0.0001$). A similar result was found for the male, female, and white youth populations, but not for black youth. Initiation among young adults overall was not affected (OR = 0.91, $p = 0.0532$), but the odds of initiating were lower for white young adults after the tax increase (OR = 0.88, $p = 0.0268$).

The odds of past-month cigarette use were lower after the tax increase for the youth population overall (OR = 0.83, $p < 0.0001$) and three out of four subpopulations (male, female, and white, ORs = 0.75–0.92, $p < 0.05$). For young adults, the odds of past-month cigarette use were also lower after the tax increase (OR = 0.92, $p < 0.0001$). The same was true for two out of four subpopulations of young adults (female and white, ORs = 0.87–0.89, $p < 0.0001$). For smoking cessation, none of the estimated ORs were statistically significant.

3.3. Smoking intensity

Table 3 shows the coefficients of the post-period indicator, estimated from the linear regression models for the number of days smoked during the past 30 days and the average number of cigarettes consumed per day of smoking, among current daily and nondaily smokers. Negative estimates indicate a reduction in the outcome following the April 1, 2009 tax increase.

Table 3. Linear regression estimates of the change in the average number of days smoked and the average number of cigarettes smoked per day (for current smokers), following the April 1, 2009 tax increase.

Age	Population	Days smoked during the past 30 days Coefficient (p-value)	Cigarettes per day of smoking	
			Daily smokers Coefficient (p-value)	Nondaily smokers Coefficient (p-value)
12-17	All	-0.97 (0.0001)	-1.02 (0.0011)	-0.25 (0.0114)
	Male	-0.83 (0.0109)	-1.22 (0.0065)	-0.24 (0.1166)
	Female	-1.25 (0.0002)	-0.85 (0.0439)	-0.27 (0.0308)
	White	-1.12 (0.0001)	-0.90 (0.0102)	-0.34 (0.0084)
18-25	All	-0.41 (0.5676)	-2.43 (0.1266)	0.32 (0.2244)
	Black	-0.84 (<0.0001)	-0.92 (<0.0001)	-0.45 (<0.0001)
	Male	-0.78 (<0.0001)	-1.04 (<0.0001)	-0.51 (<0.0001)
	Female	-0.78 (0.0002)	-0.84 (<0.0001)	-0.36 (0.0002)
	White	-0.82 (<0.0001)	-1.09 (<0.0001)	-0.57 (<0.0001)
	Black	-0.95 (0.0164)	-0.59 (0.1196)	-0.29 (0.1796)

Notes: The coefficients indicate the amount by which smoking intensity (number of days smoked, cigarettes per day) changed after April 1, 2009. Two-sided p-values are given in parentheses.

Among the overall population of youth smokers, the average number of days smoked during the past month fell by 0.97 days ($p = 0.0001$) after the tax increase. Statistically significant reductions were also found for male, female and white youth. Among the overall population of young adults, the average number of days smoked during the past month fell by 0.84 days ($p < 0.0001$). The reductions were statistically significant for all subpopulations, ranging from 0.78 days for female young adults ($p = 0.0002$) to 0.95 for black young adults ($p = 0.0164$).

Youth daily smokers smoked on average 1.02 cigarettes per day less after the federal tax increase ($p = 0.0011$). Statistically significant reductions were also found for male, female and white youth daily smokers. In the overall population of youth nondaily smokers, 0.25 fewer cigarettes ($p = 0.0114$) were smoked per day after the tax increase. Similar results were found for female and white youth who were nondaily smokers.

Among young adult daily smokers, the average number of cigarettes smoked per day decreased by 0.92 ($p < 0.0001$) after the federal tax increase. Statistically significant reductions were also found for daily smokers in the male, female and white youth populations. Young adult nondaily smokers also smoked fewer cigarettes per day (-0.45 , $p < 0.0001$), with similar reductions for young adult nondaily smokers in the male, female and white subpopulations.

4. Discussion

This study found that the April 1, 2009 federal cigarette excise tax increase of \$0.62 per pack was associated with a decrease in smoking initiation among youth and decreases in past-month smoking, days smoked per month, and cigarettes per day among youths and young adults. There was no evidence that the tax increase was associated with a significant change in the likelihood of smoking cessation among youth and young adults.

Interestingly, the likelihood of smoking initiation among young adults did not change significantly after the tax increase. A possible explanation for this finding is that our measure of initiation not only captures regular smoking uptake but also occasional experimentation with cigarettes, which may be driven by peer effects and other non-economic factors and therefore less sensitive to tax and price changes (Tyas & Pederson, 1998). The null findings for smoking

cessation may be related to the fact that the cessation indicator in the NSDUH requires the respondent to be smoke-free for an entire year. As such, it sets the bar for quitting quite high. Other studies have shown that short-term, more immediate cessation outcomes such as past 30-day cessation and the number of quit attempts are more sensitive to price and tax changes (Tauras, 2004, Tworek et al., 2010). Among current youth and young adult smokers, the number of days smoked during the past month declined after the tax increase, suggesting that some daily smokers may have become nondaily smokers. Also, fewer cigarettes were smoked per day after the tax increase, with the (absolute) reductions in the number of cigarettes being larger for daily smokers compared to nondaily smokers.

Another major finding of this study is that the strength of the association between the smoking outcomes and the April 1, 2009 federal tax increase varied by age, sex and race. In particular, among black youths, there were no significant associations between the tax increase and any smoking outcome. Among black young adults, the only statistically significant association was with days smoked per month. The likelihood of smoking initiation did not change significantly among black youth after the tax increase, whereas it did change for male, female and white youth. Smoking initiation decreased significantly among white young adults after the tax increase, but not among male, female or black young adults. Also, the odds of past-month cigarette use declined more among female and white youth and young adults, as opposed to the male and black subgroups. These findings are consistent with existing literature that has found that certain subpopulations are more responsive to tax changes than others (US DHHS, 2012b).

This study has two major strengths. First, it is the first to use multiple years of data from a large, nationally representative survey to specifically examine the impact of the April 1, 2009, federal tax increase on tobacco products on smoking among youth and young adults and a number of subpopulations (male, female, white, black). Second, we used a rich set of variables to control for differences in individual characteristics, changes in state tobacco control policies and changes in (proxies for) antismoking sentiment that coincided with the tax increase. Specifically, we controlled for demographic and socioeconomic characteristics, the increasing presence and restrictiveness of smoke-free laws, and the decreasing trend in smoking prevalence between 2002 and 2011.

A limitation of this study is that our models could not account for price movements that may have occurred before the tax increase. If, in anticipation of the federal tax increase, prices rose before April 1, 2009, smoking among youth and young adults could have started to decline before that date. This could, for example, explain our null finding for smoking initiation among young adults. Our estimates do not capture anticipatory effects and may, in fact, provide a lower bound for the full effect of the federal tax increase. A second limitation is that we were unable to use data on tobacco industry discounts and price reducing promotions (e.g., 2-for-1 deals, coupons), which have been shown to counter the depressing effect of price increases on smoking (Hyland et al., 2005, Pierce et al., 2005). A final limitation is because the NSDUH cessation variable is defined only for those who were daily smokers at some point in their lifetime, and because this applies to relatively few youth, sample sizes for the youth cessation analysis were relatively small.

This study has provided a detailed investigation of the relation between the April 1, 2009, federal tax increase on tobacco products and multiple smoking outcomes among youth and young adults. While for the overall populations of youth and young adults the tax increase was associated with reductions in the likelihood of past-month cigarette use, the number of days smoked and the number of cigarettes smoked per day, the reductions were not seen across all subgroups. Moreover, it appears that smoking initiation among young adults did not significantly change after the tax increase. The U.S. Healthy People 2020 objectives call for action to reduce tobacco use to the point where it is no longer a public health problem (US DHHS, 2012a). To achieve this goal, additional policy efforts are needed to substantially reduce tobacco initiation and use among youth and young adults. Such efforts will have to be informed by additional research. One topic for future study is an investigation into variables that moderate the impact of tax policy. While our study found differences across race and sex, it is also possible that other characteristics of tobacco control policy, such as smoke-free air laws in various settings, impacted the ability of the tax increase to change smoking behavior. Future research addressing such questions is critical, because it will support the development of effective, targeted tobacco control policies.

Disclaimer

The findings and conclusions of this study are those of the authors and do not necessarily reflect the views of the Substance Abuse and Mental Health Services Administration, the Centers for Diseases Control and Prevention, and the U.S. Department of Health and Human Services.

Role of funding sources

This study was funded by a contract from the Substance Abuse and Mental Health Services Administration and the Centers for Disease Control and Prevention to RTI International. Co-authors from these agencies played an active role in the interpretation of the data, writing the manuscript, and decision to publish.

Contributors

MVH, MP, and BRL designed the study, conducted the data analysis, interpreted the results, and wrote the manuscript. JK, BH, RSC, and JCG interpreted the results and provided comments on manuscript drafts. All authors have approved the final manuscript.

Conflict of interest statement

None to declare.

Acknowledgments

We thank Lance Couzens, Vincent Keyes and Susan Murchie at RTI International, Jeremy Bray at the University of North Carolina at Greensboro, and Frank Chaloupka at the University of Illinois at Chicago for their assistance with various aspects of this study.

References

- Altman, D.G., Wheelis, A.Y., McFarlane, M., Lee, H., & Fortmann, S.P. (1999). The relationship between tobacco access and use among adolescents: A four community study. [Clinical Trial; Randomized Controlled Trial; Research Support, Non-U.S. Gov't] *Social Science and Medicine*, 48(6), 759–775.
- Bader, P., Boisclair, D., & Ferrence, R. (2011). Effects of tobacco taxation and pricing on smoking behavior in high risk populations: A knowledge synthesis. [Research Support, Non-U.S. Gov't; Review] *International Journal of Environmental Research and Public Health*, 8(11), 4118–4139. <http://dx.doi.org/10.3390/ijerph8114118>.
- Centers for Disease Control and Prevention (CDC) (2009, May 22). Federal and state cigarette taxes — United States, 1995–2009. *Morbidity and Mortality Weekly Report*, 58(19), 524–527.
- Centers for Disease Control and Prevention (CDC) (2013, November 15). State tobacco activities tracking & evaluation (STATE) system. Retrieved November 26, 2013, from www.cdc.gov/tobacco/state_system/index.htm
- Chaloupka, F.J. (2001). Tobacco taxation. Paper presented at the National Conference of State Legislatures 5th National Health Policy Conference, Seattle, WA.
- Chaloupka, F.J., Straif, K., & Leon, M.E. (2011). Effectiveness of tax and price policies in tobacco control. [Consensus Development Conference; Research Support, Non-U.S. Gov't] *Tobacco Control*, 20(3), 235–238. <http://dx.doi.org/10.1136/tc.2010.039982>.
- Chaloupka, F.J., & Wechsler, H. (1997). Price, tobacco control policies and smoking among young adults. [Research Support, Non-U.S. Gov't] *Journal of Health Economics*, 16(3), 359–373.
- DeCicca, P., Kenkel, D., & Mathios, A. (2008). Cigarette taxes and the transition from youth to adult smoking: Smoking initiation, cessation, and participation. *Journal of Health Economics*, 27(4), 904–917. <http://dx.doi.org/10.1016/j.jhealeco.2008.02.008>.
- DiFranza, J.R., & Coleman, M. (2001). Sources of tobacco for youths in communities with strong enforcement of youth access laws. [Research Support, Non-U.S. Gov't] *Tobacco Control*, 10(4), 323–328.
- Farrelly, M.C., & Bray, J.W. (1998). Response to increases in cigarette prices by race/ ethnicity, income, and age groups—United States, 1976–1993. (Reprinted from (1998) *Morbidity and Mortality Weekly Report*, 47, 605–609) *Journal of the American Medical Association*, 280(23), 1979–1980.
- Farrelly, M.C., Pechacek, T.F., Thomas, K.Y., & Nelson, D. (2008). The impact of tobacco control programs on adult smoking. [Research Support, U.S. Gov't, P.H.S.] *American Journal of Public Health*, 98(2), 304–309. <http://dx.doi.org/10.2105/AJPH.2006.106377>.
- Forster, J.L., Murray, D.M., Wolfson, M., Blaine, T.M., Wagenaar, A.C., & Hennrikus, D.J. (1998). The effects of community policies to reduce youth access to tobacco. [Case Reports, Clinical Trial, Randomized Controlled Trial, Research Support, U.S. Gov't, P.H.S.] *American Journal of Public Health*, 88(8), 1193–1198.
- Government Printing Office (GPO) (2009). Public law 111-3: Children's Health Insurance Program Reauthorization Act of 2009. Retrieved from <http://www.gpo.gov/fdsys/pkg/PLAW-111publ3/html/PLAW-111publ3.htm>
- Guide to Community Preventive Services (2012, November). Reducing tobacco use and secondhand smoke exposure: Increasing the unit price of tobacco products (abbreviated).

- Retrieved November 26, 2013, from www.thecommunityguide.org/tobacco/increasingunitprice.html
- Hyland, A., Bauer, J.E., Li, Q., Abrams, S.M., Higbee, C., Peppone, L., et al. (2005). Higher cigarette prices influence cigarette purchase patterns. [Research Support, N.I.H., Extramural; Research Support, U.S. Gov't, P.H.S.] *Tobacco Control*, 14(2), 86–92. <http://dx.doi.org/10.1136/tc.2004.008730>.
- ImpacTeen (2013). Tobacco control policy and prevalence data: 1991–2008. Retrieved November 26, 2013, from www.impacteen.org/tobaccodata.htm
- International Agency for Research on Cancer (IARC) (2011). Effectiveness of tax and price policies for tobacco control. Lyon, France: International Agency for Research on Cancer (Report No.).
- Kennet, J., & Gfroerer, J. (Eds.). (2005). Evaluating and improving methods used in the National Survey on Drug Use and Health. DHHS Publication No. SMA 05-4044, Methodology Series M-5. Rockville, MD: Substance Abuse and Mental Health Services Administration, Office of Applied Studies.
- Orzechowski and Walker (2012). The tax burden on tobacco, historical compilation, 2011. Arlington, VA: Orzechowski and Walker, Inc.
- Pierce, J.P., Gilmer, T.P., Lee, L., Gilpin, E.A., de Beyer, J., & Messer, K. (2005). Tobacco industry price-subsidizing promotions may overcome the downward pressure of higher prices on initiation of regular smoking. [Research Support, Non-U.S. Gov't] *Health Economics*, 14(10), 1061–1071. <http://dx.doi.org/10.1002/hec.990>.
- Rice, N., Godfrey, C., Slack, R., Sowden, A., & Worthy, G. (2009). A systematic review of the effects of price on the smoking behavior of young people. Public Health Research Consortium (Retrieved from http://phrc.lshtm.ac.uk/papers/PHRC_A2-06_Final_Report.pdf).
- Ross, H., & Chaloupka, F.J. (2003). The effect of cigarette prices on youth smoking. [Research Support, Non-U.S. Gov't] *Health Economics*, 12(3), 217–230. <http://dx.doi.org/10.1002/hec.709>.
- RTI International (2012). SUDAAN®, Release 11. Research Triangle Park, NC: RTI International (Report No.). Substance Abuse and Mental Health Services Administration (SAMHSA) (2011a). Synar program factsheet. Retrieved from www.samhsa.gov/prevention/synarFactsheet.aspx
- Substance Abuse and Mental Health Services Administration (SAMHSA) (2011b). 2011 national survey on drug use and health: imputation report. Retrieved from www.samhsa.gov/data/sites/default/files/NSDUH2011MRB/NSDUH2011MRB/NSDUHmrbImputation2011.pdf
- Substance Abuse and Mental Health Services Administration (SAMHSA) (2013a). Results from the 2012 National Survey on Drug Use and Health: Summary of national findings. Rockville, MD: Substance Abuse and Mental Health Services Administration (Report No.).
- Substance Abuse and Mental Health Services Administration (SAMHSA) (2013, August 26b). Tobacco/Synar Program. Retrieved November 26, 2013, from www.samhsa.gov/prevention/synar.aspx
- Tauras, J.A. (2004). Public policy and smoking cessation among young adults in the United States. [Research Support, Non-U.S. Gov't] *Health Policy*, 68(3), 321–332. <http://dx.doi.org/10.1016/j.healthpol.2003.10.007>.

- Tauras, J.A. (2005). Can public policy deter smoking escalation among young adults? *Journal of Policy Analysis and Management*, 24(4), 771–784.
- Tauras, J.A., & Chaloupka, F.J. (2001). Determinants of smoking cessation: an analysis of young adult men and women. In M. Grossman, & C. -R. Hsieh (Eds.), *Economic Analysis of Substance Use and Abuse: The Experience of Developed Countries and Lessons for Developing Countries*. Cheltenham, England: Edward Elgar Publishing.
- Tworek, C., Yamaguchi, R., Kloska, D.D., Emery, S., Barker, D.C., Giovino, G.A., et al. (2010). State-level tobacco control policies and youth smoking cessation measures. [Research Support, N.I.H., Extramural; Research Support, Non-U.S. Gov't] *Health Policy*, 97(2–3), 136–144. <http://dx.doi.org/10.1016/j.healthpol.2010.04.009>.
- Tyas, S.L., & Pederson, L.L. (1998). Psychosocial factors related to adolescent smoking: a critical review of the literature. [Research Support, Non-U.S. Gov't, Review] *Tobacco Control*, 7(4), 409–420.
- U.S. Department of Health and Human Services (US DHHS) (2012a). Healthy People 2020 Tobacco Use Objectives. Retrieved December 18, 2012, from <http://www.healthypeople.gov/2020/topicsobjectives2020/overview.aspx?topicid=41>
- U.S. Department of Health and Human Services (US DHHS) (2012b). Preventing tobacco use among youth and young adults: a report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health (Report No.).
- U.S. Department of Health and Human Services (US DHHS) (2014). The health consequences of smoking — 50 years of progress: A report of the Surgeon general. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health (Report No.).
- U.S. Department of Labor, Bureau of Labor Statistics (2009). CPI Detailed Report: Data for April 2009. Retrieved from www.bls.gov/cpi
- U.S. Department of Labor, Bureau of Labor Statistics (2013, November 20). Consumer price index. Retrieved November 26, 2013, from www.bls.gov/cpi
- Zhang, B., Cohen, J., Ferrence, R., & Rehm, J. (2006). The impact of tobacco tax cuts on smoking initiation among Canadian young adults. [Research Support, Non-U.S. Gov't] *American Journal of Preventive Medicine*, 30(6), 474–479. <http://dx.doi.org/10.1016/j.amepre.2006.02.001>.