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The Impact of the 2018 Kentucky Cigarettes Taxes on Tobacco Use among Youth

CAPSTONE PROJECT PAPER

A paper submitted in partial fulfillment of the
Requirements for the degree of
Master of Public Health in the
University of Kentucky College of Public Health

By

Claire Mampunza
Lexington, Kentucky

Final Examination:
Lexington, Kentucky
April 23, 2021

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Abstract

Introduction: In the Commonwealth of Kentucky, cigarette smoking results in 1.92 billion dollars spent every year on medical costs, the death of approximately 9,000 Kentuckians, and 34 percent of all cancer cases. In 2017, 14.3 percent of high school students in Kentucky declared being current cigarette smokers, compared to 8.8 percent nationally. Tobacco use among youth is a public health concern because 88 percent of adult smokers initiate smoking before age 18. Youth nicotine use can damage the growing brain, which continues to develop until 25 years of age. In July 2018, the excise tax on cigarettes increased from sixty cents per pack of twenty cigarettes to one dollar and ten cents per pack of twenty in Kentucky. This study aims to assess the impact of the 2018 excise tax policy on cigarettes one year after it had been enacted on tobacco consumption behaviors among youth in Kentucky. Did the policy succeed in reducing cigarette use among youth, or did it influence youth to use other tobacco products, such as e-cigarettes or cigars?

Method: The study uses the Youth Risk Behavior Surveillance System (YBRSS) data to compare tobacco use behaviors among high school students in Kentucky before and post the 2018 price increase on cigarettes. We selected the survey years 2013, 2015, 2017, and 2019 since the YBRSS takes place every two years. We used the YBRSS interactive data analysis tool to perform a t-test analysis, generated custom tables and graphs, and selected only questions on the tobacco use topic. We present prevalence estimates with a 95% confidence interval, and we considered the statistical difference if the t-test $P < .05$.

Result: After the policy change, the difference in the prevalence of students who tried cigarette smoking was approximately three times more than the changes observed before the policy change. The difference in prevalence of students who currently smoked cigarettes was approximately two times more than the changes observed before the policy change. Cigarette smoking initiation before age 13 rates also decreased after the price increase, by 24 percent. The difference observed in students who used the vapor product was three times more than the change observed before the policy change. The

prevalence of current vaping behavior decreased before the policy change and increased after the policy change.

Conclusion: The tax increase on cigarette packs passed in July 2018 succeeded in reaching its goal since the initiation rate, and the use rate decreased on cigarette smoking. Another effect observed after the tax increase on cigarettes was the substantial increase in e-cigarettes use among youth and the lack of change in the cessation rate.

Keywords: tobacco use, cigarette, e-cigarette, Youth Risk Behavior Surveillance System, excise tax

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List of Abbreviations

ALA	American Lung Association
BRFS	Behavioral Risk Factor Surveillance
CDC	Centers for Disease Control and Prevention
CTFK	Campaign for Tobacco Free-Kids
FDA	Food Drugs Administration
FHK	Foundation for a Healthy Kentucky
KGA	Kentucky General Assembly
NHIS	National Health Interview Survey
NYTS	National Youth Tobacco Survey
TI	Truth Initiative
US	United States
USDHHS	United States Department of Health and Human Services
YBRIS	Youth Risk Behavior Survey
YBRSS	Youth Risk Behavior Surveillance System

Introduction

Tobacco use is one of the principal causes of preventable illness and death in the United States; smoking cigarettes results in 16 million Americans with at least one preventable disease and 170 billion dollars in direct health care expenses every year (CDC, 2020). In Kentucky, cigarette smoking results in 1.92 billion dollars spent every year on medical costs; the death of approximately 9,000 Kentuckians, which is more than alcohol use, HIV, car crashes injuries, illegal drugs use, murders, and suicides combined; and 34 percent of all cancer cases (FHK, 2017).

Tobacco use among youth is a public health concern because 88 percent of adult smokers initiate smoking before age 18 (USDHHS, 2012). Youth nicotine use can damage the growing brain, which continues to grow until 25 years of age. Nicotine consumption can lead to nicotine dependence, emotional disorders, and a permanent decrease of impulse control (USDHHS, 2016). In 2017, 14.3 percent of high school students in Kentucky declared being current cigarette smokers on at least one day during the 30 days before completing the Youth Behavior Risk Survey (YBRS), compared to 8.8 percent nationally (CDC, 2017). Scientists are projecting that 7.7 percent of living Americans aged 17 years and younger will die early from smoking-related diseases if cigarette smoking rates among youth stay the same as today (CDC, 2020)

In October 2017, the Coalition for a Smoke-Free Tomorrow started an advocacy campaign for a one dollar per pack tax increase in Kentucky to reduce cigarette smoking prevalence among adolescent and expectant mothers. Unfortunately, legislators reduced the excise tax increase to only fifty cents. In July 2018, the excise tax on cigarettes increased from sixty cents per pack of twenty cigarettes to one dollar and ten cents per pack of twenty in Kentucky. Meanwhile, the United States average excise tax is one dollar and seventy-three cents per pack of cigarettes (Truth Initiative, 2020). This tax bill did not include e-cigarettes and other vaping products. According to the Coalition for a Smoke-Free Tomorrow, 12 months after the new policy had been enacted, cigarette sales in Kentucky experienced a decrease of 36 million packs of cigarettes (Chandler, 2019).

This study aims to assess the impact of the 2018 excise tax policy on cigarettes one year after it had been enacted on tobacco consumption behaviors among youth in Kentucky. Did the policy succeed in reducing cigarette use among youth, or did it influence youth to use other tobacco products, such as e-cigarettes or cigars? This study is valuable because it endeavors to provide evidence of the effectiveness of applying taxing as a public health tool to change population health behaviors. It also provides data for a potential policy modification to improve population health in Kentucky, reduce health care costs and decrease premature deaths related to tobacco use.

Literature Review

Tobacco Use in the United States

There are multiple tobacco products in the United States market including traditional cigarettes, electronic nicotine delivery systems, cigars, pipes, hookah, and others. The main tobacco product used among adults in 2019 was cigarettes. Approximately 50.6 million US adults (20.8%) who participated in the 2019 National Health Interview Survey (NHIS) declared a current use of any tobacco product; among them, 14 percent reported smoking cigarettes, 4.5 percent e-cigarettes use, 3.6 percent cigar use, 2.4 percent smokeless tobacco use, and one percent pipe use (Cornelius et al., 2019). At the same time, the main tobacco product used among youth was e-cigarettes. An estimated 6.2 million American middle and high schoolers (23.0%) who participated in the 2019 National Youth Tobacco Survey (NYTS) declared a current use of any tobacco product, including 20 percent e-cigarette users, 5.3 percent cigar users, 4.3 percent cigarette users, 3.5 percent smokeless tobacco users, and less than one percent pipe users (Wang et al., 2019). The cigarette smoking rate is decreasing in the US. The rate of adult cigarette smokers experienced a 4.1 percentage point decrease from 17.8 percent in 2013 to 13.7 in 2018, and the rate of youth cigarette smokers experienced a 6.9 percentage point decrease from 15.7 percent in 2013 to 8.8 percent in 2017(ALA, 2021).

A cigarette is a thin roll of cut tobacco leaf enveloped with paper for smoking and was first known to be used in this version in 1832 (Merriam-Webster, n.d.). Smoking cigarettes burn tobacco and release multiple harmful chemicals such as tar, nicotine,

which produces the addictive effect, and carbon monoxide (Harris, n.d.). Cigarette smoke has dangerous development and health effects for the smoker and the people around them, and cigarette smoke has a direct and future effect on youth health (Ahluwalia et al., 2020). The significant known health effects of smoking cigarettes on humans include cancer, heart disease, lung disease, and reproduction effects (Harris, n.d.). Particularly among youth, smoking cigarettes' health effects include dependence on nicotine, poor lung function, poor lung development, and premature cardiovascular injury (CDC, 2014). The nicotine present in the cigarette is highly addictive, and the main primary concern is that nicotine can impair youths' brain development. According to Goriaunova & Mansvelder (2012), adolescents are more sensitive to nicotine than adults. The exposure of the adolescent brain to nicotine increases the risk of attention deficit in the short term and increases the chance of having mood disorders and cognitive impairment in the long term (Goriounova & Mansvelder, 2012). Children exposed to secondhand cigarette smoke are more likely to develop more ear infections, respiratory infections, asthma attacks, and poor school attendance affecting their school performance (USDHHS, 2014). In addition, the prevalence of cigarette smoking is higher among rural residents than urban residents. A study of the National Survey of Drug Use and Health estimated that 10.9 percent of adolescents living in rural areas smoked cigarettes compared to 8.3 percent of adolescents living in urban areas between 2008 and 2010, and from 2014 through 2016, the rate was 7.3 percent among rural adolescents in contrast with 3.8 percent among urban adolescents (Ziller et al., 2019)

Electronic nicotine delivery systems, also called e-cigarettes, e-cigs, e-hookahs, mods, vape pens, vapes, and tank systems, are popular, recent, and manufactured in diverse shapes battery-operated devices used to inhale vapor composed with nicotine, flavors, and other additives (USDHHS, 2016). Electronic nicotine delivery systems cost less than traditional cigarettes. In 2016, for a New York resident who smokes a pack a day, smoking conventional cigarettes will cost him around seven times more than e-cigarettes use (Cigarettes vs. e-cigarettes, 2016). When first introduced on the market, electronic nicotine delivery systems manufacturers and advocates marketed them as a less harmful tobacco product to support cigarette smoking cessation. However, multiple studies provided evidence that electronic nicotine delivery systems still have adverse

health effects and are not effective for smoking cessation (Drummond & Upson, 2014). Electronic nicotine delivery systems are popular among youth compared to traditional cigarettes for many reasons, including easily concealed; they can have the shape of a cigarette, a cigar, a pen, or a USB flash drive. One e-cigarette cartridge is smaller than a pack of traditional cigarettes and can contain more nicotine. According to the surgeon general report (CDC, 2019), the most popular electronic nicotine delivery system among youth is a USB flash drive-shaped e-cigarette named “Juul”, with a nicotine level comparable to approximately 20 cigarettes. Their sale saw an increase of 600% between 2016 and 2017 (CDC, 2019). Another reason electronic nicotine delivery systems are popular among youth is that they have different appealing flavors. They come in approximately 7,500 different flavors: tobacco, menthol, fruit, candy, and dessert that are more attractive to young e-cigarette users (Harrell, 2017). Finally, electronic nicotine delivery systems are popular among youth because youth are one of the main targets of electronic nicotine delivery systems marketing. In 2014, eleven US senators and representatives reported the rise in advertising electronic nicotine delivery systems to kids based on the appealing flavor between 2011 and 2012. Six top electronic nicotine delivery systems companies invested 59.3 million dollars in 2013 to promote their candy flavored product (Slomski, 2014). Since that report, the Food and Drug Administration (FDA) is working to end advertising targeted to youths. They released the first regulation in May of 2016, including e-cigarette and accessories on the list of tobacco products (USDHHS, 2016).

Electronic nicotine delivery systems are concerning because they are strongly associated with cigarette smoking initiation among young people (Khouja et al., 2020). Evidence from a study on nationally representative United States youths found over two years of follow-ups that vaping as one’s first tobacco product is associated with 4.09 times the odds of ever smoking cigarettes and 2.75 times the odds of current cigarette smoking (Berry et al., 2019). Another prospectively followed cohort study in South California among 11th and 12th-grade students also found that vaping students had 6.17 times the odds of initiation to cigarette smoking than those who never vaped (Barrington-Trimis et al., 2016). Thus, electronic nicotine delivery systems need to be considered when

elaborating or evaluating policies that aim to reduce cigarette smoking among adolescents.

Tobacco Use in Kentucky

Cigarettes were the preferred tobacco product among adults in 2019 in Kentucky. According to the 2019 Behavioral Risk Factor Surveillance (BRFS), 23.6 percent of adults smoked cigarettes compared to 16.0 percent nationally, and 6.6 percent of adults in Kentucky used smokeless tobacco products compared to 4 percent nationally (CDC, 2019). In 2017, 6.1 percent of adults in Kentucky used e-cigarettes, compared to 4.6 percent nationally (CDC, 2020). Meanwhile, e-cigarettes were the preferred tobacco product among high school students in Kentucky. The 2019 Youth Risk Behavior Survey (YBRS), 26.1 percent of high school students in Kentucky reported using electronic nicotine delivery systems devices, compared to 32.7 percent nationally, while 8.9 percent reported smoking cigarettes compared to 6.0 percent nationally, 7.9 percent reported smoking cigars, and 6.4 percent reported chewing tobacco, snuff, or dip (CDC, 2019). Looking at the previous data, the use of tobacco products in Kentucky is generally higher than the national averages. The cigarette smoking rate is also decreasing in Kentucky. The rate of adult cigarette smokers experienced a 3.1 percentage point decrease from 26.5 percent in 2013 to 23.4 in 2018, and the rate of youth cigarette smokers experienced a 3.6 percentage point decrease from 17.9 percent in 2013 to 14.3 percent in 2017(TI,2015; TI, 2020; CDC, 2017).

Kentucky's legislature enacted multiple laws and ordinances to reduce tobacco use and initiation in the state. Since July 2018, the cigarette tax is 1.10 dollars per pack of twenty. For 1.5 ounces or less of moist snuff, and one unit of chewing tobacco the tax is 19 cents. One-half pound of chewing tobacco tax is 40 cents, and one-pound tax is 65 cents. A 15 percent of the total sale price is applied to all other tobacco products (KGA, 2020). Since August 2020, the tax of e-cigarettes is 1.50 dollars per cartridge, and open vaping systems tax is 15 percent of the current distributor sales price (KGA, 2020). To reduce tobacco access to youth, the federal government enacted a law that raises the national minimum age of the sale of all tobacco products, including e-cigarettes, to age 21 (TI,2020). Another important tobacco policy is that authorities banned smoking

cigarettes and e-cigarette use in Kentucky government buildings and all properties owned or operated by the local government, including schools (TI, 2020).

The commonwealth of Kentucky underfunds tobacco prevention compared to the Center for Disease Control recommendations. According to the Campaign for Tobacco-Free Kids (2020), for the fiscal year 2021, the state of Kentucky ranks 39th in state spending on tobacco prevention, the total state tobacco revenue will be 503.3 million dollars, and the estimated annual tobacco company marketing in the state will be 274.3 million dollars. However, the total state spending on tobacco prevention will be only 2.0 million dollars when the amount recommended by the Center for Disease Control is 56.4 million dollars. In Kentucky, smoking cigarettes caused 8,900 deaths each year, the annual medical cost related to smoking is 1.92 billion dollars, and the residents' state and federal tax burden related to smoking cost 1,158 dollars per household (CTFK, 2021).

Effective Strategies to Reduce Tobacco Use

Since 1964, federal, state, and local public health authorities have implemented population-based tobacco control strategies that successfully reduced smoking initiation and prevalence among adults and youth. The percentage of adult cigarette smokers dropped in the US from 42.4% in 1964 to 13.7% in 2018 (USDHHS, 2014 and SAMHSA, 2019). The high school cigarette smoking rate dropped in the US from 27.5% in 1991 to 8.8 in 2017 (ALA, 2021). The national population-based strategy to control tobacco use focuses mainly on taxing tobacco products, implementing large anti-tobacco communication campaigns, and implementing policies that prohibit public tobacco use (CDC, 2017). The Centers for Disease Control and Prevention (2017) state first that large anti-tobacco communications campaigns contributed to a 5.0 and 3.4 percentage points median reduction in the percentage of tobacco use among adults and youth, a more than two times median increase in cessation line's calls, and a 6.7 percentage points reduction in tobacco initiation among youth. Second, the smoke-free ordinances contributed to a 50 percent exposure reduction to environmental tobacco smoke, a 2.7 percentage point reduction in tobacco smoking prevalence, 1.2 fewer cigarettes smoked a day, and 5.1 and 20.1 percent fewer patients admitted for cardiovascular incidents and asthma. Finally, a tobacco tax that led to a twenty percent price increase contributed to a 7.4 and 14.8

percent tobacco's demand reduction, 3.6 and 1.2 percent tobacco user's reduction, 8.6 percent youth's tobacco initiation rate, and 6.5 and 18.6 percent cessation rate increase among adults and youth.

The decrease in cigarette smoking is also connected to the rise of electronic nicotine delivery systems (SAMSHASA, 2019). People substituted smoking cigarettes for vaping; when the cigarette smoking rate decreased sharply, the vaping rate also increased sharply. There is an association between smoking rate decreases and e-cigarettes rate increase. A statistical analysis of the decrease and increase in cigarette use rates and vaping by age, gender, race, and ethnicity indicates that around 70 percent of the decrease in cigarette use rates from 2013 to 2017 was related to the increased vaping rates (Shapiro, 2019). Additionally, a price increase in cigarettes might increase electronic nicotine delivery systems consumption (Zhao, 2009). A study on the impact of electronic nicotine delivery systems on cigarette price suggests an association between cigarette price increase and electronic nicotine delivery systems use increase among youth (Cantrell et al., 2020).

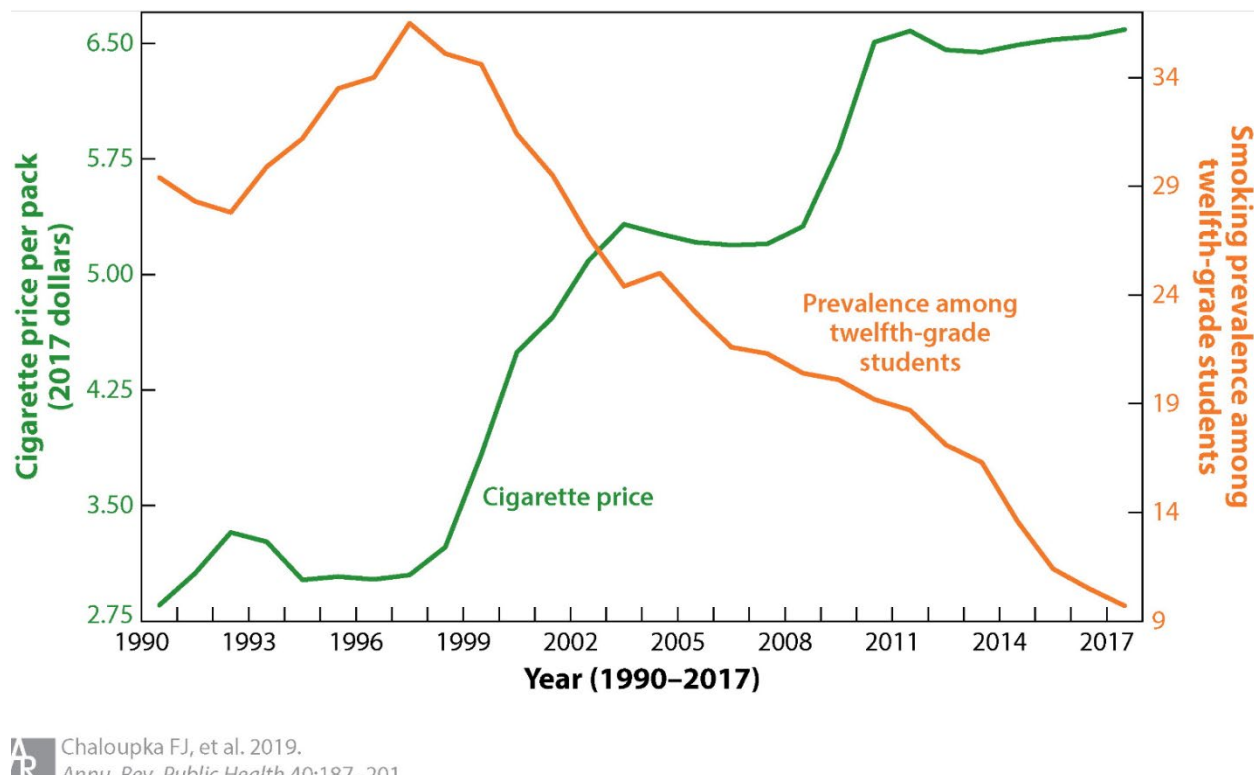
Excise Tax in Public Health

Since non-communicable diseases have become the leading cause of death and disabilities globally, public health professionals have promoted multiple strategies to reduce the consumption of unwholesome goods such as alcohol, tobacco, junk foods, and sugary beverage. Those strategies include the excise tax policy. Excise taxes increase the price of goods for consumers to decrease the demand for those goods (Chaloupka et al., 2019). Excise taxes in public health are used to reduce the consumption of unhealthy products and improve population health. While the sales tax is included at the end of the purchase process, the excise tax is added ahead of the purchase process and increases the goods shelf price. Thus, the excise tax is more noticeable to the consumers than a sales tax because it increases the counter prices when deciding to discourage the acquisition of taxed goods (Falbe et al., 2015).

Multiple studies have provided evidence and have estimated the impact of increasing tobacco product prices through taxes on tobacco products' demand. Most of them concluded that higher tobacco product price is associated with tobacco use

reduction in the United States. The price elasticity of cigarette consumption for adults is estimated around -0.4, which means that a 10 percent increase in cigarettes' price reduces the average demand by 4 percent (Chaloupka et al., 2019). Males are more price responsive than females: a 10 percent increase in cigarettes' price would reduce the average demand among male smokers by 13 percent and by 8 percent among female smokers (Nikaj et al., 2014). Also, youths are more price responsive than adults in their demand for cigarettes. The estimated price elasticity for youth smoking tends to be 2 to 3 times greater than those for adults, and it fell between -0.67 and -1.02, which implies that a 50-cent price increase could lead to a 17.8 to 19 percent demand decrease (Ross & Chaloupka, 2003 & Chaloupka et al., 2019). For e-cigarettes, a 10 percent price increase could lead to around a 9.7 percent decrease in the number of days of e-cigarette use (Pesko et al., 2018). Figure one illustrates how the prevalence of smoking cigarette change when price change.

Figure 1 Example of youth smoking prevalence and cigarette price



AR Chaloupka FJ, et al. 2019.
Annu. Rev. Public Health 40:187–201

Note: Image from Chaloupka F.J., t al., 2019

Methods

This study will analyze the impact of the 1.10-dollar excise tax on cigarettes enacted in July 2018 on tobacco use among high school students in the state of Kentucky by comparing data on tobacco use behavior five years before and nine months after Kentucky legislators enacted the policy. The study will compare data on tobacco use behavior from the Kentucky High School Youth Risk- Behavior Surveillance System (YBRSS) for the survey years 2013, 2015, 2017, and 2019 accessed on the Centers for Disease Control and Prevention (CDC) interactive data analyses tool.

Description of the system

The Youth Risk Behavior Surveillance System (YBRSS) is the United States' most extensive public health surveillance system (Kann et al., 2018). The system was developed in 1990 and is conducted biannually to track emerging and prevailing priority health-related behaviors, conditions, and experiences for high school students (Underwood et al., 2020). The health-related behaviors of interest include the following six topics: behaviors that lead to not intentional injuries and violence including suicidal behaviors, sexual behaviors that result in an unplanned pregnancy and sexually transmitted illnesses such as HIV infection, alcohol and other substance abuse, tobacco consumption, poor diet behavior, and insufficient physical activity (Underwood et al., 2020). It also tracks the prevalence of other health-related behaviors, obesity, and asthma (Kann et al., 2018).

Since 1997, the Kentucky Youth Risk Behavior Survey is conducted as part of a nationwide effort by the Centers for Disease Control and Prevention (CDC) (Bunge, 2020). It is conducted among representative samples of public, catholic, and other private high school students in grades 9-12. The survey is self-administered and anonymous. Students complete the survey during one class period (45 minutes) in the spring semester on a computer-scannable booklet (Underwood et al., 2020).

For this study, we selected the Youth Risk- Behavior Surveillance System (YBRSS) because it provides standardized data that allows us to compare those data across time and locations (Underwood et al., 2020). Thus, we can compare data from

different years and local, state, and national levels. Another reason to use the YBRSS is that data is easily accessible online one year after being collected.

Data Analysis

The Youth Risk Behavior Surveillance System (YBRSS) interactive data analysis tool (retrieved from <https://nccd.cdc.gov/youthonline/App/Results.aspx?LID=KY>) uses SAS and SUDAN software to conduct all statistical analyses for prevalence estimates and confidence intervals. The interactive data analysis tool declared a prevalence estimate statistically significant if the t-test p-value was less than 0.05. For trends between different years, the interactive data analysis tool uses logistic regression analyses to account for all available estimates. A p-value associated with the regression coefficient that was less than 0.05 was declared statistically significant. Also, the data analysts compared prevalence estimates from two different years by using t-tests for identical variables in both survey years (Underwood et al., 2020).

We used the YBRSS interactive data analysis tool to perform a t-test analysis and generate custom tables and graphs. Since the YBRSS takes place every two years, we selected the survey years 2013, 2015, 2017, and 2019 to compare data trends five years before the tax increase and a year after. We selected only questions on the tobacco use topic. The study analyzes the variables labeled as *ever tried cigarette smoking*, *first tried cigarette smoking before age 13 years*, *currently smoked*, *ever used an electronic vapor product*, *currently used an electronic vapor*, *currently used smokeless tobacco*, *currently smoked cigars*, and *tried to quit using all tobacco products to assess those tobacco use behaviors*. The study uses Ross & Chaloupka, who studies “the effect of cigarette price on youth smoking” in 2003, as a guiding framework to predict the percentage decrease in cigarette smoking.

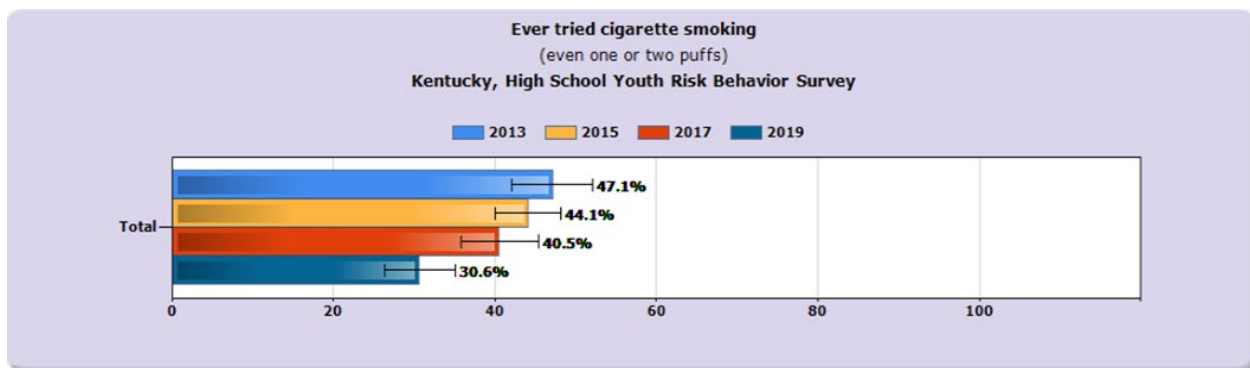
Result

The data used for this study was self-reported by Kentucky high school students in 9th, 10th, 11th, and 12th grades in 2013, 2015, 2017, and 2019 for the YBRSS. Table one presents prevalence estimates on tobacco use topics for the four different years with a 95% confidence interval. The study used t-test analysis, $P < .05$, to observe statistical differences between two different years for the four-year period of the study. Table two

resumes the result of all t-tests analysis. The t-test analysis on tobacco uses topics for different concerned years suggested significant changes mainly for the variables labeled as *ever tried cigarette smoking*, *currently smoked*, *ever used an electronic vapor product*, *currently used an electronic vapor*, *currently used smokeless tobacco*, and *currently smoked cigars* (table 2).

The percentage of students who ever tried smoking a cigarette decreased during all time periods observed (Figure 2). It decreased 3-percentage points from 2013 to 2015, 3.6 percentage points from 2015 to 2017, and 9.9 percentage points between 2017 and 2019. However, the only statistically significant decrease was observed between 2017 and 2019 ($P<.001$) (table 2).

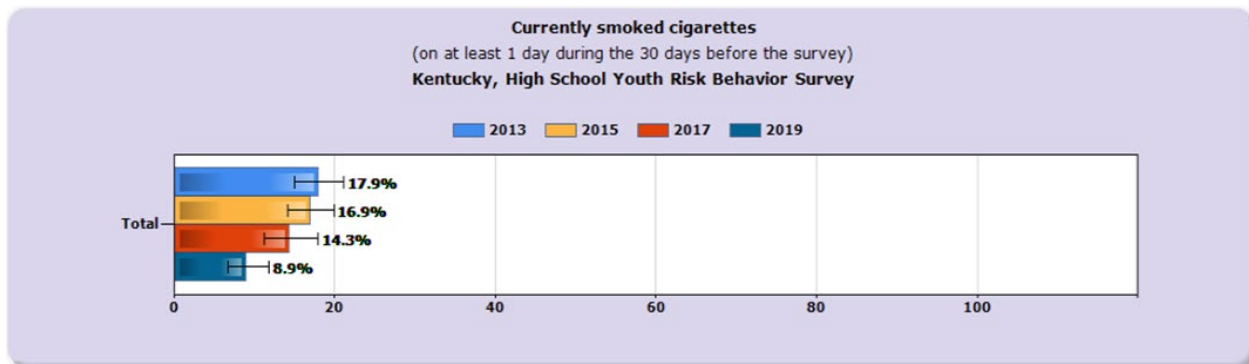
Figure 2



Note: Graph generated with YBRSS online data analysis tool (CDC, 2019).

The prevalence of students who currently smoked cigarettes decreased during all time observed (Figure 3). It experienced a 1-percentage point decrease from 2013 to 2015, a 2.6 percentage point decrease from 2015 to 2017, and a 5.4 percentage point decrease between 2017 and 2019. However, the only statistically significant decrease was observed between 2017 and 2019 ($P=.01$) (table 2).

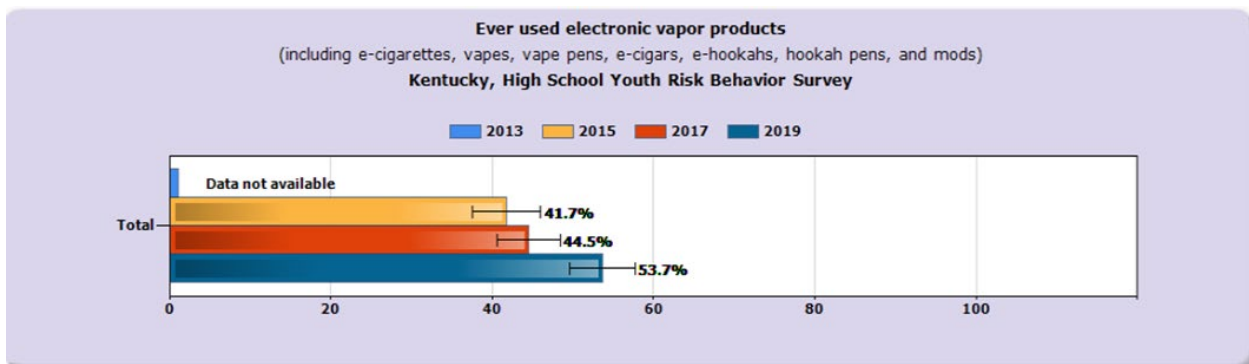
Figure 3



Note: Graph generated with YBRSS online data analysis tool (CDC, 2019).

The percentage of students who ever used electronic vapor products (including e-cigarettes, vapes, vape pens, e-cigars, e-hookahs, hookah pens, and mods) increased during all time periods observed (Figure 4), there was no data for the year 2013 because the YBRSS added that question in 2015. It experienced a 2.8 percentage point increase from 2015 to 2017 and a 9.2 percentage point increase from 2017 to 2019. There was a statistically significant increase between the years 2017 and 2019 ($P < .001$) (table 2).

Figure 4

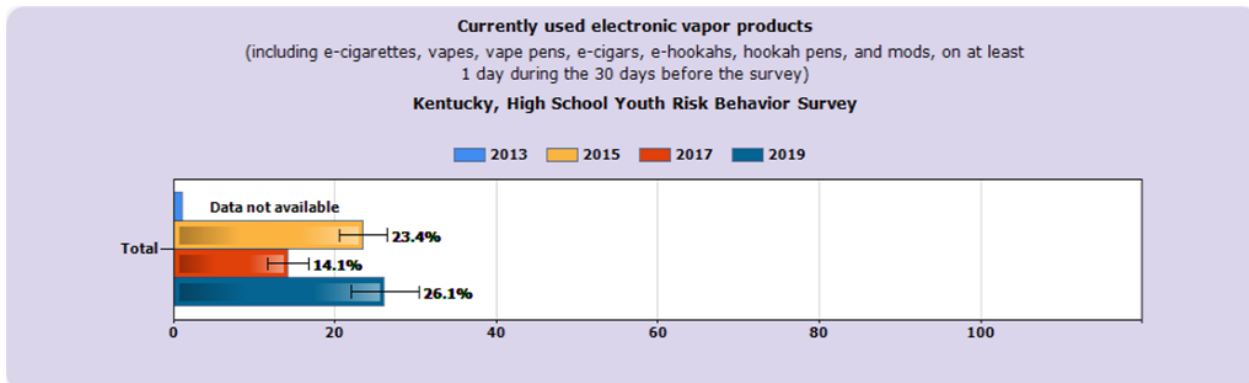


Note: Graph generated with YBRSS online data analysis tool (CDC, 2019).

The percentage of students who currently used electronic vapor products (including e-cigarettes, vapes, vape pens, e-cigars, e-hookahs, hookah pens, and mods) experienced a 9.3 percentage point decrease from 2015 to 2017 and a 12-percentage point increase from 2017 to 2019 (Figure 5). There was no data for the year 2013 because

the survey did not include that question. There was a statistical decrease between 2015 and 2017 ($P<.001$) and a statistical increase between 2017 and 2019 ($P<.001$) (table 2).

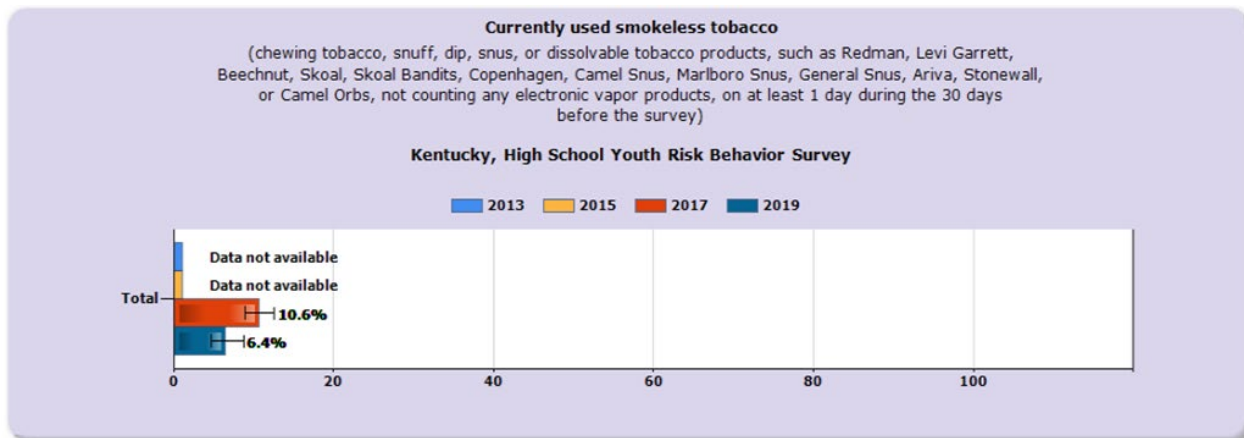
Figure 5



Note: Graph generated with YBRSS online data analysis tool (CDC, 2019).

The percentage of students who currently used smokeless tobacco (chewing tobacco, snuff, dip, snus, or dissolvable tobacco products, such as Redman, Levi Garrett, Beechnut, Skoal, Skoal Bandits, Copenhagen, Camel Snus, Marlboro Snus, General Snus, Arriva, Stonewall, or Camel Orbs, not counting any electronic vapor products, on at least one day during the 30 days before the survey) experienced a 4.2 percentage point decrease from 2017 to 2019 (Figure 6), there was no data for the year 2013 and 2015, because the survey did not include that question. There was a statistical decrease between the years 2017 and 2019 ($P<.001$) (table 2).

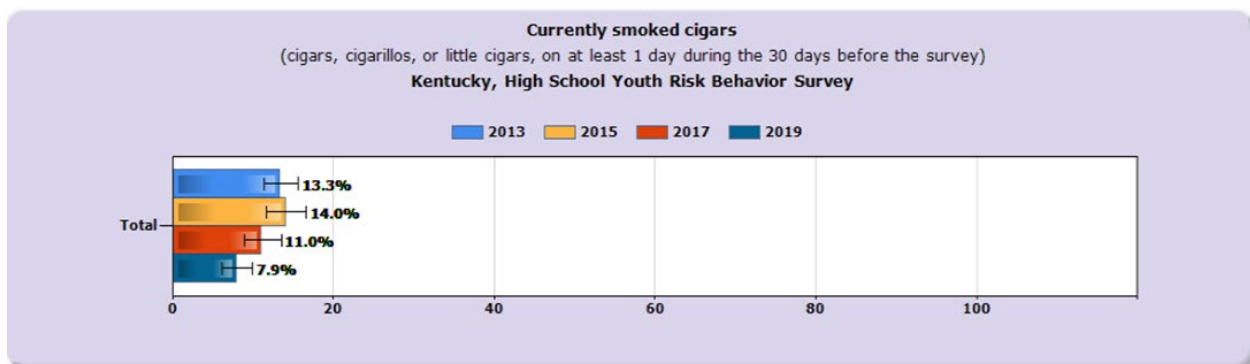
Figure 6



Note: Graph generated with YBRSS online data analysis tool (CDC, 2019).

The prevalence of students who currently smoked cigars (cigars, cigarillos, or little cigars, on at least one day during the 30 days before the survey) slightly increased between 2013 and 2015 and decreased during the rest of the time observed (Figure 7). It experienced a 0.7 percentage point increase from 2013 to 2015, a 3-percentage point decrease between 2015 and 2017 and a 3.1 percentage point decrease between 2017 and 2019. However, the only statistical decrease was observed from 2017 to 2019 ($P=0.04$).

Figure 7



Note: Graph generated with YBRSS online data analysis tool (CDC, 2019).

Another important observation was made on the tobacco age at initiation and cessation data. The percentage of students who first tried cigarette smoking before age

13 years (even one or two puffs) experienced a 3.7 percentage point decrease between 2017 and 2019. The percentage of students who did not try to quit using all tobacco products experienced a 4.7 percentage point decrease between 2017 and 2019. There was only a statistically significant decrease in the initiation percentage before age 13 ($P=0.04$) and no statistical change in the cessation rates.

Table 1: Kentucky High School Youth Risk Behavior Survey

Question	Years %			
	2013	2015	2017	2019
Tobacco Use				
Ever tried cigarette smoking (even one or two puffs)	47.1	44.1	40.5	30.6
First tried cigarette smoking before age 13 years (even one or two puffs)	-	-	15.5	11.8
Currently smoked cigarettes (on at least 1 day during the 30 days before the survey)	17.9	16.9	14.3	8.9
Ever used electronic vapor products (including e-cigarettes, vapes, vape pens, e-cigars, e-hookahs, hookah pens, and mods)	-	41.7	44.5	53.7
Currently used electronic vapor products (including e-cigarettes, vapes, vape pens, e-cigars, e-hookahs, hookah pens, and mods, on at least 1 day during the 30 days before the survey)	-	23.4	14.1	26.1
Currently used smokeless tobacco (chewing tobacco, snuff, dip, snus, or dissolvable tobacco products, such as Redman, Levi Garrett, Beechnut, Skoal, Skoal Bandits, Copenhagen, Camel Snus, Marlboro Snus, General Snus, Arriva, Stonewall, or Camel Orbs, not counting any electronic vapor products, on at least 1 day during the 30 days before the survey)	-	-	10.6	6.4
Currently smoked cigars (cigars, cigarillos, or little cigars, on at least 1 day during the 30 days before the survey)	13.3	14.0	11.0	7.9
Did not try to quit using all tobacco products (including cigarettes, cigars, smokeless tobacco, shisha or hookah tobacco, and electronic vapor products, ever during the 12 months before the survey, among students who used any tobacco products during the 12 months before the survey)	-	-	54.2	49.5

Note: Table generated with YBRSS online data analysis tool (CDC,2019).

Table 2: Kentucky High School Youth Risk Behavior Survey Statistical Changes

Question	Years Statistical differences					
	2013-2015		2015-2017		2017-2019	
	p-value	Diff.	p-value	Diff.	p-value	Diff.
Ever tried cigarette smoking (even one or two puffs)	0.35	No	0.26	No	0.00	Yes -
First tried cigarette smoking before age 13 years (even one or two puffs)	-	-	-	-	0.04	Yes -
Currently smoked cigarettes (on at least 1 day during the 30 days before the survey)	0.62	No	0.23	No	0.01	Yes -
Ever used electronic vapor products (including e-cigarettes, vapes, vape pens, e-cigars, e-hookahs, hookah pens, and mods)	-	-	0.34	No	0.00	Yes +
Currently used electronic vapor products (including e-cigarettes, vapes, vape pens, e-cigars, e-hookahs, hookah pens, and mods, on at least 1 day during the 30 days before the survey)	-	-	0.00	Yes -	0.00	Yes +
Currently used smokeless tobacco (chewing tobacco, snuff, dip, snus, or dissolvable tobacco products, such as Redman, Levi Garrett, Beechnut, Skoal, Skoal Bandits, Copenhagen, Camel Snus, Marlboro Snus, General Snus, Arriva, Stonewall, or Camel Orbs, not counting any electronic vapor products, on at least 1 day during the 30 days before the survey)	-	-	-	-	0.00	Yes -
Currently smoked cigars (cigars, cigarillos, or little cigars, on at least 1 day during the 30 days before the survey)	0.69	No	0.08	No	0.04	Yes -
Did not try to quit using all tobacco products (including cigarettes, cigars, smokeless tobacco, shisha or hookah tobacco, and electronic vapor products, ever during the 12	-	-	-	-	0.16	No

months before the survey, among students who used any tobacco products during the 12 months before the survey)						
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Note: Table generated with YBRSS online data analysis tool (CDC,2019).

Discussion

This study's primary objective was to analyze the 2018 excise tax policy's impact on cigarette sales and tobacco consumption behaviors among Kentucky youth. The t-test analysis results of observable statistical differences between different YBRSS data years show a significant change in cigarette smoking behaviors after the policy change. There was no significant statistical decrease in cigarette smoking behaviors for the three surveys preceding the policy change, but there was a statistical decrease in the survey following the policy change. The percentage of students who ever tried cigarette smoking experienced a 3- percentage point decrease between 2013 and 2015, a 3.6 percentage point decrease between 2015 and 2017, and a 9.9 percentage point decrease between 2017 and 2019. After the policy change, the difference in the prevalence of students who tried cigarette smoking was approximately three times more than the change observed before the policy change.

The same pattern was observed in the prevalence of current cigarette smokers. There was no significant statistical decrease in cigarette smoking behaviors for the three surveys preceding the policy change, but there was a statistical decrease in the survey following the policy change. The percentage of students who currently smoked cigarettes experienced a 1-percentage point decrease from 2013 to 2015, a 2.6 percentage point decrease from 2015 to 2017, and a 5.4 percentage point decrease from 2017 to 2019. After the policy change, the difference observed in the prevalence of students who currently smoked cigarettes was approximately two times more than the change observed before the policy change. Cigarette smoking initiation rates also decreased after the price increase by 24 percent. As predicted, the 60-cent price increase on cigarette packs successfully reduced the prevalence of trying, currently smoking cigarettes, and the cigarette smoking initiation rate before age 13 years among youth, demonstrating these rates are price sensitive. Those prevalence decrease in cigarette smoking behaviors could be related to the observed 36 million cigarette pack sale decrease (Chandel, 2019). Those prevalence decreases are higher than the decrease demand predicted earlier since 50 cents price increase was expected, leading to a 17.8 to 19 percent demand decrease among youth (Ross & Chaloupka, 2003 & Chaloupka et al., 2019).

The t-test analysis shows a significant statistical difference in vaping behaviors after the 2018 tax policy on cigarettes. There were two different patterns between the prevalence of those who ever vaped and those who currently vape. There was no significant statistical increase in the percentage of students who ever vape between 2015 and 2017 and increased between 2017 and 2019. The prevalence of students who ever vaped experienced a 2.8 percentage point increase between 2015 and 2017 and a 9.2 percentage point increase between 2017 and 2019. After the policy change, the increase observed in students who used the vapor product was three times more than the increase observed before the policy change.

The prevalence of current vaping behavior decreased before the policy change and increased after the policy change. The percentage of students who currently vaped experienced a 9.3 percentage point decrease between 2015 and 2017, and a 12-percentage point increase from 2017 to 2019. The Center for Disease Control and Prevention (CDC) stated that this decline was the product of public health education and awareness work on the health effect of e-cigarettes (Reinberg, 2017). Another reason for this decline could be attributed to the United States Food and Drug Administration (FDA) first regulation on e-cigarette, which happened in 2016. Thus, there was no significant statistical increase in the prevalence of current vaping between 2013 and 2019. There was only a 2.7 percentage point increase between 2013 and 2019. The increase observed in vaping behaviors reflects the literature on the correlation between cigarette smoking reduction and e-cigarette use increase. Since the tobacco use cessation demand did not statistically change after the price increase, we can imply that some of those who quit smoking cigarettes because of the price increase substituted vaping for cigarettes. Another part of this increase in vaping behaviors is related to the explosive sales increase of "Juul," which was more attractive, better tasting, and easily concealed. "Juul" experienced a more than 600% sales increase in 2017 (Harris et al., 2020).

The t-test analyses also revealed no statistical change before the 2018 cigarette price increase for current cigar use and a decrease after the price increase for current cigar use and non-combustible tobacco rates. The current non-combustible tobacco rate experienced a 40 percent decrease between 2017 and 2019, and the current cigar rate

experienced a 5 percent increase between 2013 and 2015, a 21 percent decrease between 2015 and 2017, and a 28 percent decrease between 2015 and 2019. Those significant statistical decreases could be attributed to other public health efforts to reduce tobacco use since the cigar and non-combustible tobacco products did not change prices in 2018. However, we can also justify it with the substitution of vaping since it was the only tobacco product use that increased considerably in 2019. Thus, the price increase in cigarettes did not impact the use of cigars and non-combustible tobacco products. Cigarette smokers did not substitute cigarettes with cigars or smokeless tobacco products.

Limitations

This study has potential limitations since all the data was self-reported and collected only among enrolled high school students. Thus, it might contain potential bias if some students did not report the truth. But the anonymous and voluntary character of the survey minimized this kind of bias. The fact is that school-based surveys limit this study results to only the school-aged population enrolled in school because it excluded all non-enrolled school populations. Non-enrolled students, represent around five percent of the 14 to 17-year-old population. Researchers have found that adolescents not enrolled in school have a higher prevalence of risky health behaviors than those enrolled in school (Underwood et al., 2020). Thus, the YBRSS data set is missing data on a critical vulnerable part of the youth population.

The study analyzed data from three different YBRSS before the cigarette price increase and only one YBRSS survey after the policy change, thus providing only the immediate effects. More or an equal amount of different YBRSS will be ideal for giving a long-term impact. The study also only compared one year to another year. It would be more statistically stable if we were able to compare combined rate, for example, 2013-2017 to 2019 or in the future 2019-2022.

Another limitation is the fact that the study analyzed only statistical changes between different years' surveys. It did not determine the correlation between the decrease observed in cigarette smoking and the increase observed in e-cigarette use. It

also did not determine in which proportion the cigarette price increase influenced the statistical changes observed.

Implication

Public health advocates need evidence to initiate, develop, evaluate, and improve policies. They need to collect proof that proposed policies would work and use that evidence to convince legislators to champion policy proposals and vote for them. This study shows that the tax increase on cigarette packs passed in July 2018 succeeded in reaching its goal since the initiation rate and the use rate decreased on cigarette smoking. More significant tax increases on cigarettes will have a stronger effect on reducing cigarette use in Kentucky and the prevalence of all related health effects, saving the state of Kentucky billions in health care costs.

The study also provides evidence of the importance of including all tobacco products when passing policies to reduce tobacco use to avoid substitution effects. Another effect observed after the tax increase on cigarettes was the substantial increase in electronic nicotine delivery systems use among youth and the lack of change in the cessation rate. The potential substitution effect suggests that public health policy developers need to develop public health policy that aims to reduce tobacco products initiation, use, or days of use and increase cessation seeking. The best public health policy that reduces tobacco use among youth should at the same time reduce the initiation rate and increase the cessation rate.

The Kentucky legislature passed another bill in 2020 that increased the price of e-cigarettes without changing the price of cigarettes, cigars, and noncombustible tobacco. There is a risk that adolescents would choose to substitute vaping for smoking cigarettes or other affordable tobacco products and reduce the effort made to decrease tobacco use in Kentucky since vaping products are highly nicotine addictive.

The tax collected on tobacco increases the Kentucky government revenue. Public health advocates need to convince policymakers and the government to allocate most of the revenue collected from taxing tobacco products to fund other population health efforts to

eradicate tobacco use among youth completely. Those population health efforts could be education, awareness, and research that improve cessation programs.

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