

ABSTRACT

Title of Thesis: EXAMINING THE STATE-LEVEL, AND RACIAL AND ETHNIC IMPACT OF CIGARETTE TAXES ON YOUTH SMOKING AND CESSATION

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The objective of this study is to examine the relationship between per-pack cigarette taxes at the state level and smoking behavior among youth in the United States, based on race and ethnicity. State-level Youth Behavioral Risk Surveys (YRBS) from 2017 and 2019, as well as Tax Burden on Tobacco (TBOT) data, were used to analyze current (past 30-day) cigarette use and quit attempts among high school students, stratified by race/ethnicity and adjusting for age and sex. The findings found that overall odds of cigarette use were lower with higher cigarette taxes across states. The findings look to further evaluate a key tobacco control policy from both an economic and public health perspective.

EXAMINING THE STATE-LEVEL, AND RACIAL AND ETHNIC IMPACT OF
CIGARETTE TAXES ON YOUTH SMOKING AND CESSATION

by

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DEDICATION

To the Almighty Allah for granting wisdom, blessings, and mercy.

To the entire Shinaba family for your love and advice throughout this process.

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INTRODUCTION

Tobacco product use is the leading cause of premature death in the United States, accounting for more than 480,000 deaths each year.¹ While tobacco use had declined over the years, millions of Americans, especially youth, continue to use these products. The National Youth Tobacco Survey (NYTS) found that in 2020, 4.47 million middle and high school students reported using harmful tobacco products including cigarettes within the past 30 days, including 6.7% of middle school and 23.6% of high school students.² This statistic, thankfully, is lower compared to the 2000 NYTS, where 15.1% of middle school and 34.5% of high school students alone reported using tobacco products in the past 30 days.³

The Centers for Disease Control and Prevention (CDC) states that nearly 90% of adult cigarette smokers started before age 18, and approximately 99% started by age 26. While tobacco use has declined over the years, a major population of young people remain at risk. Among the foremost of issues is the fact that smoking is associated with an addiction to nicotine.⁴ Because most tobacco product initiation begins during adolescence, youth and young adults who use cigarettes risk long-term health problems later in adulthood. One study found that smoking initiation during adolescence was a cause of developing ailments such as high blood pressure, depression, cancer, and cardiovascular problems.⁵

The decline in cigarette use may be in part attributed to higher prevalence of other tobacco products, including e-cigarettes, and policy interventions. Researchers have suggested that tobacco control efforts, such as smoke-free environments, mass media campaigns, and restricting product advertisements have been effective at reducing youth

cigarette smoking rates.^{6,7} Among the most effective policy actions have been the increase of local, state, and federal taxes on tobacco products, especially cigarettes.^{8,9}

Most of the research on cigarette taxes conclude that increased taxes can reduce youth initiation and frequent use. Furthermore, recent studies have shown that youth and young adults are more receptive than adults to price increases.⁴ For example, a study done by Sharbaugh et al. found that young adults had the greatest response to price increases, where even a \$0.25 excise tax per pack resulted in a 1.5% decrease in smoking prevalence.¹⁰ Some findings argue that smoking cessation odds remain unchanged after cigarette tax increases, but others argue that increased taxes overall can reduce the likelihood of return to cigarette use among quitters.^{11,12}

It is important to implement such tobacco control policies early, as youth and young adults were less likely to start smoking cigarettes and smoke daily.¹³ The objective of this study is to examine the relationship between per-pack cigarette taxes at the state level and smoking behavior among youth in the United States. Specifically, the study looks to determine any associations between state cigarette taxes and current cigarette use and cessation attempts among high school students. Furthermore, the study looks to determine if race and ethnicity presents differential effects on taxation and cigarette use. Secondary data collection from the nationally-representative Youth Behavioral Risk Survey (YRBS) from 2017 and 2019 serves as the basis for conducting a quantitative analysis. As a result, the thesis addresses a key research question and proposes four hypothesis:

Research Question: *What is the impact of state cigarette taxes on smoking prevalence and cessation among youth, based on race and ethnicity?*

Hypothesis 1: Youth living in states with higher cigarette taxes would be less likely to become current cigarette users compared with those living in states with lower cigarette taxes.

Hypothesis 2: Black and brown youth would be less likely than White youth to become current cigarette users if living in states with higher cigarette taxes.

Hypothesis 3: Youth current cigarette users living in states with higher cigarette taxes would be more likely to make a quit attempt compared with current cigarette users living in states with lower cigarette taxes.

Hypothesis 4: Black and brown youth current cigarette users would be more likely than White youth current cigarette users to make a quit attempt if living in states with higher cigarette taxes.

Terms and Abbreviations

YRBS – Youth Risk Behavioral Survey

Youth and young adult – youth is defined across numerous literature as individuals between the ages of 12-17; young adults are usually those between the ages of 18-24.

Current cigarette use – defined as one who reports cigarette use on at least one out of the past 30 days, as declared in YRBS.

Quit attempt – According to YRBS, trying to quit tobacco products within the past 12 months.

LITERATURE REVIEW

History of Cigarette Taxes

In 1776, Adam Smith was linked to a quote regarding items subject to taxation; he theorized that by taxing tobacco products, among other commodities, “the people might be relieved from some of the most burdensome taxes...from those which are imposed either upon the necessaries of life, or upon the materials of manufacture.”¹⁴ Tobacco was among the first consumer items in North America to face taxation.¹⁵ In 1794, the United States Congress passed the nation’s first excise taxes on tobacco products, shortly after the infamous Whiskey Rebellion that occurred that same year.¹⁶ The last federal cigarette tax increase occurred in 2009. The Children’s Health Insurance Program Reauthorization Act increased the cigarette tax to \$1.01 per pack of 20 cigarettes.¹⁷ At the state level, all 50 states, including the District of Columbia, levy taxes on cigarettes; Iowa was the first state to enact such a tax in 1921. At the time of this writing, state cigarette taxes can range from \$0.17 in Missouri to \$4.35 in the states of New York and Connecticut.¹⁸ Similar to federal taxes on tobacco products, most state cigarette tax increases are a product of creating increased revenue streams for their fiscal-year budgets. Public health advocates believe that cigarette tax increases are an effective deterrent to initiation and use, especially among youth and young adults.

Pros and Cons

Early literature believes that increased taxes on tobacco products including cigarettes would reduce preventable death.¹⁹ For example, a review of 116 studies pooled from the Community Preventive Services Task Force found that efforts to increase tobacco product prices by 20% would reduce product use by 10.4%, including a 3.6% reduction

for adults, and an 8.6% reduction among youth.^{8,20,21} Price elasticity is a method used to measure demand and prospective use based on price changes to consumer products. Similar effects were observed at the state level. Specifically, A study that tracked Minnesota's tobacco control measures from 1998 through 2017 found that increased cigarette taxes contributed to a 5.1 percentage point decrease in youth smoking prevalence, saved 1,700 lives, and prevented 1,600 cancer cases and 13,000 combined hospitalizations from diabetes, cardiovascular, and respiratory disease.²² The results reflect a combination of the Master Settlement Agreement, a cumulative state cigarette tax increase of \$2.20, and two federal tax increases in 2000 and 2009.

One of the key pieces of literature looked to pool YRBS data from the state and local level to determine whether state cigarette taxes still influenced cigarette use among youth.²³ Smoking participation was defined as "current cigarette use" whereas frequent smoking was labeled as anyone who used cigarette on 20 out of the past 30 days. The results found that states with the largest tax increases saw the greatest reductions in smoking participation among high school students. Using national and state YRBS data from 1991-2005, a one-dollar tax increase is associated with reduced smoking participation ranging from 2.7 to 5.9 percentage points from the sample mean of 29.5%, and a 2.4 to 4.1 percentage point decrease in frequent smoking from the sample mean 26.8%.

Conversely, a study using similar methodology produced less than bullish results.²⁴ In that same period, national and state data saw that a projected one-dollar cigarette tax would reduce current cigarette use by 5.6 and 2.3 percentage points from the sample mean. When factoring 2007-2013 YRBS data, that association decreased to 2.7

percentage points nationally and 0.9 percentage points at the state level. They acknowledge that the inverse relationship in cigarette tax increases with reduced cigarette use shrunk when each YRBS survey wave was added. Alone, data from 2007 through 2013 did not indicate a significant difference in cigarette use at the state level (0.4 percentage point increase). While the researchers argued that cigarette tax increases prior to 2005 and declining prevalence post-Master Settlement Agreement were key in initial findings, there is a group that will not factor cost and taxation when initiating and using cigarettes. This is concept akin to the “theory of rational addiction”, where individuals have specific reasons to why they consume goods, with future consequences already in mind.²⁵

Another drawback is that some research fails to acknowledge growing antismoking sentiment in some states. While cigarette tax increases continue to show positive results (i.e., reduced smoking prevalence and demand), A study performed by DeCicca and colleagues²⁶ found that when factoring the notion that increased antismoking sentiment drastically reduces smoking behaviors, there was no significant evidence to determine whether cigarette tax increases can actually reduce initiation of cigarette use and prevalence.

Youth Responsiveness

Among the first research studies to assess the impact of cigarette pricing on youth in the United States was done by Lewit et al, using data from the 1966–1970 National Health and Nutrition Examination Survey.²⁷ At a price elasticity of -1.20 for prevalence, the implication at the time was that a 10% increase in the price of cigarettes can reduce cigarette use by up to 12%, including a 2.5% reduction among younger smokers. These

results were replicated over subsequent years with various datasets, with many finding evidence that youth were more likely than adults to reduce cigarette use with increased costs to cigarettes.^{23,28,29} More recent evidence has found using Monitoring the Future (MTF) data that higher state cigarette taxes and average cigarette price per pack were associated with lower 30-day smoking, first cigarette smoking initiation and daily smoking initiation among 8th graders, lower intensity (number of cigarettes smoked per day) among 10th grader smokers and lower 30-day smoking participation and frequency among 12th graders.³⁰

Quitting

In the most recent Surgeon General's report on smoking cessation, the findings indicate that increasing tobacco product prices would have two key outcomes.³¹ First, there would be greater incentive for smokers to reduce cigarette use and make a quit attempt; second, the revenue would better fund other tobacco control strategies. Various studies have produced evidence stating that increased cigarette taxes and pricing can increase smoking cessation odds. Going back to Monitoring the Future data from 1976-1993, research estimated that even a 10% in cigarette prices would imply that male and female young adult cigarette users were 13% and 10% less likely to continue smoking 2 years later, compared to their smoking status at baseline.³² In addition, research has shown that taxes and geography can affect quit intentions. One study found that cigarette users are more motivated to quit if living in an area with higher cigarette prices and taxes.³³ Furthermore, cigarette price increases were positively associated with quit intentions and eventual successes. Even with these results, recent research on the association of cigarette taxes

and quitting can be limited. It is difficult to determine cessation impacts among youth especially, given that smoking behaviors are less predictable compared to that of adults.⁴

Gaps In Literature – Race and Ethnicity

Disparities concerning youth and young adult smoking are recognized in the health field. While non-Hispanic Black youth have far lower prevalence of smoking and initiation than Hispanic/Latino and non-Hispanic White youth, they are still at higher susceptibility to cigarette use in the future.^{4,34} There have been mixed results when looking at taxation from the perspective of race and ethnicity. Nonnemaker and Farrelly used 1991-2010 MTF data to find that while Hispanic youth results were mixed for some tax indicators, Black youth had a significant responsiveness for both tax and price, suggesting that higher prices and taxes reduced the rate of smoking initiation at baseline and follow-up.³⁵ However, a study from Fleischer concluded that despite higher cigarette taxes being associated with reduced smoking outcomes overall, there were no significant changes when coding for sociodemographic factors, including race and ethnicity.³⁰

Current Study – Literature Connection to Research Question.

The objective of this study is to examine the effects of state cigarette taxes on youth smoking behavior, specifically current cigarette use and quit attempts. The ensuing methodology draws similarities to prior literature. van Hasselt and colleagues looked at the relationship between cigarette taxes before and after the federal government increased taxes in 2009 from \$0.39 to \$1.01.³⁶ Using NSDUH data, binary outcomes such as smoking initiation, current smoking, and cessation were measured using logistic regression. Another study used logistic regression to examine the relationship between state cigarette taxes and cigarette use at the modal age of 18, and at follow up ages of 19

and 20.³⁷ Similar to the present study, interaction terms would assess differences among groups, including race and ethnicity.

METHODOLOGY

Data Source – YRBS

The Youth Behavioral Risk Survey System (YRBS) was developed in 1991 by the Centers for Disease Control and Prevention (CDC) to address health risk behaviors attributable to the leading causes of death and illness among youth and young adults.³⁸ Youth and young adult health risk behaviors are monitored across 6 categories, including unintentional injury/violence, sexual behaviors, alcohol use, unhealthy dietary behaviors, inadequate physical activity, and tobacco use. YRBS's main purpose is to enable policymakers, education, and public health professionals to: 1) describe the prevalence of youth health-risk behaviors; 2) assess health behavior trends over time; and 3) evaluate and improve health-related policies and programs. YRBS surveys are conducted bi-annually, in odd-numbered years (e.g., 2011, 2013, 2015). The multi-faceted survey approach includes the CDC-sponsored national school-based survey and local surveys conducted by states, territories, tribal governments, and large urban school districts. In most cases, YRBS surveys draw representative samples of high school students in 9th through 12th grade. State, territorial, tribal government, and large urban school district surveys employ a two-stage cluster design. National YRBS surveys have a three-stage cluster design for its representative sample, with the goal of providing estimated data accurate with a 95% confidence level. The sample size can range from 10,000 to 16,000 students.³⁹

The study will utilize YRBS surveys from both 2017 and 2019. Findings from the national survey found that in 2017, 8.8% of high school students reported current cigarette use, including 11.1% of non-Hispanic White, 4.4% of non-Hispanic Black, and 7.0% of Hispanic/Latino students. Current cigarette use was higher among males than females; current use also increased by grade level; upwards of 13.4% of 12th graders reported current cigarette use, compared with just 5.2% of 9th graders. In 2019, the nationwide prevalence of current cigarette use among high school students decreased to 6.0%, including 6.7% of non-Hispanic White, 3.3% of non-Hispanic Black, and 6.0% of Hispanic/Latino students.

Data Source – TBOT

The Tax Burden on Tobacco (TOBT) is an annual compendium developed by the economic firm Orzechowski and Walker that shows tobacco industry revenue and statistics, including federal and state information on cigarette pricing and taxes.⁴⁰ Data is based on fiscal years, ending June 30 of each year. 6 key data metrics in this compendium are also seen in the CDC's State Tobacco Activities Tracking and Evaluation (STATE) System.⁴¹ They include annual cigarette tax revenue, cigarette sales per capita, average cost per pack, federal and state tax per pack, and taxes as a percentage of the retail price. This has been used in prior peer-reviewed research.^{23,24} To account for changes in cigarette prevalence and quit attempts in the proposed sample, information from the previous years, 2016 and 2018 will be linked to YRBS respondents. The primary measure of use will be state tax per pack of cigarettes, expressed in U.S. dollars. The average state cigarette tax from the TBOT dataset was \$1.60 for FY2017 and \$1.71 for FY2018 (see Supplemental Table 1).

Data Collection and Measures

To perform quantitative analysis, data was pulled from the state versions of the 2017 and 2019 YRBS datasets. Inclusion criteria for this analysis comprised of the following: any student who completed the survey during one of the two study periods, reported to be in high school at the time of collection, coded as grades 9-12, and reside in a state that completed the YRBS survey and reports data on state-level cigarette taxes per pack via TBOT. Respondents will be excluded if: there is missing data on whether or they have used cigarettes in the past 30 days, or if they refuse to answer questions related to 12-month tobacco product cessation attempts. The anticipated final analytic sample will yield approximately 15,000 respondents, based on current YRBS smoking prevalence.

Variables

Exposure: The main exposure variable “state tax per pack,” will be measured by the amount of tax applied to each pack of 20 cigarettes in each state overall. The continuous variable will be expressed in U.S. dollars for fiscal years 2016 and 2018, preceding the YRBS survey periods. To explain, if the fiscal year is 2016, it would reflect data on implemented state taxes beginning from July 1, 2015, through June 30, 2016. This will be done to better examine the immediate response to cigarette taxes on smoking prevalence and cessation. Moreover, YRBS participants are asked to recall about their behavioral use in the period prior to taking the survey questionnaire.

Outcomes: YRBS survey begin data collection in an even-numbered year preceding the survey cycle.³⁸ For example, the 2017 cycle would begin in July 2016 and continue until the data is published in June 2018. The present study will have two outcome variables: current cigarette use and overall tobacco product cessation. Current cigarette use will be

measured by the question, “During the past 30 days, on how many days did you smoke cigarettes?”⁴² Responses will be numeric and categorized as: 1=1-30 days, or 2=“0 days.” Reports of cigarette use on at least one out of the past 30 days will be categorized as a current cigarette user. Tobacco product cessation was measured using the question “During the past 12 months, did you ever try to quit using all tobacco products?” Responses include 1=I do not use tobacco products, 2=yes, and 3=no. A student was considered quitting if they answered “Yes.” Respondents who answered (1) were excluded from that piece of analysis.

Effect Modifier: Race/ethnicity was a categorical variable of which individuals report as non-Hispanic Black, non-Hispanic White, Hispanic or Other race, the latter of them included respondents that identify as American Indian/Alaska Native, non-Hispanic Asian, Native Hawaiian/Other Pacific Islander, or non-Hispanic Multiple Race (multiracial). The coded variables came from the YRBS dataset in its original form.

Covariates: Several covariates are included which have previously shown to be confounders of the association between cigarette taxes and cigarette use and cessation.^{29,35} Sex is a categorical variable in which individuals identify as either Female or Male. Age is the truncated continuous variable; students' age range is from 12 through 18 years old. Grade level is a continuous variable where students report their grade from 9th through 12th.

ANALYSIS

All analyses were conducted using SAS 9.4. The 2017 and 2019 state YRBS datasets were cleaned to include the proper inputs formats. For the analysis, SAS survey procedures were used to account for complex survey design. To account for various

populations among states, strata, weight, and cluster statements were added to the procedure. These statements are considered optimal for YRBS as well as other state and national datasets that use multistage sampling designs.⁴³ Descriptive statistics would examine sample characteristics of the population, stratified by recoded age group, grade, sex, and 4-level race/ethnicity. The analysis would calculate prevalence estimates of cigarette use and quit attempts, interpreted in percentages, standard error, and 95% confidence intervals (CIs), from an overall lens and by race/ethnicity.

Bivariate analyses using the Rao-Scott chi-square test would determine whether differences between estimates (race/ethnicity) are statistically significant if the p-value is below 0.05. Logistic regression models were used to estimate odds ratios (ORs) of current cigarette use among high school students and quit attempts among those who were current cigarette users. 95% confidence intervals were also employed in the models. Three models were specified; Model 1 looked at the impact of state cigarette tax on current cigarette use and quit attempts in its crude form. Model 2 builds on Model 1, adjusting for age, sex, and race/ethnicity. Model 3 contains Model 2 controls but stratifies the association of state cigarette taxes by race/ethnicity.

RESULTS

Descriptive Statistics

The YRBS surveys drew a combined sample size of 372,214 high school students for both the 2017 and 2019 cohorts. All figures were weighted; descriptive statistics can be shown in Table 1. Overall, 6.58% percent of high school students reported current (past 30-day) cigarette use across both waves, including 7.84% in 2017, and 5.61% in 2019. Among racial and ethnic groups combined, 8.00% of non-Hispanic White students

reported current cigarette use, followed by 3.45% of non-Hispanic Black and 5.93% of Hispanic/Latino students. When accounting for additional racial and ethnic groups, American Indian and Alaska Native students had the highest prevalence. In addition, cigarette use was higher among males than females across both waves (see Supplemental Table 2).

Table 1. Descriptive Statistics - Combined

Age	NH White		NH Black		Hispanic/Latino		NH Other	
	%	SE	%	SE	%	SE	%	SE
15 and younger	37.32	0.79	36.21	1.04	38.40	1.39	40.24	1.28
16 and older	62.68	0.79	63.79	1.04	61.60	1.39	59.76	1.28
Sex								
Male	48.91	0.35	49.76	0.66	49.69	0.71	48.75	0.69
Female	51.09	0.35	50.24	0.66	50.31	0.71	51.25	0.69
Current Cigarette Use								
Yes	8.00	0.28	3.45	0.25	5.93	0.37	5.87	0.28
No	92.00	0.28	96.55	0.25	94.07	0.37	94.13	0.28
Quit Attempts among Users								
Overall	42.97	1.26	53.16	5.34	44.78	2.89	51.87	2.67
2017	41.57	1.65	52.85	7.33	42.96	4.28	52.05	3.31
2019	44.81	2.03	53.54	5.81	46.98	4.73	51.66	4.43
State Tax (mean)								
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
	1.74	0.04	1.56	0.04	2.02	0.03	2.08	0.04
Sample (N)								
	195371		46104		68356		51318	

Among current high school cigarette users, 44.52% reported trying to quit using tobacco products within the past 12 months across both waves of YRBS. The highest share of quit attempts based on 4-level race/ethnicity came from non-Hispanic Black students; 54.88%

of these student cigarette users, reported trying to quit within the past 12 months, compared with 41.57% of non-Hispanic White and 42.96% of Hispanic/Latino students who were current cigarette users. Supplemental Table 1 showed that a higher share of female students who reported current cigarette use tried to quit within the past 12 months, alongside non-Hispanic Asian and multiracial students.

Logistic Regression Modeling

The first model assessed the effects of state cigarette taxes on high school cigarette use and quit attempts (Table 2). Overall, increased cigarette taxes across states were associated with lower odds of current cigarette use among high school students across both waves of YRBS (OR=0.89; CI 0.86, 0.92). However, increased cigarette taxes across states did not significantly affect the odds of high school current cigarette users attempting to quit tobacco products within the past 12 months (OR=0.98; CI 0.90, 1.06).

Table 2. Crude Association - Combined

	Cigarette Use			Quit Attempts among Users				
	OR	95% CI		p-value	OR	95% CI		p-value
State Cigarette Tax	0.89	0.86	0.92	<0.01	0.98	0.90	1.06	0.58
Sample (N)	360765			26248				

***bold** = significant at p<0.05

The second model adjusted for key covariates, including race/ethnicity, age, and sex (Table 3). The logistic regression model found that overall, high school students presented lower odds of current cigarette use if residing in states with increased cigarette taxes (OR=0.88, CI 0.88, 0.95), compared to students living in states with decreased cigarette taxes. In addition, the adjusted model showed that when compared to non-Hispanic White students, non-Hispanic Black and reported Other high school students were significantly less likely to currently use cigarettes. In addition, female high students

had significantly reduced odds of current cigarette use as compared to male students. Even after controlling for covariates, increased cigarette taxes in states were not significant for cigarette users attempting to quit tobacco products within the past 12 months (OR=0.99; CI 0.91, 1.08). Nevertheless, non-Hispanic Black, Hispanic/Latino, and other high school students who reported current cigarette use, would have reported far greater odds of making a quit attempt when compared to non-Hispanic White students.

Table 3. Adjusted Association by Covariates - Combined

	Cigarette Use				Quit Attempts among Users			
	OR	95% CI	p-value	OR	95% CI	p-value		
State Cigarette Tax	0.88	0.85	0.92	<0.01	0.99	0.91	1.08	0.82
Age	1.33	1.29	1.37	<0.01	0.99	0.93	1.06	0.76
Sex								
Male	Ref				Ref			
Female	0.76	0.70	0.81	<0.01	1.30	1.11	1.51	<0.01
Race								
NH White	Ref				Ref			
NH Black	0.40	0.34	0.46	<0.01	1.53	0.98	2.41	0.19
Hispanic/Latino	0.74	0.67	0.81	0.09	1.09	0.85	1.40	0.16
Other	0.75	0.66	0.84	0.05	1.48	1.14	1.91	0.07

***bold** = significant at p<0.05

The third model assessed the differential impact of state cigarette taxes on smoking behavior, based on race/ethnicity and adjusting for covariates used in the previous model (Table 4). The model estimated that state cigarette taxes were presented with slightly reduced odds of current cigarette smoking within each racial and ethnic group. Among non-Hispanic White high school students, findings were significant for reducing cigarette use (OR=0.86; CI 0.82, 0.90), as well as among high school students who reported Other (OR=0.83; CI 0.76, 0.91). There were no significant associations of state cigarette taxes

and current cigarette use among non-Hispanic Black and Hispanic/Latino high school students. Regarding cessation, findings were not significant despite state cigarette taxes being associated with increased odds of making a past 12-month quit attempt among non-Hispanic Black students (OR=1.33; CI 0.83, 2.11). The association was also not significant for Hispanic/Latino students (OR=0.97; CI 0.77, 1.47).

Table 4. Adjusted Associations of State Cigarette Tax By Race - Combined

	Cigarette Use				Quit Attempts among Users			
	OR	95% CI	p-value		OR	95% CI	p-value	
NH White	0.86	0.82	0.90	<0.01	0.97	0.88	1.07	0.56
NH Black	0.98	0.89	1.09	0.74	1.33	0.83	2.11	0.23
Hispanic/Latino	0.93	0.86	1.00	0.06	0.97	0.75	1.25	0.81
Other	0.83	0.76	0.91	<0.01	1.06	0.77	1.47	0.72

***bold** = significant at p<0.05

DISCUSSION

This section will provide review of the research findings and analyses, as well as review the hypotheses and address the strengths, limitations and public health implications that can serve as a recommendations for future research.

The present literature proposed a set of hypotheses: states with higher cigarette taxes would have reduced smoking prevalence among youth and increased quit attempts among youth who currently used cigarettes. The other was that states with higher cigarette taxes would see greater reductions in smoking prevalence among Black and brown youth, as well as increased quit attempts among those who were current cigarette users. The results supported the hypothesis concerning smoking prevalence; among high school students overall, state cigarette taxes were associated with decreased odds of current (past 30-day)

cigarette use across all states in the YRBS survey waves in both 2017 and 2019. Those effects did not have a significant effect within non-Hispanic Black high school students, failing to reject the null hypothesis, but compared to other racial and ethnic groups, it greatly discouraged cigarette use.

Regarding quit attempts, the findings revealed that state cigarette taxes presented marginal odds of cessation attempts among high school cigarette users. Even if there were directional changes to cessation behavior, the figures were not significant and did not reject the null hypothesis overall and from the perspective of race/ethnicity. This finding was also observed in Hansen et al. after adding the most recent YRBS waves prior to their writing.²⁴ One reason could be that cigarette use continues to decline among youth and young adults; just 5.6% of YRBS survey respondents stated that they used cigarettes in the past 30-days in 2019. As cigarette numbers decline, time will only tell whether that trend will continue. Even with the advent of the federal government's Tobacco 21 law, prohibiting sale of tobacco products to individuals under the age of 21, other tobacco products such as e-cigarettes play a potentially dangerous factor in the role of tobacco control among youth.^{44,45}

There are select limitations that influenced the results of this study. Validity may be an area of concern in measuring the exposure. The study used previous fiscal-year data on state cigarette taxes to account for temporal effects on cigarette use and cessation attempts. Because of retrospective responses from individuals, the results may be subject to recall bias. In addition, there was a small sample size among differential racial and ethnic groups which may have affected cigarette use outcomes among sociodemographic populations; the study attempted to include American Indian/Alaska Native and Native

Hawaiian and Pacific Islanders to the analytical sample. Even then, data was limited because many respondents may report to school district and tribal government surveys; moreover, indigenous Native tribes are exempt from state tobacco excise taxation.⁴⁶ Some states may omit data from select years of YRBS surveys; 39 states in 2017 and 44 states in 2019 completed representative surveys, which still allows for looking at differences in states that did or did not increase cigarette taxes during the study periods; California did not report tobacco use data for the 2019 YRBS, which may have affected findings given its high cigarette tax rate and large population size. When assessing the effectiveness of state cigarette taxes on cessation attempts, YRBS changed the cessation variable in 2017, shifting from solely cigarettes to all tobacco products (e.g., cigars, smokeless tobacco, e-cigarettes), which may affect students' responses.

CONCLUSION

Health and advocacy groups would that increasing taxes on cigarettes, it would reduce smoking prevalence increase cessation attempts among youth and racial/ethnic populations. This study will be critical in evaluating best practices of tobacco control from an economic and public health perspective. States and the Federal Government see increased taxes as an option to increase revenue streams and reduce budgetary deficits.⁴⁷ Despite the reasons for increasing taxation, most funds will go to programs distant from the intended tobacco control purposes from the onset of the Master Settlement Agreement; states spent a projected 2.4% of the potential \$655 million on tobacco control programs, including efforts to help smokers quit.³¹ To address disparities and improve cessation trends, cigarette tax increases would be beneficial to disparate populations, especially if supplemented with smoke-free environments, restrictions on advertising, and

outlet density.⁴ The tobacco use epidemic is completely different from years and decades past, but with the rise of emerging products and a tobacco industry that continues to spend billions promoting harmful products, youth and young adults, as well as disparate populations, should be kept in mind when contemplating new policies.

SUPPLEMENTAL TABLES

Supplemental Table 1. Cigarette Tax (per pack) by State

State	FY2016	FY2018	State	FY2016	FY2018
Alabama	\$0.68	\$0.68	Montana	\$1.70	\$1.70
Alaska	\$2.00	\$2.00	Nebraska	\$0.64	\$0.64
Arizona	\$2.00	\$2.00	Nevada	\$1.80	\$1.80
Arkansas	\$1.15	\$1.15	New Hampshire	\$1.78	\$1.78
California	\$0.87	\$2.87	New Jersey	\$2.70	\$2.70
Colorado	\$0.84	\$0.84	New Mexico	\$1.66	\$1.66
Connecticut	\$3.65	\$4.35	New York	\$4.35	\$4.35
Delaware	\$1.60	\$2.10	North Carolina	\$0.45	\$0.45
Florida	\$1.34	\$1.34	North Dakota	\$0.44	\$0.44
Georgia	\$0.37	\$0.37	Ohio	\$1.60	\$1.60
Hawaii	\$3.20	\$3.20	Oklahoma	\$1.03	\$1.03
Idaho	\$0.57	\$0.57	Oregon	\$1.32	\$1.33
Illinois	\$1.98	\$1.98	Pennsylvania	\$1.60	\$2.60
Indiana	\$1.00	\$1.00	Rhode Island	\$3.75	\$4.25
Iowa	\$1.36	\$1.36	South Carolina	\$0.57	\$0.57
Kansas	\$1.29	\$1.29	South Dakota	\$1.53	\$1.53
Kentucky	\$0.60	\$0.60	Tennessee	\$0.62	\$0.62
Louisiana	\$1.08	\$1.08	Texas	\$1.41	\$1.41
Maine	\$2.00	\$2.00	Utah	\$1.70	\$1.70
Maryland	\$2.00	\$2.00	Vermont	\$3.08	\$3.08
Massachusetts	\$3.51	\$3.51	Virginia	\$0.30	\$0.30
Michigan	\$2.00	\$2.00	Washington	\$3.03	\$3.03
Minnesota	\$3.54	\$3.61	West Virginia	\$0.55	\$1.20
Mississippi	\$0.68	\$0.68	Wisconsin	\$2.52	\$2.52
Missouri	\$0.17	\$0.17	Wyoming	\$0.60	\$0.60
Average Tax	\$1.60	\$1.71			

***bold** = increase in cigarette tax

Supplemental Table 2: Descriptive Statistics - YRBS 2017 and 2019

2017				2019			
Current Cigarette Use - Race	Percent	SE	N*	Current Cigarette Use - Race	Percent	SE	N*
NH White	9.39	0.37	8669	NH White	6.65	0.31	5810
NH Black	4.13	0.39	1128	NH Black	2.84	0.22	659
Hispanic/Latino	6.76	0.36	2813	Hispanic/Latino	5.01	0.27	2096
Other	6.72	0.57	2201	Other	4.98	0.34	1407
<i>American Indian/Alaska Native</i>	<i>13.96</i>	<i>1.43</i>	<i>534</i>	<i>American Indian/Alaska Native</i>	<i>12.78</i>	<i>1.29</i>	<i>389</i>
<i>NH Multiple Race</i>	<i>7.55</i>	<i>0.63</i>	<i>911</i>	<i>NH Multiple Race</i>	<i>5.18</i>	<i>0.49</i>	<i>565</i>
<i>NH Asian</i>	<i>3.07</i>	<i>0.48</i>	<i>402</i>	<i>NH Asian</i>	<i>1.71</i>	<i>0.25</i>	<i>233</i>
<i>NHOPI</i>	<i>16.44</i>	<i>3.74</i>	<i>354</i>	<i>NHOPI</i>	<i>6.79</i>	<i>1.02</i>	<i>220</i>

Current Cigarette Use - Sex	Percent	SE	N*	Current Cigarette Use - Sex	Percent	SE	N*
Male	8.67	0.33	8540	Male	6.39	0.27	5797
Female	6.77	0.30	6658	Female	4.59	0.20	4371

Quit Attempts among Users - Race	Percent	SE	N*	Quit Attempts among Users - Race	Percent	SE	N*
NH White	41.57	1.51	1453	NH White	44.81	2.03	1258
NH Black	52.85	7.85	93	NH Black	53.54	5.81	80
Hispanic/Latino	42.96	4.57	305	Hispanic/Latino	46.98	4.73	268
Other	52.05	3.31	271	Other	51.66	4.43	261
<i>American Indian/Alaska Native</i>	<i>50.53</i>	<i>6.74</i>	<i>68</i>	<i>American Indian/Alaska Native</i>	<i>45.32</i>	<i>4.78</i>	<i>106</i>
<i>NH Multiple Race</i>	<i>53.88</i>	<i>4.69</i>	<i>137</i>	<i>NH Multiple Race</i>	<i>59.43</i>	<i>6.91</i>	<i>118</i>
<i>NH Asian</i>	<i>54.88</i>	<i>10.58</i>	<i>47</i>	<i>NH Asian</i>	<i>60.47</i>	<i>10.04</i>	<i>26</i>
<i>NHOPI</i>	<i>40.85</i>	<i>17.02</i>	<i>19</i>	<i>NHOPI</i>	<i>16.41</i>	<i>10.48</i>	<i>11</i>

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