

Executive Summary: Health Impact Review of HB 2969

Concerning Vapor Product Taxation

Evidence indicates that HB 2969 would likely decrease vaping rates in Washington State, thereby improving health outcomes and decreasing health disparities by socioeconomic status in the state.

BILL INFORMATION

Sponsors: Representatives Harris, Cody, Pollet, Robinson, Jinkins

Summary of Bill:

- Imposes a 45% tax on the taxable sales prices of vapor products.
- Creates a distributor and retailer license to distribute or sell vapor products in Washington.
- Requires that, at a minimum, 3% of the revenues collected from the vapor products tax be appropriated from the general fund to the Cancer Research Endowment Fund Match Transfer Account.

HEALTH IMPACT REVIEW

Summary of Findings:

This Health Impact Review found the following evidence regarding the provisions in HB 2969:

- A fair amount of evidence that a tax on vaping products would lead to reduced vaping rates in Washington State. While there is an extensive body of evidence indicating that taxes on combustible cigarettes have led to reduced smoking rates, it is unclear how generalizable these studies are to vaping products specifically—so the strength of the evidence was downgraded to reflect this uncertainty.
- Strong evidence that decreased vaping rates would lead to improved health outcomes.
- A fair amount of evidence that improving health outcomes through an excise tax on vaping products would lead to reduced health disparities by socioeconomic status. While there is a large body of evidence indicating that taxes on combustible cigarettes have led to greater reductions in smoking among individuals with lower socioeconomic status it is unclear how generalizable these studies are to vaping products specifically—so the strength of the evidence was downgraded to reflect this uncertainty. The evidence for the potential effects on health disparities by race/ethnicity are less clear and are discussed in more detail in the full Health Impact Review.

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Health Impact Review of HB 2969

Concerning Vapor Product Taxation

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Acknowledgement

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Introduction and Methods

A Health Impact Review is an analysis of how a proposed legislative or budgetary change will likely impact health and health disparities in Washington state ([RCW 43.20.285](#)). For the purpose of this review ‘health disparities’ have been defined as the differences in disease, death, and other adverse health conditions that exist between populations ([RCW 43.20.270](#)). This document provides summaries of the evidence analyzed by State Board of Health staff during the Health Impact Review of House Bill 2969 ([HB 2969](#)).

Staff analyzed the content of HB 2969 and created a logic model depicting possible pathways leading from the provisions of the bill to health outcomes. We consulted with experts and contacted stakeholders with diverse perspectives on the bill. State Board of Health staff can be contacted for more information on which stakeholders were consulted on this review. We conducted objective reviews of the literature for each pathway using databases including PubMed and Google Scholar.

The following pages provide a detailed analysis of the bill including the logic model, summaries of evidence, and annotated references. The logic model is presented both in text and through a flowchart (Figure 1). The logic model includes information on the strength of the evidence for each relationship. The strength-of-evidence has been defined using the following criteria:

- **Not well researched:** the literature review yielded few if any studies or only yielded studies that were poorly designed or executed or had high risk of bias.
- **A fair amount of evidence:** the literature review yielded several studies supporting the association, but a large body of evidence was not established; or the review yielded a large body of evidence but findings were inconsistent with only a slightly larger percent of the studies supporting the association; or the research did not incorporate the most robust study designs or execution or had a higher than average risk of bias.
- **Strong evidence:** the literature review yielded a large body of evidence on the relationship (a vast majority of which supported the association) but the body of evidence did contain some contradictory findings or studies that did not incorporate the most robust study designs or execution or had a higher than average risk of bias; or there were too few studies to reach the rigor of ‘very strong evidence’; or some combination of these.
- **Very strong evidence:** the literature review yielded a very large body of robust evidence supporting the association with few if any contradictory findings. The evidence indicates that the scientific community largely accepts the existence of the association.

Staff made modifications to these criteria at the start of the 2015 legislative session beginning January 12, 2015. Therefore strength-of-evidence rankings may not be comparable between reviews completed before and those completed after this date.

This review was subject to time constraints, which influenced the scope of work for this review. The annotated references are only a representation of the evidence and provide examples of current research. In some cases only a few review articles or meta-analyses are referenced. One article may cite or provide analysis of dozens of other articles. Therefore the number of references included in the bibliography does not necessarily reflect the strength-of-evidence. In addition, some articles provide evidence for more than one research question so they are referenced multiple times.

Analysis of HB 2969 and the Scientific Evidence

Summary of HB 2969

- Imposes a 45% tax on the taxable sales prices of vapor products.
- Creates a distributor and retailer license to distribute or sell vapor products in Washington.
- Requires that, at a minimum, 3% of the revenues collected from the vapor products tax be appropriated from the general fund to the Cancer Research Endowment Fund Match Transfer Account.

Health impact of HB 2969

Evidence indicates that HB 2969 would likely decrease vaping rates in Washington State, thereby improving health outcomes and decreasing health disparities by socioeconomic status in the state.

Pathways to health impacts

The potential pathways leading from the provisions of HB 2969 to decreased health disparities are depicted in Figure 1. There is a fair amount of evidence that an excise tax on vaping products would lead to reduced vaping rates in Washington.¹⁻³ There is strong evidence that decreased vaping rates would lead to improved health outcomes.^{4,5} Given the limited evidence on the long-term impacts of vapor products, the literature suggests that vaping may have less adverse effects or result in less exposure to harmful substances than combustible cigarettes.^{4,5} However, there is insufficient evidence to determine if vaping products are effectively being used to reduce or quit combustible cigarette use.⁶⁻⁹ A recent meta-analysis concluded that e-cigarettes, as they are currently being used, are actually associated with lower quit rates among combustible cigarette smokers.⁶ There is a fair amount of evidence that decreasing vaping rates and improving health outcomes through an excise tax on vaping products would lead to reduced health disparities by socioeconomic status in Washington.¹⁰⁻²⁹ The evidence for the potential effects on health disparities by race/ethnicity are less clear and are discussed in more detail on page five of this review.

Due to time limitations we only researched the most direct connections between the provisions of the bill and decreased health disparities and did not explore the evidence for all possible pathways. For example, one potential pathway that was not researched was the evidence for how having 3% of the revenues collected from the vapor products tax appropriated from the general fund to the Cancer Research Endowment Fund Match Transfer Account would likely impact health.

Magnitude of impact

A number of studies suggest that taxes on tobacco products are passed-through to the consumer at a rate of 83 to 110% (not accounting for potential price minimization strategies such as using coupons or purchasing by the carton).³⁰ This indicates that a 45% excise tax would likely result in a 37-49% increase in prices for the consumer. Two studies have estimated the price elasticity of vapor products and found it to range from -1.2 to -1.9 (meaning that a 10% increase in the price of vaping products was associated with a 12% to 19% reduction in use of vaping products).^{1,2} A recent meta-analysis by Washington State Institute for Public Policy found that a 10% increase in combustible cigarette prices is associated with a 3.5% decrease in smoking rates among youth and a 1.3% decrease in smoking rates among adults.³ While WSIPP's meta-analysis uses a much larger and more robust body of evidence, the first range of price elasticities may be more generalizable to HB 2969 as they are specific to vaping products.

Logic Model

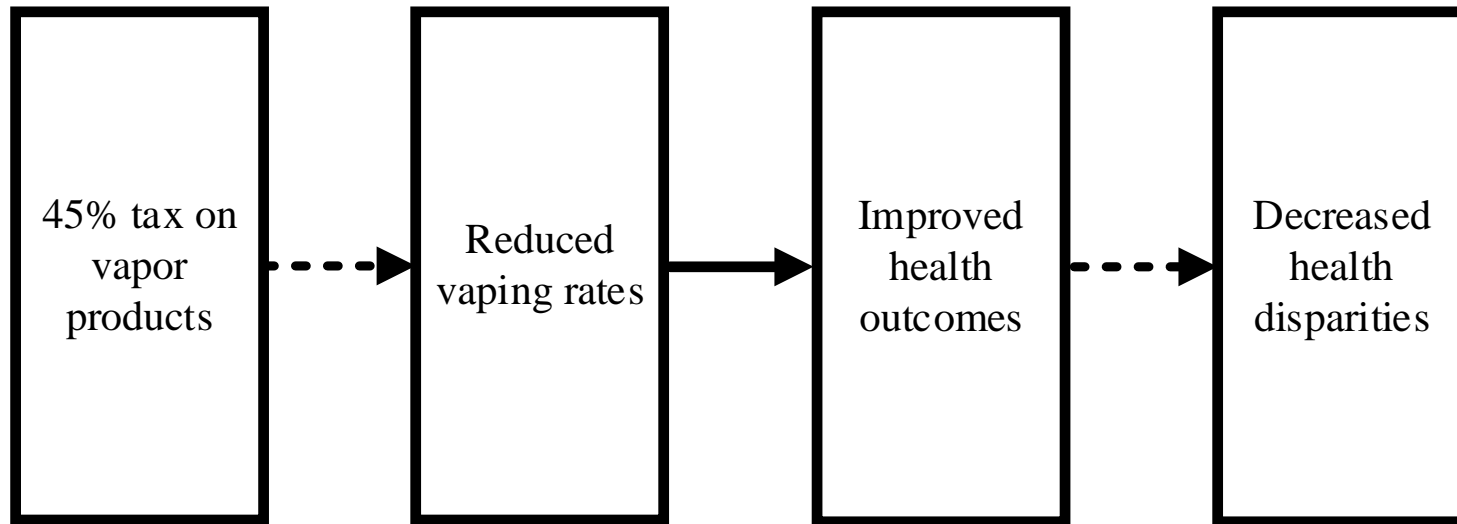
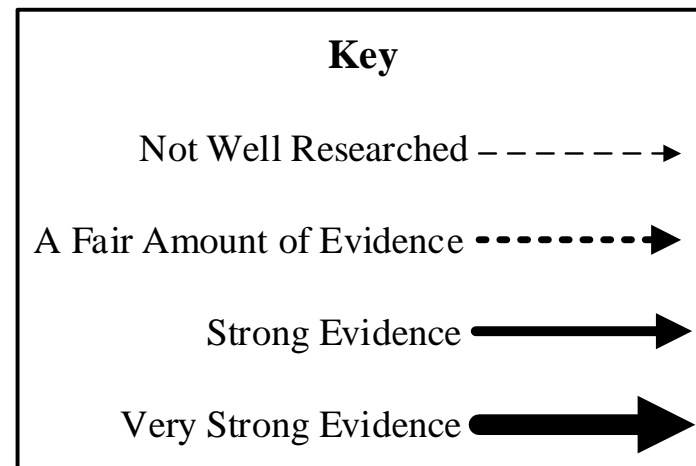


Figure 1
Concerning Vapor Product Taxation
HB 2969



Summaries of Findings

Will a 45% tax on vaping products lead to reduced vaping rates?

There is a fair amount of evidence that an excise tax on vaping products would lead to reduced vaping rates in Washington.¹⁻³ While there is robust evidence indicating that taxes on combustible cigarettes have led to reduced smoking rates,³ it is unclear how generalizable these studies are to vaping products specifically—so the strength of the evidence was downgraded to reflect this uncertainty. In addition to the large body of evidence on the effect of increasing taxes on decreased use of combustible cigarettes,³ we identified two studies which looked specifically at the impact of the prices of vaping products on vaping rates—both which found that higher prices of vaping products are associated with decreased usage of those products.^{1,2} While these two studies were specific to vaping product cost (rather than taxes on these products), evidence indicates that increases in taxes on tobacco products are passed on to the consumer,³⁰ and most meta-analyses and review articles analyzing the connection between tobacco taxes and product usage have treated studies which have evaluated the impact of price on usage and those that evaluated the impact of tax on usage interchangeably.

Will reduced vaping rates lead to improved health outcomes?

There is strong evidence that decreased vaping rates would lead to improved health outcomes.^{4,5} Many studies have found that vaping products contain substances that are harmful to humans (e.g. metals, traces of cancer-causing nitrosamines, formaldehyde, and mercury) and that smoking electronic cigarettes is associated with adverse effects such as airway and lung obstruction and harms at the cellular level. Evidence also indicates that product labels often did not show the concentrations of solvents and flavoring and that products labeled nicotine free were sometimes found to actually contain nicotine in high concentrations. There was also variability in product concentrations from cartridge-to-cartridge. There is a lack of evidence of the long-term impacts of vaping on human health as vapor products are relatively new.^{4,5}

Given the limited evidence on the long-term impacts of vapor products, the literature suggests that vaping may have less adverse effects or result in less exposure to harmful substances than combustible cigarettes.^{4,5} However, there is insufficient evidence to determine if vaping products are effectively being used to reduce or quit combustible cigarette use. While some studies suggest that e-cigarettes may be useful cessation tools or may help smokers decrease their use of combustible cigarettes, other studies have found that e-cigarette use is associated with a **decreased** likelihood of quitting combustible cigarettes and **increased** consumption of combustible cigarettes.⁶⁻⁹ A 2016 meta-analysis by Kalkhoran concluded that e-cigarettes, as they are currently being used, are actually associated with lower quit rates among combustible cigarette smokers.⁶ In addition, emerging evidence suggests that youth and adults who start using electronic cigarettes may be more likely than their peers to begin using combustible cigarettes and other tobacco products.^{28,29}

Will improved health outcomes as a result of decreased vaping rates in response to a vapor product tax decrease health disparities?

Disparities by income

There is a fair amount of evidence that decreasing vaping rates and improving health outcomes through an excise tax on vaping products would lead to reduced health disparities by socioeconomic status (SES) in Washington.¹⁰⁻²⁹ While there is a large body of evidence indicating that taxes on combustible cigarettes have led to greater reductions in smoking among individuals from lower SES groups (as a result of greater price sensitivity among these populations),¹²⁻¹⁴ it is unclear how generalizable these studies are to vaping products specifically—so the strength of the evidence was downgraded to reflect this uncertainty. Recent reviews of the impacts of increasing combustible cigarette prices on smoking disparities have concluded that of the available tobacco control interventions reviewed, increasing the purchase price of cigarettes had the clearest and most consistent evidence of positive equity impacts.^{13,14}

Evidence indicates that individuals with low SES are more likely to use vaping products,^{10,18} **and** to experience worse health outcomes than their counterparts.^{15,17,19-21,23-27} Healthy Youth Survey data from 2014 also indicate 8th and 10th grade students who reported that their mother had a high school education or less (one measure of socioeconomic status) reported significantly higher rates of using electronic cigarettes in the past month. This disparity persisted among 12th graders but was no longer statistically significant.¹⁰ Therefore, decreasing vaping rates among this population through an excise tax will likely decrease disparities by socioeconomic status in Washington.

In addition, preliminary evidence suggests that vaping may be serving as a gateway to smoking combustible cigarettes,^{28,29} therefore decreasing vaping rates for Washingtonians, particularly those from lower SES groups may potentially also help decrease disparities that we see in combustible cigarette smoking rates.^{10,16,22,24}

It is also important to consider that excise taxes are regressive. So, while a tax on vaping products has greater positive health impacts on individuals from lower SES backgrounds, thereby working to decrease health disparities—lower income individuals who are not able to quit vaping will be more financially impacted by the tax than their higher income counterparts.

Disparities by race/ethnicity

Trends in vaping rates by race/ethnicity are less consistent, therefore the likely impacts of a tax on vaping products on disparities by race/ethnicity are less clear. For example, in Washington State vaping rates tend to be higher among students of color and American/Indian Alaskan Natives than among White students, but these gaps begin to close as students reach 12th grade.¹⁰ In addition most of the studies on the impacts of tobacco taxes on disparities have focused on disparities by income, education, or occupation rather than race/ethnicity. However, in Washington, people of color are disproportionately represented among groups with lower-socioeconomic status,¹⁷ so the findings from the body of evidence related to disparities by SES may be partially generalizable to disparities by race/ethnicity. In addition, we did identify a few studies which have found that some communities of color are more price sensitive to tobacco taxes than their counterparts and are therefore more likely to decrease tobacco usage following tax increases.^{11,12} Another important aspect to consider is that current law (RCW 43.06.455) allows the Governor to enter into cigarette tax compacts with the tribes. HB 2969 does not amend this language to include vaping product compacts. If tribal retailers continue to sell vaping products to their tribal members at the current pre-excise tax rates, it is possible that

vaping rates among tribal members living on or accessing goods on tribal land will not be as positively impacted by HB 2969.

Other considerations

We also explored the potential impacts of the bill on businesses that sell vaping products as economic health can affect human health. The potential lost revenue from decreased purchases of vaping products as well as the fees associated with the vaping product retailer's and distributor's license (though retailers with a valid cigarette retail license would not have to pay the fee) has potential to impact retailers and distributors, particularly small businesses. We ultimately did not include these pathways in the logic model on page three of this review because the impacts on business have not been well researched. We only identified one peer-reviewed study which has evaluated the impact of tobacco taxes on convenience stores. This study found that, based on analysis of convenience store and gas station density in a state, increased cigarette taxes do not negatively affect convenience stores.³¹

Annotated References

1. Pesko MF, Kenkel, D. S., Wang, H., and Hughes, J. M. . The effect of potential electronic nicotine delivery system regulations on nicotine product selection. *Addiction (Abingdon, England)*. 2016.

Pesko et al. cite evidence that electronic nicotine delivery systems (ENDS) have been associated with smoking reduction, sometimes with greater success than nicotine replacement therapy (NRT), and also that ENDS are associated with negative health outcomes, though smokers who have switched to ENDS from combustible cigarettes report fewer short-term negative health effects. They cite evidence that the “consensus price elasticity estimate for [combustible] cigarettes is approximately -0.4, meaning that a 10% price increase results in a 4% decrease in cigarette purchases.” Pesko et al. employed a discrete choice experiment (DCE) design, in which respondents made hypothetical purchase choices as the attributes (price, flavor availability, and warning labels) of the products (cigarettes, ENDS, and NRT) varied. The choice-exercises were prefaced with the following question: “if you were shopping for a tobacco/nicotine product and these were your only options, which would you choose?” The participants were then able to choose between one pack of their regular cigarettes at the current market price, NRT at \$6 for a package equivalent to one pack of cigarettes, or a disposable vaping device with varying price (\$3, \$6, or \$9), varying flavor options, and one of four warning labels. The authors collected data from 1,200 adult smokers (1,020 with complete and reliable data) in the United States surveyed between December 2014 and January 2015. The sample was identified using address-based sampling (response rate not noted). Of the sample, 63.6% reported using ENDS at least once in their lifetime; 17.5% reported using ENDS in the last month, 17.4% had both tried quitting in the past year and used nicotine replacement therapy in the quit attempt; 16.5% had tried quitting using a vaping device. The authors controlled for a number of individual factors including race/ethnicity, age, education, gender, marriage status, education, income, and labor participation, tobacco use characteristics, and the price that the participant indicated usually paying for their preferred pack of cigarettes. The authors found that in the simulations, as the price of ENDS products increased, the selection of these products decreased significantly. For example, younger adults selected ENDS 34.4% of the time at a price of \$3.00 and 8.0% of the time at a price of \$9.00. Overall, increasing ENDS prices from \$3 to \$6 was associated with a 13.6 percentage point reduction in ENDS selection. ENDS were also more often chosen among those with a higher interest in quitting combustible cigarette smoking and those 18-24 years of age. Adults age 18-24 were more price-responsive than their counterparts. The authors found a price elasticity for ENDS of -1.8, indicating that a 10% increase in the price of ENDS was associated with an 18% reduction in the selection of ENDS among the adult smokers. Data collection intentionally spanned the New Year, and the researchers hypothesized that New Year’s resolutions to quit smoking may impact participants simulated decisions. They found that among participants with the highest cigarette quitting interest there was a significant 8.3% decline in choosing combustible cigarettes and a significant 24% increase in choosing ENDS between those interviewed in December 2014 and those interviewed in January 2015. The increase in choosing NRT (5.4%) for this population was not significant, indicating that more respondents may have been planning to use ENDS than NRT in an attempt to quit. It is not clear from the information presented in this article if the decrease in choosing ENDS (as a result of increased price) was associated with an increase in choosing combustible cigarettes or NRT.

2. Huang J, Tauras J, Chaloupka FJ. The impact of price and tobacco control policies on the demand for electronic nicotine delivery systems. *Tobacco Control*. 2014;23(suppl 3):iii41.

Huang et al. analyzed store scanner data collected by the Nielson Company from 2009 to 2012. This dataset includes quarterly prices and sales of e-cigarettes for 52 Nielson markets in the US. A Nielson market includes groups of counties centered around a major city. Participating retailers include food, drug, and mass (FDM) stores (e.g. Target and K-Mart) in all of the markets, and convenience stores in 25 of the 52 markets. The populations residing in those 52 markets account for about 80% of the total US population. The authors found that the sales for both reusable and disposable e-cigarettes were at least five times higher in convenience stores than in FDM stores and that sales of e-cigarettes increased significantly from 2009 to 2012. The authors used fixed-effects models to estimate the price elasticity of demand for reusable and also for disposable e-cigarettes. They started with baseline market-store fixed-effect models and then incorporated smoke free policies, combustible cigarette tax, and combustible cigarette price into the models. The authors found a price elasticity for disposable e-cigarettes of -1.2, indicating that a 10% increase in the price would likely reduce sales by 12%. The price elasticity for reusable e-cigarettes was -1.9, indicating that a 10% increase in price would likely reduce sales by 19%. They also found that markets with higher cigarette prices had higher e-cigarette sales, but the association was not statistically significant.

3. Megan Morris, et al. *Tobacco and E-Cigarette Prevention and Cessation: Benefit-Cost & Meta-Analysis Results*. Washington State Institute for Public Policy;2014.

The Washington State Institute for Public Policy (WSIPP) conducted a meta-analysis (of the literature published through December 2014) to determine the degree to which increasing combustible cigarette taxes (with an expected increase in cigarette retail prices) impacts cigarette smoking among youth. They conducted a similar meta-analysis to determine the impact on cigarette smoking among adults. The authors included only high quality studies and excluded studies with weak research methods. These two meta-analyses combined referenced 24 articles analyzing the link between cigarette prices or taxes and smoking rates. Eighteen of the 24 studies found that increased prices/taxes were associated with decreased smoking rates. Of the remaining six studies: one study found that increased prices was associated with smoking cessation but not with lower rates of smoking initiation; one study found price was associated with lower intensity of smoking but not lower rates of smoking; one study found that price increases did not impact smoking in 1970 but they did in 1985; one study found that increasing prices was associated with decreased smoking rates before the Master Settlement Agreement but not after the agreement; and one study found that higher prices were associated with decreased smoking rates, but not when a state's "anti-smoking sentiment" was controlled for. While the price-elasticities found in each of these studies vary, WSIPP's pooled results indicate that a 10% increase in combustible cigarette prices is associated with a 3.5% decrease in smoking rates among youth and a 1.3% decrease in smoking rates among adults.

4. Pisinger C, Dossing M. A systematic review of health effects of electronic cigarettes. *Preventive Medicine*. 2014;69:248.

Pisinger and Døssing conducted a systematic review of the literature on the health consequences of vaping products published before August 14, 2014. The authors identified 76 studies which met their inclusion criteria. They found that 34% of the studies' authors had a conflict of interest

(e.g. the study was funded or somehow influenced by electronic cigarette manufacturers or consultants for manufacturers of medicinal smoking cessation therapy). Many studies found that product labels did not show the concentrations of solvents and flavoring and that products labeled nicotine free were sometimes found to actually contain nicotine in high concentrations. There was also variability in product concentrations from cartridge-to-cartridge. The authors conclude that the studies had many methodological problems and that the body of evidence is inconsistent, lack long-term follow up, and don't allow any firm conclusion on the safety of vaping products. They conclude that these 76 studies indicate that electronic cigarettes cannot be regarded as safe. The available evidence does indicate that at least some vaping products are toxic to human cells and contain toxic compounds such as metals, traces of carcinogenic nitrosamines, formaldehyde, mercury, and other potentially harmful components. Vaping was associated with significant airway and lung obstruction in the short term and other adverse effects in the mouth/throat. Some studies indicate that vaping may have less adverse effects or result in less exposure to harmful substances than combustible cigarettes. Some studies suggest that electronic cigarettes may be useful as a smoking reduction/cessation aid, but the evidence on their efficacy is conflicting.

5. Hocharoen, C. An evaluation of potential harm of electronic cigarette aerosol exposures and directions for research and regulation. *ProQuest Dissertation*. 2015.

Hocharoen conducted a systematic review of the literature on electronic cigarettes published between January 1, 2009 and January 31, 2015 in academic journals. Thirty-nine articles met the inclusion criteria. Three of these studies examined inflammatory markers, cytokines, and chemokines, all of which found that interleukins (cellular messengers for immune response) increased with electronic cigarette exposure. One study found that interleukin 6 decreased with e-cigarette exposure. Seven studies examined cytotoxicity (cell toxicity) or mutagenicity (ability to cause genetic mutations). These studies looked at the impacts of e-vapors of liquids on lung, throat, and mouth specific embryonic stem cells, and various fibroblasts. Six of these seven studies found cytotoxic effects, decreased cell viability, changes in cell morphology, reduced ATP detection, and cell mutagenicity for at least one of the measured flavors or e-liquid components. The seventh study found no cytotoxicity from e-liquids for epithelial carcinoma cells or Chinese Hamster ovary cells. The author concludes that cell viability is affected by e-cigarettes and that vapor products sometimes contain “carcinogens, metals, and other potentially harmful constituents.” The author notes that while physiological effects of e-cigarettes have been found in the literature, potential adverse long-term effects have not been studied.

6. Sara Kalkhoran, Glantz SA. E-cigarettes and smoking cessation in real-world and clinical settings: A systematic review and meta-analysis. *The Lancet Respiratory Medicine*. 2016;4(2):116-128.

Kalkhoran et al. conducted a systematic review and meta-analysis to evaluate the association between e-cigarette use and combustible cigarette cessation among adults. Thirty-eight studies met their inclusion criteria for the systematic review, 20 of which had control groups and were included in the meta-analysis. They found that the odds of combustible cigarette cessation among those who used e-cigarettes was 28% lower than for those who did not use e-cigarettes (OR 0.72 [95% CI 0.57-0.91]). When the authors only included studies of smokers with an interest in quitting, they did not find a significant difference from the overall findings. The authors

conclude that e-cigarettes, as they are currently being used, are associated with lower quit rates among combustible cigarette smokers.

7. Rahman, M., Hann, N., Wilson, A., Mnatzaganian, G., & Worrall-Carter, L. E-cigarettes and smoking cessation: Evidence from a systematic review and meta-analysis. *PLoS One*. 2015;10(3), E0122544.

Rahman et al. conducted a systematic review of the literature on combustible cigarette consumption or cessation after the use of e-cigarettes. Six studies met their inclusion criteria. They found that e-cigarettes with nicotine were more effective as a cessation tool than those without nicotine. The authors pooled data from two randomized control trials and found a risk ratio of 2.29 (95% CI 1.05-4.97). They also found that use of e-cigarettes was associated with smoking cessation and reduction in the number of cigarettes used—though three of the six studies did not include a control group. The authors note that they were only able to consider the efficacy of nicotine vs. non-nicotine e-cigarettes and were not able to compare the efficacy of e-cigarettes to other cessation interventions.

8. Gmel G, Baggio S, Mohler-Kuo M, Daeppen J-B, Studer J. E- cigarette use in young Swiss men: Is vaping an effective way of reducing or quitting smoking? *Swiss Medical weekly*. 2016;146:w14271.

Gmel et al. summarize the current evidence on the impact of e-cigarettes on combustible cigarette usage, noting that the literature is conflicting—with some studies finding that vaping is associated with using fewer cigarettes but not with being less likely to completely quit smoking combustible cigarettes, other studies finding an increase in combustible cigarette usage and decreased likelihood of quitting, and still other studies finding that e-cigarettes were associated with more quit attempts and continued abstinence than NRT or using no aid. The authors used data from the Cohort Study on Substance Use Risk Factors in Switzerland. While 7,556 participants (all young men) provided consent to participate, 79.2% (n=5,987) completed the baseline questionnaire and 79.7% (n=6,020) completed the follow-up questionnaire. A total of 91.5% of the baseline respondents (n=5,476) also completed the follow-up questionnaire. Among those who did not smoke at baseline, those who were vaping at follow-up were more likely to start smoking and to become occasional or daily smokers at follow-up than were nonvapers. Among those who were occasional smokers at baseline, nonvapers were more likely to become nonsmokers and less likely to become daily smokers than vapers. Among those who did not smoke at baseline, vapers were 6 times more likely to be occasional smokers and 12 times more likely to be daily smokers at follow-up than nonvapers. Among nonsmokers at baseline, vapers smoked significantly more (10 times more) cigarettes weekly at follow-up than did nonvapers. Weekly cigarette use increased between baseline and follow-up for occasional smokers and decreased for daily smokers but these changes were not significant between vapers and nonvapers.

9. Grace RC, Kivell BM, Laugesen M. Estimating cross- price elasticity of e- cigarettes using a simulated demand procedure. *Nicotine and Tobacco Research : Official Journal of the Society for Research on Nicotine and Tobacco*. 2015;17(5):592.

Grace et al. collected data from a convenience sample of 210 daily smokers in New Zealand who were 18 years of age or older and who had no intention to quit smoking before January 1, 2013. They excluded any smokers who had ever used e-cigarettes. They interviewed participants

between February and March of 2013 (response rate not noted). The researchers had participants complete a written survey and three additional validated surveys, complete the Cigarette Purchase Task (CPT), sample an e-cigarette, and then answer questions about their intentions to purchase e-cigarettes and their regular tobacco product. The CPT is used to measure demand for tobacco products across a range of prices. The authors used the CPT completed before sampling the e-cigarette as a baseline to determine the demand for combustible cigarettes in the absence of e-cigarettes. The participants also indicated their intentions to purchase e-cigarettes and combustible cigarettes after trying the e-cigarette. The authors found that the simulated demand for e-cigarettes increased as the price of regular cigarettes increased, with an average cross-price elasticity of 0.16 (indicating that a 10% increase in the cost of combustible cigarettes was associated with a 1.6% increase in the demand for e-cigarettes). However, the simulation also found that the low-cost availability of e-cigarettes did not decrease the demand for regular cigarettes at a higher price and that a significantly lower proportion of participants said that they would quit smoking tobacco completely if e-cigarettes were available than if they were not. This finding suggests that the availability of low-priced e-cigarettes could actually encourage people who would otherwise have quit smoking completely as a result of raising tobacco prices to instead continue to use combustible cigarettes perhaps in tandem with lower-cost e-cigarettes. So, while the study found that smokers may substitute e-cigarettes for combustible cigarettes as the cost of the later increases (with the cost of the former staying low), low-cost e-cigarette availability may actually discourage combustible cigarette smokers from quitting entirely as combustible cigarette prices increase.

10. Healthy Youth Survey. QxQ Analysis: Smoking and Electronic Cigarette Use. 2014; <http://www.askhys.net/Analyzer>. Accessed November 14, 2015.

Washington State Healthy Youth Survey data from 2014 indicate that past 30-day electronic cigarette use is high among 8th (8.5% [95% CI 7.2-9.8%]), 10th (18.0% [95% CI 16.4-19.6%]) and 12th graders (23.1% [95% CI 20.9-25.3%]). The data also show that 8th and 10th grade students who reported that their mother had a high school education or less (one measure of socioeconomic status) reported significantly higher rates of using electronic cigarettes in the past month. The rates were 13.6% (95% CI 11.2-16.0%) for 8th graders whose mothers had a high school education or less and 2.9% (95% CI 4.6-7.2) for 8th graders whose mother had more than a high school education. For 10th graders the rates were 23.8% (95% CI 21.1-26.5) and 15.4% (95% CI 13.5-17.3) respectively. This disparity persisted among 12 graders (25.0% [95% CI 21.5-28.5] and 21.8% [95% CI 19.1-24.5] respectively) but was no longer statistically significant. When asked how many electronic cigarettes they had used in the past 30 days, American Indian/Alaskan Native (AI/AN) (13.1% [95% CI 7.2-19.0%]), Black, and Hispanic/Latino 8th grade respondents reported the highest usage. Black (14.2% [95% CI 9.8-19.2%]) and Hispanic/Latino (13.5% [95% CI 10.1-16.9%]) students reported significantly higher rates than their White (6.8% [95% CI 5.4-8.2%]) and API (5.8% [95% CI 3.5-8.1%]) counterparts. Among 10th grade respondents AI/AN (28.0% [95% CI 16.9-39.1%]) and Black students (23.5% [95% CI 17.3-29.7%]) had the highest rates, although these rates are only significantly higher than the rates for API students (12.0% [95% CI 8.5-15.5]). Among 12th grade respondents, White students (25% [95% CI 23.4-27.8%]) had the highest rates, though these were only significantly higher than the rates for API students (13.0% [95% CI 9.5-16.5%]). Several racial/ethnic subpopulations had lower rates of electronic cigarette use (or only slightly higher rates) among 12th graders than among 10th graders while White 12th graders and those

who identified as more than one race/ethnicity or "other" had higher rates than the 10th graders. These data indicate that among sixth grade respondents there were no statistically significant differences by race/ethnicity in the percent of students who reported smoking combustible cigarettes any days in the past 30 days. Among 8th grade respondents AI/AN students (7.7% [95% CI 4.8-10.6%]) reported significantly higher smoking rates than their Asian and Pacific Islander (API) (1.9% [95% CI 1.1-2.7%]) and White peers (3.4% [95% CI 2.7-4.1%]). Black students (7.0% [95% CI 5.0-9.0%]) also reported significantly higher rates than their White peers. Among 10th grade respondents, Black (9.1% [95% CI 6.5-11.7%]), Hispanic/Latino (8.0% [95% CI 5.9-10.1%]), and AI/AN (14.1% [95% CI 7.7-20.5%]) respondents reported significantly higher rates than did their API peers (4.3% [95% CI 2.9-5.7%]). These rates were also higher than the rate for White students (7.7% [95% CI 6.3-9.1%]), but the differences were not significant. The percent of students who had reported smoking at all in the past 30 days was highest among 12 grade respondents. Black (13.5% [95% CI 9.6-17.4%]), White (14.0% [95% CI 12.1-15.9%]) and AI/AN (15.4% [95% CI 7.8-23.0%]) students reported the highest rates, but the only significant difference was that the rate for White students was significantly higher than that for API students (8.6% [95% CI 6.3-10.9]). These data suggest that in Washington State, youth of color in the younger grades have disparately high rates of current cigarette use, while in the older grades these disparities begin to narrow as a larger proportion of White students initiate smoking. It is important to note that the current race/ethnicity categories aggregate diverse subpopulations into one category—so disparities within these categories may be masked. For example, API subpopulations likely have very different smoking and vaping rates but they are aggregated into one category so these differences are missed.

11. Oredein T, Foulds J. Causes of the decline in cigarette smoking among African American youths from the 1970s to the 1990s. *American Journal of Public Health*. 2011;101(10):e4.

Oredein, and Foulds explore potential reasons why the smoking rates among African American youth declined at a faster rate than that for White youth between the mid-1970s and early 1990s. They cite evidence that people of color, low-income people, and youth are more likely to reduce or quit smoking in response to increasing cigarette prices. For example, one study found that smoking among African American men dropped 16.5% and the rate among White men dropped 8.6% in response to tobacco price increases. The authors conclude that tobacco taxes “have become a crucial policy tool for reducing cigarette use, especially among [African American] youths.”

12. Blakely T, Cobiac LJ, Cleghorn CL, et al. Health, health inequality, and cost impacts of annual increases in tobacco tax: Multistate life table modeling in New Zealand (health and cost impacts of tobacco tax). 2015;12(7):e1001856.

Blakely et al. indicate that they identified 11 studies on tobacco tax which looked at both health impact and a costing metric. All of these studies reported that a tobacco tax was associated with overall health gains and were reported as either cost-effective or cost saving. One of these studies found greater improvements in health for men than for women, and one found greater health improvements for those in the lowest socioeconomic status (SES) group. The authors also identified six systematic reviews that have evaluated the impact of tobacco price/tax increases on equity. They note that the two most recent reviews indicate that increases in tobacco prices/taxes tend to have a positive impact on health disparities, leading to a reduction in inequalities in

smoking rates by SES in both adults and youth. Both of these recent reviews are summarized in this Health Impact Review. The four earlier reviews reported the same trend, though Blakely et al. note that the conclusions in these earlier reviews were less conclusive. The authors indicate that the indigenous Māori population in New Zealand experiences disparately high smoking rates, all-cause mortality rates, and lower life expectancy than the non- Māori population. The authors attempted to estimate the future impacts of a 10% per year increase in the tobacco tax in New Zealand using modeling based on national data. They used past evidence to estimate the tobacco price elasticity of different subpopulations in the country, and assuming a higher price-elasticity for the Māori population. They concluded that that the 2011 cohort would see a total of 260,000 (95% uncertainty interval 155,000-419,000) quality-adjusted life-years gained with an annual tax increase of 10% compared to no tax increases. They estimated that the quality-adjusted life-years gained would be 3.7 times greater for the Māori population in relation to their counterparts, leading to a reduction in health disparities.

13. Brown T, Platt S, Amos A. Equity impact of population- level interventions and policies to reduce smoking in adults: A systematic review. *Drug and Alcohol Dependence*. 2014;138:7.

Brown et al. conducted a systematic review of the literature published since 1995 on the connection between a number of tobacco control policies/interventions and adult smoking disparities (by income, education, occupation, or area-level socioeconomic deprivation) including tax/price increases. The authors assessed the quality of each article. They included 27 studies on the relationship between price/tax of tobacco products and disparities. Overall these were associated with larger reductions in smoking prevalence or consumption in lower SES populations than in higher SES populations. Fourteen of the 27 studies found a positive equity impact, four studies found a negative equity impact, six studies found a neutral equity impact, one found mixed results, and two were unclear. The authors conclude that of all of the tobacco control interventions reviewed, the “clearest and most consistent evidence of positive equity impact was for increasing the purchase price of cigarettes.”

14. Brown T, Platt S, Amos A. Equity impact of interventions and policies to reduce smoking in youth: Systematic review.(report). *Tobacco Control*. 2014;23(6):e98.

Brown et al. conducted a systematic review of the literature published between January 1995 and October 2013 on the connection between a number of tobacco control policies/interventions and youth (age 11-25 years) smoking disparities. The authors assessed the quality of each article and provide an overview of the methodological limitations of the body of evidence in aggregate. They included seven studies (five of which were conducted in the United States) which analyzed the equity impacts of cigarette price/tax increases. Four of the seven studies showed a positive equity impact (e.g. smoking rates declined more for youth in low SES groups than their counterparts), one study found a neutral impact, and two studies found negative equity impacts. Four of the five studies conducted in the United States showed a positive equity impact. The authors conclude that, among the interventions reviewed, “the only consistent effect was price/tax interventions/policies, which had the most consistent positive equity impact.”

15. Reed P KD, Cheng E, Kinne S. Washington State Department of Health. *Health of Washington State Report: Mortality and Life Expectancy*. 2013.

The authors present Washington state data on mortality and life expectancy. The data show that age-adjusted death rates were higher in Washington census tracts with higher poverty rates. The state data also show that self-reported health status decreases as income decreases.

16. Boysun M, Wasserman C. *Health of Washington State Report: Tobacco*. Washington State Department of Health;2012.

Washington state Behavioral Risk Factor Surveillance System (BRFSS) data from 2008-2010 indicate that adults with lower incomes are significantly more likely to report smoking cigarettes than their counterparts. AI/AN and Black populations also have significantly higher smoking rates than White, Hispanic, and Asian populations. It is important to note that the current race/ethnicity categories aggregate diverse subpopulations into one category—so disparities within these categories may be masked. For example, API subpopulations likely have very different smoking rates but they are aggregated into one category so these differences are missed.

17. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System Prevalence And Trends Data: Washington-2013. 2013; <http://apps.nccd.cdc.gov/brfss/page.asp?cat=XX&yr=2012&state=WA#XX>. Accessed February 11, 2015.

Behavioral Risk Factor Surveillance System (BRFSS) 2013 data from Washington state show significant correlations between lower income and a number of health indicators including: worse overall self-reported health, depression, asthma, oral health, tobacco use, women's health indicators, health screening rates, physical activity, and limited activity as a result of a disability. BRFSS data from 2011 show that Black, AI/AN, and Hispanic respondents are significantly more likely to report fair or poor general health than White or Asian respondents. Participants who identified as multiracial also reported significantly higher rates of asthma than White and Hispanic respondents. These data also show a correlation between higher educational attainment and positive health outcomes for a number of indicators including: oral health, tobacco use, women's health indicators, health screening rates, and physical activity. White respondents were also significantly more likely than all other respondents to report earning an income of \$50,000 or more per year and significantly more likely to report higher levels of educational attainment. Current race/ethnicity categories aggregate diverse subpopulations into one category—so disparities within these categories may be masked.

18. Huang J, Kim Y, Vera L, Emery SL. Electronic cigarettes among priority populations: Role of smoking cessation and tobacco control policies. *American Journal of Preventive Medicine*. 2016;50(2):199.

Huang et al. conducted an online survey using a nationally representative US sample of adults (n=17,522) in 2013. They found that 15% of participants reported ever using e-cigarettes, 5.1% reported current use, and 34.5% of ever users reported current use. They found that ever and current e-cigarette use was significantly higher among current cigarette smokers, young adults, those with low SES, and lesbian/gay/bisexual/transgender respondents than their counterparts.

19. Spencer N, Thanh TM, Louise S. Low income/socio-economic status in early childhood and physical health in later childhood/adolescence: A systematic review. *Maternal and Child Health Journal*. 2013;17(3):424-431.

Spencer et al. conducted a meta-analysis of studies examining the relationship between low socioeconomic status in the first five years of life and physical health outcomes in later childhood and adolescence. Nine studies met the researchers' strict inclusion criteria. The studies indicated significant associations between early childhood low-income status and a number of adverse health outcomes including: activity-limiting illness, parent-reported poor health status, acute and recurrent infections, increasing body mass index (BMI), dental caries, and higher rates of hospitalization.

20. Subramanyam M, Kawachi I, Berkman L, Subramanian SV. Relative deprivation in income and self-rated health in the United States. *Social Science and Medicine*. 2009;69(3):327-334.

Subramanyam et al. analyzed data from the Current Population Surveys conducted by the United States Census Bureau. Researchers found that individuals from the lowest income category were over five times more likely to report being in poor health than participants from the highest income category. In addition, they found that relative deprivation (the differences in incomes between an individual and others who have higher incomes than that individual [one measure of income inequality]) appeared to explain a large part of this association.

21. VanEenwyk J BG, Bezruchka S, Pobutky, A. Washington State Department of Health. 2013. *Health of Washington State Report: Social and Economic Determinants of Health*. 2013.

VanEenwyk et al. conducted a review of the literature on the complex relationships between the social factors that impact health. The authors found that the literature provides extensive evidence of the association between lower income and poor health outcomes.

22. Kandel DB, Griesler PC, Schaffran C. Educational attainment and smoking among women: Risk factors and consequences for offspring. *Drug and Alcohol Dependence*. 2009;104:24-33.

Researchers examined United States data from four national data sets and found that, among women, lower levels of education are associated with greater risk of being a current smoker, smoking daily, smoking heavily, being nicotine dependent, starting to smoke at an early age, having higher levels of circulating cotinine (a metabolite of nicotine) per cigarettes smoked, and continuing to smoke in pregnancy. In addition, lower levels of maternal education were linked to increased risk of antisocial behavior among offspring.

23. McLaren L. Socioeconomic status and obesity. *Epidemiologic Reviews*. 2007;29(1):29-48.

McLaren et al. conducted a meta-analysis exploring the relationship between obesity and SES among adults. A total of 333 studies published internationally met the inclusion criteria. In highly developed countries, the majority of the studies found higher body weights among women with lower education attainment. Nearly 50% of the studies in highly developed countries found the same relationship for men.

24. Mersky JP, Reynolds AJ. Educational success and adult health: Findings from the Chicago Longitudinal Study. *Prevention Science*. 2009;10(2):175-195.

Mersky and Reynolds analyzed data from a Chicago prospective cohort study that followed 1,539 individuals. Results indicate that high school completion was significantly and inversely associated with tobacco smoking, frequent substance use, depression, and no health insurance coverage. In addition, middle school reading performance was inversely related to depression and student's expectation to attend college was negatively associated with frequent drug use.

25. Mezuk B, Eaton WW, Golden SH, Ding Y. The influence of educational attainment on depression and risk of type 2 diabetes. *American Journal of Public Health*. 2008;98(8):1480.

Researchers analyzed adult survey data collected in the Baltimore Epidemiological Catchment Area and then conducted follow-up interviews with the survey cohort. Mezuk et al. found a statistically significant association between type 2 diabetes and lower educational attainment. In addition, the data indicate that depression was associated with type 2 diabetes, but each year of education attained decreased the risk of type 2 diabetes for those experiencing depression.

26. Skodova Z, Nagyova I, Dijk J, et al. Socioeconomic differences in psychosocial factors contributing to coronary heart disease: A review. *Journal of Clinical Psychology in Medical Settings*. 2008;15(3):204-213.

Skodova et al. conducted a meta-analysis of the literature addressing the relationships between SES, coronary heart disease (CHD), and psychosocial factors contributing to coronary heart disease. Researchers identified 12 studies that met their inclusion criteria. They found that higher levels of education are associated with lower rates of CHD, and that decreasing education is associated with factors that are linked to CHD such as depression, anxiety, hostility, and a lack of social supports.

27. Steptoe A, Hamer M, Butcher L, et al. Educational attainment but not measures of current socioeconomic circumstances are associated with leukocyte telomere length in healthy older men and women. *Brain Behavior and Immunity*. 2011;25(7):1292-1298.

Steptoe et al. analyzed data collected from 543 male and female London-based civil servants of white European origin. All participants were between the ages of 53 and 76 and healthy. Researchers looked at blood samples to determine telomere length and telomerase activity. Telomere shortening is associated with aging. Short telomeres are also associated with increased risk of premature heart attack and mortality. Researchers found that lower educational attainment was associated with shorter telomere length after controlling for biological and behavioral covariates. This association remained significant even after adjusting for current SES. Researchers speculated that low educational attainment may be an indicator of long-term lower SES, and may be associated with accumulated stress resulting in telomere shortening. They also postulate that education may promote problem-solving skills leading to reduced responses to stress, thereby impacting aging.

28. Leventhal AM, Strong DR, Kirkpatrick MG, et al. Association of electronic cigarette use with initiation of combustible tobacco product smoking in early adolescence.(report). 2015;314(7):700.

Leventhal et al. cite evidence that electronic cigarettes are being used among teens who have never used combustible cigarettes. They cite a 2014 estimate that in the United States 43% of 10th graders who reported using e-cigarettes in the previous 30 days reported never having tried

combustible cigarettes. Leventhal et al. analyze data from a longitudinal survey of high school students from a convenience sample of 10 public high schools in the Los Angeles, California area. They collected data in three waves: baseline (fall 2013; 9th grade), 6-month follow-up (spring 2014), and 12-month follow-up (fall 2014; 10th grade). The final sample included students who completed all three waves of the survey (n=2,530). They found that students who reported e-cigarette use at baseline were also more likely to report use of combustible tobacco products in the previous 6 months. After adjusting for potential confounding factors, the authors found that baseline e-cigarette use was also associated with a higher likelihood of using combustible tobacco products (cigarettes, cigars, or hookah) at follow-up (averaged across the two follow-up periods OR 2.73 [95% CI 2.00-3.73]). This trend was also true for combustible cigarettes specifically (OR 3.25 [95% CI 2.29-4.62]).

29. Thomas A Wills, Rebecca Knight, James D Sargent, et al. Longitudinal study of e-cigarette use and onset of cigarette smoking among high school students in Hawaii. *Tobacco Control*. 2016.

Wills et al. analyzed 2013 and 2014 longitudinal school-based survey data from Hawaii. The baseline sample included 2,338 9th and 10th graders. Students who were not smokers at baseline but who had used e-cigarettes were significantly more likely to have smoked combustible cigarettes at the one-year follow-up than their non-smoking peers who had never tried e-cigarettes (OR 2.87 [95% CI 2.03-4.05]). Among students who had tried combustible cigarettes at baseline, using e-cigarettes was not significantly related to changes in their frequency of smoking traditional cigarettes at follow-up.

30. Xiaojin Wang, Yuqing Zheng, Michael Reed, Zhen C. Cigarette tax pass-through by product characteristics: Evidence from Nielsen Scantrack Data. 2015;205375.

Wang et al. cite five studies which have found that the majority of cigarette taxes (86% to 110%) are passed through to consumer prices. They note that this research does find that some consumers may use price minimization strategies (e.g. purchasing in bulk, using coupons, purchasing generic brands, or purchasing from Indian reservations) to offset some of the price increase, leading to an actual pass-through of less than 83% (perhaps as low as 30%) for some consumers. The authors merged 2011 and 2012 Nielsen Retail Scanner data from 1,865 convenience stores across the United States with Federal and state cigarette excise tax data. They were not able to include local cigarette tax data in their modeling. After controlling for county economic and demographic variables, the authors found that cigarette taxes are fully passed through to consumer prices. They also found that a tax increase in one state is associated with a minor increase in cigarette prices in neighboring states. A one-dollar increase in a state's tax was associated with a three cent increase in cigarette prices in neighboring states.

31. Huang J, Chaloupka FJ. The economic impact of state cigarette taxes and smoke-free air policies on convenience stores. *Tobacco Control*. 2013;22(2):91.

Huang and Chaloupka analyzed state-level business count estimates of convenience stores across the United States from 1997 to 2009 to determine if increased state cigarette taxes or stronger smoke-free air policies impacted convenience store density in a state. They used store density as a proxy for store opening and closings—a reflection of store profits. The authors controlled for potential confounding factors and analyzed the data using two-way fixed effects regression models. They found that taxes were uncorrelated with combined convenience store and gas

station density in a state. When they looked only at convenience stores, they found that increased taxes were significantly correlated with greater convenience store density—but this increase was very small (a 10% increase in state cigarette taxes associated with a 0.19% increase in number of convenience stores per million people in a state). The authors conclude that higher cigarette taxes do not negatively affect convenience stores.