Executive Summary: Health Impact Review of SB 5057

Protecting youth from tobacco products and vapor products by increasing the minimum legal age of sale of tobacco and vapor products (2019 Legislative Session)

Evidence indicates that SB 5057 would likely decrease use of tobacco and vapor products among youth and young adults, thereby improving health outcomes. It is unclear how the bill would impact health disparities, though some evidence suggests that the effect on disparities may be neutral.

BILL INFORMATION

Sponsors: Kuderer, Cleveland, Bailey, Wellman, King, Keiser, Walsh, Darneille, Liias, McCoy

Summary of Bill:

- Prohibits selling or giving tobacco or vapor products to a person under the age of 21.
- Permits the Governor to seek government-to-government consultations with tribes about raising the minimum legal age of sale in cigarette tax compacts.

HEALTH IMPACT REVIEW

Summary of Findings:

This Health Impact Review found the following evidence regarding the provisions in SB 5057:

- A fair amount of evidence that changing the minimum age for purchase of tobacco and vapor products from 18 years to 21 years of age will likely decrease use of tobacco and vapor products among youth and young adults.
- Very strong evidence that decreasing use of tobacco and vapor products among youth and young adults will likely improve health outcomes.
- Unclear evidence of the bill's impacts on health inequities. Some evidence indicates that increasing the minimum purchase age is associated with decreased smoking rates across income, race/ethnicity, and grade level, indicating that the impacts of the bill on health inequities is potentially neutral. However, this is only preliminary evidence and a large body of evidence has not yet been established. Other factors may also influence how this bill impacts inequities such as access to tobacco on tribal lands and military bases and smoking rates during pregnancy. Each of these factors is analyzed in more detail in the full Health Impact Review.

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Governor's Interagency Council on Health Disparities

Health Impact Review of SB 5057

Protecting youth from tobacco products and vapor products by increasing the minimum legal age of sale of tobacco and vapor products (2019 Legislative Session)

January 8, 2019

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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 Senate Bill 5057 (SB 5057).

Staff analyzed the content of SB 5057 and created a logic model depicting possible pathways leading from the provisions of the bill to health outcomes. We consulted with experts and contacted key informants about the provisions and potential impacts of the bill. We conducted an objective review of published literature for each pathway using databases including PubMed, Google Scholar, and University of Washington Libraries. More information about key informants and detailed methods are available upon request.

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-evidence for each relationship. The strength-of-evidence has been defined using the following criteria:

- **Not well researched:** the review of literature 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 review of literature 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 percentage 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 review of literature 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 review of literature 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.

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 are referenced multiple times.

Analysis of SB 5057 and the Scientific Evidence

Summary of relevant background information

- In 2018, the U.S. Food and Drug Administration (FDA) took action to reduce youth access to tobacco products. The FDA:
    - Issued 1,300 warning letters and fines to "retailers who illegally sold JUUL and other e-cigarette products to minors," marking the "largest coordinated enforcement effort in the FDA's history."[1]
    - Issued letters to the top five-selling e-cigarette brands (which compromise 97% of the U.S. e-cigarette market) requiring each company to submit plans detailing how they will limit marketing and youth access to their product.[1]
    - Launched "The Real Cost" youth e-cigarette prevention campaign.[2]
    - Issued a directive that all "flavored [electronic nicotine delivery system] products (other than tobacco, mint, and menthol flavors or non-flavored products) must be sold in age-restricted, in-person locations and, if sold online, under heightened practices for age verification."[2]
    - Issued a Notice of Proposed Rulemaking to ban menthol in combustible tobacco products, including cigarettes and cigars.[2]
- In December 2018, the Office of the Surgeon General issued an advisory about e-cigarette use among youth.[3] The statement noted that, "any e-cigarette use among young people is unsafe, even if they do not progress to future cigarette smoking."[3]

Summary of SB 5057

- Prohibits selling or giving tobacco or vapor products to a person under the age of 21.
- Permits the Governor to seek government-to-government consultations with tribes about raising the minimum legal age of sale in cigarette tax compacts.

Health impact of SB 5057

Evidence indicates that SB 5057 would likely decrease use of tobacco and vapor products among youth and young adults, thereby improving health outcomes. It is unclear how the bill would impact health inequities, though some evidence suggests that the effect on inequities may be neutral.

Pathway to health impacts

The potential pathway leading from the provisions of SB 5057 to decreased health inequities are depicted in Figure 1. There is a fair amount of evidence that changing the minimum age for purchase of tobacco and vapor products from 18 years to 21 years of age will decrease use of tobacco and vapor products among youth and young adults. [4-24] There is very strong evidence that decreasing use of tobacco[13,33-37] and vapor products[25-41] among youth and young adults will improve health outcomes for Washingtonians.[14,25,42-46] It is unclear from available evidence how the bill would impact health inequities. Two studies have found that increasing the minimum purchase age is associated with decreased smoking rates across income, race/ethnicity, and grade level,[7,9] indicating that the impacts of the bill on health inequities is potentially neutral. However,

this is only preliminary evidence and a large body of evidence has not yet been established. Other factors may also influence how this bill impacts inequities such as access to tobacco on tribal lands and military bases and smoking rates during pregnancy. Each of these factors is analyzed beginning on page six.

Due to time limitations, we only researched the most direct connections between the provisions of the bill and decreased health inequities and did not explore the evidence for all possible pathways. For example, we did not evaluate potential impacts related to:

- Enforcement and compliance efforts for retailers. Some researchers have discussed the importance of adequate enforcement for tobacco retailers to ensure the success of Tobacco 21 laws.[47-49]
- Enforcement of possession laws for youth. Although SB 5057 does not raise the age of youth tobacco possession laws, some members of the community expressed concern that Tobacco 21 enforcement efforts may disproportionately target and negatively impact youth of color. Similarly, in passing Tobacco 21 legislation in 2017, Oregon cited concerns that tobacco possession laws would disproportionately harm communities of color as a reason for choosing not to penalize underage tobacco possession.[49]
- Availability of smoking cessation resources for youth. Community members also expressed concern about increasing the minimum age to purchase tobacco without also increasing youth access to tobacco cessation resources.

Magnitude of impact

Overall, tobacco product use among middle and high school students decreased from 2011 to 2017 nationally.[50] Data from the National Youth Tobacco Survey, administered by the Centers for Disease Control and Prevention (CDC), show that tobacco use decreased from 24.2% of high school students (grades 9-12) in 2011 to 19.6% of high school students in 2017, and from 7.5% of middle school students (grades 6-8) in 2011 to 5.6% of middle school students in 2017.[50] Similarly, the prevalence of ever-trying cigarette smoking significantly decreased from 70.1% of youth in 1991 to 28.9% of youth in 2017.[15] The prevalence of current cigarette use among youth also significantly decreased from 27.5% in 1991 to 8.8% in 2017.[15]

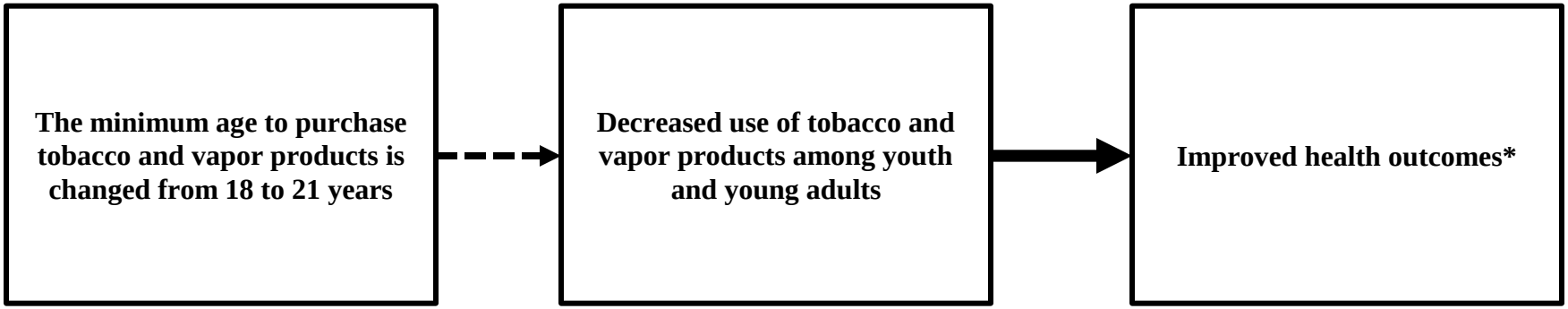
Contrary to these declines, e-cigarette use has increased dramatically among middle and high school students, and e-cigarettes are now the most commonly used tobacco product among youth.[2,3,26,50] E-cigarette use statistically significantly increased from 1.5% of high school students in 2011 to 20.8% of high school students in 2018.[51] For middle school students, 0.6% reported using e-cigarettes in 2011 compared to 4.9% in 2018.[51] The 2016-2017 Youth Risk Behavior Surveillance System also found that 42.4% of students had ever used an electronic vapor product, and 13.2% currently used e-cigarettes.[15] In addition, recent data from CDC found that e-cigarette use increased 78% (from 11.7% to 20.8%) among high school students and 48% (from 3.3% to 4.9%) among middle school students from 2017 to 2018, reversing previous trends suggesting use may be declining.[2,3,51] In a recent Morbidity and Mortality Weekly Report, CDC attributed the increase in e-cigarette use from 2017 to 2018 to "recent popularity of e-cigarettes shaped like a USB flash drive, such as JUUL."[51] The Office of the Surgeon General cited evidence that JUUL sales increased 600% from 2016 to 2017.[3]

As of early 2018, approximately 25% of the U.S. population lived in areas with a Tobacco 21 law.[48] In 2015, the Institute of Medicine (IOM) convened a committee to examine the existing literature and to use modeling to predict the likely impacts of increasing the minimum purchase age for tobacco to 21 years of age.[4] The committee's modeling was informed by existing scientific literature and estimated that raising the tobacco purchase age to 21 would reduce tobacco initiation, including a 12.5-18% reduction for those under 15 years of age; a 20.8-30% reduction for those 15-17 years; and a 12.5-18% reduction for those 18-20 years.[4]

Decreased smoking initiation rates would likely lead to significant health impacts in the long term. With an age increase to 21, IOM modeling predicted that by 2040-2059 there would be a 0.2-0.8% reduction in deaths (8.2-9.9% by 2080-2099); 0.5% reduction in years of life lost (9.3% by 2080-2099); 0.3% reduction in lung cancer deaths (10.5% by 2080-2099); 12.2% reduction in low birth weight cases; 13% reduction in pre-term birth cases; and 18.5% reduction in sudden infant death syndrome (SIDS) cases.[4] Based on this report, Washington State Department of Health projected that if the minimum age for purchasing tobacco was raised from 18 to 21 in Washington, the policy would reduce adverse birth outcomes, including preterm birth by 4.3% (53 cases) and low birth weight by 4.1% (88 cases).[52] These reductions would save approximately $2 billion to $3 billion in healthcare costs in the first five years after the minimum purchase age for tobacco was raised to 21.[52]

Lastly, unpublished data from the Washington State Administrative Office of the Courts showed that 432 youth under the age of 18 were charged with a civil infraction for possessing tobacco between 2011 and 2017 under RCW 70.155.080 (personal communication, Administrative Office of the Courts, January 2018). While SB 5057 does not raise the age of youth tobacco possession laws, the impact of raising the minimum purchase age for tobacco on the number of youth charged with a civil infraction is unknown. Some members of the community have expressed concern that enforcement efforts may disproportionately target youth of color. The data provided by the Administrative Office of the Courts for race/ethnicity and sex are self-reported, and the dataset is not complete enough to run further analyses to examine potential differences by these demographics.

Logic Model

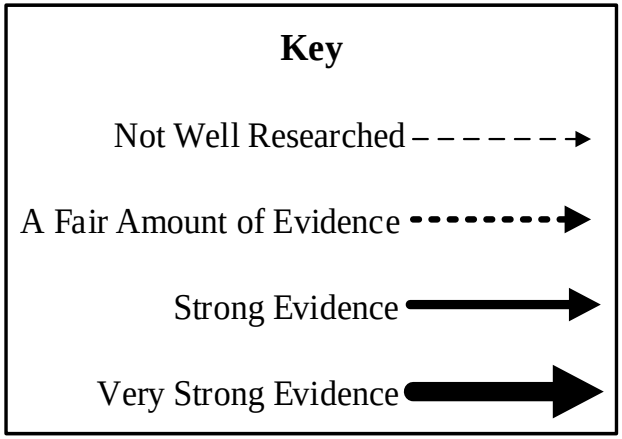


**See page 6 for a detailed analysis of potential impacts of SB 5057 on health inequities.*

Figure 1

Protecting youth from tobacco products and vapor products by increasing the minimum legal age of sale for tobacco and vapor products

SB 5057



Summaries of Findings

Will changing the minimum age for purchase of tobacco and vapor products from 18 years to 21 years of age decrease use of tobacco and vapor products among youth and young adults?

There is a fair amount of evidence, including results from evaluations of tobacco 21 policies in Needham, Massachusetts, New York City, and California, that changing the minimum age for purchase of tobacco and vapor products from 18 years to 21 years of age will likely decrease use of tobacco and vapor products among youth and young adults.[4-24]

In April 2005, Needham, Massachusetts raised the minimum purchase age for tobacco to 21 years. An analysis of the impact of this legislation demonstrated that from 2006 to 2010, the smoking rate among high school students in Needham decreased by 47%.[7] This reduction was significantly greater than the reductions seen in 16 comparison communities who had not raised the purchase age.[7]

Further, New York City began enforcing a Tobacco 21 purchase age in August 2014 and unpublished data provided by the New York City Department of Health and Mental Hygiene demonstrated a decrease in public high school student smoking rates from 8.2% in 2013 to 5.8% in 2015 (personal communication, New York City Department of Health and Mental Hygiene, November 2016). Similarly, a formal analysis of the policy found that adolescent tobacco use statistically significantly decreased ($p < 0.05$) after New York City raised the minimum purchase age to 21, though the decline was small (1.04 percentage points, or 3%).[17] However, tobacco use decreased at a greater rate for the rest of New York State (9.39 percentage points, $p < 0.001$) than for New York City.[17] In addition, although tobacco use in New York State and New York City both decreased overall, in 2016, rates of youth tobacco use in New York State were actually lower than rates in New York City.[17] These findings suggest that "increasing the [minimum legal purchase age] to 21 years in [New York City] did not accelerate reductions in youth tobacco use any more rapidly than declines observed in comparison sites."[17]

The authors note that findings from New York City may indicate that the policy "may have been rendered less effective because of poor retailer compliance and illicit tobacco supplies."[17] An earlier analysis of retailer compliance with tobacco control laws before and after New York City passed their Tobacco 21 law found that retailer compliance actually decreased after the law went into effect, and that retailer compliance with identification checks significantly decreased from 71% to 62% after implementation.[47] The authors pointed out that retailer compliance is important to ensure the success of Tobacco 21 laws, and noted that New York City did not appropriate any additional funding to ensure retailer compliance when they passed Tobacco 21 laws in 2014.[47,48]

On the contrary, although California's Tobacco 21 policy has not been in place long enough to evaluate the impact on youth tobacco use, preliminary data suggests high levels of policy awareness and acceptance among retailers and youth.[16] Retail violation rates in California statistically significantly decreased from 10.3% before raising the minimum purchase age to 21 to 5.7% after the law, with illegal tobacco sales to 15-16 year olds decreasing significantly.[16]

Researchers have also evaluated the impact of setting a national minimum purchase age for e-cigarettes. In 2016, the FDA prohibited the sale of e-cigarettes to individuals younger than 18. While research has showed mixed results about whether setting a minimum legal sales age for e-cigarettes leads to increased or decreased *cigarette* smoking among adolescents, some current studies have found that restricting access to e-cigarettes has reduced *cigarette* smoking among youth.[18,19]

While not fully generalizable to tobacco and vaping purchase policies, a separate body of evidence has documented that policy changes that raise the minimum purchase age for alcohol have decreased alcohol consumption.[10,12] These studies also provide some insight into the potential impacts of raising the minimum purchase age for tobacco and vaping products.

While the impact on youth tobacco use has been mixed, another goal of raising the minimum purchase age for tobacco and vapor products is to prevent or delay initiation of smoking among youth and young adults. While analysis of the National Survey on Drug Use and Health indicate that cigarette initiation among 12-17 year olds has significantly decreased from 2002 to 2015, the authors found that cigarette initiation was highest among 18-21 year olds for this time period.[20] They suggest that raising the minimum purchase age to 21 could be one option, "to improve and enforce policies to reduce first initiation among the young adult population."[20]

In addition, removing some of the availability of these products by raising the minimum purchase age of tobacco and vapor products may also decrease initiation and use. The 2016-2017 Youth Risk Behavior Surveillance System survey found that, of students currently using electronic vapor products, 13.6% had gotten their own products by buying them in a store.[15] A separate survey of over 1,700 youth aged 15 to 17 who reported vaping in the past 30 days found that 78.2% owned their own vaping device, with 32.2% purchasing their device online and 22.3% purchasing it in a vapor shop or lounge.[21] A survey with 9th and 12th grade students in California found that 9.3% reported buying tobacco products (including hookah, e-cigarettes, and cigarettes) from retailers directly.[22]

Social availability was also a large access point, with 72.8% of youth reporting using someone else's vaping device in the past 30 days, and 80.5% who borrowed stating that they borrowed from a friend.[21] A survey with 9th and 12th grade students in California found that 55% reported getting tobacco products (including hookah, e-cigarettes, and cigarettes) from peers.[22] Similarly, data from the 2016 Washington State Healthy Youth Survey indicate that 34.6% of Washington 10th graders say that it would be either "very easy" or "sort of easy" to access cigarettes.[23] The survey found that 76% of Washington 10th graders who used cigarettes said they received cigarettes from "social or other" sources including friends and family members.[23] One researcher suggested that, "social sources might be even more important for vaping than for smoking cigarettes; cigarette smokers likely get cigarettes from other people only when they do not possess their own, but vapers use others' devices even when they have their own."[21]

Although the evidence on the effects of minimum tobacco purchase ages have focused specifically on smoking rates among youth and young adults, it is possible that raising the minimum purchase age could also decrease smoking rates among older adults in the future.[18] Research indicates that 95% of adult smokers begin smoking before they turn 21[53] and early

smoking onset is associated with greater likelihood of addiction and decreased likelihood of cessation.[2,24] Therefore, declines in the tobacco and vaping use rates associated with increasing the minimum purchase age for tobacco and vaping products may extend beyond the age groups directly impacted by the change.

Overall, there is a fair amount of evidence that increasing the minimum purchase age from 18 to 21 may decrease youth tobacco use, delay smoking initiation, and reduce access to tobacco products for youth and young adults.

Will decreasing use of tobacco and vapor products among youth and young adults improve health outcomes?

There is very strong evidence that decreasing use of tobacco and vapor products among youth and young adults will likely improve health outcomes for these individuals, as well as for other individuals who would have been exposed to secondhand smoke or smoking in utero.[14,25-46]

Tobacco use is the leading cause of preventable disease and death in the U.S.[42] A very strong body of evidence has shown a causal link between combustible cigarette smoking and diseases in nearly every organ, diminished health status, exacerbation of asthma, inflammation, impaired immune function, age-related macular degeneration, harms to the fetus, diabetes, erectile dysfunction, arthritis, cancer, and premature death.[14] CDC has found that tobacco use is causally associated with at least 12 types of cancer, including cancer of the oral cavity and pharynx; esophagus; stomach; colon and rectum; liver; pancreas; larynx; lung, bronchus, and trachea; kidney and renal pelvis; urinary bladder; cervix; and acute myeloid leukemia.[42] Other research found that higher average cigarette use during adolescence was associated with poorer academic performance, mental health, physical health, and social functioning as well as with greater academic unpreparedness, physical ailments, and delinquency.[44] Research has also shown that secondhand smoke causes SIDS, respiratory infections, ear infections, asthma attacks in infants and children, coronary heart disease, stroke, and lung cancer in adult non-smokers.[14,43]

While the health outcomes of cigarettes are well-established, evidence related to the impact of e-cigarette use on health is still emerging. Although e-cigarettes pose less risk to individuals than combustible cigarettes, [25-27] the use of e-cigarettes has been shown to have negative impacts on health for youth and young adults,[1-3,26,28] and there is very strong evidence that decreased vaping rates would lead to improved health outcomes.[25-41]

In a 2018 report about the public health consequences of e-cigarettes, the National Academy of Sciences stated that, although e-cigarette use poses less risk to individuals than combustible cigarettes, there is conclusive evidence that use of e-cigarettes has multiple impacts on health.[26] They found evidence that e-cigarettes can explode and cause burns and injuries; intentional or accidental exposure to e-liquids can result in seizures, anoxic brain injury, vomiting, lactic acidosis, and other effects; and intentionally or unintentionally drinking or injecting e-liquids can be fatal.[26] From 2011 to 2017 the Washington Poison Center received 2,966 total cases related to nicotine exposure among children 0 to 12 years of age.[29] The majority of cases were in children under 5, and 22% of cases were related to e-cigarettes.[29] Children were primarily exposed through ingestion, and experienced symptoms like vomiting, coughing/choking, drowsiness/lethargy, and pallor.[29]

The National Academy of Sciences also found substantial evidence that e-cigarette use results in symptoms of dependence on e-cigarettes, formation of reactive oxygen species/oxidative stress, increased heart rate shortly after nicotine intake, and exposure to chemicals capable of causing DNA damage and mutagenesis, suggesting the possibility that long-term exposure could increase risk of cancer and adverse reproductive health outcomes.[26] Overall, the report concluded that e-cigarettes contain and emit numerous potentially toxic substances (e.g., metals, mercury, formaldehyde, and other cancer-causing nitrosamines),[4,26] and that nicotine intake among adult e-cigarette users is comparable to intake from combustible tobacco cigarettes.[26] Similarly, a study of adolescents aged 13-18 years old who use e-cigarettes found that, compared to non-users, users had three times greater levels of five volatile organic compounds in their urine and saliva, most of which are known carcinogens.[30]

Additional emerging research also supports the IOM finding that smoking e-cigarettes is associated with adverse effects such as airway and lung obstruction and harms at the cellular level.[28] One study demonstrated that a single exposure to cinnamaldehyde flavoring in e-cigarettes impairs lung function, potentially resulting in the development or exacerbation of respiratory disease.[32,54] Other research has found that e-cigarette use is independently and significantly associated with increased odds of heart attack.[31] Lastly, recent studies have found that e-cigarette devices emit particulate matter, and that passive or secondhand exposure to vaping products could impact health.[41,55] A study among youth in Florida found that secondhand exposure to aerosol from electronic nicotine delivery systems was associated with higher odds of asthma attacks among youth with asthma.[55]

The National Academy of Sciences stated that, "the net public health effect, harm or benefit, of e-cigarettes depends on three factors: their effect on youth initiation of combustible tobacco products, their effect on adult cessation of combustible tobacco products, and their intrinsic toxicity."[26] There is mixed evidence that e-cigarettes provide opportunity for cessation for adult combustible cigarette smokers.[2,26] 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.[33-36] A 2016 meta-analysis concluded that e-cigarettes, as they are currently being used, are actually associated with lower quit rates among adult combustible cigarette smokers.[36]

In addition, there is substantial evidence that use of e-cigarettes among youth is associated with future use of combustible cigarettes,[26,37,38] potentially increasing risk of long-term negative health outcomes and resulting in an overall net negative impact on public health.[2,26] Evidence suggests that youth and young adults who start using e-cigarettes may be more likely than their peers to begin using combustible cigarettes and other tobacco products.[39,40] In a national survey of 12 to 17 year olds, researchers found that ever-using e-cigarettes was associated with 2.53 times greater odds of subsequently smoking cigarettes.[37] Another study found that using e-cigarettes was strongly and consistently associated with greater risk of cigarette smoking initiation among youth and young adults, and that e-cigarette use was an independent risk factor for cigarette smoking, even after controlling for multiple additional risk factors.[38]

Beyond the youth who are directly impacted by this bill, SB 5057 may also provide health benefits to infants and children who would potentially be exposed to secondhand smoke or smoking in utero. Data from the Pregnancy Risk Assessment Monitoring System (PRAMS) from 2010-2012 indicate that smoking rates among pregnant women before and during pregnancy are highest among mothers younger than 20 (36%) and remain high for mothers 20 to 24 years of age (32%).[45] Since women may not be aware that they are pregnant until several weeks into their pregnancy, the smoking rates in the months leading up to pregnancy may impact fetal development and growth.[45] One study found that young mothers living in an area with a higher tobacco purchase age during pregnancy actually had better birth outcomes than their counterparts.[46]

Overall, there is very strong and consistent evidence that decreasing use of tobacco and vapor products among youth and young adults will likely improve health outcomes.

Will improving health outcomes for youth and young adults impact health inequities?
It is unclear from the available evidence how increasing the minimum tobacco and vaping product purchase age to 21 would likely impact health inequities. Two studies have found that increasing the minimum purchase age is associated with decreased smoking rates across income, race/ethnicity, and grade level,[7,9] indicating that the impacts of the bill on health inequities is potentially neutral. However this is only preliminary evidence and a large body of evidence has not yet been established.

We did not identify any evidence suggesting that increasing the minimum purchase age would increase smoking rates among any population. Given the lack of evidence regarding impacts across subpopulations, if an increase in the purchase age *did* lead to an increase in inequities, it would likely be a result of a disproportionate *positive* impact for communities with lower tobacco and vaping rates. There would still likely be a positive effect for all communities. Any observed increases in inequities as a result of smaller declines in smoking rates in some subpopulations could potentially be addressed through culturally and linguistically appropriate tobacco and vaping prevention interventions tailored to those populations.

While little research has looked at the impacts of increasing the minimum purchase age across subpopulations, inequities in smoking rates and tobacco use are well-documented and presented below.

Inequities by race/ethnicity
Evidence indicates that rates of smoking and age at initiation of cigarette use vary by race/ethnicity. Nationally, by pooling data from the National Youth Tobacco Survey from 2014 to 2017, CDC found that ever-use and current use of tobacco products was highest among American Indian/Alaska Native (AI/AN) and Native Hawaiian and Other Pacific Islander youth.[56] Of tobacco products used, e-cigarettes were the most common ever-used and currently used product overall and among all racial/ethnic groups except AI/AN and blacks.[56] AI/AN youth most commonly had ever-used cigarettes, and black youth most commonly had ever-used and currently used cigars.[56]

In Washington State, data from the 2016 Healthy Youth Survey indicate that AI/AN and black youth reported smoking combustible and electronic cigarettes at significantly higher rates than their white counterparts across all grade levels (8th, 10th, and 12th).[23] For all grade levels, cigarette and e-cigarette use was highest among AI/AN youth. For example, AI/AN 10th graders report smoking at almost double the smoking prevalence of white students (13% compared to 6%).[23] Combined 2012-2014 Behavioral Risk Factor Surveillance System (BRFSS) data from adults in Washington also indicate that AI/AN respondents report the highest smoking rates into adulthood.[45]

In addition, a study of middle school students in Rhode Island found that AI/AN and multiracial students were more likely to initiate cigarette use in early adolescence than other students.[57] A 2017 study found that, while the rates of smoking initiation have decreased for all adolescent and young adult age groups over time, black and Hispanic males continue to have higher rates of initiation than their white peers.[58]

Evidence also indicates that earlier age of initiation of tobacco use is associated with greater difficulty quitting.[24] In the 2016-2017 Youth Risk Behavior Survey, 9.5% of students had tried cigarette smoking before 13 years of age.[15] Youth who initiate smoking at 13 years or younger have the most difficulty quitting, while each year that an individual delays initiation increases their chances of quitting.[24] This suggests that if increasing the purchase age decreases smoking and vaping rates for all racial/ethnic groups and grade levels, it could potentially have greater positive impacts on youth of color and AI/AN youth than their white counterparts as these youth seem to be initiating smoking at a younger age in Washington.[23] In this case, changing the minimum age to purchase tobacco could potentially result in a decline in the disproportionally high smoking rates among AI/AN adults in Washington in the future.

In addition, PRAMS data from 2010-2012 indicate that AI/AN mothers are more likely than their counterparts to report smoking before pregnancy.[45] This may indicate that decreasing smoking rates evenly across all demographic groups could actually have a greater positive health impact in AI/AN communities because the decrease would not only benefit the smoker, but her unborn child as well.

Current law (RCW 43.06.455) allows the Governor to enter into cigarette tax compacts with the tribes and stipulates that these compacts must prohibit retailers on tribal land from selling or giving cigarettes to anybody under the age of 18. While SB 5057 allows government-to-government consultation around the cigarette tax compact to occur, the bill does not amend the current language of the cigarette tax compact. Therefore, if tribal retailers continue to sell tobacco products to young adults between 18 and 20 years of age, it is possible that smoking rates among AI/ANs and other Washingtonians living on or accessing goods on tribal land will not be as positively impacted by SB 5057. If this leads to a greater decline in tobacco use among other subpopulations, this could exacerbate the smoking inequities that currently exist for AI/AN communities in Washington.

Overall, while some research has suggested that tobacco use rates may decrease for all racial/ethnic groups after the implementation of Tobacco 21 policies, it is unclear how the bill

would impact communities in Washington, especially for AI/AN youth and other youth living on or accessing tobacco products on tribal land.

Inequities by income
Washington State BRFSS data from 2012-2014 indicate that as income increases smoking rates decrease.[45] One study specifically addressed how smoking rates among students with different family incomes (using eligibility for free school meals as a proxy for family income) were impacted by an increase in the minimum tobacco purchase age. This study found that smoking rates declined equally for non-eligible and eligible students.[9] This suggests that SB 5057 may have neutral impacts on smoking inequities by income; however, the evidence is insufficient to make a determination. Similarly, PRAMS data from 2010-2012 indicate that mothers with low-incomes are more likely than their counterparts to report smoking before pregnancy,[45] so decreasing smoking rates evenly across all income groups could actually have a greater positive health impact on low-income communities because the decrease would not only benefit the smoker, but her unborn child as well, thereby potentially decreasing inequities.

Inequities by sexual orientation/gender identity
In 2015, the Youth Risk Behavior Surveillance System survey added questions about sexual orientation for the first time.[15] Washington State did not participate in the 2016-2017 national survey. Overall, gay, lesbian, and bisexual students were more likely to have engaged in tobacco use risk behaviors than heterosexual students, and the prevalence for current, current frequent, and current daily cigarette use was twofold or greater for gay, lesbian, and bisexual students compared to heterosexual students.[15] For example, cigarette use was twice as high among gay, lesbian, and bisexual students (16.2%) compared to heterosexual students (8.1%).[15] Students identifying as gay, lesbian, and bisexual were also more likely to use e-cigarettes than heterosexual students (17.5% versus 13.2%, respectively).[15] Other analyses by CDC found that lesbian and bisexual females and bisexual males reported significantly higher prevalence of cigarette use than students identifying as heterosexual.[59] Washington State's 2016 Healthy Youth Survey also found that students identifying as lesbian, gay, or bisexual reported higher smoking rates than their straight counterparts.[23] Lastly, a 2017 study found that transgender youth are more likely to use tobacco and to start smoking cigarettes at an earlier age than non-transgender (cisgender) youth.[60]

Overall, this evidence did not look specifically at how raising the minimum age to purchase tobacco would impact tobacco use among gay, lesbian, bisexual, or transgender youth, and it is unclear if raising the purchase age to 21 would impact youth equally. Therefore, it unclear how SB 5057 would impact tobacco use inequities by sexual orientation and/or gender identity.

Inequities by military status
National data indicate that active duty military members are more likely than civilians to report currently smoking, and that veterans are also more likely to be current smokers than non-veterans.[61] However, BRFSS data and Health Related Behavior Survey data for Active Duty Service Members from 2011 suggest that in Washington State the rates among active duty personnel, the general population, veterans, and non-veterans are similar.[62,63] Because SB 5057 would not affect the minimum tobacco product purchase age on military bases in Washington, it is possible that this bill could have a smaller impact on decreasing use of tobacco and vaping

products among active duty military personnel, thereby potentially creating a disparity or exacerbating inequities that already exist at the national level. It is important to note that in Hawaii, where a Tobacco 21 purchase age law was passed in 2015, the U.S. Army, Department of the Navy, and the Marine Corps all announced their support, and all military bases in Hawaii decided to comply with the law.[a,64] Similarly, the U.S. Navy stated that it supported California's efforts to pass a Tobacco 21 law, which went into effect in 2016.[64] If military bases in Washington decided to comply with SB 5057, this could potentially decrease inequities in smoking rates for military personnel.

Overall, there has not been a large enough body of evidence established to determine how Tobacco 21 laws may impact different subpopulations and communities in Washington State, and the impact on health inequities is unclear.

Other considerations

The Association of State and Territorial Health Officials has noted that challenges to Tobacco 21 laws have been related to enforcement, exceptions, and fiscal impacts.[49] They stated that, "although evidence supports Tobacco 21 as an effective public health intervention, fiscal and business impacts and concerns over individual freedom can create barriers to adoption and implementation."[49] We explored the potential impacts of the bill on businesses that sell tobacco or vaping products as economic health can affect human health. We ultimately did not include these pathways in the logic model on page five of this review because the impacts on business have not been well researched. We did not identify any studies that analyzed the impact of increasing purchase ages (of tobacco, alcohol, etc.) on business solvency, jobs, wages, or prices. One publication noted that no tobacco retailers have gone out of business in Needham, Massachusetts since it implemented a Tobacco 21 purchase age in 2005,[65] but this has not been rigorously studied.

One study estimated the impact of a national tobacco purchase age of 21 on cigarette sales. Winickoff et al. (2014) used national data on the proportion of legal tobacco sales that are made by (or for) 18 to 20 year olds to estimate the potential impact on retailers if the sale age is increased to age 21.[65] Winickoff notes that 18 to 20 year olds account for 2.12% of the total cigarette consumption in the U.S. and therefore, if all 18 to 20 year olds stopped smoking following an increase in the purchase age, the maximum amount that sales revenue could decline would be close to 2%.[65] This estimate is also based on the notion that there would be universal implementation and enforcement of the law. Assuming that the policy would have a long-term impact on smoking rates of adults in the future (through the aging of this low tobacco-use cohort), this could lead to a gradual reduction in the sale of cigarettes to older adults over time. This estimate does not account for other tobacco product or vaping product sales.[65]

Further, New York City began enforcing a Tobacco 21 purchase age in August 2014 and unpublished preliminary data demonstrate that the rate of decline of tobacco tax revenue remained steady before and after implementation (personal communication, New York City Department of Health and Mental Hygiene, November 2016). This finding strongly supports the projections from the IOM that an immediate impact on revenue would be small, particularly

[a] This correspondence can be found here in a media release from the U.S. Army Garrison, Hawaii, and in administrative messages from the Navy (NAVADMIN 298/15) and Marine Corps (MARADMIN 649/15).

because raising the purchase age delays or prevents the initiation of smoking rather than causing current smokers to quit.[4] A fiscal note from New Jersey suggested that implementing Tobacco 21 in the state would decrease state revenue by $6 million to $16 million.[49] Given the scarcity of research on the impact of age of purchase laws on business we are unable to make a conclusion about how SB 5057 would likely impact businesses, and this pathway was not included in the analysis.

Annotated References

Uncategorized References

1. **FDA News Release--FDA takes new steps to address epidemic of youth e-cigarette use, including a historic action against more than 1,300 retailers and 5 major manufacturers for their roles perpetuating youth access [press release]. 2018.**
In September 2018, the U.S. Food and Drug Administration issued 1300 warning letters and fines to retailers who illegally sold JUUL and other e-cigarette products to minors. The FDA news release stated that this was the "largest coordinated enforcement effort in the FDA's history." FDA Commissioner Scott Gottlieb stated, "we see clear signs that youth use of electronic cigarettes has reached an epidemic proportion, and we must adjust certain aspects of our comprehensive strategy to stem this clear and present danger. This starts with the actions we're taking today to crack down on retail sales of e-cigarettes to minors." The FDA also issued letters to the top five-selling e-cigarette brands (which comprise 97% of the U.S. e-cigarette market) , including JUUL, Vuse, MarkTen XL, blu e-cigs, and Logic requiring each company "to submit to FDA within 60 days plans describing how they will address the widespread youth access and use of their product." The FDA also committed to increasing enforcement efforts for e-cigartte manufacturers and retailers.

2. **FDA Statement--Statement from FDA Commissioner Scott Gottlieb, M.D., on proposed new steps to protect youth by preventing access to flavored tobacco products and banning menthol in cigarettes [press release]. 2018.**
FDA Commissioner Scott Gottlieb outlines a "policy framework [that] reflects a re-doubling of the FDA's efforts to protect kids from all nicotine-containing products." He states that, "if we're to break the cycle of addiction to nicotine, preventing youth initiation on nicotine is a paramount imperative." He cites research showing that 90% of current adult smokers started smoking before 18 years of age, 95% started smoking before 21 years of age, and only 1% started smoking after 26 years of age. Research with the Centers for Disease Control and Prevention found that e-cigarette use among high school students increased 78% from 2017 to 2018, and 48% among middle school students- reversing prior trends from 2015 to 2017 suggesting that use was declining. To address these trends, FDA has taken a number of recent actions as part of their Youth Tobacco Prevention Plan, including increasing enforcement against retailers, targetting e-liquid manufacturers marketing to youth, working with eBay to remove products from their website, and launching "The Real Cost" Youth E-Cigarette Prevention Campaign. Dr. Gottlieb stated, "I repeatedly said that, although we continue to believe that non-combustible tobacco products may provide an important opportunity to migrate adult smokers away from more harmful forms of nicotine delivery, these opportunities couldn't come at the expense of addicting a generation of kids to nicotine." This statement includes two directives from the FDA. First, FDA requires that all "flavored [electronic nicotine delivery systems] products (other than tobacco, mint, and menthol flavors or non-flavored products) must be sold in age-restricted, in-person locations and, if sold online, under heightened practices for age verification." Second, FDA issued a "Notice of Proposed Rulemaking that would seek to ban menthol in combustible tobacco products, including cigarettes and cigars." Data indicate that youth are more likely to use methol cigarettes than any other group and that, "more than half (54 percent) of youth smokers ages 12-17 use menthol cigarettes, compared to less than one-third of smokers ages 35 and older." In addition, approximately 70% of African American youth use menthol cigarettes. In

response, FDA is proposing a policy to ban flavors in cigars. Dr. Gottlieb emphasized that, "if youth trends don't move in the right direction, we will revisit all of these issues."

3. **Surgeon General's Advisory on E-cigarette Use Among Youth [press release]. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2018.**

In December 2018, the Office of the Surgeon General issued a statement "emphasizing the importance of protecting our children form a lifetime of nicotine addiction and associated health risks by immediately addressing the epidemic of youth e-cigarette use. The recent surge in e-cigarette use among youth, which has been fueled by new types of e-cigaretes that have recently entered the market, is a cause for great concern. We must take action now to protect the health of our nation's young people." The statement included background information that e-cigarette use increased dramatically from 2017 to 2018, and that e-cigarette aerosol can negatively impact health. The Surgeon General noted that e-cigarette aerosol and flavorings can expose users and bystanders to metals, volatile organic compounds, and ultrafine particles that can be inhaled deeply into the lungs. The statement also includes information about JUUL. The sale of JUUL increased 600% from 2016 to 2017, and the Surgeon General stated that "all JUUL e-cigarettes have a high level of nicotine. A typical JUUL cartridge or 'pod' contains about as much nicotine as a pack of 20 regular cigarettes." In addition, JUUL uses nicotine salts which allow nicotine to be inhaled more easily and with less irritation than tobacco products and other e-cigarettes. The statement noted that, "any e-cigarette use among young people is unsafe, even if they do not progress to future cigarette smoking."

4. **IOM. Public health implications of raising the minimum age of legal access to tobacco products. Washington D.C.: The National Academies Press; 2015.**

The Tobacco Control Act of 2009 directed the Food and Drug Administration (FDA) to convene a panel of experts to conduct a study on the health impacts of raising the minimum purchase age for tobacco products and submit a report to Congress. The FDA contracted with the Institute of Medicine (IOM) to convene a committee to examine the existing literature and use modeling to predict the likely impacts of increasing the minimum purchase age to 21 or 25 years of age. The committee concluded in their report that increasing the minimum purchase and possession age for tobacco products would likely prevent or delay initiation of tobacco use by adolescents and young adults and therefore also lead to a “substantial reduction in smoking-related mortality.” The authors also concluded that while (for a purchase age of 21) 18 to 20 year olds would be affected, the largest reduction in tobacco initiation would likely be among 15 to 17 year olds. They note that increasing the purchase age to 19 would likely have a modest impact on decreasing tobacco access to minors compared to increasing the age to 21. The authors cite evidence that younger age of smoking initiation is associated with heavier smoking later in life, a higher likelihood of continuing to smoke through the lifespan, and increased risk of adverse health outcomes. The report also summarizes the literature on the effect of tobacco purchase, use, and possession (PUP) laws. A 2008 study conducted in California by Rogers et al. found that in the previous 12 months, across all 249 enforcement agencies statewide, an average of 24.1 citations were issued per agency. A study by Gottlieb et al. also found that African-American and Hispanic students were significantly more likely than their White counterparts to receive a PUP citation. Jason et al. (2007b) found that youth who were fined for PUP violations were more likely than youth in a tobacco prevention education program to reduce or quit tobacco use.

However Gottlieb et al. (2004) found that receiving a PUP citation was only associated with reduced smoking intention in some of the sample schools. The committee conducted modeling (informed by the existing scientific literature) and estimated that raising the tobacco purchase age to 21 would lead to the following reductions in tobacco initiation: 15% (range: 12.5-18%) reduction for those under 15 years of age, 25% (range: 20.8-30%) reduction for those 15-17 years, 15% (range 12.5-18%) reduction for those 18-20 years. Their modeling predicts that with an age 21 minimum, by 2040-2059 there would be 0.2-0.8% reduction in deaths (8.2-9.9% by 2080-2099); 0.5% reduction in years of life lost (9.3% by 2080-2099); 0.3% reduction in lung cancer deaths (10.5% by 2080-2099); 12.2% reduction in low birth weight cases; 13% reduction in pre-term birth cases; and 18.5% reduction in sudden infant death syndrome (SIDS) cases.

5. **Chaloupka F. Grossman, M. Price, tobacco control policies, and youth smoking. *NBER Working Paper No. 5740.* 1996.**

Chaloupka and Grossman analyzed national survey data collected annually from 1992 through 1994 with eighth, tenth, and twelfth grade students as part of the University of Michigan's Monitoring the Future Project. Each year approximately 15,000 to 19,000 students in each grade are included in the sample. The total sample included 110,717 respondents with compete data (response rate not noted). The authors added age of purchase policies in each county to the dataset. This ecological study found that as the minimum purchase age increased, tobacco use among surveyed youth showed a statistically significant increase. A causal relationship between these two variables cannot be determine using this study design (e.g. did the jurisdictions increase their minimum purchase age to address high smoking rates? Did the minimum purchase age contribute to high smoking rates? Or were there other uncontrolled for variables that impacted both?). The authors note that there was limited variation in the purchase age (from 18 to 19 with only one state with a minimum of 21) and that these laws were poorly enforced at this time.

6. **Fidler J. A., West R. Changes in smoking prevalence in 16-17-year-old versus older adults following a rise in legal age of sale: findings from an English population study. *Addiction.* 2010;105(11):1984-1988.**

On October 1, 2007 England, Scotland, and Wales increased the legal age to purchase tobacco from 16 to 18 years. Smoking among 16 to 17 year olds, however, remained legal. Fidler et al. analyzed data from the monthly Smoking Toolkit Study of randomly selected households and compared the prevalence of smoking among 16-17 year olds compared to other age groups after the age to purchase tobacco was increased. The surveys are collected through face-to-face interviews with one member (over 16 years old) from the selected household and then the data are weighted to ensure they are representative of the population in England. The analysis included data from November 2006 through May 2009 and included 53,322 participants (response rate not noted). While the smoking rate declined for all age groups after implementation of the higher age law, this change was only significant for three age groups (16-17 year olds, 18-24 year olds, and 55-64 year olds), and the greatest decline was among 16-17 year olds (7.1%). The decline in smoking prevalence after the law change for respondents under 18 years was significantly greater than the decline among respondents 18 and older.

7. **Kessel Schneider S., Buka S. L., Dash K., et al. Community reductions in youth smoking after raising the minimum tobacco sales age to 21. *Tobacco Control.* 2016;25(3):355-359.**

In April 2005, Needham, Massachusetts raised the minimum age to purchase tobacco to 21 years. Kessel-Schneider et al. used data from the MetroWest Adolescent Health Survey to determine if smoking rates had declined at a different rate in Needham than in 16 nearby communities that had not raised the minimum age to 21, and also to determine if the effects were specific to tobacco or if similar patterns existed for youth alcohol use. This school-based health survey is administered every other year to students in grades 9-12 starting in the fall of 2006. Seventeen of the 26 public high schools in the region participated in all four years of the survey (2006, 2008, 2010, and 2012). Participation rates among students ranged from 88.8% to 89.6%, with 16,385 to 17,089 students participating each year. The authors controlled for two factors of school composition—percent of students receiving free and reduced lunch and percent of Caucasian students. In 2006 the smoking rates were not significantly different between Needham and the 16 comparison communities. From 2006 to 2008 and also from 2008 to 2010 the smoking rates decreased significantly more in Needham than in the comparison communities. From 2010 to 2012, the smoking rates decreased significantly more in the comparison cities than in Needham. The authors indicate that this suggests that raising the minimum purchase age may lead to a greater decline in smoking in the years immediately after the policy change. When looking at the time period from 2006 to 2010 the authors found that the smoking rates declined significantly more in Needham than in the comparison communities. This trend was true for all observed subgroups (females, males, Caucasian, non-Caucasian, and for each grade except for 9th graders who reported low smoking rates). From 2006 to 2012 the percentage of students under 18 who reported purchasing cigarettes in stores declined significantly more in Needham (from 18.4% to 11.6%) than in the comparison communities (from 19.4% to 19.0%). The authors also found that this greater decline in Needham occurred between each of the survey years, but that the decline between 2010 to 2012 was not significantly greater in Needham than the comparison communities. There was a general decrease in alcohol use between 2006 and 2012, but there was not a significant difference in the decline between Needham and the comparison communities. The authors note that the age change was paired with enforcement efforts across Massachusetts. In 2008 there were 57 compliance checks in Needham, and zero illegal sales to those under age 18 were identified. The researchers highlight a few limitations of the study, such as a lack of baseline data because the first survey was administered over a year after the legislation was adopted. They note that Needham and one of the comparison communities passed a law in 2009 prohibiting tobacco sales in pharmacies, which may also have impacted smoking rates. They note that no other tobacco legislation passed during the study period, but that they did not account for non-policy tobacco programs in Needham or the comparison communities.

8. **Lewit E.M., Hyland, A., Kerrebrock, N., et al. Price, public policy, and smoking in young people. *Tobacco Control.* 1997;6(Supplement 2):S17.**

Lewit et al. analyzed data from two cross-sectional, school-based surveys. The surveys were conducted with ninth graders from randomly selected classrooms in 21 communities (one in Canada and the rest in the United States) in 1990 (n=8,504 students) and 1992 (n=8,858 students). Student and parent refusal rates were 4% in both 1990 and 1992. Almost 89% of these respondents had complete data and were included in the analyses. Smoking "participation" was defined as smoking at least one whole cigarette in the past 30 days. The authors included a

number of variables in their multivariate logistic regression models including: age, race, sex, exposure to tobacco education in school, exposure to pro- and anti-tobacco messages, cigarette price in the area, and tobacco control policies in the area. They found that policies that restricted purchase of cigarettes for those under 18 years were associated with lower smoking participation among both male and female students in the sample. These policies were not associated with non-smoking participants' reported intent to smoke in the future.

9. **Millett C., Lee J. T., Gibbons D. C., et al. Increasing the age for the legal purchase of tobacco in England: impacts on socio-economic disparities in youth smoking. *Thorax.* 2011;66(10):862-865.**

On October 1, 2007 England, Scotland, and Wales increased the legal age to purchase tobacco from 16 to 18 years. Millet et al. explored the impact of the change on the disparities in access to cigarettes and smoking behavior in England. The authors analyzed 2003 to 2008 data (with 2007 data excluded) from the Smoking, Drinking, and Drug Use Among Young People in England annual survey. This school-based survey is conducted with a random sample of 11-15 year olds. In 2008 the survey had a 58% response rate among schools (264 schools) and an 88% response rate among selected students in these school (n=7,798 students). The survey schools were reflective of the schools in England generally. The researchers controlled for several potential confounding factors (age, gender, race/ethnicity, and past alcohol or drug use) in their analysis. They found that students receiving free school meals (FSM)—a proxy for family income—were more likely to smoke than their counterparts. The year after the minimum tobacco purchase age was increased to 18 years, there was a significant reduction in regular smoking (smoking at least one cigarette per week) among students (adjusted OR 0.67 [95% CI 0.55-0.81]). There were not significant difference in the effect on smoking rates for students eligible for FSMs and their counterparts. There was also a significant decrease after the law passed in the number of regular smokers who reported usually buying cigarettes from a commercial vendor or vending machine. This trend was true for both FSM and non-FSM eligible students accept for purchases from vending machine which did not decline significantly for FSM eligible students. Both groups of students did report a significant increase in the rates of buying cigarettes from friends, relatives, and others following enactment of the law. FSM eligible students were no more likely than their counterparts to usually buy cigarettes from these sources in both 2006 (before the law) and in 2008. There were significant increases in the number of non-FSM regular smokers who reported that it was difficult to buy cigarettes from a shop and also a significant decrease in the number of non-FSM respondents who reported that their last attempt to buy cigarettes from a shop was successful after implementation of the law. These trends were not significant among FSM regular smokers; however there was no significant difference between the FSM and non-FSM regular smokers in the ease of purchase in either 2006 or 2008. The authors conclude that increasing the minimum age to purchase tobacco in England was associated with a significant reduction in smoking among youth with neutral impacts on disparities by FSM.

10. **Norberg K. E., Bierut L. J., Grucza R. A. Long-term effects of minimum drinking age laws on past-year alcohol and drug use disorders. *Alcohol Clin Exp Res.* 2009;33(12):2180-2190.**

Norberg et al. cite several studies on the connection between MLDA policies and alcohol use conducted after 1999 (the cut-off year for studies included in the 2002 systematic review by Wagenaar and Toomey summarized in this Health Impact Review). The authors indicate that

most of these studies have "found that higher MLDAs led to later initiation of drinking and reduced frequency of heavy drinking." The authors analyzed the connection between adolescent exposure to different minimum legal drinking ages and later alcohol and substance use disorders using data from the 1991 National Longitudinal Alcohol Epidemiological Survey and the 2001 National Epidemiological Study of Alcohol and Related Conditions (total n=33,869 respondents). They controlled for a number of potential confounding factors and found that adults who had been legally allowed to purchase alcohol before age 21 were significantly more likely to have an alcohol use disorder or other drug use disorder in later adulthood.

11. **Rimpela A. H. The effectiveness of tobacco sales ban to minors: the case of Finland. *Tobacco Control.* 2004;13(2):167-174.**

In March 1, 1977 Finland introduced a ban on tobacco sales to people "apparently" under 16 years of age. In 1995 this age limit was raised to 18 years. Every two years, starting in 1977, the Adolescent Health and Lifestyle Survey (AHLS) was mailed to a nationally representative sample of 12, 14, 16, and 18 year olds in Finland. The response rates (separated by sex) ranged from 50-92% depending on the year, but were above 70% in most years. Every year since 1996 the School Health Promotion Survey (SHPS) has been administered in eighth and ninth grade classrooms. The authors included schools in the analysis that had participated in each of the following years: 1997, 1999, 2001, and 2003 (n=226,681). Participation ranged from about 20% to 80% of the Finish municipalities depending on the year. The percentage of 14 year old daily smokers who reported buying tobacco for themselves from a commercial source had a slight but significant decrease from 1977 (when the age 16 limit was enacted) to 1981(from 87% to 83%) , while no significant change was observed among the 16 and 18 year olds. In these same years there was a significant decrease in the proportion of 14 year old daily smokers who bought tobacco from shops (one commercial source), a trend that was seen among 16 year olds (not targeted by the law) as well. Between 1995 (when the age 18 limit was enacted) and 2001 there were significant decreases in the number of 14 and 16 year olds who reported purchasing tobacco, while no significant change was observed among 18 year olds. In these same years there were significant decreases in the proportion of 14 and 16 year old daily smokers who had purchased tobacco from shops and kiosks, while there were no significant changes among 18 year olds. However, purchases of tobacco from other outlets increased in 14, 16, and 18 year olds from 1995 to 1997. This trend reversed among 14 and 16 year olds between 1999 and 2003, but not among 18 year olds. There was also a significant increase in the purchase of tobacco from friends among 16 year olds from 1995 to 1997. There was a decrease in daily smoking among all age groups after 1977, but this was a short term change. There was no immediate decrease in daily smoking after the 1995 legislation, but there was a significant decline in smoking rates between 2001 and 2003 among all 14 year olds and among 16 year old boys. Smoking rates among 18 year olds remained flat during the entire period. The delay between the 1995 legislation and the 2001-2003 decline in smoking rates implies that factors other than the increase to age 18 (or some interaction of factors with the age increase) led to this decline rather than the smoking age increase alone. Daily consumption of cigarettes did not diminish after the 1977 or 1995 policy changes. The authors speculated that a lack of enforcement of the bans and the fact that the bans did not address social sources of tobacco may be responsible for a lack of sustained change to the smoking rates immediately following the legislation changes. The lack of enforcement was highlighted by data indicating that in 2002-2003 72% of schoolchildren reported that it was very easy or fairly easy to buy tobacco from a commercial source.

12. **Wagenaar A.C., Toomey, T.L. Effects of minimum drinking age laws: Review and analyses of literature from 1960 to 2000. *Journal of studies on alcohol.* 2002;14(Supplement):206.**

Wagenaar and Toomey conducted a systematic review of the literature published between 1960 and 1999 on the impacts of minimum legal drinking age (MLDA) laws. The authors identified 132 studies. They graded the quality of each study based on sampling design, study design, and presence of a comparison group. Forty-eight of these studies looked at the impact of MLDA laws on indicators of alcohol consumption; and these studies looked at 78 alcohol consumption outcome measures. Twenty-seven of these 78 analyses (35%) found that as the legal age was raised alcohol consumption decreased significantly or as it was lowered alcohol consumption increased significantly (an inverse relationship between the MLDA and alcohol consumption). Eight additional analyses also found this inverse relationship between the MDLA and drinking—but they did not report statistical significance. Five of the 78 analyses found a positive association between the MLDA and alcohol consumption. Only 17 of these 78 analyses reported statistical significance; used higher quality study designs, a probability sample or census, a comparison group, and an indicator of alcohol consumption (rather than alcohol purchase). Of these 17 higher quality analyses (from 14 different studies) eight (47%) found that increases in the MDLA were associated with significant decreases in alcohol consumption. One analysis found that the MLDA increase was associated with an increase in alcohol consumption, and eight analyses (47%) found no significant change in alcohol consumption. The authors conclude that several factors may account for the variability in results, including by how many years the MLDA was increased.

13. **Yoruk C., Yoruk, B. Do Minimum Legal Tobacco Purchase Age Laws Work? *IDEAS Working Paper Series from RePEc.* 2014.**

Yörük and Yörük applied a regression discontinuity design to the National Longitudinal Survey of Youth 1997 cohort (NLSY97) data to estimate the potential impacts of minimum legal tobacco purchase ages in the United States. The NLSY97 is a national sample of 12 to 16 year olds (n=9,022). The authors note that the response rate is "quite high" but do not provide the exact number. Data were collected through annual personal interviews with youth respondents. In the first year of the survey, one of the respondents' parents was also interviewed. The authors only included respondents who had been surveyed over the 1998 to 2004 period, who were up to two years older or younger than the minimum purchase age in their jurisdiction, and who were single as of the interview date. The researchers applied several models, and while some found significantly higher smoking rates among youth who had reached the minimum age, the authors concluded that their most robust model found that the higher smoking rates among youth over the minimum age compared to those younger than the minimum age were not significant. This model did, however, indicate that the probability of smoking for males and those who reported smoking before reaching the minimum purchase age was higher for those that had reached the minimum legal purchase age than for those who had not yet reached the minimum age. For those who had reported smoking before they reached the legal age, reaching the legal age was associated with a 5.1 percentage point increase in the probability of smoking recently, and a 24.7 percent increase in the number of days they smoked in the past month. The authors suggest that this indicates that youth who have not smoked by the minimum purchase age are unlikely to start smoking when they reach that age, but those who have smoked before this age may increase their

usage when they reach the minimum purchase age. For males, reaching the minimum purchase age was associated with a 3.1 percentage point increase in the probability of smoking, and a 10.4 percent increase in the average number of cigarettes smoked per day. The authors conclude that their models indicate that minimum purchase age policies are only effective in reducing smoking participation among certain groups (young males and youth who reported smoking at all before reaching the minimum purchase age). The authors note that their results can only be generalized to youth who are around the minimum purchase age and not to other age groups.

14. **Centers for Disease Control and Prevention National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. The Health Consequences of Smoking: 50 Years of Progress. A Report of the Surgeon General. U.S. Department of Health and Human Services; 2014.**

The analysts writing the Surgeon General's reports on the health effects of smoking use a set of criteria to rank the strength of evidence that a causal relationship exits. For each health indicator, the analysts synthesize the evidence and then apply the criteria to the body of evidence. The report is then vetted by a series of external editors who are tasked with ensuring the accuracy of the report. This comprehensive analysis includes hundreds of references. The 2014 report concludes that since the 1964 Surgeon General's report, a very strong body of evidence has shown a causal link between cigarette smoking and diseases in nearly every organ, cancer (e.g. lung, liver and colorectal cancer), diminished health status, exacerbation of asthma, inflammation, impaired immune function, age-related macular degenera¬tion, harms to the fetus, diabetes, erectile dysfunction, arthritis, and premature death. Research also shows that secondhand smoke causes cancers, reparatory disease, cardiovascular disease, stroke, and harms to infant and child health. This report also summarizes the evidence indicating that tobacco use may have a different impact on adolescents than adults. The authors indicate that adolescence is a vulnerable stage of brain development, and that nicotine exposure during this age may have lasing adverse effects on brain development.

15. **Kann L., McManus T., Harris W.A., et al. Youth Risk Behavior Surveillance--United States, 2017. *Morbidity and Mortality Weekly Report, Centers for Disease Control and Prevention.* 2018;67(8).**

This MMWR Surveillance Report provides updated findings from the 2016-2017 Youth Risk Behavior Surveillance System (YRBSS) on the leading causes of morbidity and mortality among youth, including unintentional injuries and violence; tobacco use; alcohol and drug use; sexual behaviors; dietary behaviors; and physical inactivity. It presents data on health behaviors and health disparities by sex, race/ethnicity, grade in school, and sexual orientation. This is the first YRBSS survey that reports on questions added in 2015 related to sexual orientation. Washington State did not participate in the 2016-2017 YRBSS. Specific to tobacco use, this version of YRBSS either changed the wording of the question or response or asked a question for the first time related to the following measures: "having first tried cigarette smoking before age 13 years; having usually gotten their own electronic vapor products by buying them in a store; current, current frequent, and current daily smokeless tobacco uses; current cigarette, cigar, or smokeless tobacco use; current cigarette, cigar, smokeless tobacco, or electronic vapor produce use; having tried to quit using all tobacco products." From 1991 to 2017, the prevalence of ever trying cigarette smoking significantly decreased from 70.1% to 28.9% nationally. Male, white, andgay, lesbian, and bisexua) students were more likely to have ever tried cigarette smoking compared to

other students. In addition, this YRBSS asked for the first time about cigarette smoking before 13 years of age, and results indicated that 9.5% of students had tried cigarette smoking before 13 years of age. From 1991 to 2017, the prevalence of current cigarette use (smoked a cigarette at least once in the past 30 days) also significantly decreased from 27.5% to 8.8% nationally. Among students that currently used cigarettes, the prevalence was higher for males (9.8%) than females (7.8%), and whites (11.1%) compared to Hispanic (7.0%) or black (4.4%) students. Current cigarette use was almost twice as high among gay, lesbian, and bisexual students (16.2%) compared to heterosexual students (8.1%). Nationally, 2.6% of students had smoked cigarettes on 20 or more days in the past 30 days, and 2.0% of students had smoked cigarettes on all 30 days. Frequent cigarette use was higher among whites and gay, lesbian, and bisexual students. Nationally, 42.4% of students had every used an electronic vapor product (e.g. e-cigarettes, e-cigars, e-pipes, vape pipes, vaping pens, e-hookahs, hookah pens), and 13.2% of students currently used e-cigarettes (used an electronic vapor product at least once in the past 30 days). Among students that currently used e-cigaretes, the prevalence was higher for males (15.9%) than females (11.8%); whites (15.6%) compared to Hispanic (11.4%) or black (8.5%) students; and gay, lesbian, and bisexual students (17.5% compared to 13.2% of heterosexual students). Nationally, 3.3% of students had used an electronic vapor product on 20 or more days in the past 30 days, and 2.4% of students had used an electronic vapor product on all 30 days. Frequent vapor product use was higher among male, white, and gay, lesbian, and bisexual students. Among students that currently used electronic vapor products, 13.6% had gotten their own electronic vapor products by buying them in a store. Nationally, 5.5% of students currently used a smokeless tobacco product (e.g. chewing tobacco, snuff, dip, snus, or a dissolvable tobacco product). Approximately 24% of students had used any tobacco product during the past 12 months. Of these students, 41.4% had tried to quit and females, whites and Hispanics, and gay, lesbian, and bisexual students were more likely to have tried to quit. Overall, males were more likely to have engaged in tobacco use risk behaviors than females. White students were more likely to have engaged in tobacco use risk behaviors than Hispanic or black students. Gay, lesbian, and bisexual students were more likely to have engaged in tobacco use risk behaviors than heterosexual students, and the prevalence for current, current frequent, and current daily cigarette use was twofold or greater for gay, lesbian, and bisexual students compared to heterosexual students. The prevalence for current frequent and current daily cigarette use, and current frequent and current daily cigar use was twofold or greater for students who had sexual contact with only the same sex or with both sexes compared to students who had sexual contact with only the opposite sex.

16. **Zhang X., Vuong T. D., Andersen-Rodgers E., et al. Evaluation of California's 'Tobacco 21' law. *Tobacco Control.* 2018;27(6):656-662.**

California's Tobacco 21 law went into effect in June 2016 and raised the purchase age from 18 to 21 for tobacco products and e-cigarettes. The law did not apply to active-duty military personnel or tribal lands. Zhang et al. described the implementation evaluation plan and preliminary findings. California launched an informational campaign using used mass media and retailer communication to increase awareness, acceptance, and compliance with the law. This study presents preliminary findings related to the campaign's proximal outcomes to increase awareness of the law among the general public, youth, and retailers; to increase awareness about the dangers of smoking at a young age; to increase the perception that tobacco is difficult to obtain for youth; to increase retailer compliance with the new law; and to increase call volume to

California's quitline. The authors used a phone survey of tobacco retailers, an online survey of adults aged 18 to 64 years of age, and surveys with retailers to understand changes in awareness, acceptance, and compliance. Results from these surveys found that 98.6% (95% CI 98.0 to 99.2)of retailers surveyed were aware of the Tobacco 21 laws, and 60.6% (95% CI 58.1 to 63.2) supported the law. In addition, retail violation rates statistically significantly decreased from 10.3% before Tobacco 21 to 5.7% after the law, with illegal tobacco sales to 15-16 year old decreasing significantly. Tobacco-only retailers were more likely to violate the law than other retailers. Among youth and young adults aged 18 to 24, approximately 63.6% were aware of the Tobacco 21 law and 61.7% agreed that raising the purchase age would reduce youth tobacco use. While awareness was high across all racial/ethnic groups, Hispanics and non-Hispanic blacks were statistically significantly more likely to agree that raising the age of tobacco sales to 21 would reduce youth tobacco use. In addition, "e-cigarette users were signficantly less likely to agree, suggesting that continued public health education campaigns are needed to communicate the health risks associated with e-cigarettes." Of retailers surveyed, approximately 58% also reported that they recieve at least one complaint per month about the law and "23.6% of retailers reported observing shoulding tapping at least once per month, suggesting that educational efforts need to discourage persons over 21 years of age purchasing tobacco products for underage persons." The authors note that only short-term outcome information is available, and that the law has not been in place long enough to evaluate how the law has impacted tobacco use among 18-24 year olds.

17. **Macinko J., Silver D. Impact of New York City's 2014 Increased Minimum Legal Purchase Age on Youth Tobacco Use. *American Journal of Public Health.* 2018;108(5):669-675.**

Macinko and Silver evaluated the impact of New York City's Tobacco 21 law on adolescent tobacco use. New York City implemented a Tobacco 21 law in October 2013, and also passed Sensible Tobacco Enforcement legislation which strengthened penalties for violating the law. The authors noted that, at the time of publication in March 2018, "there has only been 1 empirical study showing modest reductions in youth cigarette smoking after [a minimum legal purchase age] 21 law was passed in 1 small town." This study represents the second study to empirically evaluate the impact of a Tobacco 21 law on youth tobacco use. Macinko and Silver compared tobacco use in New York City to tobacco use in two groups that did not change the minimum legal purchase age using a difference-in-differences designs. As control groups, they used the rest of New York State and four cities in Florida that did not have Tobacco 21 laws and had similar demographics as New York City. They used survey results from the Youth Tobacco Survey and the Youth Risk Behavior Survey, both implemented by the Centers for Disease Control and Prevention. All analyses controlled for grade (or age), sex, race/ethnicity, and disposable income. Overall, they found that adolescent tobacco use statistically significantly decreased ($p < 0.05$) after New York City implemented Tobacco 21, though the decline was small (1.04 percentage points, or 3%). However, tobacco use decreased at a greater rate in control locations than in New York City. For example, after the implemention of Tobacco 21 in New York City, adolescent tobacco use decreased 9.39 percentage points ($p < 0.001$) for the rest of New York State. The authors stated, "over the study period, combined rates of cigarette, smokeless tobacco, and cigar use declined in both [New York City] and the rest of New York State, although the decline in New York State was steeper with a statistically significant difference in 2016." In addition, although tobacco use in New York State and New York City

both decreased overall, in 2016, rates tobacco use in New York State were lower than rates in New York City. The authors also "observed no signficant change in [New York City] or in the rest of New York State in the percentage reporting buying cigarettes in stores or having their ID checked from 2008 ot 2016." E-cigarette use increased significanatly after the implementation of Tobacco 21. In addition, "the percentage reporting quit attempts during the study period increased in New York State and decreased in [New York City]." The authors found no significant change before and after implemeting Tobacco 21 in purchase of loose cigarettes, quit attempts, or mean age of tobacco initiation in New York City. They stated, "these findings suggest that either the broad set of regulations adopted by [New York City] were not robust enough to alter youth tobacco use in the city beyond those occuring in comparison communities or may have been rendered less effective because of poor retailer compliance and illicit tobacco supplies." The authors concluded that, "increasing the [minimum legal purchase age] to 21 years in [New York City] did not accelerate reductions in youth tobacco use any more rapidly than declines observed in comparison sites." They recommend that other locations considering Tobacco 21 legislation ensure adequate enforcement and compliance monitoring among retailers, and suggest that locations with high tobacco use and low tobacco excise taxes may see a greater impact.

18. **Dutra L. M., Glantz S. A., Arrazola R. A., et al. Impact of E-Cigarette Minimum Legal Sale Age Laws on Current Cigarette Smoking. *Journal of Adolescent Health.* 2018;62(5):532-538.**

Dutra et al. evaluated the impact of state-level implementation of minimum legal sale age for e-cigarettes. In 2016, the U.S. Food and Drug Administration prohibited the sale of e-cigarettes to individuals younger than 18. Prior research has found mixed results about whether setting a minimum legal sale age for e-cigarettes (essentially reducing access) leads to increased or decreased cigarette smoking among adolescents. This study, "used individual-level data from the 2009-2014 [National Youth Tobacco Survey] to assess the relationship between e-cigarette [minimum legal sales age] laws and cigarette smoking among youth, adjusting for e-cigarette and other tobacco use, as well as other individual and state-level covarieates. The relationship bewteen e-cigarette [minimum legal sales age] laws and youth e-cigarette use was also assessed." The study controlled for individual factors, including sex, race/ethnicity, age, current e-cigarette and other tobacco use, and for state-level factors like household income, unemployment rate, legalization of marijuana, smoke-free laws, and state cigarette tax. The authors used logistic regression models, and were able to test for temporality. Their analysis found that states with minimum legal purchase age laws for e-cigarettes increased from 0% in 2009 to approximately 50% in 2014. Overall, implementing a minimum legal sale age (of 18 or 19) for e-cigarettes was not signficantly associated with past 30-day cigarette smoking or current e-cigarette use for adolescents. However, the authors note that, "the lack of statistical significance in the present analysis is likely due to adjusting for current e-cigarette and other tobacco use because the exclusion of these variables from the model resulted in a signficant negative association between lagged and unlagged e-cigarette [minimum legal sales age] laws and youth smoking, suggesting that these laws may help reduce e-cigarette use." They also noted that, "in addition to its direct effect on e-cigarette use, increasing the age of legal purchase for e-cigarettes to 21 has the potential to reduce cigarette smoking because lognitudinal analyses suggest that adolescent e-cigarette use is a predictor of future cigarette smoking."

19. **Abouk R., Adams S. Bans on electronic cigarette sales to minors and smoking among high school students. *Journal of Health Economics.* 2017;54:17-24.**
Abouk and Adams found that banning electronic cigarette sales to minors reduced the incidence of cigarette smoking and e-cigarette use among high school seniors. In 2016, the U.S. Food and Drug Adnimistration regulated e-cigarettes, setting a minimum legal sales age of 18 nationally. The authors note that the impact of restricting access to e-cigarettes was unclear as, "the question of whether e-cigarettes and regular cigarettes are substitutes or complements is not resolved." Using results from the 2007 to 2014 Monitoring the Future survey , the authors looked at whether restricting the sale of e-cigarettes reduces the indicence of adolescent cigarette smoking. Monitoring the Future is an annual survey of 8th, 10th, and 12th graders at 420 public and private schools in 26 states and the District of Columbia. Sampling is not meant to be representative of the U.S. population. The authors chose to look at survey results for 12th graders in California, Minnesota, New Hampshire, New Jersey, and Utah, which restricted e-cigarette sales in 2010. Looking at state policy variables, the authors found that, in states with sales bans, "the smoking prevelance declines from 17.4% to 11.5% after the bans take effect. We note that although there were downward trends in smoking among youths nationally over this time period, the reduction implied...is particularly large in those states with e-cigarette bans." Their analysis showed that smoking rates significantly declined by 2.01 percentage points (12%) after restricting the sale of e-cigarettes to minors. At the individual level, the authors found a 2.54 percentage point (15%) decrease in smoking after restricting the sale of e-cigarettes to minors. They note that, "the explanation most sensible for these findings is that e-cigarettes and conventional cigarettes are complements and are dually used." They also found some evidence that the bans reduced e-cigarette use, especially among 12th graders who may be more likely to purchase products from retailers, but data are limited because e-cigarettes have not been on the market long.

20. **Cantrell J., Bennett M., Mowery P., et al. Patterns in first and daily cigarette initiation among youth and young adults from 2002 to 2015. *PLoS One.* 2018;13(8):e0200827.**
Cantrell et al. examined trends and patterns in first use of cigarettes and first daily use of cigarettes by age (12-14, 15-17, 18-21, 22-25), race/ethnicity (African American, Hispanic, white), and sex (female, male). They analyzed data from the National Survey on Drug Use and Health, which is an annual, cross-sectional survey of 12 to 25 year olds in the U.S. from 2002 to 2015. Cigarette initiation among 12-14 year olds and 15-17 year olds significantly decreased over time (average annual 0.32 percentage point decrease and average annual 0.53 percent point decrease , respectively). These decreases were consistent across all racial/ethnic groups and by sex. Cigarette initiation among 18-21 year olds increased from 2002 to 2009, and decreased after 2009 resulting in an overall increase over the entire study period of 0.01. The increase from 2002 to 2009 was most marked among Hispanic males. Cigarette initiation among 22-25 year olds did not change significantly over time. However, among this age group, "Hispanics experienced a signficiant linear increase of 0.12 percentage points ($p < 0.01$), resulting in an increase in initiation of about 1.6 percent points over the study period." Most of the increase was driven by Hispanic males. Daily cigarette intitiation decreased significantly over time for 12-14, 15-17, and 18-21 year olds. This trend was consistent for males and females. For 22-25 year olds, there was a small, statistically significant increase in daily cigarette use for males ($p < 0.05$). The authors concluded that, "cigarette initiation was higher among 18-21 year olds than among youth for the

period from approximately 2004 to 2015. This suggests that cigarette initiation is being delayed until young adulthood, with the highest risk of initiation occuring among young adults aged 18-21...these trends point to the need to improve and enforce policies to reduce first initiation among the young adult population. Raising the minimum age of purchase to age 21 could be particularly efective." Across race/ethnicity, Hispanic males experienced an increase in initiation rates among 22-25 year olds and "increased cigarette initiation among young adult groups may lead to long-term patterns of non-daily smoking, which does not translate to higher rates of successful quitting for Hispanics as expected compared with non-Hispanic whites." Overall, cigarette initiation among African Americans were lower than among whites, however "late-onset African American smokers have the lowest cessation rates compared with early-onset counterparts and with early- and late-onset white smokers." Whites aged 18-21 had higher initiation rates than African Americans or Hispanics.

21. **Pepper J. K., Coats E. M., Nonnemaker J. M., et al. How Do Adolescents Get Their E-Cigarettes and Other Electronic Vaping Devices?** ***American Journal of Health Promotion.*** **2018:890117118790366.**

Pepper et al. conducted an online survey of 1,729 adolescents aged 15-17 who reported vaping in the past 30 days (using an e-cigarette or similar device) to determine how youth obtain or access vaping devices. Adolescent use of e-cigarettes increased significantly between 2011 and 2015, and in 2016 11% of U.S. 10th graders and 12% of U.S. 12 graders reported vaping. Minimum purchase age for e-cigarettes was established nationally as 18 years in 2016. While prior studies have found that social sources are the main way adolescents access cigarettes, little is known about how adolescents access e-cigarettes and other devices. Approximately half of respondents reported smoking cigarettes in the past 30 dyas, and one-third of respondents reported using other tobacoo products in the past 30 days. They found that 78.2% of adolescents surveyed owned their own vaping device, with 32.2% purchasing their device online and 22.3% purchasing it in a vapor shop or lounge. Sources varied significantly by sex, race/ethnicity, and polytobacco use. In addition, 72.8% reporting using someone else's vaping device in the past 30 days, with 80.5% who borrowed stating that they borrowed from a friend. Adolescents were more likely to borrow a vaping device if they vaped more often, did now own their own, vaped in social situations, or had been resfused purchase. The authors suggested that, "social sources might be even more important for vaping than for smoking cigarettes; cigarette smokers likely get cigarettes from other people only when they do not possess their own, but vapers use others' devices even when they have their own."

22. **Meyers M. J., Delucchi K., Halpern-Felsher B. Access to Tobacco Among California High School Students: The Role of Family Members, Peers, and Retail Venues.** ***Journal of Adolescent Health.*** **2017;61(3):385-388.**

Meyers et al. surveyed 772 adolescents in California to determine how they obtain cigarettes, e-cigarettes, and hookah. They recruited 9th and 12th grade students from 8 high schools in California to participate in a longitudinal study related to tobacco access, perceptions, social norms, marketing, and use. In general, 32.7% of students reported using hookah, 28.7% reported using e-cigarettes, and 19.2% reported using cigarettes. Approximatley 55% of respondents reporting getting their tobacco products from peers, and "adolesents [were]significantly more likely to obtain hookah, e-cigarettes, and cigarettes from a friend than any of the other sources addresssed." Of students who purchased tobacco products, students were significantly more

likely to purchase e-cigarettes or hookah from a smoke shop than any other retailer. The authors found that, "9.3% of participants under the age of 18 reported purchasing tobacco products themselves...thus, depsite legislation banning the sale to minors, [adolescents and young adults] continue to directly purchase tobacco products at alarming rates." However, this survey was completed before California enacted their Tobacco 21 law.

23. **QxQ Analysis: Smoking and Electornic Cigarette Use. 2016. http://www.askhys.net/Analyzer. Accessed January 18, 2018.**
Washington State Healthy Youth Survey data from 2016 indicate that among 8th grade respondents American Indian/Alaskan Native (AI/AN) students (6.8% [95% CI 3.5-10.1%%) and black students (4.4% [95% CI 2.3-6.5%]) reported higher smoking rates than their Asian and Pacific Islander (API) (1.5% [95% CI 0.6-2.4%]), white (2.8% [95% CI 2.2-3.4%)], and Hispanic peers (3.1% (95% CI 2-4.2%). Among 10th grade respondents, the same trends held, with AI/AN (13% [95% CI 7.8-18.3]) and black students (7.8% [95% CI 4.2-11.4%]) reporting higher smoking rates than their peers. The percent of students who had reported smoking at all in the past 30 days was highest among 12 grade respondents. AI/AN (18.3% [95% CI 12-24.6%]) and black respondents (15% [95% CI 8.9-21.1%]) again reported higher smoking rates than their peers with 11.9% (95% CI 10-13.8%) of white youth smoking. These data suggest that in Washington State, AI/AN and black youth have disparately high rates of current cigarette use across all grades. Students from the subsample of schools who participate in the extended form version of the Healthy Youth Survey also answered questions about their sexual orientation. Eighth grade respondents who identified as lesbian, gay, or bisexual were more likely to report smoking cigarettes at all in the last 30 days (10.2% [95% CI 5.7-14.7%]) than their peers who identified as straight (2.6% [95% CI 2-3.2%]). This disparity also existed among 10th graders (15.2% [95% CI 11.5-18.9%] vs. 4.9% [95% CI 4.1-5.7%]) and 12 graders (23.5% [95% CI 19.3-27.7%] vs. 9.3% [95% CI 7.4-11.2%]). When asked how many electronic cigarettes they had used in the past 30 days, black (8.7 [95% CI 3.4-14%]) and AI/AN 8th graders (7.8% [95% CI 3.3-12.3%]) reported the highest usage. AI/AN reported the highest useage among both 10th grade respondents AI/AN (22.6% [95% CI 14-31.2%]) and 12th grade respondents (18.3% [95% CI 12-24.6%]). 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 may be missed.

24. **Lydon David M., Wilson Stephen J., Child Amanda, et al. Adolescent brain maturation and smoking: What we know and where we're headed. *Neuroscience and Biobehavioral Reviews.* 2014;45:323-342.**
Lydon et al. conducted a review of the literature on adolescent brain development and nicotine dependence. They cite evidence that smoking is most likely to be initiated during adolescence and that most adults who smoke daily initiate smoking by 18 years of age. The authors also note that once adolescents begin smoking, they are more likely than adults to continue smoking because they experience heightened positive effects from nicotine and are more susceptible to developing nicotine addiction than adults. Research also indicates that individuals who smoked their first cigarette at a younger age and who had a more pleasant experience are more likely to smoke additional cigarettes. Early-initiation smokers also tend to develop nicotine dependence faster and have higher daily cigarette consumption rates than later-initiation smokers. The

authors cite a 1996 study by Breslau and Petterson which found that early smoking onset is associated with decreased likelihood of cessation. The likelihood of quitting was lowest for youth who initiated smoking at 13 or younger, with likelihood of quitting increasing with each year that initiation was delayed for adolescents.

25. **Pisinger Charlotta, Dossing Martin. 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.

26. **Sciences National Academy of. *Public Health Consequences of E-Cigarettes.* Washington, D.C.: The National Academies Press; 2018.**

The U.S. Food and Drug Administration requested the National Academy of Sciences complete a report about the health impacts of e-cigarettes. As part of this white paper, the National Academy of Sciences evaluated existing published literature to determine whether there was conclusive, substaintial, moderate, limited, insufficient, or no available evidence to determine the link between e-cigarette use and health outcomes. They stated that, "the net public health effect, harm or benefit, or e-cigarettes depends on three factors: their effect on youth initiation of combustible tobacco products, their effect on adult cessation of combustible tobacco products, and their intrinsic toxicity." E-cigarette use among youth and young adults has increased, and in 2016, e-cigarette use was higher than cigarette smoking or use of any other tobacco product. Use was also higher among boys and Hispanic and non-Hispanic whites. They reached 9 conclusions about the make-up of e-cigarettes. They found conclusive evidence that: 1) E-cigarette use increases airborne concentrations of particulate matter and nicotine in indoor environments. 2) Exposure to nicotine from e-cigarette use is variable and depends on product characteristics and operation. 3) E-cigarettes contain and emit numerous potentially toxic substances in addition to nicotine. 4) The number, quantity, and characteristics of potentially toxic substances in e-cigarettes are highly variable and depend on product characteristics and operation. They found substantial evidence that: 5) Nicotine intake from e-cigarettes among experienced adult e-

cigarette users is comparable to that from combustible tobacco cigarettes. 6) Under typical use, except for nicotine, there is lower exposure to potentially toxic substances from e-cigarettes compared to combustible tobacco cigarettes. 7) E-cigarettes contain metals. They found limited evidence that: 8) E-cigarette use increases levels of nicotine and other chemicals on indoor surfaces. 9) the number of metals in e-cigarettes could be greater than the number of metals in combustible cigarettes. The National Academy of Sciences also made 26 conclusions about the impact of e-cigarettes on health outcomes. They concluded that, "the implications for long-term effects on morbidity and mortality are not yet clear. Use of e-cigarettes instead of combustible tobacco cigarettes by those with existing repiratory disease might be less harmful." They found conclusive evidence that: 1) E-cigarette devices can explode and cause burns and injuries. 2) Intentional or accidental exposure to e-liquids can result in seizures, anoxic brain injury, vomiting, and lactic acidosis, among other effects. 3) Intentionally or unintentionally drinking or injecting e-liquids can be fatal. They found substantial evidence that: 4) Components of e-cigarettes can promote formation of reactive oxygen species/oxidative stress. 4) E-cigarette use results in symptoms of dependence on e-cigarettes. 5) E-cigarette use increases heart rate shortly after nicotine intake. 6) Chemicals in e-cigarettes are capable of causing DNA damage and mutagenesis, suggesting the possibility that long-term exposure could increase risk of cancer and adverse reproductive outcomes. Related to initiation and cessation, they found 7 conclusions. They found mixed evidence that, "while e-cigarettes might cause youth who use them to transition to use of combustible tobacco products, they might increase adult cessation of combustible tobacco products." They found substantial evidence that "e-cigarette use increases risk of ever using combustible tobacco cigarettes among youth and young adults." Overall, the National Academy of Sciences found that the evidence across a range of outcomes suggests that, "e-cigarttes pose less risk to an individual than combustible tobacco cigarettes." They also concluded that "there would be net public health harm in the short and long terms if the products do not increase combustible tobacco cessation in adults."

27. **Hocharoen Chanalee. An evaluation of potential harm of electronic cigarette aerosol exposures and directions for research and regulation. In: Taft D, ed: ProQuest Dissertations Publishing; 2015.**

Hocharoen conducted a systematic review of the literature on electronic cigarettes published between January 1, 2009 and January 31, 2015. 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.

28. **General Office of the Surgeon. E-Cigarette Use Among Youth and Young Adults: A Report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office of Smoking and Health; 2016.**
This report was prepared by the Centers for Disease Control and Prevention's National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. It focused on examining the research around the epidemiology and health effects of e-cigarette use among youth and young adults in the United States. They note that, "the initial drafts of the chapters were written by 27 experts who were selected for their knowledge of the topics addressed. These contributions are summarized in five chapters that were evaluated by approximately 30 peer reviewers. After peer review, the entire manuscript was sent to more than 20 scientists and other experts, who examined it for its scientific integrity." The chapters outline the following topic areas: (1) historical background, (2) patterns of e-cigarette use among U.S. youth and young adults, (3) health effects of e-cigarette use among U.S. youth and young adults, (4) activities of e-cigarette companies, and (5) e-cigarette policy and practice implications.

29. **Center Washington Poison. 2017 Annual Toxic Trend Report: Nicotine and E-Cigarette. 2017.**
This brief report from the Washington Poison Center provides summary data from calls about nicotine exposure among children 0 to 12 years of age. From 2011 to 2017, the Washington Poison Center recieved 2,966 total cases related to nicotine exposure. The most cases occured in 2015, with 521 total cases of nicotine exposure. In 2017, the Center had 440 cases of nicotine exposure and 373 (84.8%) cases were among children 0-5 years of age. About half of nicotine exposures come from cigarette/cigar exposure, 22% are related to e-cigarettes, and 22% are related to chewing tobacco. Children are primarily exposed through ingestion (94.5% of cases are due to ingestion), and common symptoms of nicotine exposure include vomiting, coughing/choking, drowsiness/lethargy, and pallor. Washington Poison Center noted that exposure reporting is voluntary, and that these numbers likely underrepresent nicotine exposure.

30. **Rubinstein M.L., Delucchi K., Benowitz N.L., et al. Adolescent Exposure to Toxic Volatile Organic Chemicals from E-Cigarettes. *Pediatrics.* 2018;141(4).**
Rubinstein et al. analyzed urine and saliva samples from adolescents aged 13-18 years old who use electronic cigarettes to evaluate the presence of volatile organic compounds. More adolescents use e-cigarettes than cigarettes, and chemicals found in e-cigarettes are known to be harmful to human health. However, the authors noted that, "there are no data on toxicant exposure in adolescent e-cigarette users. Howevever, there is great concern because exposure to toxicants during adolescence may result in greater harm than exposure in adulthood, given vulnerability to the acute and chronic effects of toxicants in general and from their cumulative exposure if started early." This study included adolescents participating in a larger longitudinal study of the effects of e-cigarettes on adolescents in the San Francisco Bay Area. Adolescents who used e-cigarettes were scheduled for a baseline appointment within 24 hours of use and provided saliva and urine samples for analysis. Saliva samples were analyzed for cotinine, a metabolite of nicotine. Urine samples were analyzed for NNAL (a potent carcinogen) and eight volatile organic compounds that are toxic environmental or tobacco smoke constituents. They used use categories based on self-report as well as chemical levels so that, "conservative criteria for group definitions meant that the e-cigarette-only group was clearly differentiated from the

dual user group, and any [volatile organic compounds] found in the e-cigarette-only group could be clearly attributed to e-cigarette use." Based on their criteria, samples were analyzed for 67 e-cigarette-only users, 16 dual users, and 20 controls. They found that the presence of 5 volatile organic compounds was significantly higher in e-cigarette-only users compared with controls ($p < .05$ for all compounds), but lower than in dual-users. For e-cigarette-only users, levels were statistically significantly higher for users that used e-cigarettes with nicotine all or some of the time and for users that reported more sessions of e-cigarette use per day. They also found that "levels of 3 other significant and likely toxic [volatile organic compounds] were just as high in users of nonnicotine products as in those using nicotine." The authors concluded, "adolescent e-cigarette-only users had levels of 5 [volatile organic compound] toxicants detected in their urine in quantities up to 3 times greater than in matched controls...levels of toxicant exposure in dual users were up to 3 times higher than in those who used only e-cigarettes." Many of these compounds are known carcinogens.

31. **Alzahrani T., Pena I., Temesgen N., et al. Association Between Electronic Cigarette Use and Myocardial Infarction. *American Journal of Preventive Medicine.* 2018;55(4):455-461.**

Alzahrani et al. evaluated 2014 and 2016 National Health Interview Survey data to determine whether electronic cigarette use could increase the risk of myocardial infarction. This was the first study to examine the relationship bewteen e-cigarette use and heart attack. E-cigarette use has been shown to stimulate similar reactions as traditional cigarette use in otherwise healthy individuals, including endothelial dysfunction, oxidative stress, inflammation, platelet activtion, and activiation of the sympathetic nervous system. Interviewees were classified as never, former, and current e-cigarette and cigarette users. However, the definition of former use was not consistent between e-cigarette uers and cigarette users. Based on NHIS responses, 25.8% of current e-cigarette users were former smokers and 66.2% of current e-cigarette users were also current cigarette smokers. Overall, the authors found that daily e-cigarette use was independently associated with increased odds of myocardial infarction (OR= 1.79, 95% CI= 1.20, 2.66, p-value= 0.004). Former and some day e-cigarette use were not associated with increased risk of heart attack. Former, some day, and current cigarette use were all associated with increased risk of heart attack. The authors also found that, "dual use of e-cigarettes and conventional cigarettes appears to be more dangerous than using either product alone." The authors state that their study likely underestimates the increased risk of heart attack from using e-cigarettes, and that more research is needed to fully understand the health impacts of former or some day e-cigarette use. They state that, "it is not known when the [myocardial infarctions] occured relative to e-cigarette use, and it is likely that some of the heart attacks subjects reported occured before e-cigarettes became available in the U.S. (around 2009). This situation will bias the [odds ratio] estimates toward the null, meaning that the study results likely underestimate the true risks associated with e-cigarette use."

32. **Clapp P., Lavrich K., Reidel B., et al. The E-Cigarette Flavoring Cinnamaldehyde Suppresses Mitochondrial Function and Trasiently Impairs Cilia Beat Frequency in Human Bronchial Epithelial Cells. Paper presented at: Epithelial Function in Health and Disease- Poster Discussion Session; May 23, 2018, 2018; San Diego, California.**

In this abstract, Clapp et al. explain that compounds in cigarettes impair mitochondrial function and reduce cilia beat frequency, impairing lung function. They note that cinnamaldehyde, which

is commonly used to flavor e-cigarette products, has similar structural properties to compounds in cigarettes. They determined the content of cinnamaldehyde in e-cigarette products and exposed human bronchial epithelial cells to various levels to evaluate a dose-response relationship. Overall, the authors concluded, "data suggest that cinnamaldehyde, a ubiquitous flavoring agent commonly used in e-cigarettes, adducts to mitochondrial proteins, disrupts mitochondrial function, and significantly reduces intracellular ATP levels, which correlates with impared [cilia beat frequency] in airway epithelial cells...inhalational exposures of cinnamaldehyde may increase the risk of respiratory infections in e-cigarette users."

33. **Gmel Gerhard, Baggio Stéphanie, Mohler-Kuo Meichun, et al. 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 with being less likely to completely quit smoking combustible cigarettes, and 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 non-vapers. Among those who were occasional smokers at baseline, non-vapers were more likely to become non-smokers 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 occasion smokers and 12 times more likely to be daily smokers at follow-up than no-nvapers. Among non-smokers at baseline, vapors smoked significantly more (10 times more) cigarettes weekly at follow-up then did non-vapers. Weekly cigarette use increased between baseline and follow-up for occasional smokers and decreased for daily smokers but these changes were not significantly between vapers and non-vapers.

34. **Grace Randolph C., Kivell Bronwyn M., Laugesen Murray. Estimating cross- price elasticity of e- cigarettes using a simulated demand procedure.** ***Nicotine & 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.

35. **Rahman M. A., Hann N., Wilson A., et al. E- Cigarettes and Smoking Cessation: Evidence from a Systematic Review and Meta- Analysis. *PLoS One.* Vol 102015.**
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.

36. **Kalkhoran Sara, Glantz Stanton A. 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.

37. **Watkins S. L., Glantz S. A., Chaffee B. W. Association of Noncigarette Tobacco Product Use With Future Cigarette Smoking Among Youth in the Population Assessment of Tobacco and Health (PATH) Study, 2013-2015. *JAMA Pediatrics.* 2018;172(2):181-187.**
Watkins et al. used data from the national Population Assessment of Tobacco and Health (PATH) survey to determine whether adolescents use of electronic cigarettes, hookah, noncigarette combustible tobacco, or smokeless tobacco led to cigarette smoking initiation. The

authors stated that, "in addition to their direct health effects, how these products affect youth cigarette smoking is a major consideration in determining their net influence on public health." PATH is a nationally representative survey of 12 to 17 year olds, and the authors completed a longitudinal evaluation of survey responses for 10,384 youth from 2013 and 2015. At baseline, approximately 9% of youth had never tried a cigarette and had tried at least one non-cigarette tobacco product. They found that cigarette initation was higher among youth that had used e-cigarettes, hookah, noncigarette combustible tobacco, or smokeless tobacco. Overall, "the odds of past 30-day cigarette use at follow-up were approximately twice as high among baseline ever users of e-cigarettes (odds ratio [OR], 1.87; 95% CI, 1.15-3.05), hookah (OR, 1.92; 95% CI, 1.17-3.17), noncigarette combustible tobaco (OR, 1.78, 95% CI, 1.00-3.19), and smokeless tobacco (OR< 2.07; 95% CI, 1.10-3.87)." The authors found that "ever use of e-cigarettes was asociated with 2.53 times greater odds of subsequent cigarette use." Using two or more types of non-cigarette tobacco products was associated with 4 times greater odds of past 30-day cigarette smoking at follow-up (OR, 3.95,; 95% CI, 2.65-5.90, P , .001). The authors cite previous research showing that "approximately 90% of adult smokers first tried a cigarette by 18 years of age, and even infrequent smoking in adolescence is associated with established adult smoking."

38. **Soneji S., Barrington-Trimis J.L., Wills T.A., et al. Association Between Initial Use of e-Cigarettes and Subsequent Cigarette Smoking Among Adolescents and Young Adults--A Systematic Review and Meta-analysis. *JAMA Pediatrics.* 2017;171(8):788-797.**
Soneji et al. conducted a systematic review and meta-analysis of longitudinal studies to determine whether initial use of e-cigarettes leads to subsequent cigarette smoking among youth and young adults. They included 9 studies in their analysis. Overall, they found that e-cigarette use was strongly and consistently associated with greater risk for cigarette smoking initiation (OR 3.50, 95% CI 2.38-5.16) and past 30-day cigartte smoking (OR 4.28, 95% CI 2.52-7.27) among youth and young adults. In addition, their analysis found that e-cigarette use is an independent risk factor for cigarette smoking, after controlling for multiple additional risk factors.

39. **Leventhal Adam M., Strong David R., Kirkpatrick Matthew G., 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]).

40. **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.

41. **Protano C., Avino P., Manigrasso M., et al. Environmental Electronic Vape Exposure from Four Different Generations of Electronic Cigarettes: Airborne Particulate Matter Levels.** ***International Journal of Environmental Research and Public Health.*** **2018;15(2172).**
Protano et al. evaluated the levels of airborne particulate matter emitted by four generations of e-cigarette models in use in Italy. They found that all e-cigarette devices emitted particulate matter of a size that can be inhaled into the lungs (inculding PM10, PM4, PM2.5, and PM1). Newer models emitted greater levels of small particulate matter as a result of increased operating power. Overall, their findings suggest that passive vaping does occur, supporting "the need for legislative interventions to regulate e-cigs use in public places and other enclosed environments, in order to protect the health of any subject who is potentially exposed."

42. **Gallaway M.S., Henley S.J., Steele C.B., et al. Surveillance for Cancers Associated with Tobacco Use--United States, 2010-2014.** ***Morbidity and Mortality Weekly Report, Centers for Disease Control and Prevention.*** **2018;67(12):1-42.**
In this Surveillance Summary, the Centers for Disease Control and Prevention evaluates tobacco-associated cancer incidence for 12 types of cancer associated with tobacco use from 2010 to 2014. They find that tobacco use contributes "to at least 12 types of cancer, including acute myeloid leukemia (AML) and cancers of the oral cavity and pharynx; espophagus; stomach; colon and rectum; liver; pancreas; larynx; lung, bronchus, and trachea; kidney and renal pelvis; urinary bladder; and cervix." They used cancer incidence data covering approximately 99% of the U.S. population from CDC's National Program of Cancer Registries and the National Cancer Institute's Surveillance, Epdiemiology, and End Results program. Approximately 3.3 million new tobacco-associated cancer cases were reported from 2010 to 2014, or approximately 667,000 cases per year. They found that incidence remains high among whites, blacks, non-Hispanics, and individuals living in rural areas.

43. **Tsai J., Homa D.M., Gentzke A.S., et al. Exposure to Secondhand Smoke Among Nonsmokers-- United States, 1988-2014.** ***Morbidity and Mortality Weekly Report, Centers for Disease Control and Prevention.*** **2018;67(48):1342-1346.**
This Morbidity and Mortality Weekly Report updates data and information about secondhand smoke exposure and health outcomes. It notes that secondhand smoke can cause sudden infant death syndrome, respiratory infections, ear infections, asthma attacks in infants and children, coronary heart disease, stroke, and lung cancer in adult non-smokers.

44. **Dunbar M.S., Tucker J.S., Ewing B.A., et al. Ethnic Differences in Cigarette Use Trajectories and Health, Psychosocial, and Academic Outcomes. *Journal of Adolescent Health.* 2018;62:327-333.**
Dunbar et al. presented previous research that, "youth who initiate smoking and continue to smoke demonstrate poorer academic and occupational outcomes, social difficulties, behavioral problems, and more physical and mental health problems in young adulthood relative to individuals who abstain entirely or desist after a period of experiementation." They also summarized previous research suggesting that youth alcohol and marijuana use may impact academic performance and physical health disproportionately for some racial/ethnic groups. In this study, they examined adolescent smoking trajectories and academic, health, and social outcomes by race/ethnicity for students at the end of high school. The authors followed students who were in sixth or seventh grade in 2008 through their completion of high school in 2016. Approximately 6500 students from 16 middle schools in Los Angeles, California completed annual surveys during physical education classses. Surveys asked about current cigarette smoking, sociodemographics and race/ethnicity, academic orientation, academic unpreparedness, physical ailments/symptoms, physical health, mental health , social functioning, and delinquency. Overall, they found that higher average cigarette use was associated with poorer academic performance, mental health, physical health, and social functioning as well as with greater academic unpreparedness, physical ailments, and delinquency. Controlling for cigarette use trajectories, "racial/ethnic minority youth showed poorer outcomes in multiple domains--notably physical health and physical impairments." The authors concluded, "after adjusting for similar use patterns over time, as well as an index of socioeconomic status (mother's education), cigarette smoking during adolescense is associated with poorer outcomes for racial/ethnic minority youth compared with white peers, and these disparities in health, academic, and other functional domains are evident as early as high school."

45. **Christenson T., Weisser, J. Health of Washington State Report: Tobacco Use. Washington State Department of Health; 2015.**
Combined 2012-2014 Behavioral Risk Factor Surveillance System (BRFSS) data indicate that AI/AN adults in Washington have significantly higher rates of current cigarette use than their white, black, Hispanic/Latino, and Asian counterparts. Cigarette use also decreased significantly as educational attainment or income increased. This report also indicates that smoking rates among gay, lesbian, and bisexual respondents were significantly higher than for their straight counterparts. These BRFSS data and 2014 Healthy youth survey data also show that smoking prevalence is highest in late adolescence and early adulthood, peaking among 25-34 years old for men and women. Pregnancy Risk Assessment Monitoring System (PRAMS) data from 2010-2012 indicate that the smoking rates among pregnant women before and during pregnancy are highest among mothers younger than 20 (36% [95% CI 28-45%]). Thirty-two percent of mothers age 20-24 also reported smoking before and during pregnancy (95% CI 27-37%) compared to 9% (95% CI 6-12%) of mothers 35 years or older. These data also indicate that smoking before pregnancy is highest among AI/AN (50% [95% CI 45-55%]) and low-income mothers. Because women often are not aware that they are pregnant until several weeks into their pregnancy, the smoking rates in the months leading up to pregnancy can have an important impact on fetal development and growth.

46. **Yan J. Does the Minimum Cigarette Purchase Age of 21 Protect Young Mothers from Cigarettes, Help Their Babies?** ***Department of Economics, Appalachian State University.*** **2011;11-17.**

Yan analyzed national birth sample data (which consists of all live births in Pennsylvania) using a regression discontinuity method to estimate the impact of the Tobacco 21 legislation that existed in Pennsylvania from 1992 to 2002. Yan analyzed the impact of this legislation on young mothers' cigarette use and their babies' birth outcomes. The response rate for each of the smoking variables was over 98% (n=60,710). Yan excluded mothers who were born outside of the United State or who resided in states other than Pennsylvania. Yan only included women whose age at conception was within 10 months to either side of the purchase age cut-off and who conceived between October 1, 1992 and July 10, 2001. The author controlled for potential confounding factors and found that mothers over the age 21 threshold during their pregnancy were significantly more likely than their counterparts to smoke cigarettes and also that they reported smoking significantly more cigarettes per day. The babies of mothers who were old enough to legally purchase cigarettes during their pregnancy also had significantly worse birth outcomes than their counterparts (e.g. lower birth weight, shorter gestation, and lower APGAR scores). Yan speculates that these data indicate that the Tobacco 21 legislation had positive impacts on lower smoking rates and volume and on positive birth outcomes.

47. **Silver D., Macinko J., Giorgio M., et al. Retailer compliance with tobacco control laws in New York City before and after raising the minimum legal purchase age to 21.** ***Tob Control.*** **2016;25(6):624-627.**

Researchers in New York City compared retailer compliance with tobacco control laws before and after the city passed their Tobacco 21 policy in 2014. With the passage of Tobacco 21, New York City raised the purchase age for tobacco from 18 to 21, required retailers to post a new sign about the legal age for purchase as well as a sign showing the new tax stamp, and required retailers to adhere to a new minimum sales price. The Tobacco 21 law did not provide any additional funding to ensure retailer compliance. This study looked at compliance for all four provisions before and after the passage of the law. Researchers trained youthful, racially diverse, female field officers to complete compliance checks at tobacco retailers located in easily accessible, retail dense areas of the Bronx, Brooklyn, Manhattan, and Queens. Field officers visisted retail stores twice before and twice after the Tobacco 21 laws went into effect. They assessed whether retailers requested ID, posted a sign about the legal age for purchase and the new tax stamp, and complied with minimum sale price laws. The study concluded that retailer compliance actually decreased after the Tobacco 21 law went into effect, and that retailer compliance with ID checks significantly decreased from 71% to 62%. They also found a decrease in the percent of retailers complying with minimum sale price laws. Data showed that chain retail stores were more likely than independent retailers to comply with Tobacco 21 laws. Overall, the study concluded that retailers that followed other tobacco sales regulations were also more likely to check ID during sale of tobacco.

48. **Winickoff J. P. Maximizing the Impact of Tobacco 21 Laws Across the United States.** ***American Journal of Public Health.*** **2018;108(5):594-595.**

Winickoff provided an editorial in the American Journal of Public Health about the impact of Tobacco 21 laws in the U.S. As of early 2018, approximately 25% of the U.S. population lived in areas with a Tobacco 21 law. He discusses recent research that has shown a decline in tobacco

use among youth 18 months after New York City implemented Tobacco 21, and a 47% decrease in high school student tobacco use five years after Needham, Massachusetts implemented Tobacco 21. He also shared findings from the National Academies of Science that Tobacco 21 laws can account for a "25% reduction in tobacco use by those aged 15 to 17 years and a 12% reduction in population tobacco use over time." Winickoff also discusses the importance of adequate enforcement for tobacco retailers. He suggests seven recommendations to maximize the effectiveness of Tobacco 21 Laws: 1) Increase random compliance inspections. 2) Track where illegal sales occur and where fines are imposed. 3) Levy maximum penalties for infractions. 4) Publicize fines and license suspensions to retailers. 5) Revoke and retire (cap and winnow) licenses to sell tobacco after infractions. 6) Pursue maximum criminal penalties for retailers that sell products illegally. 7) Evaluate the impact of Tobacco 21 laws.

49. **Officials Agency for State and Territorial Health. Tobacco 21: Legislative Policy Analysis. 2018.**

In this policy brief, ASTHO described recent Tobacco 21 laws and provides lessons learned for enactment and implementation. From 2015 to 2017, California, Guam, Hawaii, Maine, New Jersey, Oregon, and Washington D.C. increased the minimum legal purchase age for tobacco to 21. ASTHO noted that some challenges to Tobacco 21 laws have been related to enforcement, exceptions, and fiscal impacts. While most states have updated tobacco possession penalties, Oregon "chose not to penalize underage tobacco possession due to concerns that this measure would disproportinately harm racial and ethnic minorities." Guam chose not to impose penatlies and instead require that underage individuals in possession of tobacco complete smoking cessation education. ASTHO noted that laws tend to excempt three groups from Tobacco 21 laws, including members of the military, youth currently smoking, and underage individuals completing underage possession compliance checks. They stated that, "although evidence supports Tobacco 21 as an effective public health intervention, fiscal and business impacts and concerns over individual freedom can create barriers to adoption and implementation." A fiscal note from New Jersey suggested that implementing Tobacco 21 in the state would decrease state revenue by $6 million to $16 million.

50. **Wang T.W., Gentzke A., Sharapova S., et al. Tobacco Product Use Among Middle and High School Students--United States, 2011-2017. *Morbidity and Mortality Weekly Report, Centers for Disease Control and Prevention.* 2018;67(22):629-633.**

Centers for Disease Control and Prevention and the Food and Drug Administration evaluated data from the National Youth Tobacco Surveys from 2011 to 2017. They estimated nationwide current use of tobacco products for students in middle and high school. Overall, they found that tobacco use decreased from 24.2% of high school students (grades 9-12) in 2011 to 19.6% of high school students in 2017, and from 7.5% of middle school students (grades 6-8) in 2011 to 5.6% of middle school students in 2017. E-cigarettes were the most commonly used tobacco product across all grades. Although use of tobacco products decreased overalll, e-cigarette use increased from 1.5% of high school students in 2011 to 11.7% of high school students in 2017. E-cigarette and hookah use also increased from 2011 to 2017 for middle school students. Currently, "in 2017, approximately one in five high school students (2.95 million) and one in 18 middle school students (0.67 million) currently used a tobacco product." The authors note that, "several factors continue to promote and influence tobacco produt use among youths, including

exposure to tobacco product advertising and imagery through various media, as well as the availability of flavored tobacco products."

51. **Cullen K.A., Ambrose B.K., Gentzke A.S., et al. Notes From The Field: Use of Electronic Cigarettes and Any Tobacco Product among Middle and High School Students--United States, 2011-2018. *Morbidity and Mortality Weekly Report, Centers for Disease Control and Prevention.* 2018;67(45).**
E-cigarettes entered the U.S. market in 2007, and were the most commonly used tobacco product among youth by 2014. This Morbidity and Mortality Weekly Report update provides a summary of adolescent e-cigarette use in the U.S. from 2011 to 2018. Using data from the National Youth Tobacco Survey, this update shows that e-cigarette use among high school and middle school students statistically significantly increased between 2011 and 2018. For high school students, 1.5% of students reported using e-cigarettes in 2011 and 20.8% reported using e-cigarettes in 2018 ($p < 0.001$). For middle school students, 0.6% reported using e-cigarettes in 2011 and 4.9% reported using e-cigarettes in 2018 ($p < 0.001$). Both groups experienced large increases between 2017 and 2018, with high school use increasing by 78% (11.7% to 20.8% of students, $p<0.001$) and middle school use increasing by 48% (3.3% to 4.9% of students, $p=0.001$). The authors attribute the increase in e-cigarette use between 2017 and 2018 to "recent popularity of e-cigarettes shaped like a USB flash drive, such as JUUL."

52. **Health Washington State Department of. Unpublished data, Averted adverse pregnancy outcomes in Washington State attributable to the passage of a law increasing the minimum legal age to purchase cigarettes from 18 to 21 in the first five years. 2016.**
Washington State Department of Health conducted an analysis to determine near-term cost savings from changing the minimum purchase age of tobacco from 18 to 21. They determined that the policy would reduce adverse birth outcomes, including preterm birth by about 4.3% (53 cases) and low birth weight by about 4.1% (88 cases). These reductions would save approximately $2 billion to $3 billion in healthcare costs in the first five years after the Tobacco 21 policy was implemented. Approximately $1 million to $3 million of these savings would be in state Medicaid dollars.

53. **Knox B. Increasing the Minimum Legal Sale Age for Tobacco Products to 21.: Campaign for Tobacco-Free Kids; 2016.**
In this report, the author presents an overview of the issues surrounding tobacco use among youth in the United States and outlines potential benefits to increasing the tobacco purchasing age to 21. Key points discussed include the modeling predictions from the 2015 Institute of Medicine report, tobacco company marketing towards youth, the success of raising the minimum drinking age to 21 and lessons learned, as well as the overall benefits to a Tobacco 21 approach.

54. **Widely used e-cigarette flavoring impairs lung function [press release]. 2018.**
In this press release, the American Thoracic Society summarizes recent research by Clapp et al. entitled, "The E-cigarette Flavoring Cinnamaldehyde Suppresses Mitochondrial Function and Transiently Impairs Cilia Beat Frequency in Human Bronchial Epithelial Cells." The study found that a single exposure to cinnamaldehyde in e-cigarettes impairs lung function. In the press release, the authors state that, "'our data suggets that when used in e-cigarettes cinnamaldehyde, like toxic aldehydes in cigarette smoke, significantly disrupts normal cell physiology in ways

that may have implications for the development and exacerbation of respiratory disease...our finding that cinnamaldehyde impairs normal airway cilia motility is significant because it demonstrates that a common, food-safe flavoring agent, in the context of e-cigarette use, is capable of dysregulating a critical anti-bacterial defense system in the lungs.'" The authors note that flavoring agents, while safe for ingestion, may not be safe for inhalation. In addition, since flavoring agents are used in high concentrations in e-cigarettes, indivdiuals may be exposed to higher doses of the agent. The authors state, '"The two principles of toxicology- 'The Dose Makes the Poison' and 'The Route of Exposure Affects Toxicity'- clearly apply here.'"

55. **Bayly J.E., Bernat D., Porter L., et al. Secondhand Exposure to Aerosols from Electronic Nicotine Delivery Systems and Asthma Exacerbations Among Youth With Asthma. *CHEST*. 2018;Ahead of print.**
Bayly et al. analyzed data from the 2016 Florida Youth Tobacco Survey to determine whether there was a relationship between secondhand exposure to aerosol from electronic nicotine delivery systems (ENDS) and asthma exacerbation among youth with asthma. They examined survey responses for youth aged 11 to 17 years old from middle and high schools in Florida. Overall, approximately one-third of youth reported secondhand exposure to ENDS aerosols. The authors found that secondhand exposure to aerosol from ENDS was significantly associated with higher odds of asthma attacks among youth with asthma ($p < 0.01$; OR 1.27, 95% CI 1.11-1.47). The authors concluded that, "secondhand exposure to ENDS aerosols may be related to asthma symptoms in youth...future research is necessary to evaluate the longitudinal realtionship between secondhand ENDS aerosol exposure and asthma control."

56. **Odani S., Armour B.S., Agaku I.T. Racial/Ethnic Disparities in Tobacco Product Use Among Middle and High School Students-- United States, 2014-2017. *Morbidity and Mortality Weekly Report, Centers for Disease Control and Prevention.* 2018;67(34):952-957.**
The Centers for Disease Control and Prevention analyzed pooled race/ethnicity data from the 2014 to 2017 National Youth Tobacco Surveys. Pooling the data allowed them to have sufficient sample size to examine tobacco use among middle and high school students in seven racial/ethnic groups, including whites, blacks, Hispanics, Asians, American Indian/Alaska Native, Native Hawaiian and Other Pacific Islanders, and multiracial individiuals. They evaluated ever (more than once in lifetime) and current (more than once in past 30-days) use for cigarettes, cigars, smokeless tobacco, e-cigarettes, hookahs, pipes, and bidis. They found that ever use of tobacco products and current use of tobacco products was highest for Native Hawaiian and Other Pacific Islander students (45.1% and 23.4%, respectively) and lowest for Asian students (16.3% and 5.0%, respectively). More specifically, "ever-use of any tobacco product among U.S. middle and high school students was highest among [Native Hawaiians and Other Pacific Islanders] (45.1%) and [American Indian/Alaska Natives] (43.8%), and did not signficantly differ between these groups." Multiracial students, Hispanics, blacks, whites, and Asians had significantly lower prevalence of ever-using tobacco products. In addition, males reported signficantly higher ever-use of tobacco prodcuts among white, Hispanic, and Asian students, but no signficant difference across other racial/ethnic groups. Ever-use of tobacco products was significantly higher among high school students than middle school students. Current use of any tobacco product was also highest among Native Hawaiian and Other Pacific Islanders (23.4%) and American Indian/Alaska Natives (20.6%). Compared with Asian students, current use of any tobacco product was signficantly higher among blacks, Hispanics, whites, and

multiracial students. Males were more likely than females to currently use tobacco products among whites, Hispanics, Native Hawaiian and Other Pacific Islanders, and multiracial students, but no signficant difference across other racial/ethnic groups. Current use of tobacco procuts was signficantly higher among high school students than middle school students. Of tobacco products used, e-cigarettes were the most commonly ever-used and currently used product overall and among all racial/ethnic groups except blacks and American Indian/Alaska Natives. Black students most commonly had ever-used and currently used cigars. American Indian/Alaskan Native students most commonly had ever-used cigarettes.

57. **Roberts M. E., Spillane N. S., Colby S. M., et al. Forecasting Disparities with Early Substance-Use Milestones.** ***J Child Adolesc Subst Abuse.*** **2017;26(1):56-59.**
Roberts et. al. collected demographic information from 917 12-year olds attending six middle schools in Rhode Island. They followed up with these students semi-annually and after three years to determine if they had ever tried alcohol, cigarettes, or marijuana. Students self-reported race and ethnicity. Parents provided information about annual household income, highest level of educational attainment, and whether their family qualified for free or reduced-price lunches. This information was combined to determine socioeconomic status. The researchers found significant differences in initiation of cigarette use based on socioeconomic status and race and ethnicity. Native American and multiracial youth were most likely to initiate cigarette use at an early age. The authors noted that these group-based differences in smoking initiation were concerning since these communities also experience differences in substance use and health disparities in adulthood.

58. **Thompson A. B., Mowery P. D., Tebes J. K., et al. Time Trends in Smoking Onset by Sex and Race/Ethnicity Among Adolescents and Young Adults: Findings From the 2006-2013 National Survey on Drug Use and Health.** ***Nicotine Tob Res.*** **2017.**
Thompson et al. (2017) analyzed data from the 2006 to 2013 National Survey of Drug Use and Health to analyze trends in smoking onset among different age and racial and ethnic groups. Data from approximately 180,000 adolescents and young adults were included in the study. Specifically, the researchers looked at the change in rate of smoking onset over time, differences in rate between adolescents and young adults, and differences in rate by sex and race and ethnicity. The researchers found that the average age of smoking onset was 17.7 years. Overall, the rate of smoking onset declined across all age groups. However, the rate of the decline was not constant across all demographic groups. Black and Hispanic males had higher rates of onset than their white peers, and the rate of onset was higher among young adults aged 18 to 25 years compared to adolescents aged 12 to 17 years. In addition, the study found that women were more likely than men to initiate smoking as young adults, especially black and Asian females. The researchers note that findings from the study suggest that prevention efforts should focus on young adults, and that reducing onset of smoking among young adults may improve smoking-related health outcomes later in adulthood, especially for communities of color.

59. **Johns M.M., Lowry R., Rasberry C.N., et al. Violence Victimization, Substance Use, and Suicide Risk Among Sexual Minority High School Students--United States, 2015-2017.** ***Morbidity and Mortality Weekly Report, Centers for Disease Control and Prevention.*** **2018;67(43):1211-1215.**

The Centers for Disease Control and Prevention found that, "youths identifying as lesbian, gay, bisexual, or another non-heterosexual identity...report more violence victimization, substance use, and suicide risk than do heterosexual youths." They use pooled data to acheive sufficient sample size from the 2015 and 2017 Youth Risk Behavior Surveys to evaluate victimization, substance use, and suicide risk among gay/lesbian, bisexual, not sure, and heterosexual students in grades 9-12. Specific to substance use, the authors evaluated lifetime use of alcohol, cigarettes, and marijuana and found found that lesbian and bisexual females reported signficantly higher use of all three substances. They found that "lesbians reported a higher prevalence of using cigarettes ([adjusted prevalence ratio]= 1.8) and marijuana (1.5) than did heterosexual females...Compared with heterosexual females, bisexual females had a higher prevalence of use of cigarettes (1.8), alcohol (1.2), and marijuana (1.6); females who were not sure of their sexual identity reported a higher prevalence of using cigarettes (1.2)." Among male students, those identifying as bisexual had a higher prevalence of cigarette use (1.4).

60. **Day J. K., Fish J. N., Perez-Brumer A., et al. Transgender Youth Substance Use Disparities: Results From a Population-Based Sample. *J Adolesc Health.* 2017;61(6):729-735.**

Day et al. (2017) completed a cross-sectional, population-based, representative analysis of substance use among transgender and nontransgender middle and high school students in California. Data was collected as part of the 2013-2015 Biennial Statewide California Student Survey. The sample included 32,072 middle and high school students from across California (71% response rate). Of these students, 335 self-identified as transgender. The sample of students were representative of the California population as a whole. Day concluded that transgender students were 2.5 to 4 times more likely to use tobacco, marijuana, alcohol, and other illicit drugs compared to nontransgender students. For tobacco, approximately 35% of transgender youth reported ever smoking cigarettes. Transgender youth were 2.7 times more likely to have ever smoked cigarettes and 4.2 times more likely to have used cigarettes in the past 30 days compared to nontransgender youth. In addition, transgender students were more likely to have started using cigarettes at an early age and were at higher risk for ever using cigarettes than their nontransgender peers. The increased likelihood of substance use among transgender youth was partially mediated by victimization, mental health, and perceived risk of substance use. Victimization significantly mediated the relationship between gender identity and cigarette use. The authors noted that the study was limited by the measure of gender identity, and by the fact that this analysis was cross-sectional.

61. **Prevention Centers for Disease Control and. Burden of Tobacco Use in the U.S.: Current Cigarette Smoking Among U.S. Adults Aged 18 Years and Older. 2017.**

Evidence indicates that, nationally, cigarette use is higher among active military personnel than among the civilian population. Prevalence of cigarette use is even higher among military personnel who have been deployed. United States data for men from 2007 to 2010 from the National Health Interview Survey indicate that male veterans are significantly more likely than non-veterans to be current smokers in every age group.

62. **Behavioral risk factor surveillance system prevalence and trends data: Washington-2011. 2011; Available at:**

http://apps.nccd.cdc.gov/brfss/page.asp?cat=XX&yr=2012&state=WA#XX. Accessed November 14, 2015.
Behavioral Risk Factor Surveillance System data from 2011 indicate that young adults of color experience worse health outcomes than their white counterparts on a number of health indicators. While there were too few respondents in this age category to report rates at the state level, nationally these data indicate that black respondents between the ages of 18 and 24 were significantly more likely than white respondents to report that frequent poor physical or mental health prevented them from doing their usual activities. These rates were also higher for Native Hawaiian and other Pacific Islander, American Indian/Alaska Native (AI/AN), and Hispanic participants as well as those that reported multiple races or "other race," however these differences did not reach statistical significance using one year of data. In addition, BRFSS data indicate that a similar number of veteran respondents and non-veteran respondents report currently smoking cigarettes. The rate for veterans is 17.1% (95% CI 14.3-19.9%) and the rate for non-veterans is 17.6% (95% CI 16.4-18.8%). Some of the most vulnerable veterans (e.g. those experiencing homelessness) may not be reached by this telephone survey. Among all respondents, 17.5% (95% CI 16.4-18.6%) reported currently smoking cigarettes.

63. **Defense Department of. 2011 Health Related Behavior Survey for Active Duty Service Members. 2011.**
Health Related Behavior Survey data for Active Duty Service Members is a Department of Defense Survey used to track health indicators for the military. Survey data from 2011 indicate that 18% of respondents reported smoking in the past 30 days. Thirty-seven percent indicated that they had smoked in their lifetime, and 19% indicated that they were former smokers.

64. **Smith Elizabeth A., Walker S. Poston, Sara A. Jahnke, Nattinee Jitnarin, Christoper Haddock, Ruth Malone. United States Military Tobacco Policy Research: A White Paper. University of California San Francisco and National Development and Research Institutes, Inc.; 2016.**
This report was funded by the National Institutes of Health, and completed by University of California San Francisco. It summarizes current tobacco use among members of the U.S. military and provides an overview of current military tobacco policy. The report states that high smoking prevalence among U.S. military personnel results in training injuries, premature discharge, lower cardiovascular and respiratory health, reduced troop readiness, and high costs for the Department of Defense. Specific to Tobacco 21 laws, this report states that the U.S. Navy decided to comply with Hawaii's Tobacco 21 policy and supported California's efforts to increase the minimum age of purchase. California exempted military personnel from their Tobacco 21 laws.

65. **Winickoff Jonathan P., Hartman Lester, Minghua L. Chen, et al. Retail impact of raising tobacco sales age to 21 years.(Report). *The American Journal of Public Health.* 2014;104(11):e18.**
Winickoff et al. cite evidence that: 59% of 18 and 19 year olds have been asked by a younger person to buy cigarettes for them; high-school students are less likely to have social connections with adults over 20 than with 18 to 20 year olds; almost 90% of smokers nationally began smoking before the age of 21; and other studies have estimated that raising the tobacco sale age to 21 could reduce tobacco use by 55% for 15 to 17 year olds within seven years. The authors analyzed 2011 National Health Interview Survey data (n=33,014) in order to determine the

proportion of current legal tobacco sales that are made by (or for) 18 to 20 years olds to estimate the potential impact on retailers if the sale age is increased to age 21. They make the assumption the law would be universally implemented and enforced. These data show that 18 to 20 year olds make up 3.06% of the total adult smoking population and account for 2.12% of cigarette consumption. The authors use these figures to estimate that the immediate loss of sales would be about 2% of total cigarette sales nationally. Then, assuming that the policy would have a long-term impact on smoking rates of adults in the future (through the aging of this low tobacco-use cohort), this could lead to a gradual reduction in the sale of cigarettes to older adults over time. This analysis only made predictions about combustible cigarette sales and not about other tobacco or vaping products. The authors also note that no tobacco retailers have gone out of business in Needham Massachusetts since it implemented a Tobacco 21 purchase age in 2005.