

Executive Summary: Health Impact Review of HB 2313

Concerning the Age of Individuals at Which Sale or Distribution of Tobacco and Vapor Products May be Made

Evidence indicates that HB 2313 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: Orwall, Magendanz, S. Hunt, Harris, Cody, Johnson, Stanford, Nealey, Haler, Goodman, Riccelli, DeBolt, Pollet, Short, Kagi, Jinkins, Stokesbary, Kilduff, Reykdal, Van De Wege, McBride, Fey, Bergquist, Tharinger, Frame

By Request: Attorney General

Summary of Bill:

- Prohibits selling or giving tobacco or vapor products to a person under the age of 21.
- Modifies the definition of a “vapor product.”

HEALTH IMPACT REVIEW

Summary of Findings:

This Health Impact Review found the following evidence regarding the provisions in HB 2313:

- 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.
- Very strong evidence that decreasing use of tobacco and vapor products among youth and young adults will improve health outcomes.
- Unclear evidence for the bill’s impacts on health disparities. 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 disparities 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 disparities 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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Health Impact Review of HB 2313
**Concerning the Age of Individuals at Which Sale or Distribution of
Tobacco and Vapor Products May be Made**

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Acknowledgement

We would like to thank the individuals who provided data and various perspectives on the potential impacts of the bill.

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Introduction and Methods

A Health Impact Review is an analysis of how a proposed legislative or budgetary change will likely impact health and health disparities in Washington State ([RCW 43.20.285](#)). For the purpose of this review ‘health disparities’ have been defined as the differences in disease, death, and other adverse health conditions that exist between populations ([RCW 43.20.270](#)). This document provides summaries of the evidence analyzed by State Board of Health staff during the Health Impact Review of House Bill 2313 ([HB 2313](#)).

Staff analyzed the content of HB 2313 and created a logic model depicting possible pathways leading from the provisions of the bill to health outcomes. We consulted with experts and contacted stakeholders with diverse perspectives on the bill. State Board of Health staff can be contacted for more information on which stakeholders were consulted on this review. We conducted objective reviews of the literature for each pathway using databases including PubMed and Google Scholar.

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

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

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

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

Analysis of HB 2313 and the Scientific Evidence

Summary of HB 2313

- Prohibits selling or giving tobacco or vapor products to a person under the age of 21.
- Modifies the definition of a “vapor product.”

Health impact of HB 2313

Evidence indicates that HB 2313 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.

Pathways to health impacts

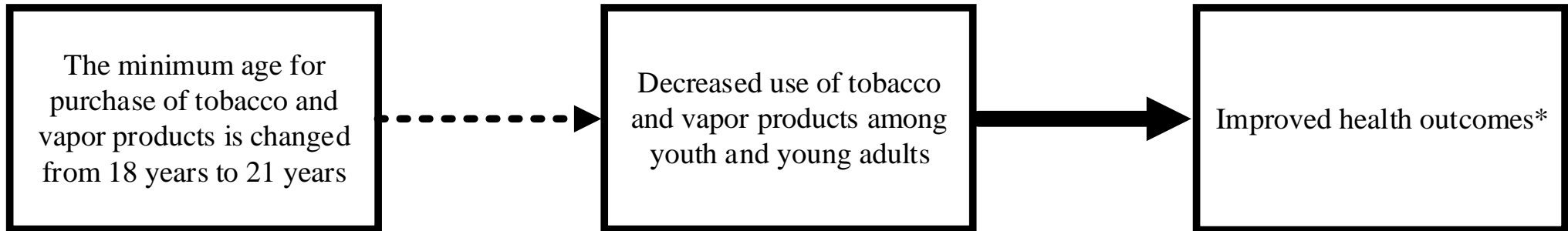
The potential pathways leading from the provisions of HB 2313 to decreased health disparities are depicted in Figure 1. There is a fair amount of evidence that changing the minimum age for purchase of tobacco and vapor products from 18 years to 21 years of age will decrease use of tobacco and vapor products among youth and young adults.¹⁻¹¹ There is very strong evidence that decreasing use of tobacco and vapor products among youth and young adults will improve health outcomes for Washingtonians.^{1,12,13} It is unclear from available evidence how the bill would impact health disparities. Two studies have found that increasing the minimum purchase age is associated with decreased smoking rates across income, race/ethnicity, and grade level^{4,6}—indicating that the impacts of the bill on health disparities 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 disparities 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 on page five.

Due to time limitations we only researched the most direct connections between the provisions of the bill and decreased health disparities and did not explore the evidence for all possible pathways. For example we did not evaluate the evidence for how minimum purchase age laws impact retailer compliance and how compliance then affects usage of the restricted product.

Magnitude of impact

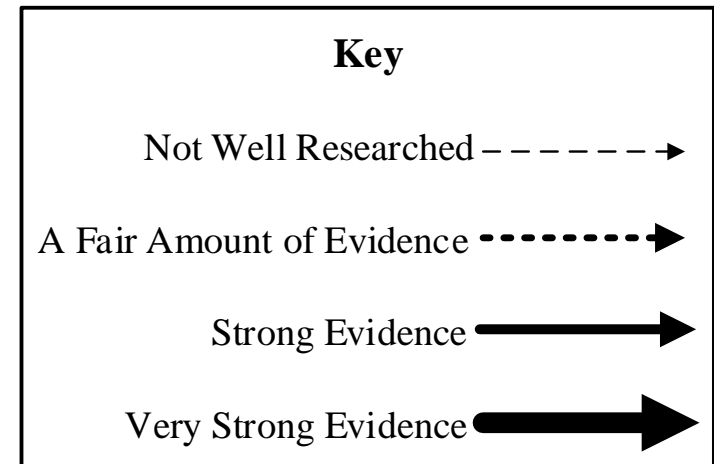
The Institute of Medicine (IOM) convened a committee to examine the existing literature and use modeling to predict the likely impacts of increasing the minimum purchase age to 21 years of age. The committee’s modeling was informed by the existing scientific literature and estimated that raising the tobacco purchase age to 21 would lead to the following reductions in tobacco initiation: a 12.5-18% reduction for those under 15 years of age, a 20.8-30% reduction for those 15-17 years, a 12.5-18% reduction for those 18-20 years. With an age increase to 21, modeling predicted that 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.¹

Logic Model



*See the full Health Impact Review for a detailed analysis of the likely impacts of HB 2313 on health disparities

Figure 1
Concerning the Age of Individuals at Which Sale or Distribution of Tobacco and Vapor Products May be Made
SHB 2313



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 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.¹⁻⁹ An additional body of evidence in relation to the effects of raising the minimum purchase age for alcohol indicates that higher alcohol purchase ages are associated with decreased alcohol consumption.^{10,11} While research on alcohol purchase policies are not fully generalizable to tobacco/vaping purchase policies, these alcohol studies do provide additional insight into the likely effects of raising the minimum purchase age for tobacco and vaping products.

While 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. Research indicates that smoking is most likely to be initiated during adolescence, most adults who smoke daily initiated smoking by 18 years of age, and early smoking onset is associated with decreased likelihood of cessation.¹⁴ So the declines in the tobacco/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.

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 improve health outcomes for these individuals, as well as for those who would otherwise have been exposed to their secondhand smoke or smoking in utero.^{1,12,13} A very strong body of evidence has shown a causal link between combustible 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 degeneration, harms to the fetus, diabetes, erectile dysfunction, arthritis, and premature death. Research also shows that secondhand smoke causes cancers, respiratory disease, cardiovascular disease, stroke, and harms to infant and child health.¹³

Data from the Pregnancy Risk Assessment Monitoring System (PRAMS) from 2006-2008 indicate that smoking rates among pregnant women the three months prior to conception are highest among mothers younger than 20 and remain high for mothers 20 to 24 years of age. 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.¹⁵ One study found that the babies of young mothers exposed to a higher tobacco purchase age during pregnancy actually had better birth outcomes than their counterparts.⁸ The health benefits of HB 2313 may therefore extend beyond youth and young adults to children and others who would potentially, in the absence of the bill, be exposed to secondhand smoke or smoking in utero.

The evidence on the health effects of vaping products is less established than the evidence on the effects of combustible cigarettes. However many studies have found that vaping products contain substances that are harmful to humans (e.g. metals, traces of cancer-causing nitrosamines, formaldehyde, mercury) and that smoking electronic cigarettes is associated with adverse effects such as airway and lung obstruction. Evidence also indicates that product labels often did not show the concentrations of solvents and flavoring and that products labeled nicotine free were sometimes found to actually contain nicotine in high concentrations. There was also variability in product concentrations from cartridge-to-cartridge. There is a lack of evidence of the long-term impacts of vaping on human health. While some studies indicate that vaping may have less adverse effects or result in less exposure to harmful substances than combustible cigarettes, it is not clear from the available evidence how many people are using electronic cigarettes to reduce combustible cigarette use versus how many individuals who would never have smoked combustible cigarettes are vaping and potentially transitioning to combustible cigarettes.¹²

Will improving health outcomes for youth and young adults impacted by HB 2313 impact health disparities?

It is unclear from the available evidence how increasing the minimum tobacco/vaping product purchase and possession age to 21 would likely impact health disparities. Two studies have found that increasing the minimum purchase age is associated with decreased smoking rates across income, race/ethnicity, and grade level^{4,6}—indicating that the impacts of the bill on health disparities 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 which suggests that increasing the minimum purchase age would increase smoking rates among any subpopulations. Therefore if an increase in the purchase age *did* lead to an increase in disparities (as the evidence that the impacts are uniform across subpopulations is inconclusive at this point) it would likely be a result of a disproportionate *positive* impact for communities with lower tobacco/vaping rates. There would still likely be a positive effect for all communities. Any observed increases in disparities as a result of smaller declines in smoking rates in some subpopulations could potentially be addressed through culturally and linguistically appropriate tobacco/vaping prevention interventions tailored to those populations.

Disparities by race/ethnicity

Data from Washington State's 2014 Healthy Youth Survey indicate that youth of color and American Indian/Alaskan Native (AI/AN) youth report smoking combustible and electronic cigarettes at significantly higher rates than their White counterparts in the younger grades (6th, 8th, and 10th grades). However smoking rates among White students increase in the higher grades, and by 12th grade these disparities have minimized. In some cases (such as electronic cigarette use) White students are actually using these products at a higher rate than their counterparts by 12th grade.¹⁶ Combined 2008-2010 Behavioral Risk Factor Surveillance System (BRFSS) data from adults in Washington indicate that people of color and AI/AN respondents report higher smoking rates than their White counterparts again in adulthood. How HB 2313 will affect these nuanced changes in smoking disparities is not clear; however evidence indicates that

earlier age of initiation of tobacco use is associated with greater difficulty quitting. Youth who initiate smoking at 13 years or younger have the most difficulty quitting, while each year that a child delays initiation increases their chances of quitting.¹⁴ This suggests that if increasing the tobacco/vaping product 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.¹⁶ This could potentially result in a decline in the disproportionately high smoking rates among adults of color in Washington in the future.

PRAMS data from 2006-2008 indicate that AI/AN and low-income mothers are more likely than their counterparts to report smoking in the three months prior to conception.¹⁵ This may indicate that decreasing smoking rates evenly across all demographic groups could actually have a greater positive health impact in AI/AN and low income communities because the decrease would not only benefit the smoker, but her unborn child as well. However, 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. HB 2313 does not amend this language. 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 HB 2313. If this leads to a greater decline in tobacco use among other subpopulations, this could exacerbate the smoking disparities that currently exist for AI/ANs in Washington.

Disparities by income

Washington Behavioral Risk Factor Surveillance System data from 2008-2010 indicate that as income increases smoking rates decrease.¹⁵ 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.⁶ This suggests that HB 2313 may have neutral impacts on smoking disparities by income; however the evidence is insufficient to make a determination. As mentioned above PRAMS data from 2006-2008 indicate that low-income mothers are more likely than their counterparts to report smoking in the three months prior to conception,¹⁵ 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.

Disparities by sexual orientation

Data also show that 2014 Healthy Youth Survey respondents in Washington who self-identified as lesbian, gay, or bisexual (LGB) reported higher smoking rates than their straight counterparts.¹⁶ The literature has not addressed if changing minimum tobacco purchase and possession laws impacts LGB and straight youth equally, so it unclear how HB 2313 would impact tobacco use disparities by sexual orientation.

Disparities 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.¹⁷ However, Behavioral Risk Factor Surveillance System (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.^{18,19} Because HB 2313 would not affect the minimum tobacco/vaping product purchase age on military bases in Washington, it is possible that this bill could have a smaller impact on decreasing tobacco and vaping product use among active duty personnel, thereby potentially creating a disparity or exacerbating disparities that already exist at the national level.

Other considerations

We also 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 three of this review because the impacts on business have not been well researched. We did not identify any studies which have 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 2005,²⁰ but this has not been studied rigorously.

One study estimated the impact of a national tobacco purchase age of 21 on cigarette sales. Winickoff et al. used national data on the proportion of 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 that the law would be universally implemented and enforced. The authors estimate that the immediate loss of sales would be about 2% of total cigarette sales nationally. 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.²⁰ Given the scarcity of research on the impact of age of purchase laws on business we are unable to make a conclusion about how HB 2313 would likely impact business.

Annotated References

1. Institute of Medicine (IOM). 2015. *Public Health Implications of Raising the Minimum Age of Legal Access to Tobacco Products*. Washington, DC: The National Academies Press.

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.

2. 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 complete 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.

3. Fidler JA, 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 (Abingdon, England)*. 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) 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.

4. Kessel Schneider S, Buka SL, Dash K, Winickoff JP, L OD. Community reductions in youth smoking after raising the minimum tobacco sales age to 21. *Tobacco Control* 2015; Epub ahead of print.

In April of 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 from 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.

5. Lewit EM, Hyland A, Kerrebrock N, Cummings KM. Price, public policy, and smoking in young people. *Tobacco Control*. 1997;6 Suppl 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.

6. Millett C, Lee JT, Gibbons DC, Glantz SA. 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 except for purchases from vending machines 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.

7. Rimpelä AH, Rainio SU. The effectiveness of tobacco sales ban to minors: The case of Finland. *Tobacco Control*. 2004;13(2):167.

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 Finnish 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.

8. Yan J. Does the minimum cigarette purchase age of 21 protect young mothers from cigarettes, help their babies? Vol 11-17: Department of Economics, Appalachian State University; 2011.

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 age 21 tobacco purchase 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.

9. Yörük C, Yörük 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 the 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 conclude 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.

10. Norberg KE, Bierut LJ, Gruza RA. Long- term effects of minimum drinking age laws on past- year alcohol and drug use disorders. *Alcoholism: Clinical and Experimental Research*. 2009;33(12):2180-2190.

Norberg et al. cite several studies on the connection between Minimum Legal Drinking Age (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 MLDA 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. Wagenaar AC, Toomey TL. Effects of minimum drinking age laws: Review and analyses of the literature from 1960 to 2000. *Journal of Studies on Alcohol. Supplement*. 2002(14):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 MLDA 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 MLDA 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.

12. Pisinger C, Døssing M. A systematic review of health effects of electronic cigarettes. *Preventive Medicine*. 2014;69:248-260.

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, 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. Some studies suggest that electronic cigarettes may be useful as a smoking reduction/cessation aid, but the evidence on their efficacy is conflicting.

13. U.S. Department of Health and Human Services. *The Health Consequences of Smoking: 50 Years Of Progress. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2014. Printed with Corrections, January 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 exists. 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 degeneration, harms to the fetus, diabetes, erectile dysfunction, arthritis, and premature death. Research also shows that secondhand smoke causes cancers, respiratory 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 lasting adverse effects on brain development.

14. Lydon DM, Wilson SJ, Child A, Geier CF. 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.

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

Combined 2008-2010 Behavioral Risk Factor Surveillance System (BRFSS) data indicate that AI/AN and Black adults in Washington have significantly higher rates of current cigarette use than their White, 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 2010 Healthy Youth Survey data also show that 12th graders, 18-24 year olds and 25-34 year olds report the highest rates of current smoking, rates that are significantly higher than many of the younger or older age groups. Pregnancy Risk Assessment Monitoring System (PRAMS) data from 2006-2008 indicate that the smoking rates among pregnant women the three months prior to conception are highest among mothers younger than 20 (35% [95% CI 28-42%]). Thirty-one percent of mothers age 20-24 also reported smoking in the three months before pregnancy (95% CI 27-35%) compared to 9% (95% CI 5-13%) of mothers 35 years or older. These data also indicate that smoking before pregnancy is highest among AI/AN (41% [95% CI 36-46%]) 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.

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

Washington State Healthy Youth Survey data from 2014 indicate that among sixth grade respondents there were no statistically significant differences by race/ethnicity in the percent of students who reported smoking any days in the past 30 days. Among 8th grade respondents American Indian/Alaskan Native (AI/AN) students (7.7% [95% CI 4.8-10.6%]) reported

significantly higher smoking rates than their Asian and Pacific Islander (API) (1.9% [95% CI 1.1-2.7%]) and White peers (3.4% [95% CI 2.7-4.1%]). Black students (7.0% [95% CI 5.0-9.0%]) also reported significantly higher rates than their White peers. Among 10th grade respondents, Black (9.1% [95% CI 6.5-11.7%]), Hispanic/Latino (8.0% [95% CI 5.9-10.1%]), and AI/AN (14.1% [95% CI 7.7-20.5%]) respondents reported significantly higher rates than did their API peers (4.3% [95% CI 2.9-5.7%]). These rates were also higher than the rate for White students (7.7% [95% CI 6.3-9.1%]), but the differences were not significant. The percent of students who had reported smoking at all in the past 30 days was highest among 12 grade respondents. Black (13.5% [95% CI 9.6-17.4%]), White (14.0% [95% CI 12.1-15.9%]) and AI/AN (15.4% [95% CI 7.8-23.0%]) students reported the highest rates, but the only significant difference was that the rate for White students was significantly higher than that for API students (8.6% [95% CI 6.3-10.9]). These data suggest that in Washington State, youth of color in the younger grades have disparately high rates of current cigarette use, while in the older grades these disparities begin to narrow as a larger proportion of white students initiate smoking. 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 significantly more likely to report smoking cigarettes at all in the last 30 days (14.8% [95% CI 8.4-21.2%]) than their peers who identified as straight (3.6% [95% CI 2.2-5.0%]). This disparity also existed among 10th graders (18.5% [95% CI 10.7-26.3%] vs. 7.6% [95% CI 5.0-10.2%]) and 12 graders (29.7% [95% CI 18.9-40.5%] vs. 13.7% [95% CI 10.8-16.6%]). When asked how many electronic cigarettes they had used in the past 30 days, AI/AN (13.1% [95% CI 7.2-19.0%]), Black, and Hispanic/Latino 8th grade respondents reported the highest usage. Black (14.2% [95% CI 9.8-19.2%]) and Hispanic/Latino (13.5% [95% CI 10.1-16.9%]) students reported significantly higher rates than their White (6.8% [95% CI 5.4-8.2%]) and API (5.8% [95% CI 3.5-8.1%]) counterparts. Among 10th grade respondents AI/AN (28.0% [95% CI 16.9-39.1%]) and Black students (23.5% [95% CI 17.3-29.7%]) had the highest rates, although these rates are only significantly higher than the rates for API students (12.0% [95% CI 8.5-15.5%]). Among 12th grade respondents, White students (25% [95% CI 23.4-27.8%]) had the highest rates, though these were only significantly higher than the rates for API students (13.0% [95% CI 9.5-16.5%]). Several racial/ethnic subpopulations had lower rates of electronic cigarette use (or only slightly higher rates) among 12th graders than among 10th graders while White 12th graders and those who identified as more than one race/ethnicity or "other" had higher rates than the 10th graders. It is important to note that the current race/ethnicity categories aggregate diverse subpopulations into one category—so disparities within these categories may be masked. For example, API subpopulations likely have very different smoking rates but they are aggregated into one category so these differences are missed.

17. Centers for Disease Control and Prevention. Current Cigarette Smoking Among U.S. Adults Aged 18 Years and Older.

<http://www.cdc.gov/tobacco/campaign/tips/resources/data/cigarette-smoking-in-united-states.html#ten>. Accessed November 15, 2015.

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.

18. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System Prevalence And Trends Data: Washington-2011. 2011;
<http://apps.nccd.cdc.gov/brfss/page.asp?cat=XX&yr=2012&state=WA#XX>. Accessed November 14, 2015.

BRFSS data from 2011 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.

19. Military Health System. Health Related Behavior Surveys for Active Duty Service Members, unpublished data. 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.

20. Winickoff JP, Hartman L, Minghua LC, Gottlieb M, Nabi-Burza E, DiFranza JR. 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 others 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. This study was funded by the National Institute of Health, National Cancer Institute, National Institute on Drug Abuse, and the Agency on Healthcare Research and Quality. The authors note that the funders played no role in the design or execution of the study, analysis of the data, or review and approval of the article.