

# Update on Performance in Tobacco Control: A Longitudinal Analysis of the Impact of Tobacco Control Policy and the US Adult Smoking Rate, 2011-2013

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**Context:** Tobacco use remains the leading cause of preventable death in the United States. States and municipalities have instituted a variety of tobacco control measures (TCMs) to address the significant impact tobacco use has on population health. The American Lung Association annually grades state performance of tobacco control using the State of Tobacco Control grading framework. **Objective:** To gain an updated understanding of how recent efforts in tobacco control have impacted tobacco use across the United States, using yearly State of Tobacco Control TCM assessments. **Design:** The independent TCM variables of smoke-free air score, cessation score, excise tax, and percentage of recommended funding were selected from the American Lung Association State of Tobacco Control reports. Predictors of adult smoking rates were determined by a mixed-effects model. **Setting/Participants:** The 50 US states and District of Columbia. **Main Outcome Measure:** Adult smoking rate in each state from 2011 to 2013. **Results:** The average adult smoking rate decreased significantly from 2011 to 2013 (21.3% [SD: 3.5] to 19.3% [SD: 3.5],  $P = .016$ ). All forms of TCMs varied widely in implementation levels across states. Excise taxes ( $\beta = -.812$ ,  $P = .006$ ) and smoke-free air regulations ( $\beta = -.057$ ,  $P = .008$ ) were significant, negative predictors of adult smoking. Cessation services ( $\beta = .015$ ,  $P = .46$ ) did not have a measurable effect on adult smoking. **Conclusion:** Tobacco control measures with the strongest influence on adult smoking include the state excise tax and state smoke-free air regulations. The lack of robust

funding for tobacco cessation services across the majority of US states highlights an important shortfall in current tobacco control policy.

**KEY WORDS:** excise taxation, prevention, smoke-free, tobacco control policy, tobacco cessation

Tobacco use remains the leading cause of preventable death in the United States. Cigarette smoking causes approximately 1 in every 5 deaths per year and reduces life expectancy by up to 10 years. A large

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volume of research causally connects tobacco use to cancer, cardiovascular disease, and metabolic disease.<sup>1</sup> Despite existing knowledge on the negative impact of tobacco use to health, cigarettes and other forms of tobacco continue to be used by large proportions of the US population. Current estimates indicate that 42.1 million (17.8%) adults in the United States smoke cigarettes.<sup>2</sup>

States and municipalities have instituted a variety of tobacco control measures (TCMs) to address the significant impact tobacco use has on population health.<sup>3,4</sup> The 2014 US Surgeon General report on the health consequences of smoking states that the following TCMs are supported by evidence as effective in both reducing the initiation and increasing the cessation of tobacco use: price increases, smoke-free indoor air policies, tobacco cessation treatments, and mass media campaigns. Despite supporting evidence, however, the current level of TCM implementation by states and communities is inadequate to reach established targets for tobacco use reduction.<sup>5</sup> The degree to which each state implements, enacts, or enforces TCMs varies from year to year and is influenced by factors such as the state's political climate, fiscal limitations, and tobacco industry opposition.<sup>6,7</sup>

We sought to gain an updated understanding of how recent efforts in tobacco control have impacted tobacco use across the United States using the most recent available data. We used the established assessment of TCMs completed each year by the American Lung Association (ALA) to identify those TCMs that have the strongest impact on the adult smoking rate across time. For the past 12 years, the ALA has tracked and evaluated tobacco control policies at both the state and federal levels, publishing an annual State of Tobacco Control (SOTC) report. Within the SOTC, states and the federal government are assigned grades in primary areas of tobacco control on the basis of the laws and regulations in effect during each evaluation period; the areas assessed at the state level are tobacco prevention and control spending, smoke-free air laws, state cigarette excise tax, and cessation treatment coverage.<sup>4</sup>

The results of this analysis should yield insight to policy makers on the current SOTC implementation, the impact of active policies on the prevalence of cigarette use, and areas of tobacco control that can be bolstered to strengthen state efforts to reduce tobacco consumption.

## ● Methods

### Variable selection

The outcome for these analyses—the adult smoking rate—was obtained from the Behavioral Risk Fac-

tor Surveillance Survey (BRFSS), which is made publicly available by the Centers for Disease Control and Prevention (CDC).<sup>8</sup> Differences in BRFSS sampling methodologies prevent the comparison of data collected before and after 2010; we chose to focus on the most recently collected data from 2011 to 2013. Independent variables were selected from the ALA's SOTC reports for the years 2011 through 2013, and include the following:

1. American Lung Association smoke-free score: Quantitative score of the level of smoking restriction and enforcement in specific locations. Points are awarded up to 40 for states without casinos and up to 44 for states with casinos; states can be awarded an additional 7 bonus points if certain laws meet targeted criteria.
2. American Lung Association cessation score: Quantitative score of the level of support for smoking cessation under Medicaid and state employee health plans and the investment per smoker devoted to the state quitline (a phone counseling service for tobacco users available in all 50 states). Points are awarded up to 60, with an additional 5 bonus points available for coverage standards for private insurance.
3. Total funding for tobacco prevention and control as a percentage of the level of spending recommended by the CDC.
4. State cigarette excise tax (per pack of 20).

American Lung Association smoke-free air scoring is based upon 10 categories: Government Workplaces, Private Workplaces, Schools, Child Care Facilities, Restaurants, Bars, Retail Stores, Recreational/Cultural Facilities, Penalties, and Enforcement; an 11th category was added to assess regulations in states that have casinos and gambling establishments outside of Native American territories. American Lung Association cessation scoring is based upon Medicaid coverage of cessation services, state employee health plan coverage of cessation services, and investment per smoker in state quitlines. To enable comparison of scores between states, percentages were calculated from each state's total points out of the maximum available. Bonus points were awarded in some categories, but these points were not counted toward the maximum totals; therefore, state scores can exceed 100%.<sup>4</sup>

Percent CDC-recommended funding is based upon the total amount that states spend on tobacco control (including federal grants from the CDC and the Food and Drug Administration) as a percentage of the CDC-recommended level of tobacco control spending.<sup>4</sup> Each state's CDC-recommended level is calculated separately on the basis of adult population, school enrollment, and smoking prevalence, and includes a budget for statewide programs, community programs, school

programs, tobacco-related disease programs, enforcement, counter-marketing, cessation services, surveillance, evaluation, and administration.<sup>9</sup>

Control variables for state demographic characteristics were also selected for these analyses on the basis of their association with tobacco use established in prior literature: percent female population; percent African American, Native American, Asian, Native Hawaiian/Pacific Islander, and white and Hispanic population; and median household income.<sup>5,10,11</sup> These data were collected from the US Census Bureau American Community Survey.<sup>12,13</sup> Monetary variables were transformed into constant 2011 dollars using the Bureau of Labor Statistics Consumer Price Index to adjust for inflation.<sup>14</sup> This study utilized publicly available secondary data and was thus exempt from ethical review as human subjects research.

## Analysis

Descriptive statistics for state demographic characteristics, TCMs, and adult smoking rate were calculated by year. For ALA cessation score and ALA smoke-free air score, descriptive statistics on score components were calculated on 153 state-years in aggregate (50 states plus the District of Columbia over a 3-year period). Differences across years were calculated using 1-way repeated measures analysis of variance. Predictors of smoking rates over the 3-year period were determined by a mixed-effects model using maximum likelihood estimating method with unstructured covariance controlling for random effects of intercept. Covariates with  $P < .20$  in a univariate analysis were candidate variables for multivariable analysis and were manually se-

lected in a backward fashion at .05 significance level, with the exception of ALA cessation score, which was forced into the final model as it was determined a priori as a variable of interest. All possible interactions were assessed in the final multivariable model. All statistical analyses were conducted in SAS 9.3 (SAS Institute, Cary, North Carolina).

## Results

Table 1 displays the descriptive statistics across 3 years for the state demographic characteristics, TCMs, and adult smoking rate. Changes across time within the state demographic characteristics and TCMs were not significant (see Table 1). The average adult smoking rate across the 50 states decreased significantly from 21.3 (SD: 3.5) in 2011 to 19.3 (SD: 3.5) in 2013 ( $P < .05$ ).

A summary of the score components for ALA smoke-free score and ALA cessation score is presented in Table 2; the mean scores represent the average number of points obtained for each component category across the 153-state years in our sample. American Lung Association smoke-free air regulations varied widely across states. One state, Wyoming, did not score a single point in any category in any year; whereas the highest-scoring state, Illinois, had a score of 109% during all 3 years of the study. Across state-years, regulations were strongest in childcare facilities and schools; regulations were weakest in private workplaces and casinos/gaming establishments. The scores for penalties and enforcement indicate that exceptions or delays to penalties exist for individuals, proprietors, and employers who violate smoke-free air legislation, and that

**TABLE 1 ● State Demographic Characteristics, Tobacco Control Measures, and Adult Smoking Rate by Year, 2011-2013**

|   | 2011          |                | 2012          |                | 2013          |                | <i>P</i> <sup>a</sup> |
|---|---------------|----------------|---------------|----------------|---------------|----------------|-----------------------|
|   | Mean (SD)     | Observed Range | Mean (SD)     | Observed Range | Mean (SD)     | Observed Range |                       |
| <i>State demographic characteristics</i>  |               |                |               |                |               |                |                       |
| % Hispanic Population                     | 10.79 (10.01) | 1.1-46.7       | 10.97 (10.03) | 1.30-47.00     | 10.93 (10.07) | 1.40-47.30     | .99                   |
| % African American population             | 12.13 (11.12) | 0.70-51.20     | 12.24 (11.04) | 0.80-50.80     | 12.29 (11.03) | 0.70-50.20     | .99                   |
| % Female                                  | 50.70 (0.76)  | 48.40-52.70    | 12.24 (11.04) | 0.80-50.80     | 12.29 (11.03) | 0.70-50.20     | .88                   |
| Median household income (\$) <sup>b</sup> | 50 899 (8442) | 36 919-70 004  | 50 921 (8489) | 36 343-69 680  | 52 613 (9990) | 36 656-84 203  | .55                   |
| <i>Tobacco control measures</i>           |               |                |               |                |               |                |                       |
| ALA smoke-free score                      | 33.53 (13.10) | 0.00-48.00     | 34.37 (12.67) | 0.00-48.00     | 34.37 (12.67) | 0.00-48.00     | .93                   |
| ALA cessation score                       | 31.51 (9.12)  | 7.00-49.00     | 31.20 (7.34)  | 12.00-46.00    | 31.88 (7.86)  | 9.00-48.00     | .91                   |
| % CDC funding level                       | 27.44 (24.74) | 1.95-114.23    | 25.55 (24.84) | 2.17-110.51    | 26.20 (25.43) | 2.05-114.77    | .93                   |
| Excise Tax per pack of 20 (\$)            | 1.47 (0.96)   | 0.17-4.35      | 1.48 (0.97)   | 0.17-4.35      | 1.53 (1.01)   | 0.17-4.35      | .94                   |
| <i>Adult smoking rate</i>                 | 21.27 (3.45)  | 11.80-29.00    | 19.83 (3.59)  | 10.60-28.30    | 19.31 (3.49)  | 10.30-27.30    | .016                  |

Abbreviations: ALA, American Lung Association; CDC, Centers for Disease Control and Prevention.

<sup>a</sup>One-way repeated measures analysis of variance comparing mean values across years.

<sup>b</sup>Variable was not included in final mixed-effects model.

**TABLE 2 • Summary of State Performance on ALA Tobacco Control Measure Score Components Across 153 State-Years, 2011-2013**

| ALA TCM Score Components                      | Mean Score (SD) | Maximum Score Available | Observed Score Range |
|---|-----------------|-------------------------|----------------------|
| ALA smoke-free score                          |                 |                         |                      |
| Casinos/gaming establishments                 | 2.3 (1.7)       | 4                       | 0-4                  |
| Retail stores                                 | 3.1 (1.5)       | 4                       | 0-4                  |
| Recreational/cultural facilities              | 3.2 (1.4)       | 4                       | 0-4                  |
| Childcare facilities                          | 3.6 (1.0)       | 4                       | 0-4                  |
| Enforcement                                   | 2.8 (1.4)       | 5                       | 0-5                  |
| Private workplaces                            | 3.0 (1.7)       | 5                       | 0-5                  |
| Restaurants                                   | 3.1 (1.5)       | 5                       | 0-5                  |
| Bars/Taverns                                  | 3.4 (1.9)       | 5                       | 0-5                  |
| Penalties                                     | 3.4 (1.3)       | 5                       | 0-5                  |
| Government workplaces                         | 3.5 (1.3)       | 5                       | 0-5                  |
| Schools                                       | 3.8 (1.0)       | 5                       | 0-5                  |
| ALA cessation score                           |                 |                         |                      |
| State employee plan coverage without barriers | 1.0 (0.3)       | 2                       | 0-2                  |
| State employee plan medication coverage       | 2.4 (1.1)       | 4                       | 0-4                  |
| Private insurance coverage mandate            | 0.5 (1.2)       | 5                       | 0-5                  |
| State employee plan counseling coverage       | 2.2 (1.2)       | 5                       | 0-5                  |
| Medicaid counseling coverage                  | 4.4 (2.9)       | 10                      | 0-10                 |
| Medicaid coverage without barriers            | 6.3 (1.9)       | 10                      | 2-10                 |
| Medicaid medication coverage                  | 8.4 (2.1)       | 10                      | 2-10                 |
| Quitline investment per smoker                | 6.6 (6.2)       | 20                      | 0-20                 |

Abbreviations: ALA, American Lung Association; TCM, tobacco control measure.

states did not always have designated enforcement authorities, nor required sign posting in smoke-free spaces.<sup>4</sup>

On average, states achieved higher ALA cessation score points for Medicaid medication coverage than those for Medicaid counseling coverage; this pattern is repeated for medication and counseling coverage by state employee health plans. No state-year earned full points for addressing barriers to coverage within Medicaid, and only 9 state-years received full points for addressing barriers to coverage in state employee health plans. Only 2 states, Rhode Island and New Mexico, have legislation requiring private insurance plans to

cover cessation medications and counseling. Only 13 state-years received a full score (spending \$9.50 per smoker) for investment in the state quitline; conversely, 63 state-years spent less than \$1.40 per smoker, which is 10 times below the recommended amount.

On average, states achieved between 25% and 27% of the CDC-recommended funding level for tobacco control in 2011-2013 (Table 1). However, the range of recommended funding achievement varied widely across the 153 state-years, with some dedicating funding over 100% the recommended level and others achieving only 2% of the recommended funding level for tobacco control. The cigarette excise tax rate was, on average, between \$1.47 and \$1.53 per pack of 20 during each year in the study period. However, as with the percentage of CDC-recommended funding in place, the excise tax rate varied widely across the 153 state-years.

Within the mixed-effects model, the time trend was the strongest significant predictor of the adult smoking rate and pointed toward a decrease in adult smoking across the 3 years under analysis (Table 3). For every additional year advanced from 2011, the adult smoking rate decreased by almost 1 full percentage point ( $\beta = -.913$ ,  $P < .001$ ). Among the TCMs evaluated in this analysis, the state excise tax rate was a strong predictor of the adult smoking rate: for every \$1 increase in the excise tax rate, the adult smoking rate decreased by 0.81% ( $P = .006$ ). The ALA smoke-free score was also a significant predictor of a reduction in the adult smoking rate ( $\beta = -.057$ ,  $P = .008$ ). The percentage of the CDC-recommended funding level in place was significantly associated with an increase in the adult smoking rate ( $\beta = .023$ ,  $P = .047$ ). The ALA cessation score did not have a significant effect on the adult smoking rate.

The state racial/ethnic composition variables of percent African American and percent Hispanic population were the only demographic characteristics included in the final analysis; no other demographic variables were associated with adult smoking rate in

**TABLE 3 • Association of Tobacco Control Measures and State Adult Smoking Rate: Mixed-Effects Model, 2011-2013**

| Variable                      | Coefficient (SE) | P     |
|-------------------------------|------------------|-------|
| Time                          | -0.913 (0.076)   | <.001 |
| Excise tax per pack of 20     | -0.812 (0.307)   | .006  |
| ALA smoke-free score          | -0.057 (0.021)   | .008  |
| ALA cessation score           | 0.015 (0.020)    | .458  |
| % CDC funding level           | 0.023 (0.011)    | <.05  |
| % African American population | 0.062 (0.033)    | .066  |
| % Hispanic population         | -0.112 (0.033)   | .001  |

Abbreviations: ALA, American Lung Association; CDC, Centers for Disease Control and Prevention.



univariate models and were thus excluded from the final mixed-effects model. A 1% increase in the state's Hispanic population was associated with a decrease in the adult smoking rate of 0.11% ( $P = .001$ ); a 1% increase in the state's African American population was associated with a non-significant increase in the adult smoking rate ( $\beta = .062$ ,  $P = .066$ ).

## ● Discussion

### Tobacco control regulations

Current literature provides strong support for the efficacy of price increases in reducing the initiation and continued use of tobacco products, particularly cigarettes.<sup>15</sup> Using an updated measure of self-reported adult tobacco use across the United States, the findings of our analyses provide corroborating evidence that excise taxes are one of the most effective TCMs states can adopt to tackle tobacco use. Thus, states wishing to reduce the number of adults currently smoking, as well as prevent initiation, can utilize price increases at the point of sale through excise taxes as one method to achieve this end. It is important to note, however, that it is essential that the equity and efficacy of excise tax implementation be considered in the drive for improved public health. For those individuals who have difficulty quitting, excise taxes can cause economic hardship and may require the provision of additional support through cessation services to ease this burden.<sup>16,17</sup>

Our analyses also indicate that smoke-free legislation is a strong state-level TCM. The CDC defines comprehensive smoke-free laws as those that prohibit smoking in all indoor areas of private workplaces, restaurants, and bars, without exception. One important component of smoke-free air laws is that they are comprehensive.<sup>18-20</sup> Laws that are not comprehensive may have exemptions for certain industries or spaces, such as casinos and drinking establishments.<sup>21</sup> Another important component of these laws is that they are adequately enforced; many states and cities rely on self-enforcement of smoke-free regulations. The low scores observed for the enactment of regulations across all facilities and locations, as well as for the enforcement of smoke-free air regulations, across the 153 state-years in this study indicate that states and municipalities in the United States can strengthen the breadth of their smoke-free regulations to be more comprehensive, as well as increase enforcement of existing regulations, in order to make a stronger impact on tobacco control. Smoke-free laws reduce opportunities, both real and perceived, for smokers to use cigarettes, and some argue that the implementation of these laws may be the initial step to changing social norms toward the acceptability of tobacco use.<sup>22-26</sup>

Although this study did not find a significant relationship between ALA cessation score and adult smoking rate after adjustment, other studies have demonstrated the economic and health value of cessation services. For example, quitlines have been shown to make quit attempts 40% more successful and are estimated to cost only \$400 per year of life added.<sup>27</sup> One reason this study may have failed to measure ALA cessation score as a significant predictor is that cessation services are underfunded nationwide, despite their demonstrated merit as an effective TCM. Coverage of cessation services under health insurance plans also remains spotty in many states. Out of the 153 state-years considered in the study, only 3 received an ALA cessation grade of a "B" or above, which corresponds to 48 points out of 60. To detect an effect on the adult smoking rate, it is possible that additional funding must be invested into and additional coverage must be obtained for cessation services, with a focus on counseling coverage and quitlines. Offering cessation services to low-income individuals is especially important, not only because smoking rates are higher in this population but also because these individuals are less capable of paying for cessation services out-of-pocket.<sup>4</sup> Another possible reason why ALA cessation score was not a significant predictor after adjustment is that the effectiveness of cessation services depends critically on the will of smokers to quit and their engagement in available services, which is not created by the provision of cessation services alone. Thus, our state-level policy variable measuring the availability of cessation services would not have captured the degree to which individuals engage with and benefit from those services provided. Similarly, the variable we employed would not capture the level to which cessation coverage is utilized at the practice level. There may be great variability, for example, in the extent to which clinicians probe for or offer cessation services, regardless of coverage.

Another surprising finding of this study is that the percentage of CDC-recommended funding that states dedicated to tobacco control was a positive predictor of adult smoking rate. Current evidence indicates that statewide tobacco control programs are effective at reducing smoking, and that programs with more available funds have a larger impact.<sup>28-30</sup> One possible explanation of our incongruous finding is that the percentage of CDC-recommended funding variable does not provide adequate granularity to distinguish the varying dedication of funds within tobacco control programs in each state, and states with a high amount of overall funding may be underfunding one or more components of a comprehensive program that impact adult smoking.<sup>31</sup> States dedicating larger proportions of funding to program planning and development, rather than program implementation, may not have a

measurable impact on the adult smoking rate until future years.<sup>28</sup> In addition, it is possible that states with a higher need for tobacco control dedicate a larger budget to combating tobacco use, although this concept requires further investigation and substantiation.

### Limitations

Since Americans are increasingly relying solely upon cell phones for telephone communication, the 2011 BRFSS began to incorporate cell phones into the sample population, which was previously exclusive to landlines. In addition, the 2011 BRFSS began to use ranking as the sole statistical weighting method, as opposed to poststratification. Because of these methodological changes, prevalence estimates from the BRFSS 2011 are not comparable with those from earlier versions of the survey.<sup>32</sup> Since our outcome variable, adult smoking rate, was taken from BRFSS data, our analyses were limited to a 3-year time frame. This short time horizon may have inhibited our ability to detect the statistical influence of the independent variables; future analysis with a larger sample of data years will provide a more robust evaluation of the impact of current TCMs.

Another limitation is that this study does not comprehensively examine all forms of tobacco control. States may have various media campaigns, evidence-based interventions, and legislation on tobacco marketing and sales<sup>33,34</sup>; current evidence suggests that these forms of tobacco control have independent effects on tobacco use.<sup>5,35</sup> These forms of tobacco control are not directly evaluated within the ALA's SOTC reports and were thus not captured by our methodology. In addition, we did not evaluate all sources and amounts of funding devoted to tobacco control. Non-profit spending within states was not measured, and the relationship between the mix of state-federal funding and tobacco control was not evaluated. We plan to more closely examine the funding structure associated with tobacco control in a future article.

Another limitation that must be acknowledged centers on the ALA SOTC variables themselves. While the ALA has been conducting annual SOTC reports for the past 13 years, utilizing a well-documented methodology to assign scores, the fact remains that the variables used in these analyses are proxy measures for the implementation of population policy levers designed to impact individual behavior regarding tobacco use. These measures may not have adequate granularity to account for the processes on the ground that directly impact adult smoking and may thereby fail to fully capture the impact of TCMs. Nevertheless, our analyses demonstrated findings consistent with existing theory regarding the impact of key TCMs.

### Conclusion

The results of our analyses indicate that the adult smoking rate is decreasing over time within the United States. Tobacco control measures with the strongest influence on the adult smoking rate include the state excise tax and state smoke-free air regulations, both of which have a strong track record of high public support.<sup>36-38</sup> Policy makers wishing to reduce levels of adult tobacco use within their state may look to strengthening gaps in existing TCMs. Specifically, the lack of robust funding for tobacco cessation services and lack of coverage requirements under health insurance plans across the majority of US states highlights an important shortfall in current tobacco control policy. Increased funding and coverage for tobacco cessation services, including both insurance coverage benefits and state quitlines, will likely impact the adult smoking rate, as current smokers turn to these services when faced with increased regulation over the price and use of tobacco products.

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