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Healthy People Countdown 2030: reaching 5% cigarette smoking prevalence among US adults through state cigarette excise tax increases

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ABSTRACT

Objective The Healthy People 2030 goal is to reduce US current adult cigarette smoking prevalence to 5% by 2030. The objective of this report is to investigate if this goal is achievable using state cigarette excise tax increases.

Methods State-specific linear trends in smoking prevalence over 2011–2019 were determined using fractional logit regression and compared with the desired linear trends for achieving 5% smoking prevalence by 2030 in individual states and the District of Columbia (DC). The gaps between price-adjusted and desired trends were used in a simulation model for identifying state-specific systematic annual increases in state cigarette excise tax rates based on state-specific price elasticity of smoking prevalence, maintaining the status quo in other non-tax tobacco control measures.

Results The price-adjusted trends in smoking prevalence observed over 2011–2019 exceed the desired trends for achieving 5% smoking prevalence target by 2030 in only five states (eg, Washington, Utah, Rhode Island, Massachusetts and Maryland) and the DC. It suggests that majority of states and USA overall will miss the target smoking prevalence at the current rate of reduction in smoking. 45 states would need systematic annual increases in cigarette excise tax rate in a range of \$0.02–\$1.37 per pack over 2022–2030 to meet the target.

Conclusions The feasibility of reaching the Healthy People 2030 goal would critically depend on the acceleration of progress in tobacco control. Tax increases tailored to the needs of individual states combined with scaled-up non-tax tobacco control policy interventions can help achieve the desired progress.

INTRODUCTION

USA experienced two-thirds reduction in adult smoking prevalence from 42.4% to 13.7% over 1965–2018.¹ The Healthy People goal is to reduce it to 5% by 2030.² The feasibility of achieving this goal is yet to be tested in view of the recent progress in tobacco control. In this report, state-specific trends in smoking prevalence over 2011–2019 were compared with the desired trends for achieving 5% smoking prevalence by each state. The gaps between price-adjusted and desired trends were used as the basis for state-specific interventions through systematic annual increases in state cigarette excise tax, maintaining the status quo in non-tax tobacco control measures.

Previous research applied several microsimulation and macrosimulation models to project

the effects of tobacco tax increases on population health and economic outcomes.^{3–12} Only one of these studies explored the potential of reaching the Healthy People 2010 goal of reducing smoking prevalence to 12% by simulating the combined effect of national level tax and price increase, smoke-free indoor air law, mass media campaign and cessation support.¹² The present study simulates the effect of cigarette tax and price increases only in reducing adult cigarette smoking prevalence to 5% by 2030. The major innovation in this paper is to make state-specific projections that can better inform state-level tobacco control interventions.

METHODS

The analysis was conducted in three stages in a simulation model using STATA (V.15; Stata) and Microsoft Excel. First, the existing trends in smoking prevalence in state s in terms of average annual change in percentage points (pp) adjusted for price changes were determined using fractional logit regression (a generalised linear model for dependent variables bounded between 0 and 1) of smoking prevalence on the year variable and average state-level cigarette prices based on historical annual data from the Behavioral Risk Factor Surveillance System (BRFSS) and the Tax Burden on Tobacco (TBOT) database over 2011–2019.^{13–15} The regression equation estimated for each state separately is given by: $Y_{st} = \alpha_{sp} + \beta_s^{ep}t + \beta_{sp}P_{st} + v_{st}$, where Y_{st} is adult cigarette smoking prevalence (%) in state s in year t , α_{sp} is the state-specific intercept, β_s^{ep} represents the existing trend adjusted for the effects of price changes, P_{st} is the average cigarette price per pack in state s in year t , β_{sp} is the state-specific coefficient of price changes and v_{st} is the random disturbance term and $t=2011, 2012, \dots, 2019$. Thus, the sample size for each regression run for individual states was nine to allow for nine data points between 2011 and 2019.

Second, the state-wise desired trends (in pp) were determined by the linear trend required to reduce smoking prevalence from the baseline level to the 5% target by 2030. Suppose the desired annual trend is β_s^d pp. So, $Y_{s,2021} - 9\beta_s^d = Y_{s,2030} = 5$ or $\beta_s^d = (Y_{s,2021} - 5)/9$. The price-adjusted trends (β_s^{ep}) were used to calculate the 'gap' ($\beta_s^{ep} - \beta_s^d$).

Third, the marginal effects of price on smoking prevalence among US adults by age group estimated by Sloan and Trogdon based on BRFSS data for 1992–2002 were used to obtain average marginal effect size (β_1) of -0.0096 for the overall population.¹⁶ It was then used to estimate



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state-specific price elasticity of smoking prevalence for each year as $C_{st} = \beta_1 \times (P_{st}/Y_{st})$. Thus, the price elasticity estimates were adjusted for higher prices and lower smoking prevalence in each successive year. The price elasticity estimates in year t were then used to estimate the required percentage increase in price to achieve the target reduction in smoking prevalence in year $t+1$ for each year from 2022 through 2030 using the formula:

$$\frac{P_{s,t+1} - P_{st}}{P_{st}} = \frac{1}{\epsilon_{st}} \left(\frac{\beta_s^d - \beta_s^{ep}}{Y_{st}} \right)$$

The year-on-year increase in price necessary to achieve a target reduction in smoking prevalence was then translated into year-on-year increase in state cigarette excise tax under the assumption of full pass-through of tax increase to price. In other words, $TAX_{s,t+1} = TAX_{st} + (P_{s,t+1} - P_{st})$, where TAX_{st} is state cigarette excise tax per pack in state s in year t .

The baseline for the projection of tax and price increases was set in 2021. The unadjusted trends in smoking prevalence estimated from the equation $Y_{st} = \alpha_s + \beta_s^e t + u_{st}$, where α_s is the state-specific intercept, β_s^e is the unadjusted trend in smoking prevalence in state s , and u_{st} is the random disturbance term, which were used to extrapolate from 2019 to initialise smoking prevalence in the baseline year 2021. The smoking prevalence in the baseline year 2021 was thus estimated using the equation: $Y_{s,2021} = Y_{s,2019} + 2\beta_s^e$, where $Y_{s,2019}$ is the latest smoking prevalence data for state s in 2019 available from the BRFSS. The unadjusted trend β_s^e was multiplied with 2 to account for 2 years from 2019 to 2021. The projections were adjusted for tax increases in Colorado and Oregon in 2021 and in Virginia in 2020. The projections for Colorado and Oregon states were given by $Y_{s,2021} = (Y_{s,2019} + \beta_s^e)(1 + \epsilon_{s,2020} \times (P_{s,2021} - P_{s,2020})/P_{s,2020}) + \beta_s^{ep}$. The projection for Virginia was given by $Y_{s,2021} = Y_{s,2019} (1 + \epsilon_{s,2019} \times (P_{s,2020} - P_{s,2019})/P_{s,2019}) + \beta_s^{ep} + \beta_s^e$.

As TBOT data on tax and prices are available only up to 2019, the tax rates were updated up to the baseline year 2021 based on the announcements of tax increases by state revenue authorities. The state average cigarette prices for 2020 and 2021 were predicted based on a price regression given by: $P_{st} = \gamma_0 + \gamma_1 TAX_{st} + \gamma_2 E_{st} + \gamma_3 + \sum \gamma_3 D_{st}$, where γ_s is the state fixed effect, D_{st} represents the state-specific time trend and P_{st} , TAX_{st} and E_{st} are the price, tax and median earnings of state s in year t as defined before.

RESULTS

The baseline cigarette smoking prevalence varies widely from a low of 7.1% in Utah to 22.7% in West Virginia in 2021 (table 1). The price-adjusted trends over 2011–2019 also varies widely from -1.13 pp in the District of Columbia (DC) to 0.00 pp in Hawaii and Montana. The desired annual trends varies from -0.23 pp in Utah to -1.97 pp in West Virginia. The price-adjusted trends exceed the desired trends for only five states (eg, Washington, Utah, Rhode Island, Massachusetts and Maryland) and the DC which are on target. Among the remaining states, California with a trend gap of -0.02 pp is closest to the target, while West Virginia with a trend gap of -1.31 pp needs to catch up most.

At the price-adjusted trends, the DC is projected to hit the lowest smoking prevalence of 0.5% while West Virginia will remain at the top at 16.8% by 2030, bringing the state average (weighted by state adult population in 2019) price-adjusted expected smoking prevalence down from 13.6% in 2021 to 8.4% in 2030.

Notes

- ▶ The smoking prevalence in the baseline year 2021 (column 2) was projected using the equation: $Y_{s,2021} = Y_{s,2019} + 2\beta_s^e$, where $Y_{s,2019}$ is the latest smoking prevalence data for state s in 2019 available from the BRFSS, β_s^e is the unadjusted linear trend which is multiplied with 2 to account for 2 years from 2019 to 2021. The projections were adjusted for tax increases in Colorado and Oregon in 2021 and in Virginia in 2020. The projections for Colorado and Oregon states were given by $Y_{s,2021} = (Y_{s,2019} + \beta_s^e)(1 + \epsilon_{s,2020} \times (P_{s,2021} - P_{s,2020})/P_{s,2020}) + \beta_s^{ep}$. The projection for Virginia was given by $Y_{s,2021} = Y_{s,2019} (1 + \epsilon_{s,2019} \times (P_{s,2020} - P_{s,2019})/P_{s,2019}) + \beta_s^{ep} + \beta_s^e$.
- ▶ The price-adjusted expected smoking prevalence in 2030 (column 3) was calculated using the formula: $Y_{s,2021} = Y_{s,2019} + 9\beta_s^{ep}$ accounting for linear trend over 9 years from 2021 to 2030.
- ▶ The desired average annual changes (β_s^d) (column 4) were estimated using the formula: $\beta_s^d = (Y_{s,2021} - Y_{s,2019})/9$.
- ▶ The price-adjusted average annual changes (β_s^{ep}) (column 5) were estimated using the fractional logit regression: $Y_{st} = \alpha_s + \beta_s^{ep} t + \beta_s P_{st} + v_{st}$.
- ▶ The state average cigarette prices for 2021 (column 7) were predicted based on the estimated price equation:

$$P_{st} = 5.28^{***} + 0.53^{***} TAX_{st} + 0.02 E_{st} + \gamma_s + \sum \gamma_3 D_{st}$$

where γ_s is the state fixed effect, D_{st} represents the state-specific time trend, and P_{st} , TAX_{st} and E_{st} are the price, tax and median earnings, respectively, of state s in year t . *** stands for significance at 1% level. Since the coefficient of the earnings variable is statistically insignificant, only the tax increases were considered for prediction.

- ▶ The price elasticity estimates for state s in year t (st) were used to estimate the required percentage increase in price to achieve the target reduction in smoking prevalence in year $t+1$ for each year from 2022 through 2030 using the formula:

$$\frac{P_{s,t+1} - P_{st}}{P_{st}} = \frac{1}{\epsilon_{st}} \left(\frac{\beta_s^d - \beta_s^{ep}}{Y_{st}} \right)$$

The target prices for only 2030 are reported in column 8 for brevity of presentation.

- ▶ As TBOT data on tax and prices are available only up to 2019, the tax rates were updated up to the baseline year 2021 (column 9) based on the announcements of tax increases by state revenue authorities.
- ▶ The year-on-year increase in price necessary to achieve a target reduction in smoking prevalence was translated into year-on-year increase in state cigarette excise tax under the assumption of full pass-through of tax increase to price, that is, $TAX_{s,t+1} = TAX_{st} + (P_{s,t+1} - P_{st})$, where TAX_{st} is state cigarette excise tax per pack in state s in year t . The target tax rates for only 2030 are reported in column 10 for brevity of presentation.
- ▶ The price and tax in 2030 and corresponding price increases are not shown in this table for the states for which the price-adjusted trend (β_s^{ep}) exceeded the desired trend (β_s^d).

The state-level estimates of price elasticity of smoking in 2021 vary from -0.25 in Kentucky to -0.93 in Utah. The state-specific price elasticity estimates by year from 2021 to 2029 are provided in online supplemental Table A1.

After adjustment for effects of price changes, 45 states were found in need of catching up with desired trends using tax increases. Based on the estimated elasticities, the required annual average cigarette excise tax increase ranges from \$0.02

Table 1 Price-adjusted and desired trends in adult cigarette smoking prevalence over 2022–2030 and current and target average cigarette price and excise tax (in 2021 US\$) by state in the USA in 2021 and 2030

State	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Smoking prevalence (%), 2021	Price-adjusted expected smoking prevalence (%), 2030	Desired average annual change (percentage point) in smoking prevalence over 2022–2030 to reach target (β_s^d)	Price-adjusted average annual change (percentage point) (β_s^{ep})	Price-adjusted average annual price reduction (percentage point) in smoking prevalence ($\beta_s^d - \beta_s^{ep}$)	Average cigarette price (\$), 2021	Average cigarette price per pack, 2030 (in 2021 \$)	State cigarette tax (\$), 2021	State cigarette tax (\$), 2030 (in 2021 \$)	Average annual increase in cigarette tax per pack over 2022–2030 (in 2021 \$)
Alabama	19.3	14.3	-1.59	-0.56	-1.03	5.59	15.29	0.68	10.37	1.08
Alaska	16.4	12.7	-1.27	-0.41	-0.85	9.57	17.62	2.00	10.05	0.89
Arizona	13.9	6.7	-0.99	-0.80	-0.19	7.52	9.31	2.00	3.80	0.20
Arkansas	18.8	12.4	-1.53	-0.71	-0.83	6.10	13.88	1.15	8.93	0.86
California	9.2	5.2	-0.47	-0.45	-0.02	8.02	8.19	2.87	3.04	0.02
Colorado	11.9	7.7	-0.81	-0.47	-0.29	6.59	9.36	1.94	4.72	0.31
Connecticut	10.8	5.7	-0.64	-0.56	-0.08	9.91	10.66	4.35	5.11	0.08
Delaware	14.5	8.4	-1.06	-0.68	-0.38	6.89	10.48	2.10	5.68	0.40
District of Columbia	10.7	0.5	-0.63	-1.13	0.50	9.92		4.94		
Florida	13.8	9.1	-0.97	-0.52	-0.45	6.18	10.46	1.34	5.62	0.48
Georgia	15.1	9.6	-1.13	-0.61	-0.51	5.27	10.11	0.37	5.21	0.54
Hawaii	11.5	11.5	-0.72	0.00	-0.72	9.50	16.32	3.20	10.02	0.76
Idaho	14.6	11.6	-1.07	-0.34	-0.73	5.68	12.56	0.57	7.45	0.76
Illinois	13.1	9.1	-0.91	-0.45	-0.45	7.65	11.94	2.98	7.27	0.48
Indiana	18.0	11.6	-1.44	-0.70	-0.74	5.76	12.72	1.00	7.96	0.77
Iowa	15.5	11.5	-1.17	-0.45	-0.72	6.33	13.08	1.36	8.12	0.75
Kansas	15.0	9.0	-1.11	-0.66	-0.45	6.27	10.49	1.29	5.51	0.47
Kentucky	22.2	15.4	-1.91	-0.75	-1.16	5.72	16.66	1.10	12.04	1.22
Louisiana	20.9	16.6	-1.77	-0.48	-1.29	5.95	18.08	1.08	13.21	1.35
Maine	16.5	11.1	-1.28	-0.59	-0.68	7.24	13.67	2.00	8.44	0.72
Maryland	11.3	4.9	-0.70	-0.71	0.01	6.96		2.00		
Massachusetts	10.8	4.7	-0.64	-0.67	0.03	9.75		3.51		
Michigan	17.5	11.8	-1.39	-0.63	-0.75	6.80	13.91	2.00	9.11	0.79
Minnesota	13.4	9.6	-0.93	-0.42	-0.51	8.99	13.78	3.61	8.41	0.53
Mississippi	19.1	13.2	-1.57	-0.66	-0.91	5.40	13.99	0.68	9.27	0.95
Missouri	18.4	13.0	-1.49	-0.60	-0.89	4.99	13.38	0.17	8.56	0.93
Montana	15.5	15.5	-1.17	0.00	-1.17	6.83	17.86	1.70	12.73	1.23
Nebraska	13.4	7.6	-0.93	-0.64	-0.29	5.59	8.33	0.64	3.38	0.30
Nevada	14.4	7.3	-1.04	-0.79	-0.25	6.85	9.22	1.80	4.17	0.26
New Hampshire	15.3	11.8	-1.14	-0.39	-0.75	6.73	13.80	1.78	8.86	0.79
New Jersey	12.0	6.7	-0.78	-0.59	-0.19	7.79	9.57	2.70	4.47	0.20
New Mexico	14.7	7.3	-1.07	-0.82	-0.25	6.78	9.14	2.00	4.36	0.26
New York	11.5	7.2	-0.72	-0.47	-0.25	10.51	12.86	4.35	6.70	0.26
North Carolina	17.5	12.8	-1.38	-0.52	-0.86	5.21	13.36	0.45	8.60	0.91
North Dakota	15.9	10.1	-1.22	-0.65	-0.57	5.27	10.65	0.44	5.81	0.60
Ohio	19.8	13.9	-1.65	-0.66	-0.99	6.47	15.79	1.60	10.92	1.04

Continued

Table 1 Continued

State	Smoking prevalence (%), 2021	Price-adjusted expected smoking prevalence (%), 2030	Desired average annual change (percentage point) in smoking prevalence over 2022–2030 to reach target (β_i^d)	Price-adjusted average annual change (percentage point) (β_i^{ep})	Difference between desired and price-adjusted average annual reduction (percentage point) in smoking prevalence ($\beta_i^d - \beta_i^{ep}$)	Average cigarette price (\$/per pack, 2021)	Average cigarette price (in 2021 \$)	State cigarette tax (\$/per pack, 2021)	State cigarette tax 2030 (in 2021 \$)	Average annual increase in cigarette tax per pack over 2022–2030 (in 2021 \$)
Oklahoma	17.3	8.4	-1.37	-0.99	-0.38	7.19	10.77	2.03	5.61	0.40
Oregon	12.5	8.1	-0.94	-0.49	-0.34	7.53	10.74	3.33	6.54	0.36
Pennsylvania	16.0	9.6	-1.22	-0.70	-0.52	8.27	13.13	2.60	7.46	0.54
Rhode Island	11.9	4.4	-0.77	-0.83	0.07	9.75	9.97	4.25	5.18	0.51
South Carolina	16.2	9.4	-1.24	-0.75	-0.49	5.36	9.97	0.57	5.18	0.51
South Dakota	17.3	11.2	-1.37	-0.68	-0.69	6.58	13.12	1.53	8.07	0.73
Tennessee	-0.60	-1.54	13.5	18.9	-0.94%	5.32	14.17	0.62	9.47	0.98
Texas	13.7	8.7	-0.97	-0.56	-0.41	6.36	10.20	1.41	5.24	0.43
Utah	7.1	3.3	-0.23	-0.43	0.19	6.92	1.70	1.70	3.08	0.62
Vermont	14.3	10.3	-1.03	-0.44	-0.59	8.73	14.27	3.08	8.62	0.62
Virginia	12.3	5.5	-0.82	-0.76	-0.05	5.64	6.13	0.60	1.09	0.05
Washington	11.3	2.5	-0.70	-0.98	0.27	8.48	3.03	3.03	13.55	1.37
West Virginia	22.7	16.8	-1.97	-0.66	-1.31	6.08	18.43	1.20	4.40	0.21
Wisconsin	14.1	6.8	-1.01	-0.81	-0.20	7.70	9.58	2.52	6.60	0.67
Wyoming	17.3	10.7	-1.37	-0.73	-0.64	5.58	11.58	0.60	6.60	0.67

in California to \$1.37 in West Virginia in 2021. The current and target cigarette prices and excise tax rates per pack in 2021 and 2030 and annual average tax increases over 2022–2030 are presented by state in [table 1](#).

DISCUSSION

The findings in this report suggest that majority of states in the USA and the nation as a whole will miss the Healthy People 2030 target in the absence of accelerated progress in tobacco control measures through the most effective means. To meet the target smoking prevalence of 5% by 2030, 45 states need systematic annual increases in state cigarette excise tax rates while continuing with other tobacco control measures. This requirement stands in sharp contrast with only 22 states increasing cigarette excise tax rates occasionally during 2011–2021. It suggests that cigarette excise tax policy has remained a severely underused measure of tobacco control despite its proven effectiveness in reducing smoking and related health disparities.^{17–20}

The 2014 US Surgeon General’s Report on the health consequences of smoking recommended raising average cigarette retail price to \$10 per-pack or higher across the nation as a key measure to reduce smoking.²⁰ The state-level final prices in 2030 measured in this report as required to fill the ‘gap’ between the desired and the price-adjusted trends are higher than the recommended \$10 minimum in 35 states. These measures, however, refer to an ‘unconstrained’ scenario and do not necessarily reflect the feasible range of tax-induced price increases that may be subject to several political-economic constraints including parity in taxes and prices across states. The baseline state average cigarette prices range from \$4.99 to \$10.51 and the highest price is 2.10 times the lowest price. The desired state average price in 2030 ranges from \$6.13 to \$18.43 where the highest price is 3.01 times the lowest price. To keep the ratio between the lowest and the highest prices at the baseline level, the highest price can be capped at \$12.87 (= \$6.13 × 2.10). There are 21 states that have desired prices in 2030 above this cap and that may need to scale up non-tax tobacco control policy interventions to make up for the ‘gap’.

One major limitation of this study is that it is restricted to tax policy interventions only. The underlying assumption here is that the acceleration of reduction in smoking prevalence would be attained by price increases only. Stronger comprehensive tobacco control measures in addition to tax-induced price increases would imply that the tax and price increases required for the target reduction in smoking prevalence would be lower than those projected in this model. The model thus predicts the upper bound of the tax and price increases for the desired outcome.

During the observation period under study from 2011 to 2019, the federal cigarette tax was not changed. As a result, it was not possible to quantify the effect of a federal tax increase and account for potential federal tax increases in the analysis. Should the federal cigarette tax increase over the projection period of 2022–2030, the required state-level tax increases would be lower than the levels computed in this report.

The tax and price increases envisioned to contribute to the tobacco endgame in the USA are not meant to deny the unintended and adverse financial consequences for the smokers who are unable to quit, specifically among those in the disadvantaged communities. There might be other political-economic constraints, such as increased cross-state cigarette purchases or stronger tobacco industry lobbying resisting tax policy interventions, that can potentially undermine the intended effects

of such measures. It is, therefore, crucial to scale up non-tax tobacco control measures targeted to disadvantaged communities, harmonise tax and price across neighbouring states and monitor and counter tobacco industry interference to mitigate these unintended consequences of tax and price increases.²¹

CONCLUSION

The feasibility of reaching the Healthy People 2030 goal of attaining 5% adult smoking prevalence by 2030 would critically depend on the acceleration of progress in tobacco control. Cigarette tax policy has remained severely underused in mitigating the disease burden of smoking in the US. Tax increases tailored to the needs of individual states with scaled-up non-tax tobacco control measures can help achieve the desired progress.

What this paper adds

What is already known on this subject

- ▶ Smoking causes illnesses among more than 16 million adults and nearly half a million premature deaths in the USA annually.
- ▶ The Healthy People 2030 goal is to reduce current adult cigarette smoking prevalence to 5% by 2030.
- ▶ The 2014 US Surgeon General's Report recommended raising average cigarette retail price to \$10 per-pack or higher across the nation as a key measure to reduce smoking.

What important gaps in knowledge exist on this topic

- ▶ The feasibility of achieving the Healthy People 2030 goal is yet to be tested in view of the recent progress in tobacco control made in the USA.
- ▶ Previous research explored the potential of reaching the Healthy People goal by simulating the combined effect of tax and price increase, smoke-free indoor air law, mass media campaign and cessation support at the national level. Far less is known about how state-level tobacco control interventions can be tailored to help achieve a target level of smoking prevalence across all US states.

What this paper adds

- ▶ In the USA, 45 states need systematic annual increases in cigarette excise tax rate in a range of \$0.02–\$1.37 per pack over 2022–2030 to meet the 5% smoking prevalence target.
- ▶ Tax increases tailored to the needs of individual states with scaled-up non-tax interventions can help achieve the desired progress in tobacco control.

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