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Public health impact of a US menthol cigarette ban on the non-Hispanic black population: a simulation study

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ABSTRACT

Introduction With the US Food and Drug Administration recently proposing to implement a ban on menthol cigarettes, it is critical to estimate the potential public health effects of such a ban. With high rates of menthol cigarette use and important smoking-related health disparity implications, the impact of the ban on the non-Hispanic black (NHB) population merits strong consideration.

Methods We apply the previously developed Menthol Smoking and Vaping Model to the NHB population. A status quo scenario is developed using NHB-specific population, smoking and vaping initiation, cessation and death rates. Estimates from a recent expert elicitation on behavioural impacts of a menthol cigarette ban on the NHB population are used to develop a menthol ban scenario implemented in 2021. The public health impacts of the menthol ban are estimated as the difference between smoking and vaping attributable deaths (SVADs) and life years lost (LYLs) in the status quo and the menthol ban scenarios from 2021 to 2060.

Results Under the menthol ban scenario, overall smoking is projected to decline by 35.7% in 2026 and by 25.3% in 2060 relative to the status quo scenario. With these reductions, SVADs are estimated to fall by about 18.5% and LYLs by 22.1%, translating to 255 895 premature deaths averted, and 4.0 million life years gained over a 40-year period.

Conclusions A menthol cigarette ban will substantially reduce the smoking-associated health impact on the NHB population, thereby reducing health disparities.

INTRODUCTION

Menthol represents 35% of US cigarette sales,¹ and menthol smoking is associated with higher smoking initiation and lower cessation.^{2–5} The US Food and Drug Administration (FDA) has proposed a nationwide ban on menthol cigarettes⁶ but will be required to assess its potential public health impact.^{7 8}

The Menthol Smoking and Vaping Model (SAVM) estimated the public health impact of a menthol ban on the total US population.^{9 10} The recent FDA menthol ban proposal⁶ cited public health impact projections from the original menthol SAVM model¹⁰ in support of banning menthol in cigarettes. On page 93, however, the report noted that failure to separately consider ‘vulnerable populations’, particularly the non-Hispanic black (NHB) population, was a limitation of the analysis. Policy simulation models often lack analyses for specific subpopulations of interest.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ A ban on menthol in cigarettes has been shown to reduce smoking rates and smoking-attributable deaths for the overall population, but less is known about the impact of menthol ban on non-Hispanic blacks. This study evaluates the public health impact of a menthol ban on the non-Hispanic black population.

WHAT THIS STUDY ADDS

⇒ We show that, with a ban on menthol in cigarettes implemented in 2021, non-Hispanic black adult smoking and vaping attributable deaths are estimated to fall by about 18.5% and years of life lost by 22.1% by 2060, translating to 255 895 premature deaths averted, and 4.0 million life years gained over a 40-year period.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE AND/OR POLICY

⇒ Our findings support the implementation of a ban on menthol in cigarettes, resulting simultaneously in considerable health gains and in reductions in health disparities between the non-Hispanic black and the rest of the US population.

Due to their high rates of menthol cigarette use^{11–13} and important smoking-related health disparity implications,^{14 15} we apply the previously developed Menthol SAVM¹⁰ to evaluate the impact of a menthol cigarette ban on the NHB population. We apply NHB-specific population and menthol and non-menthol smoking and nicotine vaping product (NVP) data, develop NHB-specific initiation, cessation and switching rates relative to the total population, and calibrate and validate the model to recent trends in NHB smoking prevalence. We then discuss the impacts of a menthol ban on smoking and mortality outcomes for the NHB population and their implications for racial disparities in mortality rates.

METHODS

The SAVM is a publicly available model¹⁶ that simulates the public health impact of cigarette and NVP use.¹⁷ On distinguishing menthol and non-menthol cigarette use, menthol SAVM¹⁰ projects averted deaths and life years lost (LYLs) from 2013 to 2060



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under status quo and menthol ban scenarios. Further model details can be found elsewhere.¹⁰

Status quo scenario

The NHB observed and projected population and overall mortality rate by single year, age and sex were obtained from CDC Wonder^{18 19} and the US Census Bureau.^{20 21}

To initialise the model, menthol and non-menthol NHB smoking prevalence by age and sex are from the 2013/2014 Population Assessment of Tobacco and Health survey.²² Current smoking is defined as having smoked ≥ 100 cigarettes during one's lifetime and currently smoking at least some days, with menthol smoking defined as the regular brand flavoured to taste like menthol. Smokers become former smokers after having quit for 2 years, thereby reflecting cessation net of relapse. Regular NVP use is defined in terms of at least 10 days use in the last month.

SAVM¹⁷ projects never, current and former smoking prevalence using age-specific and sex-specific initiation and cessation rates estimated by applying an age-period-cohort model to the National Health Interview Survey (NHIS).^{23–26} Using prevalence estimates from the 2014/2015 Tobacco Use Supplement to the Current Population Survey to calibrate to NHB smoking initiation, we scaled US cigarette initiation rates by 0.91, calculated as the ratio of NHB ages 18–34 years to total US ages 18–34 years smoking prevalence. To calibrate NHB smoking cessation, we scaled US cessation rates by 0.81, calculated as the ratio of the total US ages 35+ years to NHB ages 35+ years smoking prevalence.

To distinguish menthol and non-menthol smoking initiation, the proportion of menthol smokers among NHB smokers at age 30 years (males 87.8%; females 86.3%), the age at which menthol and non-menthol prevalence rates tended to stabilise, was applied to smoking initiation rates at each age. To distinguish NHB menthol versus non-menthol cessation rates, we applied results of a meta-analysis,²⁷ which reported that NHB menthol smokers had 12% lower odds of cessation than non-menthol smokers. Similar results were reported by Brouwer *et al.*²⁸

To determine gender-specific and age-specific NHB death rates by smoking status for each year, the ratio of NHB to total US population death rates^{19 21} was applied to US never, current and former smoker death rates.^{23 24 29} Mortality rates of menthol and non-menthol smokers are not distinguished, given limited evidence of differences.^{30 31} To estimate life expectancy for NHB never smokers, the ratio of 2016 NHB life expectancy³² to 2016 US life expectancy³³ was applied to the US never smokers life expectancy by age and gender for 2013–2060.^{23 24 29}

Transitions to NVP use start in 2013. Recent studies^{27 34–37} report lower rates of NVP use among NHB adults than the total adult population. Based on the results from Usidame *et al.*,³⁷ we scaled US NVP prevalence by 70% for the NHB population. Based on lower transition rates from cigarette use to exclusive NVP use among NHB menthol and non-menthol smokers (0.3% and 0.6%) reported by Brouwer *et al.*,²⁸ we estimated that NHB menthol smokers switch from smoking to vaping at 50% of the rate of non-menthol smokers.

Menthol ban scenario

We model a federal menthol cigarette ban implemented in 2021. Although the FDA just recently proposed a menthol ban on cigarettes,⁶ we consider 2021 as the ban implementation date in order to make direct comparisons between the results of the

total US¹⁰ and this (NHB) menthol SAVM model. An expert elicitation on the impact of a menthol ban⁹ found that, of the NHB population who would otherwise initiate into menthol smoking in the absence of a ban, 34.0% would instead become non-menthol smokers, 2.9% illicit menthol smokers, 14.1% NVP users and 49.0% would not use cigarettes or NVPs. These transitions are applied in the model to the initiation rates of otherwise NHB menthol smokers in 2021 and all future years. Among current NHB menthol smokers ages 18–24 years, experts expected 9.4% to switch to illicit menthol combustibles, 43.7% to non-menthol combustibles, 23.4% to NVPs and 23.4% to quit all product use.⁹ These transitions are applied to those who were current NHB menthol smokers through age 30 years in 2021. Among NHB menthol smokers ages 35–54 years, experts expected 8.7% to switch to illicit menthol combustibles, 50.9% to non-menthol cigarette use, 15.3% to NVPs and 25.1% to quit all product use.⁹ These transitions are applied to age 30+ years current NHB menthol smokers in 2021. Current non-menthol smokers are unaffected except for those menthol smokers who switch to non-menthol use.

Outcomes

We estimate the public health impact of a menthol ban as the differences in smoking and vaping attributable deaths (SVADs) and LYs in the status quo and menthol ban scenarios over 2021–2060. Smoking-attributable deaths are estimated as the excess mortality risk for current and former smokers multiplied by their respective populations. Vaping-attributable deaths are estimated assuming 15% of excess smoking risks.^{38 39} Total LYs are estimated by the number of SVADs multiplied by the expected years of life remaining of a never smoker.

Validation

We validated the preban NHB smoking prevalence model projections against NHIS estimates from Mattingly *et al.*⁴⁰ The model projected that overall smoking prevalence would decline by 21% in relative terms among NHB adult smokers during the first 5 years (2013–2018), which is consistent with the 20% decline in 2010–2015 reported by Mattingly *et al.*⁴⁰ Our projected decline of 19% in the menthol smoking rate is also consistent with the menthol smoking decline obtained by Mattingly *et al.*⁴⁰ Our projected menthol smoking prevalence trends are also roughly consistent with those of Weinberger *et al.*⁴¹ reported for ages 12 years and above using the 2012–2016 National Survey on Drug Use and Health.

RESULTS

Table 1 shows menthol and non-menthol smoking and NVP prevalence, SVADs and LYs for NHB adults (ages > 18 years). Under the status quo, NHB menthol smoking prevalence declines from 12.1% in 2021 to 9.9% in 2026 and 4.4% in 2060, while non-menthol smoking prevalence declines from 2.2% in 2021 to 1.6% in 2026 and 0.6% in 2060. The rapid decline in smoking prevalence reflects the lower levels of smoking initiation and higher levels of smoking cessation in recent years. A recent paper⁴² also notes dramatic reductions in adolescent menthol and non-menthol smoking rates, especially among the NHB population. Cumulative SVADs from 2021 to 2060 of 1 386 457 translate to 17 887 742 LYs.

Under the menthol ban, NHB adult menthol smoking prevalence declines from 12.1% in 2021 to 0.7% in 2026 and 0.2% in 2060, while non-menthol smoking prevalence increases from 2.2% in 2021 to 6.7% in 2026 and declines to 3.6% in 2060. Cumulative SVADs of 1 130 563 translate to 13 931 273 LYs. Comparing the

Table 1 NHB adult smoking and NVP prevalence, smoking and vaping attributable deaths, life years lost and public health impact, ages 18 years and above, 2021–2060

Status quo scenario					
Category	Category/year	2021	2026	2060	Cumulative impact *
Prevalence	Menthol smoker	12.1%	9.9%	4.4%	–63.5%
	Non-menthol smoker	2.2%	1.6%	0.6%	–74.4%
	Total smokers†	14.4%	11.5%	5.0%	–65.2%
	Former smoker	10.5%	10.5%	5.5%	–48.0%
	Exclusive NVP user‡	3.3%	4.4%	6.3%	88.0%
	Former NVP user	0.2%	0.4%	3.6%	2013.1%
Smoking and vaping attributable deaths§	Menthol smoker	30 063	27 622	10 153	779 841
	Non-menthol smoker	8238	6255	1180	138 930
	Former smoker	8437	9745	9091	413 089
	Exclusive NVP user	696	1015	1479	53 062
	Former NVP user	0	0	215	1535
	Total	47 435	44 637	22 117	1 386 457
Life years lost	Menthol smoker	474 557	418 730	139 225	11 348 726
	Non-menthol smoker	109 873	82 091	16 468	1 839 936
	Former smoker	83 179	93 507	84 484	3 850 838
	Exclusive NVP user	11 059	15 546	24 267	820 043
	Former NVP user	0	0	3420	28 200
	Total	678 668	609 874	267 865	17 887 742
Menthol ban scenario					
Prevalence	Menthol smoker	12.1%	0.7%	0.2%	–98.6%
	Non-menthol smoker	2.2%	6.7%	3.6%	58.7%
	Total smokers	14.4%	7.4%	3.7%	–74.0%
	Former smoker	10.5%	12.8%	5.5%	–47.4%
	Exclusive NVP user	3.3%	6.5%	8.1%	143.4%
	Former NVP user	0.2%	0.5%	4.6%	2590.1%
Smoking and vaping attributable deaths	Menthol smoker	30 063	2442	560	89 509
	Non-menthol smoker	8238	20 663	5479	496 086
	Former smoker	8437	10 687	9642	451 850
	Exclusive NVP user	696	2213	2085	91 213
	Former NVP users	0	0	268	1904
	Total	47 435	36 006	18 034	1 130 563
Life years lost	Menthol smoker	474 557	36 249	7580	1 291 542
	Non-menthol smoker	109 873	298 181	79 258	7 020 456
	Former smoker	83 179	105 110	88 381	4 258 908
	Exclusive NVP user	11 059	32 115	32 234	1 325 126
	Former NVP users	0	0	4290	35 242
	Total	678 668	471 656	211 743	13 931 273
Public health impact: difference between the status quo and menthol ban scenario¶					
Relative reduction in prevalence	Menthol smoker	–	–92.7%	–96.1%	–
	Non-menthol smoker	–	308.5%	518.7%	–
	Total smokers	–	–35.7%	–25.3%	–
	Total NVP users	–	46.0%	29.4%	–
Gain	Averted deaths	–	8631	4083	255 895
	Averted life years lost	–	138 218	56 122	3 956 469
	% averted deaths	–	19.3%	18.5%	18.5%
	% averted life years lost	–	22.7%	21.0%	22.1%

*The cumulative impact is measured in terms of the relative change from 2021 to 2060 for prevalence rates (ie, (2060–2021)/2021) and the sum of the smoking and vaping attributable deaths or life years lost over the years 2021–2060.

†Total smokers include menthol and non-menthol smokers.

‡Exclusive NVP users includes exclusive NVP users who initiated from never smokers and who switched from current smokers (former smoker now using NVPs).

§The number of smoking and vaping attributable deaths and life years lost is rounded to the nearest integer.

¶The difference between two scenarios includes the comparisons for prevalence in relative terms and for health gains in absolute terms. Relative reduction in prevalence is measured as the relative difference between the status quo scenario and the menthol ban scenario, (ie, (postban – preban)/preban) in year 2026 and 2060; the gain is measured as the increase in the averted deaths and life years lost from the status quo scenario and the menthol ban scenario, and % reduction in gain is calculated as gain/preban.

NHB, non-Hispanic black; NVP, nicotine vaping product.

status quo and menthol ban scenarios, the model projects 255 895 SVADs and 3 956 469 LYs averted from 2021 to 2060.

DISCUSSION

A menthol cigarette ban implemented in 2021 would result in relative reductions in overall menthol and non-menthol NHB cigarette use of 35.7% in 2026 and 25.3% in 2060. While NVP and non-menthol cigarette use would increase, 255 895

premature deaths would be averted (an average of almost 6562 per year) and 4.0 million life years gained (almost 101 448 per year) by 2060.

The ban's impact on the NHB population compares favourably to projections for the overall US population.¹⁰ We estimated that the ban leads to a relative reduction in NHB adult smoking prevalence of 35.7% compared with 14.7% for the USA in 2026 and 25.3% compared with 15.1% for the USA

in 2060.¹⁰ The reduction in cumulative NHB averted deaths from 2021 to 2060 is 18.5% compared with 4.6% for the USA,¹⁰ with a 22.1% relative reduction in NHB cumulative LYLs compared with 7.9% for the USA.¹⁰ Projected gains in NHB averted deaths and LYLs are approximately 1/3 of those previously developed for the total population,¹⁰ despite the NHB population disproportionately making up about 13% of the overall 2021 US population.^{18 20} Health disparities are commonly measured in terms of the difference in overall mortality rates between subgroups.^{43 44} Since the 2021 mortality rate for those ages 40–84 years (when smoking-attributable deaths predominantly occur) is 1.33% for NHB population compared with 1.13% for the overall population,²¹ the substantially greater per capita reduction in smoking-attributable deaths for the NHB population relative to that of the rest of the population would lead to a reduction in health disparities (see online supplemental appendix 1). Our results are also consistent with earlier modelling results that find disproportionately greater health impacts on the NHB than the general population from a menthol cigarette ban⁴⁵ and past menthol use.^{46 47}

Our findings are dependent on the model structure, parameters and assumptions. We set the excess risk of vaping to 15% (SVADs averted=255 895, averted LYLs=3 956 469, by 2060). Since this risk level is controversial, we conducted a sensitivity analysis with risks at 5% (SVADs averted=268 211, averted LYLs=4 152 320, by 2060) and at 40% (SVADs averted=226 784, averted LYLs=3 484 083, by 2060).

While we calibrated the model to smoking and NVP rates, smoking and NVP rates have been subject to recent instability,⁴⁸ including in the NHB population.⁴² The model also does not distinguish the health impact of exclusive menthol cigarette smokers who switch to cigar use as a result of a menthol ban.

In addition to the proposed ban of menthol cigarettes,⁶ the FDA has also proposed a ban of all flavoured cigars,¹⁹ which may not be implemented at the same time as a ban on menthol in cigarettes. For a ban to be effective, especially as it relates to the NHB population, it will be important that it is applied to both menthol cigarettes and flavoured cigars, since little cigars are a close substitute for cigarettes.^{49–51} A ban on flavoured cigars would yield additional health gains, especially for the NHB population. We also note that a ban on flavours in NVPs could lead to more smokers quitting and not becoming NVP users but may instead lead to fewer smokers quitting to the extent that NVPs are used to quit smoking menthol cigarettes rather than transitioning to smoking non-menthol cigarettes. A further limitation of the model is that dual users of NVPs and cigarettes are not distinguished from current cigarette users.¹⁰ In our expert elicitation,⁹ we did not distinguish dual-use due to definition and measurement issues in determining a stable dual-use state and difficulties in distinguishing the likely transitions from that state.^{52 53} In terms of the potential impacts of a menthol ban on dual use, a menthol ban may lead to menthol smokers transitioning to dual use of non-menthol cigarettes with NVPs, but current dual menthol and NVP users may be more likely than exclusive menthol smokers to transition to exclusive NVP or no use. Finally, the results are also subject to uncertainties regarding the impacts of a menthol ban. The effects of a menthol ban on smoking and vaping initiation and cessation were based on results of an expert elicitation and thus depend on the participating reviewers' assessments and the process applied in the elicitation.⁹

In conclusion, our study strongly supports the implementation of a ban on menthol in cigarettes on public health and especially on health equity grounds for the NHB population.

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Appendix 1.

The impact of a policy-induced reduction in smoking and vapid attributable deaths on health disparities

A review focusing on disparities by Braverman¹ addressed definitions of health disparity in general and its measurement implications. The author suggested using a ratio or absolute difference of the death rates between two groups to measure the health disparity. Closer death rates in two groups mean smaller health disparity.

In the Status Quo Scenario, the overall death rates for Non-Hispanic Black (NHB) population are higher than the rest of the population according to the CDC death rates by race and Hispanic origin.² Therefore, if we can show that the menthol ban has greater effects in reducing overall death rates for the NHB population than for the rest of US population, and that the absolute reduction in death rates for NHBs is greater than the absolute reduction for the rest population, we can conclude that the menthol ban will reduce disparities in adult mortality rates over time.

Denoting the overall death rates for NHBs and the rest population as ODR_NHB and ODR_rest, never smokers death rates for NHBs and the rest of the population as Never DR_NHB and Never DR_rest, NHB% as the NHB population as a percent of total population, and smoking- and vaping- attributable deaths as SVADs, the health disparity can be defined as the absolute difference in overall death rates between the two groups as:

$$\begin{aligned} \text{ODR_NHB} &= (\text{Never DR_NHB} * \text{Pop_NHB} + \text{SVAD_NHB}) / \text{Pop_NHB} \\ &= \text{Never DR_NHB} + \text{SVAD_NHB} / \text{Pop_NHB} \\ &= \text{Never DR_NHB} + \text{SVAD_NHB} / (\text{NHB\%} * \text{Pop_US}) \end{aligned}$$

$$\begin{aligned} \text{ODR_rest} &= \text{Never DR_rest} + \text{SVAD_rest} / \text{Pop_rest} \\ &= \text{Never DR_rest} + \text{SVAD_rest} / ((1 - \text{NHB\%}) * \text{Pop_US}) \end{aligned}$$

We calculate the disparity as

$$\begin{aligned} \text{Disparity} &= \text{ODR_NHB} - \text{ODR_rest} \\ &= \text{Never DR_NHB} + \text{SVAD_NHB} / (\text{NHB\%} * \text{Pop_US}) - \text{Never DR_rest} - \\ &\quad \text{SVAD_rest} / ((1 - \text{NHB\%}) * \text{Pop_US}) \\ &= (\text{Never DR_NHB} - \text{Never DR_rest}) + (\text{SVAD_NHB} / \text{NHB\%} - \text{SVAD_rest} / \\ &\quad (1 - \text{NHB\%})) / \text{Pop_US} \\ &= (\text{Never DR_NHB} - \text{Never DR_rest}) + (\text{SVAD_NHB} - \text{NHB\%} * (\text{SVAD_NHB} + \\ &\quad \text{SVAD_rest})) / [\text{NHB\%} * (1 - \text{NHB\%}) * \text{Pop_US}] \\ &= (\text{Never DR_NHB} - \text{Never DR_rest}) + (\text{SVAD_NHB} - \text{NHB\%} * (\text{SVAD_US})) / \\ &\quad [\text{NHB\%} * (1 - \text{NHB\%}) * \text{Pop_US}]. \end{aligned}$$

Comparing the disparity in the different scenarios:

$$\begin{aligned}
 \text{Disparity}_{\text{Menthol}} - \text{Disparity}_{\text{Status Quo}} &= [(\text{Never DR}_{\text{NHB}} - \text{Never DR}_{\text{rest}}) + (\text{SVAD}_{\text{NHB}}_{\text{Menthol}} - \text{NHB}\% * (\text{SVAD}_{\text{US}}_{\text{Menthol}})) / (\text{NHB}\% * (1 - \text{NHB}\%) * \text{Pop}_{\text{US}})] - [(\text{Never DR}_{\text{NHB}} - \text{Never DR}_{\text{rest}}) - (\text{SVAD}_{\text{NHB}}_{\text{Status Quo}} - \text{NHB}\% * (\text{SVAD}_{\text{US}}_{\text{Status Quo}})) / (\text{NHB}\% * (1 - \text{NHB}\%) * \text{Pop}_{\text{US}})] \\
 &= (\text{SVAD}_{\text{NHB}}_{\text{Menthol}} - \text{NHB}\% * (\text{SVAD}_{\text{US}}_{\text{Menthol}}) - \text{SVAD}_{\text{NHB}}_{\text{Status Quo}} + \text{NHB}\% * (\text{SVAD}_{\text{US}}_{\text{Status Quo}})) / (\text{NHB}\% * (1 - \text{NHB}\%) * \text{Pop}_{\text{US}}) \\
 &= ((\text{SVAD}_{\text{NHB}}_{\text{Menthol}} - \text{SVAD}_{\text{NHB}}_{\text{Status Quo}}) - \text{NHB}\% * (\text{SVAD}_{\text{US}}_{\text{Menthol}} - \text{SVAD}_{\text{US}}_{\text{Status Quo}})) / (\text{NHB}\% * (1 - \text{NHB}\%) * \text{Pop}_{\text{US}}) \\
 &= (\text{NHB}\% * (\text{SVAD}_{\text{US}}_{\text{Status Quo}} - \text{SVAD}_{\text{US}}_{\text{Menthol}}) - (\text{SVAD}_{\text{NHB}}_{\text{Status Quo}} - \text{SVAD}_{\text{NHB}}_{\text{Menthol}})) / (\text{NHB}\% * (1 - \text{NHB}\%) * \text{Pop}_{\text{US}})
 \end{aligned}$$

For both the NHB and the US population, SVADs in the Menthol Ban Scenario is smaller than in the Status Quo Scenario, and the NHB proportion is a positive number and smaller than 100%. Therefore, if the averted SVADs from NHBs is greater than the product of the NHB proportion and US averted SVADs, $\text{Disparity}_{\text{Menthol}} - \text{Disparity}_{\text{Status Quo}}$ will be negative, thereby showing that the menthol ban reduces the disparity between the NHB and the rest population.

Assuming that averted SAVDs for NHB is a proportion (X%) of US averted SVADs, then the formula can be rewritten as:

$$\begin{aligned}
 \text{Disparity}_{\text{Menthol}} - \text{Disparity}_{\text{Status Quo}} &= (\text{NHB}\% * (\text{SVAD}_{\text{US}}_{\text{Status Quo}} - \text{SVAD}_{\text{US}}_{\text{Menthol}}) - X\% * (\text{SVAD}_{\text{US}}_{\text{Status Quo}} - \text{SVAD}_{\text{US}}_{\text{Menthol}})) / (\text{NHB}\% * (1 - \text{NHB}\%) * \text{Pop}_{\text{US}}) \\
 &= (\text{NHB}\% - X\%) * (\text{SVAD}_{\text{US}}_{\text{Menthol}} - \text{SVAD}_{\text{US}}_{\text{Status Quo}}) / (\text{NHB}\% * (1 - \text{NHB}\%) * \text{Pop}_{\text{US}})
 \end{aligned}$$

Thus, if X% is greater than NHB%, the disparity difference will be negative and the disparity reduced.

According to our model, X% is about 42% in 2021-2060, which is greater than the 13%-16% NHB proportion in 2021-2060. Therefore, the menthol ban would reduce the disparity in mortality rates.

References

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