

## Appendix 1.

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

A review focusing on disparities by Braverman<sup>1</sup> 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.<sup>2</sup> 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

1. Braveman P. Health disparities and health equity: concepts and measurement. *Annu Rev Public Health*. 2006;27:167-94.
2. Death rate by single age, gender, and race in 1999-2019 [CDC Wonder] [Available from: <https://wonder.cdc.gov/ucd-icd10.html>].