The Impact of Menthol Cigarette Flavor in the U.S.: Cigarette and ENDS Transitions by Sociodemographic Group

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Introduction: A better understanding of how menthol cigarette flavoring and ENDS impact smoking initiation, cessation, and transitions between tobacco products could help elucidate the potential impact of a U.S. menthol ban on combustible tobacco products.

Methods: A multistate transition model was applied to data on 23,232 adults from Waves 1−4 (2013−2017) of the Population Assessment of Tobacco and Health Study (analysis was conducted in 2020−2021). Transition rates among never, noncurrent, nonmenthol versus menthol cigarette, ENDS, and dual everyday/someday use were estimated, as were transition-specific hazard ratios for age, sex, race/ethnicity, education, and income.

Results: Non-Hispanic Blacks who smoked menthol discontinued smoking at a much lower rate than those who smoked nonmenthol (hazard ratio=0.43, 95% CI=0.29, 0.64), but there was no statistically significant difference in the discontinuation rates among non-Hispanic Whites (hazard ratio=0.97, 95% CI=0.80, 1.16) or Hispanics (hazard ratio=0.81, 95% CI=0.56, 1.16). Non-Hispanic Whites who smoked menthol were more likely to become dual users than those who smoked non-menthol (hazard ratio=1.43, 95% CI=1.14, 1.80). Young adults initiated menthol smoking at a higher rate than older adults (age 18−24 years versus ≥55 years: hazard ratio=2.45, 95% CI=1.44, 4.15) but not nonmenthol smoking (hazard ratio=1.02, 95% CI=0.62, 1.69). There were differences by sex in the impact of menthol flavor on smoking initiation and discontinuation but little difference by education or income.

Conclusions: Sociodemographic differences in product transitions should be accounted for when estimating the potential impact of a menthol ban.

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Menthol is the only flavor currently allowed in cigarettes in the U.S. Since the U.S. Food and Drug Administration Tobacco Products Scientific Advisory Committee concluded in 2011 that the removal of menthol cigarettes would result in a public health benefit,13 there have been increasing calls for a federal ban on menthol in tobacco products. In 2021, the Food and Drug Administration announced that it would propose tobacco product standards to ban menthol (and other flavors) in combustible tobacco products but not in ENDS.14 Rulemaking is ongoing, making this a crucial period for improving the understanding of the use of menthol cigarettes influences on smoking cessation and product switching in an evolving tobacco product landscape.

The prevalence and sociodemographic profile of those who smoke menthol are well understood, and there is evidence of an impact of menthol flavoring on cigarette initiation and cessation.1−5 However, very little is generally known about how those who smoke menthol transition to other tobacco products, nor how these transitions are impacted by the increasing prevalence of ENDS use. Developing a fuller picture of menthol’s impact on tobacco use transitions—and how the effect differs for different sociodemographic groups—is needed. To better understand how individual patterns of tobacco use (menthol and nonmenthol smoking, ENDS use, and dual use) change over time and how menthol impacts these patterns, this analysis estimates transition rates using a multistate transition model15 and longitudinal data from the Population Assessment of Tobacco and Health (PATH) Study.16−18 This approach to analyzing longitudinal data is increasingly being used in the tobacco control field19−22 because it allows for the estimation of each transition rate simultaneously, accounting for the competing events that are the other potential transitions. In this study, transition rates are estimated among cigarette, ENDS, and dual use and whether transition rates depend on menthol cigarette flavoring. This study further investigates whether the impact of menthol on these transitions differs by sociodemographic factors, including age, sex, race/ethnicity, education, and income. Understanding the impact of menthol cigarette flavoring on the rates of various transitions under the current status quo will be critical to assess the potential health and health equity impacts of a ban on menthol in combustible tobacco products in the U.S.

METHODS

Study Sample

The PATH Study is a nationally representative, longitudinal cohort study, described in detail elsewhere.16−18 Public-use, de-identified data on adults in Waves 1−4 (2013−2017) with a Wave 4 all-waves longitudinal weight were used.18 The time between waves was approximately 1 year. Analysis was conducted in 2020−2021.

Each PATH participant was assigned to a tobacco use state in each wave on the basis of answers to questions about established use of cigarettes (≥100 ever used) and ENDS (ever fairly regularly used) as well as everyday or someday use of cigarettes and ENDS. Participants were defined as smoking menthol if their regular brand was flavored to taste such as menthol or mint.5,23 Flavor information for ENDS was not included because it was not possible to consistently determine whether a person used mint/menthol-flavored ENDS in PATH. The Appendix (available online) provides further information and variable coding.

Measures

A total of 7 tobacco use states were considered: never use (of either product), noncurrent use (of both products), exclusive use of nonmenthol cigarettes, exclusive use of menthol cigarettes, exclusive ENDS use, dual use of ENDS and nonmenthol cigarettes, and dual use of ENDS and menthol cigarettes (Figure 1A). Information about other tobacco products (e.g., cigars, cigarillos, smokeless tobacco) was not included, so never/noncurrent/exclusive use is only in the context of these 2 products. Noncurrent users were defined as established users (of cigarette or ENDS) who indicated that they did not currently use either product every or some days. Because this definition does not consider how long the user has been abstinent, this study uses the word discontinuation (as opposed to cessation) to denote transitions to this state. Information on age, sex, race/ethnicity, educational attainment, and income.

Figure 1. (A) Tobacco use state definitions and (B) the direct transitions allowed between states in the model.
incorporating weights. PATH Wave 4 all-wave longitudinal cigarette rates were used to determine whether transitions differed by menthol smoking. Finally, the estimated univariable transition for a model that did not distinguish between menthol and nonmenthol cigarettes. To understand the impact of stratifying by menthol cigarette users remaining cigarette users after 1 wave (adding Columns 3, 4, 6, and 7 across a single row in Figure 2A). By contrast, ENDS use was less persistent, with 71.6% (95% CI=66.2, 77.0) of exclusive ENDS users, 52.8% (95% CI=47.2, 58.5) of nonmenthol dual users, and 53.4% (95% CI=46.4, 60.3) of menthol dual users remaining ENDS users after 1 wave (adding Columns 5, 6, and 7 within a row). Many exclusive ENDS users transitioned to noncurrent use (21.8%, 95% CI=19.1, 24.5), and many dual users became exclusive cigarette users (nonmenthol: 40.8%, 95% CI=38.0, 43.5; menthol: 39.6%, 95% CI=36.1, 43.0). The CIs for both the transition rates and probabilities are provided in the Appendix (Appendix Table A3, available online).

Transition probabilities differed substantially by race/ethnicity (Figures 2B–D). Among NHBs, exclusive menthol smoking was more persistent (84.6% in 1 wave, 95% CI=83.0, 86.2) than either exclusive nonmenthol smoking (83.1%, 95% CI=82.1, 84.2) or exclusive menthol smoking (77.5%, 95% CI=75.5, 79.6) among non-Hispanic Whites (NHWs), whereas NHB exclusive nonmenthol smoking was less persistent (54.7%, 95% CI=49.7, 59.6). NHB exclusive ENDS use was also less persistent (46.9%, 95% CI=35.6, 58.1) than NHW exclusive ENDS use (60.9%, 95% CI=57.5, 64.2). The persistence of exclusive smoking among Hispanics was lower than that among the overall population and was similar for nonmenthol (73.9%, 95% CI=70.9, 77.0) and menthol (74.2%, 95% CI=71.0, 77.4) cigarettes. Hispanic exclusive ENDS use was less persistent (46.9%, 95% CI=40.5, 53.5) than that among NHBs. Transition probabilities for other sociodemographic groups can be found in the Appendix (Appendix Figures A3–A7, available online).

These differences in transition probabilities were driven by differences in the underlying transition hazard rates. After adjusting for other sociodemographic variables (Figure 3 and Appendix Table A4, available online), NHBs initiated nonmenthol smoking at a lower rate than NHWs (HR=0.56, 95% CI=0.34, 0.91) but initiated menthol smoking at a much greater rate than NHWs (HR=4.43, 95% CI=2.73, 7.18). Similarly, NHBs discontinued nonmenthol smoking (HR=1.65, 95% CI=1.14, 2.39).
2.37) at a greater rate than NHWs. NHBs also switched from nonmenthol to menthol smoking at a much higher rate than NHWs (HR=18.5, 95% CI=13.5, 25.4) and added ENDS use to menthol smoking at a lower rate than NHWs (HR=0.28, 95% CI=0.18, 0.43). Hispanics initiated nonmenthol smoking at a lower rate than NHWs (HR=0.55, 95% CI=0.36, 0.86), but the estimate for the initiation rate of menthol smoking was not statistically significant (HR=2.40, 95% CI=0.93, 6.16). Hispanics had a higher discontinuation rate of nonmenthol (HR=1.88, 95% CI=1.52, 2.33) and menthol (HR=1.65, 95% CI=1.18, 2.30) smoking than NHWs. Hispanics also switched cigarette flavors at a greater rate than NHWs.

There was increased initiation in younger ages for menthol smoking initiation (age 18–24 years versus ≥55 years: HR=2.44, 95% CI=1.44, 4.15) but not for nonmenthol smoking initiation (HR=1.02, 95% CI=0.62, 1.68). Men initiated smoking at a greater rate than women, and the difference was more pronounced for nonmenthol smoking initiation (HR=2.24, 95% CI=1.66, 3.02) than for menthol (HR=1.61, 95% CI=1.12, 2.32). There were no significant differences in discontinuation rates by sex for menthol or nonmenthol smoking. A comparison of age effects for men and women is in the Appendix (Appendix Figures A8–A10, available online).

Lower education and income and were associated with greater smoking initiation and reduced discontinuation for both menthol and non-menthol cigarette flavors, although the impact on initiation was somewhat

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Figure 2. One-wave (approximately 1-year) modeled transition probabilities for (A) the adult U.S. population, (B) non-Hispanic White adults, (C) non-Hispanic Black adults, and (D) Hispanic adults.

Excl, exclusive.
greater for nonmenthol than for menthol smoking initiation.

To more directly understand whether menthol cigarette flavoring impacted transition rates, this study compared the relative rates of selected transitions by cigarette flavoring. The direction and magnitude of menthol’s impacts differed by sociodemographic group (Table 1). Overall, the rate of initiating menthol smoking was about 20% lower than for nonmenthol smoking. However, this ratio differed dramatically between NHBs and NHWs, with NHBs initiating menthol smoking at a much higher rate than nonmenthol smoking (HR=2.35, 95% CI=1.49, 3.71) and NHWs initiating menthol smoking at lower rates than nonmenthol smoking (HR=0.34, 95% CI=0.24, 0.49). The preference for nonmenthol cigarette initiation increased with age and was nonexistent for women, unlike for men.

Exclusive menthol cigarette users had a lower discontinuation rate than exclusive nonmenthol cigarette users. Again, this ratio differed dramatically between NHBs
Table 1. Hazard Ratios for Pairs of Transitions That Differ by Cigarette Flavor by Sociodemographic Group

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<th>Comparisons</th>
<th>Age, years</th>
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<th>Race</th>
<th>Education</th>
<th>Household income</th>
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<td>All</td>
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<td>25–34</td>
<td>35–54</td>
<td>≥55</td>
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<td></td>
<td>HR (95% CI)</td>
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<td>Never to menthol smoking versus never to nonmenthol smoking</td>
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<td>Menthol smoking to noncurrent versus nonmenthol smoking to noncurrent</td>
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<td>Menthol smoking to exclusive ENDS versus nonmenthol smoking to exclusive ENDS</td>
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<td>Menthol dual use to menthol smoking versus nonmenthol dual use to nonmenthol smoking</td>
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**Note:** Boldface indicates statistical significance (p<0.05).

95% CIs do not include 1.0.

AA, associate’s degree; BA, bachelor’s degree; HR, hazard ratio; NH, non-Hispanic.
DISCUSSION

This study estimated the impact of menthol cigarette flavoring on transitions between cigarettes, ENDS, and dual use by fitting a multistate transition model to longitudinal data of individuals’ tobacco product use. This approach allowed the investigators to simultaneously estimate the transition rates between these products and to understand how they together contributed to the observed patterns of use. There were large differences by race/ethnicity in how menthol cigarette flavoring impacted cigarette and ENDS use transitions. There were moderately different impacts of age and sex on initiation and discontinuation of menthol smoking versus nonmenthol smoking but comparatively little interaction between menthol cigarette flavoring and education or income.

The impact of menthol cigarette flavoring was different between NHBs and NHWs for almost all tobacco product use transitions. NHBs who smoked menthol cigarettes discontinued smoking at a 60% lower rate than NHWs who smoked nonmenthol cigarettes, but there was no difference in discontinuation rates by menthol flavoring for NHWs. By contrast, for Hispanics, there was no significant difference by menthol flavoring for any of the transitions. These findings are consistent with a recent meta-analysis on the association between menthol cigarette flavoring and smoking cessation.\(^5\)

Given the racial/ethnic differences in the impact of menthol on cessation, these results may reflect targeted marketing practices by the tobacco industry, structural barriers resulting in differential access to tobacco products and cessation services, or other factors\(^5\) rather than menthol’s pharmacologic effects on the patterns of smoking topography and dependence.\(^26−29\) One limitation of this study is that race/ethnicity and the other socially constructed sociodemographic variables are only indicators of the underlying causal factors and fail to address intersectional effects or capture the nuance of specific subgroups (e.g., sexual or gender minorities, Hispanic subgroups).

For most sociodemographic groups other than NHWs, menthol smoking was not significantly associated with initiation or discontinuation of ENDS products compared with that of nonmenthol smoking, although the estimates may have been underpowered because dual use was relatively rare. Given that the data were from 2013 to 2017, largely before the widespread use of pod-based and disposable ENDS,\(^30,31\) and because new products will continue to emerge, it is uncertain whether these results will change in future surveys. This analysis also did not account for ENDS flavors; future work will investigate whether there are associations of mint/menthol-flavored ENDS with transitions for those who smoke menthol cigarettes.

Young adults initiated menthol smoking at a much higher rate than older adults, but their rates of nonmenthol smoking initiation were about the same as those of older adults. That menthol smoking initiation is higher in younger adults than in older adults is consistent with previous literature,\(^4,32\) but it is surprising that there was no statistically significant increase in nonmenthol initiation among young adults compared with that among older adults. Because smoking initiation is not common at older ages, these results imply that menthol smoking was the predominant pathway for young adult smoking initiation during this time period. However, this result may be in part a cohort effect, where decreased initiation with increasing age is offset by decreasing initiation in newer birth cohorts.\(^33,34\) If a cohort effect is reducing the age gradient for nonmenthol smoking initiation, then the true age effects for menthol smoking initiation are likely even greater than estimated.

This work has several important implications for the potential impact of a menthol ban on combustible products. First, a menthol ban would likely address racial inequities in tobacco-related harms. NHBs who smoke are disproportionately less likely to discontinue smoking when using menthol cigarettes than when using nonmenthol cigarettes. Thus, a menthol ban could result in substantial smoking cessation among NHBs who would otherwise not quit. Second, this work also suggests that a menthol ban may reduce young adult smoking initiation. Between enhanced cessation and reduced initiation, removing menthol cigarettes from the marketplace would likely result in a lower incidence of smoking.
overall. This work adds to the growing literature indicating that banning menthol will likely have a public health impact through increased cessation and reduced initiation. 35,36

Limitations
Overall, these results complement and further strengthen the broader literature on the impact of menthol on cessation. 4 Nonetheless, this study has a few limitations that should be noted when interpreting these results. Discontinuation was defined as no longer smoking every or some days rather than as long-term quitting, and so the results could be biased if shorter-term periods of abstinence that are not sustained are more common for one product than for the other. This analysis also did not explicitly account for other combustible tobacco products, including cigars and cigarillos, which can be flavored and are disproportionately used by NHBs and young adults. 37,38 This analysis also did not distinguish between everyday and someday users. 39

CONCLUSIONS
Given the prevalence and the patterns of transition between menthol and nonmenthol smoking and ENDS that were identified, a ban on menthol in combustible tobacco products has the potential to address the health disparities in NHBs and other groups. A menthol ban in combustible tobacco products may be the policy tool—short of banning tobacco products entirely—with the most potential for substantial impact on smoking prevalence and thus tobacco-related health outcomes, 13 particularly if paired with high-quality cessation programs and thoughtful regulation of the ENDS marketplace.

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SUPPLEMENTAL MATERIAL
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REFERENCES

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