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ABSTRACT

Of the 45.7 million current smokers in the U.S. age 12 and over, more than 18.5 million usually smoke menthol cigarettes. The Food and Drug Administration (FDA) recently proposed a tobacco product standard that would prohibit menthol as a characterizing flavor in cigarettes (FDA 2022b). Although menthol is not harmful per se, the FDA concludes that the prohibition of menthol in cigarettes is appropriate for public health, meeting the criterion established by the 2009 Tobacco Control Act for FDA regulation of tobacco products. In this paper we explore whether menthol smokers are different in ways that provide an applied welfare economics rationale to prohibit menthol. In national data from the 2018-2019 Tobacco Use Supplement to the Current Population Survey (TUS-CPS), after controlling for socio-demographics, we mainly find small associations between menthol use and smoking behaviors, many quitting behaviors, and cigarette purchase behaviors. Although menthol use is much more common among Black smokers, Blacks are less likely to be current smokers, and conditional on current smoking Blacks are less likely to be daily smokers, are less likely to have started smoking before age 18, smoke fewer cigarettes per day, and are less likely to be addicted. In data from a 2021 Cornell Online Survey, we find no evidence that menthol smokers are less informed or are more likely to experience smoking-related internalities. Our analysis of stated preference data suggests that menthol and non-menthol smokers have similar preferences over tobacco product attributes, except that menthol smokers have a stronger preference for flavored e-cigarettes. In a potentially important exception to the patterns just described, in the 2018-2019 TUS-CPS data we find evidence that among ever smokers, menthol smokers and Black smokers are less likely to be lifetime quitters.

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1. Introduction

Of the 45.7 million current smokers in the U.S. age 12 and over, more than 18.5 million usually smoke menthol cigarettes.[1] The Food and Drug Administration (FDA) recently proposed a tobacco product standard that would prohibit menthol as a characterizing flavor in cigarettes (FDA 2022b). The FDA cites evidence that because menthol reduces the irritation and harshness of smoking, menthol promotes youth smoking initiation and makes it more difficult for adult smokers to quit. Although menthol is not harmful per se, the FDA concludes that the prohibition of menthol in cigarettes is appropriate for public health, meeting the criterion established by the 2009 Tobacco Control Act for FDA regulation of tobacco products.

Executive Orders 12866 and 13563 require that Federal agencies complete a regulatory impact analysis of any economically significant regulation. The FDA has determined that the tobacco product standard prohibiting menthol is an economically significant regulation and has completed a preliminary regulatory impact analysis (PRIA) (FDA 2022c). In addition to applying the public health criterion, the FDA's PRIA conducts an applied welfare economics analysis that examines the market failures addressed by the prohibition of menthol, the benefits and costs of the regulation, and regulatory alternatives. The PRIA argues that "Nicotine addiction can lead to cigarette smoking that does not accurately reflect individual preferences" and reviews behavioral economics research on internality-related market failures and

[1] From its analysis of the 2019 National Survey on Drug Use and Health (NSDUH), the Food and Drug Administration estimates that there are 18.589 million menthol smokers and 27.113 million non-menthol smokers, which totals 45.7 million current smokers (FDA 2022a, Table 1). From data from the 2018-2019 Tobacco Use Supplement to the Current Population Survey (TUS-CPS), which we use below, the National Cancer Institute estimates that there are 28.367 million current smokers in the U.S. age 18 and over (https://cancercontrol.cancer.gov/brp/tcrb/tus-cps/results/2018-2019/table-1). The NSDUH estimates include 0.534 million smokers aged 12-17, an age group which is not included in the TUS-CPS data. The sources of the remaining discrepancy are not obvious. DeCicca, Lovenheim, and Kenkel (2022 forthcoming) provides additional comparisons of U.S. smoking rates across several national data sets.

neuroscience research on the development of the brain during adolescence, when almost all smokers start (FDA 2022b, pp. 19-22). From its discussion of market failures associated with smoking and the role of menthol, the PRIA concludes that the prohibition of menthol would reduce the initiation and experimentation of smoking and "would provide those who seek to quit smoking an improved chance of aligning their smoking behavior with their preferences and reduce negative internalities…." (FDA 2022c, p. 26). The PRIA also reviews evidence on negative externalities including secondhand smoke, thirdhand smoke, and fires, and on smoking-related health disparities across population groups including Blacks with higher rates of menthol use.

In this paper we provide evidence on how menthol smokers – as economic consumers – are different from non-menthol smokers. We begin by providing descriptive evidence on how menthol use is associated with smoking behaviors, quitting behaviors, and cigarette purchasing behaviors. For these empirical exercises, we use nationally representative data from the 2018-2019 Tobacco Use Supplement to the Current Population Survey. We next use data from the Online Cornell Survey (OCS) of adult smokers conducted in November 2021 to explore how menthol use is associated with smoking-related information and with two proxies for internalities. In addition, the OCS included a discrete choice experiment (DCE) where smokers made hypothetical choices between cigarettes, e-cigarettes, and quitting. We use the DCE data to explore whether menthol and non-menthol smokers have systematically different stated preferences for tobacco product attributes.

We provide an empirical economics perspective on whether there are differences between menthol and non-menthol smokers that might warrant the prohibition of menthol cigarettes. We do not take a stance on the proposed prohibition itself. Our descriptive economic evidence

parallels the descriptive epidemiologic evidence reviewed by the FDA's Tobacco Products Scientific Advisory Committee (2011) and the FDA (2022d). Both economic and epidemiologic research studies on menthol use rely on statistical associations in observational data because randomized clinical trials are unethical and impractical. Analysis of the quasi-experiments created by Canada's and the European Union's prohibitions of menthol provide evidence on the immediate impacts of the prohibitions on smoking but may lack external validity when extrapolated to the U.S. (Carpenter and Nguyen 2021, Liber et al. 2022).

2. Data and Empirical Approach

Our first source of data is the 2018-2019 Tobacco Use Supplement to the Current Population Survey (TUS-CPS). The TUS is sponsored by the National Cancer Institute and administered as part of the U.S. Census Bureau's CPS. We use data from adult self-respondents. An Appendix available upon request provides more details about the sample sizes uses in our analyses and provides descriptive statistics.

Our second source of data is the Online Cornell Survey (OCS), which was conducted for us in November 2021 by the survey firm SSRS. Survey respondents were obtained using the SSRS Probability Panel. SSRS Opinion Panel members are recruited randomly based on nationally representative Address Based Sample design.[2] The sample for the OCS consists of 1200 current smokers aged 18 and above. The OCS included a background survey about smoking behaviors, a

[2]The ABS includes Hawaii and Alaska. ABS respondents are randomly sampled by MSG through the U.S. Postal Service's Computerized Delivery Sequence, a regularly updated listing of all known addresses in the U.S. For the SSRS Opinion Panel, known business addresses are excluded from the sample frame. Additionally, the SSRS Opinion Panel recruits hard-to- reach demographic groups via the SSRS Omnibus survey platform. The SSRS Omnibus completes more than 50,000 surveys annually with 80 percent cell allocation.

discrete choice experiment, and follow-up survey questions about smoking-related information, internalities, and other topics.

Our empirical approach presents the results of three specifications: the first specification only includes an indicator for menthol use and a constant term; the second specification adds a set of socio-demographic variables and state fixed effects; and the third specification adds an interaction term between menthol use and Black race. Our focus on the Black indicator and the menthol x Black interaction term reflects the much higher prevalence of menthol smoking among Blacks, and the role of racial disparities in menthol cigarette smoking and health-related outcomes as part of the motivation for the proposed prohibition of menthol (FDA 2022b, 2022c).

3. Menthol Use and Smoking Behavior

To provide an overview of smoking behavior, we begin by estimating linear probability models of smoking participation and, conditional on smoking participation, menthol smoking (Table 1). In our analysis sample from the 2018-2019 TUS-CPS data, the smoking participation rate is 12 percent. Conditional on smoking participation, 29 percent smoke menthol cigarettes. The model of smoking participation presented in column (1) of Table 1 shows well-known socio-demographic gradients. Smoking participation among Blacks is almost 4 percentage points lower than among whites. Compared to people with less than a high school education, among college graduates smoking participation is 9.4 percentage points lower; compared to people in households with annual income of less than $25,000, among people in households with annual income of above $75,000 smoking participation is 6.7 percentage points lower. The schooling and income gradients are similar when we restrict the sample to Blacks (column 2).

Columns (3) and (4) of Table 1 present results from models of the probability of menthol smoking, conditional on smoking participation. In the full sample of current smokers, the most

striking (and also well-known) pattern is that compared to white smokers, Black smokers are 51.6 percentage points more likely to smoke menthol cigarettes (column 3). Interestingly, in the full sample of current smokers, smoking menthol does not show strong gradients with schooling or household income. When the sample is restricted to Black current smokers, smoking menthol does not show a strong gradient with schooling but there is some evidence of a negative gradient with income. Self-selection on observables might provide insight into self-selection on unobservables (Altonji, Elder, and Taber 2005, Oster 2019). Self-selection into menthol conditional on smoking appears to be different than self-selection into smoking; if unobservables like consumer information and smoking-related internalities are correlated with schooling, they might place less of a role in self-selection into menthol.

We next turn to describing how smoking behaviors are associated with menthol use (Table 2). In the column (1) models that simply compare menthol smokers to non-menthol smokers, menthol smokers are less likely to smoke daily, smoke fewer cigarettes per day, and are less likely to have started smoking before age 18. The associations are statistically significantly different from zero but are not very large in magnitude. When the socio-demographic control variables are added in the column (2) models, the associations between menthol use and the smoking behaviors are smaller in magnitude. Black is more strongly associated with the smoking behaviors than menthol use. Black smokers are 11 percentage points less likely to be daily smokers, smoke 4 fewer cigarettes per day, and are 10 percentage points less likely to have started smoking at before age 18.

Table 2 also includes results from models of nicotine addiction, based on the heaviness of smoking index (HSI). The HSI is a simplified version of the Fagerstrom Test of Nicotine Dependence (Borland et al. 2010). The HSI is based on the two items in the Fagerstrom Test that

have been found to be most predictive of quitting: cigarettes per day and time to first cigarette of the day. The HSI takes values from 0 to 6 and is scored as follows: 0 if 1-10 cigarettes per day, 1 if 11-20 cigarettes per day, 2 if 21-30 cigarettes per day, and 3 if 31 or more cigarettes per day; and 0 if 61 or more minutes time to first cigarette, 1 if 31 to 60 minutes time to first cigarette, 2 if 6-30 minutes time to first cigarette, and 3 if 5 minutes or less time to first cigarette. Our measure of nicotine addiction indicates that the HSI is 3 or above. In our 2018-2019 TUS sample, by this measure 45.1 percent of all daily smokers are addicted. At the extreme values of the HSI index, 12.6 percent of daily smokers score 0 (low or no addiction) and 1.4 percent score 6 (strong addiction).

In the column (1) model, menthol is associated with a 7.1 percentage point lower probability of being addicted to nicotine. In the column (2) model, menthol use is associated with 1.2 percentage points lower probability of addiction, while Black is associated with an 18.4 percentage point lower probability of addiction. Adding the interaction term in the column 3 model does not change these patterns much.

To sum up, the descriptive evidence in Table 2 suggests that menthol smokers tend to smoke less, are less likely to have started smoking before age 18 and are less likely to be addicted. The differences are modest and the associations with Black are stronger than the associations with menthol. Although the findings from previous research are mixed, our findings are in part consistent with the conclusions of previous reviews of descriptive epidemiologic evidence. The FDA Tobacco Products Scientific Advisory Committee concluded that “the preponderance of evidence shows that menthol smokers do not report an earlier age of initiation of cigarette use” (TPSAC 2011, p. 113). The TPSAC report also concluded that there was insufficient evidence to conclude that menthol increases addiction among adults but concluded that a relationship

between menthol and addiction in youth smokers was more likely than not (TPSAC 2011, p. 217). Similarly, the FDA's more recent literature review concluded that the "evidence is not sufficient to support a conclusion of an association of menthol in cigarettes with dependence [addiction] among adults due to inconsistent findings." (FDA 2022d, p. 5)

4. Menthol Use and Quitting Behavior

Our next set of empirical exercises explores differences in quitting behaviors among menthol and non-menthol smokers (Table 3). We focus first on past-year and lifetime quitting. To estimate the models of past-year quitting, we use the sample of all past-year daily smokers, i.e., current daily smokers and former daily smokers who quit in the past year. In the Table 3 column (1) model, the probability of past-year quitting is about the same for menthol and non-menthol smokers; the results are similar in the column (2) model that includes additional control variables, and in the column (3) model that includes the menthol x Black interaction term. However, when we use the sample of ever smokers, in the column (1) model the probability of lifetime quitting is 7 percentage points lower among menthol ever smokers.[3] When additional control variables are included in the column (2) model, the probability of lifetime quitting is 2.6 percentage points lower for menthol smokers and 4.9 percentage points lower for Blacks. The pattern is similar in the column (3) model that includes the menthol x Black interaction term. The prevalence of lifetime quitting is 63.8 percent, compared to the past-year quit rate of 8.9 percent. It is possible that in our data we are unable to detect small differences in past-year quitting among menthol users and Blacks that, over time, cumulate into detectably lower rates of lifetime quitting.

[3] The measures needed to conduct this analysis of menthol use and lifetime quitting are only available for the respondents to the May 2019 TUS-CPS.

The lower panels of Table 3 explore other dimensions of quitting behavior: the probability of a quit attempt in the past year, the number of quit attempts in the past year, and intentions to quit in the next six months. [4] In the column (1) models that simply compare menthol and non-menthol smokers, menthol smokers are more likely to have attempted to quit smoking in the past year and reported more quit attempts in the past year. In the column (2) models that includes additional controls, the associations between quit attempts and menthol use become smaller, while the probability of an attempt and the number of quit attempts are more strongly associated with Black. The column (3) models show an interaction effect where the probability of an attempt and the number of quit attempts are highest among Black menthol smokers. Turning to another dimension of quitting behaviors, we do not find strong associations between intentions to quit in the next six months and menthol use, Black, or the menthol x Black interaction.

The last panel of Table 3 reports models of the probability of successful past-year quitting conditional on having made at least one quit attempt. In the column (1) model, conditional on attempting at least once, menthol smokers are slightly less likely to successfully quit. The column (2) model shows the conditional probability of quitting given at least one attempt is 5.2 percentage points lower for Black smokers. The column (3) model provides evidence of an interaction effect where the conditional probability of quitting given at least one attempt is lower for Blacks who also smoke menthol; however, the coefficients on menthol, Black, and menthol x Black are estimated imprecisely. Recalling that we find small associations between these variables and the unconditional probability of successful quitting, the associations with the

[4] We use the sample of past-year smokers to estimate the model of past-year quit attempts. The TUS-CPS question to current smokers about past-year quit attempts is not given to former smokers. Our definition of quit attempts assumes that all former smokers who reported quitting within the past year also attempted to quit within the past year. We use the sample of current daily smokers to estimate the models of the number of quit attempts in the past year and intentions to quit in the past six months. These questions were not given to former smokers.

conditional probability of quitting are mainly driven by the higher rate of quit attempts among menthol smokers and Black smokers.

To sum up, although the results are mixed, we find evidence that menthol use is associated with lower rates of lifetime quitting and lower rates of successful past-year quitting conditional on having made at least one attempt. As in the Table 2 models of other smoking behaviors, there are also differences in quitting behaviors between Black and white smokers. Our findings on the associations between menthol use and quitting smoking are broadly consistent with the TPSAC comprehensive review and the FDA's more recent literature review. The TPSAC review concluded that the evidence is sufficient to conclude that a relationship is more likely than not that menthol cigarettes reduced successful quitting among Blacks, but that the relationship was as likely as not for other racial/ethnic groups (TPSAC 2011, p. 217). Similarly, the FDA's more recent literature review reaches the stronger conclusion that menthol "is associated" with less quitting among Black smokers but only reaches the qualified conclusion that that menthol smoking "is likely associated" with less quitting in the general population. (FDA 2022d, p. 5)[5]

5. Menthol Use and Cigarette Purchasing Behaviors

We now turn to exploring differences between menthol and non-menthol smokers in their cigarette purchasing behaviors. The first panel of Table 4 presents linear probability models of whether their last cigarette purchase was by the pack versus a carton (of ten packs). In the column (1) model, menthol smokers are 8.7 percentage points more likely to purchase cigarettes by the pack. When socio-demographic control variables are included in the column (2) model, Black smokers are 17.6 percentage points more likely to purchase cigarettes by the pack. The

[5] The FDA's conclusions about the overall quality and strength of evidence are grouped into five possible statements: is associated, is likely associated, is likely not associated, is not associated, or is not sufficient to support a conclusion of an association (FDA 2022, p. 16).

column (3) model provides evidence of an interaction effect where Black menthol smokers are the group most likely to purchase cigarettes by the pack. The differences are substantial compared to the sample mean of 67 percent pack-purchases. The next panel of Table 4 presents models of the price paid per pack, conditional on having purchased by the pack. Similar to the patterns in purchasing by the pack, menthol smokers and Blacks pay higher prices per pack and there is evidence of a menthol x Black interaction effect. Compared to the sample mean price paid of $6.61 per pack, the price differences are small.

The next panel of Table 4 presents models of the probability of making a cigarette purchase in a state other than the respondent's state of residence, which often reflects the incentives to avoid high home-state cigarette taxes (DeCicca, Kenkel, and Liu 2013). Menthol smokers and Black smokers are slightly less likely to make out-of-state purchases.

The final panel of Table 4 presents models of the probability of having purchased a single cigarette or "loosie." Sales of single cigarettes are illegal and often occur on the street. In the column (1) model, menthol smokers are more likely to have made a single-cigarette purchase. In the column (2) model, menthol is not associated with single-cigarette purchases, but Black smokers are 7.6 percentage points more likely to have made such a purchase, which is substantial compared to the sample mean of 4.1 percent. The column (3) results are similar. These patterns are consistent with the evidence of illegal street markets in some areas of large cities such as the South Bronx neighborhood of New York City (Shelley et al. 2007).

6. Menthol Use and Consumer Information and Internalities

In this section we use data from the Online Cornell Survey's questions about smoking-related consumer information and internalities. The first panel of Table 5 explores differences in consumer perceptions about the life expectancy loss due to smoking. On average, OCS

respondents perceived that the life expectancy loss due to smoking is 11.4 years, slightly more than the public health consensus of 10 years (Jha et al. 2013).[6] In the column (1) model, menthol use is associated with perceiving an additional 1.6 years of life expectancy loss, but in the column (2) model Black is more strongly associated with perceived life expectancy loss than menthol use. In the column (3) model the coefficient on Black is large and positive while the menthol x Black interaction term is about the same size and negative. As a result, compared to white non-menthol smokers, Black menthol smokers perceive about 1.1 years of life expectancy loss. Black non-menthol smokers perceive 4.5 more years of life expectancy loss than white non-menthol smokers.

The models presented in the second panel of Table 5 explore differences in a common misperception, that nicotine is the substance that causes most of the cancer caused by smoking. Although nicotine is addictive, by itself it does not cause cancer. In the column (1) model, menthol smokers are 5.8 percentage points more likely to believe that nicotine causes cancer. In the column (2) model, menthol use is not associated with this misperception, but Black smokers are 15.6 percentage points more likely to believe that nicotine causes cancer. The results in the column (3) model provide some evidence of an interaction effect where Black menthol smokers are more likely to have this misperception. In contrast, menthol smokers and Black smokers are less likely to think that e-cigarettes – which contain nicotine but not the harmful components of tobacco smoke generated by combustion – are as harmful or more harmful than smoking; however, the differences are small and statistically insignificant.

[6] Darden, Gilleskie, and Strumpf (2018) use data from a long panel to jointly model smoking and health and allow for correlated unobservable heterogeneity. Their estimates imply that smoking causes 4.3 years of life expectancy loss, which implies that the public health consensus and the OCS respondents both over-estimate the loss due to smoking.

The models presented in the last panels of Table 5 explore differences in smoking-related internalities. The dependent variable for one set of models measures strong agreement with the statement "I smoke more than I should." We follow Allcott, Lockwood, and Taubinsky (2019, p. 1586) who use agreement with an analogous statement about consumption of sugar-sweetened beverages to measure internalities. By this measure, 53 percent of the sample of smokers impose internalities on themselves. In the column (1) and (2) models, this measure of internalities does not vary by menthol use. In the column (3) model, the coefficients on Black and the menthol x Black interaction are large and have opposite signs. Compared to the omitted category of white non-menthol smokers, Black menthol smokers are 4.4 percentage points more likely to experience the internality.[7] White menthol smokers are 2 percentage points less likely to experience the internality than white non-menthol smokers. Black non-menthol smokers are 23 percentage points less likely to experience this externality compared to white non-menthol smokers or to Black menthol smokers.

The dependent variable for the models presented in the last panel of Table 5 measure whether the respondent continued to smoke longer than they planned when they started smoking. The measure takes a value of one if the smoker's current age is older than the age at which they planned to quit smoking. The measure also takes a value of one for smokers who were not thinking about quitting smoking when they started. By this measure, 84 percent of smokers have smoked longer than they planned, or failed to plan. Again, in the column (1) and (2) models, there is no evidence that this measure of internalities varies with menthol use. The results in the column (2) and (3) models provide some evidence that Black smokers, especially those who do

[7] The association between the internality and being a Black menthol smoker is given by the sum of the coefficients on menthol, Black, and menthol x Black = -0.020 – 0.230 + 0.294 = 0.044.

not smoke menthol, are less likely to experience this internality; however, the coefficients are estimated imprecisely and are not statistically significant at conventional confidence levels.

7. Menthol and Non-Menthol Smokers' Stated Preferences for Tobacco Products

In this section we report evidence on menthol and non-menthol smokers' stated preferences in a Discrete Choice Experiment (DCE) included in the Cornell Online Survey. In the DCE, subjects were asked to make hypothetical choices between cigarettes, e-cigarettes, or quitting both smoking and vaping. The prices of cigarettes and e-cigarettes, and the attributes of the e-cigarettes including the availability of flavors, the available nicotine levels, and the e-cigarette health warning, were experimentally varied. In addition, when making their choices half of the sample saw one of the current text cigarette health warnings, while the other half of the sample saw one on the new graphic cigarette warnings (to be required on cigarette packs effective July 2023). Subjects responded to 12 choice sets; for each choice set they indicated their immediate choice today and their choice six months from now. Kenkel et al. (2022) provide more discussion of the DCE methods and additional results.

Table 6 presents estimates of linear probability models of subjects' stated tobacco product choices. The models are estimated separately for the sub-samples of 518 menthol smokers and 624 non-menthol smokers.[8] In general, menthol and non-menthol smokers respond similarly to tobacco product prices and attributes. For example, increasing the price of cigarettes by $1 decreases the probability of choosing cigarettes by 1.7 percentage points among both menthol and non-menthol smokers. Compared to subjects who saw the text cigarette warning, menthol smokers who saw the graphic pictorial warning were 7.1 percentage points less likely to choose

[8] Some subjects were dropped from the estimation sample because the reported price they paid for their last pack of cigarettes was outside any reasonable range. Each subject provided 12 responses the choice scenarios, leading to the numbers of observations reported in Table 6. Standard errors are clustered at the individual-level.

cigarettes while non-menthol smokers were 6.9 percentage points less likely to choose cigarettes. Higher cigarette prices and the graphic warning shifted both menthol and non-menthol smokers into e-cigarettes and into quitting. The only substantial difference in stated preferences is that the availability of flavors in e-cigarettes increased the probability that menthol smokers chose e-cigarettes but did not affect non-menthol smokers' choices.

8. Discussion

In this paper we explore whether menthol smokers are different in ways that provide an applied welfare economics rationale to prohibit menthol. In national data from the 2018-2019 TUS-CPS, after controlling for socio-demographics, we mainly find small associations between menthol use and smoking behaviors, many quitting behaviors, and cigarette purchase behaviors. Although menthol use is much more common among Black smokers, Blacks are less likely to be current smokers, and conditional on current smoking Blacks are less likely to be daily smokers, are less likely to have started smoking before age 18, smoke fewer cigarettes per day, and are less likely to be addicted. In data from the 2021 Cornell Online Survey, we find no evidence that menthol smokers are less informed or are more likely to experience smoking-related internalities. Our analysis of stated preference data suggests that menthol and non-menthol smokers have similar preferences over tobacco product attributes, except that menthol smokers have a stronger preference for flavored e-cigarettes.

In a potentially important exception to the patterns just described, in the 2018-2019 TUS-CPS data we find evidence that among ever smokers, menthol smokers and Black smokers are less likely to be lifetime quitters. As we note in the introduction, the role of menthol in quitting is an important rationale for the proposed tobacco standard to prohibit menthol (FDA 2022b, 2022c). However, our results pose something of a puzzle. The TPSAC (2012, Figure 1, p. 15)

describes a conceptual framework that shows how a causal factor like the biochemical properties of menthol act through pathways to produce smoking outcomes. The cooling properties of menthol suggest a possible pathway where menthol smokers inhale cigarettes more deeply, become more addicted, and therefore have more difficulty quitting. However, the FDA's recent literature review concludes that the evidence is not sufficient to support a conclusion that menthol is associated with altered puff topography such as inhaling more deeply, nor is the evidence sufficient to show that menthol is associated with differences in addiction (FDA 2022d). Another possible causal factor in the TPSAC (2012) conceptual framework is tobacco industry marketing, which might operate through different pathways than the biochemical properties. For example, for a given level of addiction, exposure to menthol product advertising might act as a cue that triggers cravings and thus makes quitting more difficult. However, Kenkel, Mathios, and Wang (2018) conduct an econometric study of the effects of magazine advertisements and do not find any evidence that menthol advertising affects cigarette demand on multiple margins including quitting.

Our findings indicate an association between menthol use and lower lifetime quitting, but it remains puzzling that we and other research find a lack of associations with plausible causal pathways from menthol use to reduced quitting. The familiar comment that association does not prove causation provides a potential explanation of the puzzle and a more general caveat to our findings. Smokers are not randomly assigned to use menthol or non-menthol cigarettes, so neither our results nor the descriptive epidemiologic research reviewed by the TPSAC (2012) and FDA (2022d) necessarily correspond to the causal treatment effects of menthol use on smoking behavior. The nature and direction of the potential selection bias is unclear. In Table 1 we find that schooling plays a strong role in self-selection into smoking but does not play a role

in self-selection into menthol use. This pattern is suggestive evidence against the explanation that unobservable heterogeneity in factors like smoking-related health information or internalities drives the association between menthol use and reduced lifetime quitting. In Table 1, the strongest predictor of selection into menthol use is Black, which poses a fundamental challenge in trying to disentangle the causal effects of menthol use from other differences between Blacks and other races/ethnicities.

As was true in 2009 when the Tobacco Control Act established the FDA's authority to regulate tobacco products, smoking continues to be the leading preventable cause of death in the U.S. Smoking is currently estimated to cause almost 500,000 deaths each year (U.S. Department of Health and Human Services 2020). From the perspective of public health, perhaps the question should not be whether differences between menthol and non-menthol smokers makes prohibiting menthol appropriate. The perhaps more natural question is whether prohibiting all cigarettes is appropriate for public health. However, the Tobacco Control Act explicitly does not allow the FDA to ban all cigarettes.

Our empirical evidence presented above addresses whether there is an economic rationale for regulating menthol cigarettes differently than non-menthol cigarettes. We do not address whether much stronger regulation – perhaps a prohibition – of all cigarettes, not just menthols, would be socially optimal in an applied welfare economics framework. DeCicca, Kenkel, and Lovenheim (2022 forthcoming) review empirical estimates of smoking-related externalities and internalities. The reviewed evidence suggests that cigarette taxes are currently high enough to correct for smoking-related externalities. The reviewed evidence, and the new results from the Cornell Online Survey presented above, suggest that smoking-related internalities are common. However, to compare current cigarette regulation to the optimal regulation also requires

estimates of the size of the internalities (Allcott and Rafkin 2021). Empirical evidence on the size of smoking-related internalities is more limited. Current cigarette regulation reflects over 50 years of anti-smoking policies including not just taxation, but also mandatory health warnings on cigarette packs, restrictions on advertising, mass media anti-smoking informational campaigns, restrictions of smoking in workplaces and other public places, and minimum purchase age laws. Jin et al. (2015) conduct retrospective and prospective cost-benefit analyses and conclude that the benefits of U.S. anti-smoking policies through 2010 likely dwarfed the costs, but that it less clear that the net benefits of future regulations will be positive.

Beyond smoking-related externalities and internalities, another part of the rationale for the proposed prohibition of menthol is to reduce health disparities and improve the health of vulnerable populations including Blacks (FDA 2022c). Good policy analysis considers alternative policy approaches to achieve the same ends. Some tobacco control policies are likely to reduce smoking across the board; for example, the results of the discrete choice experiment reported above suggest that the new graphic cigarette warnings scheduled to take effect in July 2023 will, after six months, increase quitting among both menthol and non-menthol smokers by almost 7 percentage points. An obvious way to reduce smoking-related health disparities is to adopt policies that target the vulnerable populations. For example, policies could target improving access to medical care, including pharmaceutical treatments for smoking cessation, among Black smokers and other vulnerable populations. An important recent market development is the introduction of non-combustible tobacco products like e-cigarettes that deliver nicotine without the toxicants created by tobacco combustion. The FDA recognizes the lower health risks of non-combustible tobacco products and has authorized the sale of a form of smokeless tobacco, a heated tobacco product, nicotine-containing discs and chews, and some

brands of e-cigarettes as appropriate for public health due to the potential health benefits to smokers who switch (see for example, FDA 2021). Allcott and Rafkin (2021) provide evidence that Blacks are less likely to use e-cigarettes. Public policies to encourage smokers, especially Black smokers, to switch to e-cigarettes and other tobacco harm reduction products are another route to improve health and reduce health disparities.

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Table 1: Smoking Participation and Menthol Smoking Participation

	(1) Current Smoking	(2) Current Smoking	(3) Menthol, Conditional on Smoking	(4) Menthol, Conditional on Smoking
	Full Sample	Blacks	Full Sample	Blacks
Black	-0.0371***		0.516***	
	(0.00302)		(0.0112)	
Asian	-0.0525***		0.127***	
	(0.00430)		(0.0240)	
Other race	0.0369***		0.0549**	
	(0.00754)		(0.0219)	
Hispanic	-0.0963***		0.0836***	
	(0.00295)		(0.0131)	
Male	0.0338***	0.0540***	-0.105***	-0.0598***
	(0.00174)	(0.00601)	(0.00673)	(0.0208)
age_less40	0.0712***	0.0688***	-0.00725	0.101**
	(0.00329)	(0.0106)	(0.0125)	(0.0393)
age_less50	0.0655***	0.0708***	-0.0829***	0.0693*
	(0.00348)	(0.0110)	(0.0133)	(0.0405)
age_less60	0.0738***	0.101***	-0.0920***	0.0737*
	(0.00344)	(0.0109)	(0.0129)	(0.0387)
age_abov60	0.00916**	0.0712***	-0.0785***	0.0277
	(0.00359)	(0.0117)	(0.0142)	(0.0412)
Not married (divorced, etc.)	0.0662***	0.0364***	0.00808	0.000627
	(0.00220)	(0.00787)	(0.00814)	(0.0304)
Never_married	0.0500***	0.0616***	0.0150	0.0459
	(0.00250)	(0.00782)	(0.00924)	(0.0289)
high_school	-0.0285***	-0.0563***	0.0142	0.0280
	(0.00345)	(0.00993)	(0.0104)	(0.0275)
some_college	-0.0570***	-0.0864***	0.0336***	0.0203
	(0.00368)	(0.0108)	(0.0115)	(0.0328)
higher_college	-0.124***	-0.126***	0.00463	0.00858
	(0.00346)	(0.0105)	(0.0115)	(0.0350)
unemployed	0.0720***	0.0921***	0.0162	0.0855**
	(0.00570)	(0.0146)	(0.0168)	(0.0411)
Retired	-0.0404***	-0.0426***	-0.0248**	-0.0367
	(0.00282)	(0.0102)	(0.0120)	(0.0376)
notlabormarket	0.0530***	0.0535***	-0.0143	0.0226
	(0.00270)	(0.00837)	(0.00895)	(0.0270)
between25to50k	-0.0138***	-0.0269***	0.00259	-0.0188
	(0.00251)	(0.00752)	(0.00858)	(0.0256)
between50to75k	0.00509**	-0.0107	0.00276	-0.0573*
	(0.00229)	(0.00842)	(0.00908)	(0.0348)

above75k	-0.0566***	-0.0613***	0.000701	-0.0219
	(0.00236)	(0.00814)	(0.00899)	(0.0346)
region_betwen250kto500k	-0.00389	-0.00334	0.0308**	0.00233
	(0.00342)	(0.0124)	(0.0125)	(0.0423)
region_above500k	-0.0232***	-0.00508	0.0358***	-0.0135
	(0.00190)	(0.00714)	(0.00716)	(0.0239)
Constant	0.176***	0.119***	0.306***	0.704***
	(0.00484)	(0.0151)	(0.0165)	(0.0500)
Observations	136649	13124	16352	1749
R^2	0.074	0.063	0.149	0.027
Mean of dependent variable	0.121	0.136	0.294	0.754

Table 2: Menthol Use and Smoking Behaviors

	(1)	(2)	(3)
Daily Smoker			
Menthol	-0.0229**	0.00719	0.00380
	(0.00708)	(0.00758)	(0.00804)
Black		-0.114***	-0.0135***
		(0.0119)	(0.202)
menthol x Black			0.0302
			(0.0238)
Observations	16352	16352	16352
R^2	0.001	0.056	0.056
Mean of dependent variable	0.782	0.782	0.782
Cigarettes Smoked per Day			
menthol	-1.880***	-0.468**	-0.463**
	(0.156)	(0.162)	(0.171)
Black		-4.354***	-4.321***
		(0.263)	(0.463)
menthol x Black			-0.0474
			(0.539)
Observations	12626	12626	12626
R^2	0.011	0.123	0.123
Mean of dependent variable	14.35	14.35	14.35
Started Smoking Before Age 18			
menthol	-0.0373***	-0.00727	-0.00512
	(0.00867)	(0.00929)	(0.00983)
Black		-0.118***	-0.104***
		(0.0146)	(0.0252)
menthol x Black			-0.0197
			(0.0295)
Observations	15923	15923	15923
R^2	0.001	0.056	0.056
Mean of dependent variable	0.532	0.532	0.532

Heaviness of Smoking Index			
menthol	-0.0712***	-0.0120	-0.0103
	(0.0100)	(0.0107)	(0.0112)
Black		-0.184***	-0.170***
		(0.0176)	(0.0321)
menthol x black			-0.0194
			(0.0369)
Observations	11970	11970	11970
R^2	0.004	0.068	0.068
Mean of dependent variable	0.451	0.451	0.451

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Menthol Use and Quitting Behaviors

	(1)	(2)	(3)
Past-year successful quitting			
menthol	0.00446	0.00526	0.00688
	(0.00533)	(0.00580)	(0.00610)
Black		-0.0150	-0.00330
		(0.00948)	(0.0166)
menthol x Black			-0.0166
			(0.0193)
Observations	13802	13802	13802
R^2	0.000	0.021	0.021
Mean of dependent variable	0.0885	0.0885	0.0885
Lifetime quitting			
menthol	-0.0708***	-0.0255**	-0.0243*
	(0.00926)	(0.00912)	(0.00958)
Black		-0.0485**	-0.0401
		(0.0157)	(0.0251)
Menthol x Black			-0.0133
			(0.0308)
Observations	13914	13914	13914
R^2	0.004	0.161	0.161
Mean of dependent variable	0.638	0.638	0.638
Past-year quit attempt			
menthol	0.0405***	0.0190	0.0144
	(0.00922)	(0.0100)	(0.0105)
Black		0.0496**	0.0167
		(0.0164)	(0.0286)
menthol x Black			0.0468
			(0.0333)
Observations	13802	13802	13802
R^2	0.001	0.027	0.027
Mean of dependent variable	0.408	0.408	0.408

Table 3 (continued)

	(1)	(2)	(3)
Number of Past-year Quit Attempts			
menthol	0.136***	0.0704*	0.0496
	(0.0259)	(0.0283)	(0.0297)
Black		0.185***	0.0384
		(0.0458)	(0.0801)
Menthol x Black			0.209*
			(0.0934)
Observations	12536	12536	12536
R^2	0.002	0.023	0.023
Mean of dependent variable	0.828	0.828	0.828
Intention to Quit in Next 6 Months			
menthol	0.0146	-0.00166	-0.0144
	(0.00975)	(0.0106)	(0.0112)
Black		0.0541**	-0.0366
		(0.0172)	(0.0302)
menthol x Black			0.129***
			(0.0352)
Observations	12287	12287	12287
R^2	0.000	0.023	0.025
Mean of dependent variable	0.398	0.398	0.398
Successful Quit Conditional on Quit Attempt			
menthol	-0.0102	0.000770	0.00557
	(0.0119)	(0.0130)	(0.0137)
Black		-0.0523*	-0.0150
		(0.0210)	(0.0386)
menthol x Black			-0.0510
			(0.0442)
Observations	5633	5633	5633
R^2	0.000	0.033	0.034
Mean of dependent variable	0.217	0.217	0.217

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Menthol Use and Cigarette Purchasing Behaviors

	(1)	(2)	(3)
Purchase by the pack			
menthol	0.0871***	0.0245**	0.0142
	(0.00811)	(0.00855)	(0.00906)
Black		0.176***	0.112***
		(0.0134)	(0.0228)
menthol x Black			0.0927***
			(0.0269)
Observations	16039	16039	16039
R^2	0.007	0.090	0.090
Mean of dependent variable	0.670	0.670	0.670
Price paid per pack			
menthol	0.158***	0.0655*	0.0380
	(0.0415)	(0.0326)	(0.0347)
Black		0.365***	0.199*
		(0.0487)	(0.0868)
menthol x Black			0.229*
			(0.0992)
Observations	10264	10264	10264
R^2	0.001	0.515	0.516
Mean of dependent variable	6.614	6.614	6.614
Purchase in state other than state of residence			
menthol	-0.0119*	0.00335	0.00484
	(0.00508)	(0.00531)	(0.00562)
Black		-0.0224**	-0.0130
		(0.00830)	(0.0143)
Menthol x Black			-0.0135
			(0.0168)
Observations	14905	14905	14905
R^2	0.000	0.107	0.107
Mean of dependent variable	0.0883	0.0883	0.0883

Table 4 (continued)

	(1)	(2)	(3)
Single-cigarette Purchase			
menthol	0.0318***	0.00586	0.00384
	(0.00342)	(0.00367)	(0.00390)
Black		0.0755***	0.0630***
		(0.00575)	(0.00980)
menthol x Black			0.0181
			(0.0115)
Observations	16154	16154	16154
R^2	0.005	0.053	0.053
Mean of dependent variable	0.0411	0.0411	0.0411

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Menthol Use and Consumer Information and Internalities

	1.609**	0.293	0.569
	(1)	(2)	(3)
Perceived Life Years Lost Due to Smoking			
menthol	1.609**	0.293	0.569
	(0.570)	(0.587)	(0.608)
Black		1.275	4.544*
		(0.960)	(2.128)
menthol x Black			-4.022
			(2.337)
Observations	1,200	1,200	1,200
Mean of dependent variable	11.40	11.40	11.40
Agree that nicotine causes cancer			
menthol	0.058*	0.002	-0.003
	(0.029)	(0.030)	(0.031)
Black		0.156**	0.096
		(0.049)	(0.108)
menthol x Black			0.075
			(0.119)
Observations	1,200	1,200	1,200
Mean of dependent variable	0.40	0.40	0.40
Perceive e-cigarette use as or more harmful than smoking			
menthol	-0.007	-0.028	-0.020
	(0.029)	(0.031)	(0.032)
Black		-0.039	0.056
		(0.050)	(0.112)
menthol x Black			-0.117
			(0.123)
Observations	1,200	1,200	1,200
Mean of dependent variable	0.56	0.56	0.56

Table 5 (cont.)

Strongly agree that I smoke more than I should			
Smoke Menthol	-0.004	0.000	-0.020
	(0.029)	(0.031)	(0.032)
Black		0.009	-0.230*
		(0.051)	(0.113)
Menthol x Black			0.294*
			(0.124)
Observations	1,200	1,200	1,200
Mean of dependent variable	0.53	0.53	0.53
Smoked longer than I thought I would			
Smoke Menthol	-0.036	0.001	-0.003
	(0.021)	(0.021)	(0.022)
Black		-0.065	-0.108
		(0.034)	(0.076)
Menthol x Black			0.053
			(0.084)
Observations	1,200	1,200	1,200
Mean of dependent variable	0.84	0.84	0.84

Source: Online Cornell Survey 10/28 – 11/15, 2021. Standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001

Table 6: Menthol and Non-Menthol Smokers' Stated Preferences for Tobacco Products

Variables		Immediate Choice Today						Choice of six months from now					
		Menthol smokers			Non-menthol smokers			Menthol smokers			Non-menthol smokers		
		Cigarette	E-cigarette	Quit	Cigarette	E-cigarette	Quit	Cigarette	E-cigarette	Quit	Cigarette	E-cigarette	Quit
Cigarette warning	Pictorial warning	-0.071**	0.040	0.032	-0.069**	0.027	0.041*	-0.094***	0.029	0.066*	-0.088***	0.018	0.069**
		(0.032)	(0.029)	(0.025)	(0.028)	(0.023)	(0.024)	(0.034)	(0.029)	(0.034)	(0.032)	(0.025)	(0.033)
Price	Cigarette price	-0.017***	0.007***	0.011**	-0.017***	0.009***	0.008**	-0.016***	0.005***	0.011**	-0.013***	0.006***	0.007**
		(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
	E-cigarette price	0.014***	-0.019***	0.005**	0.019***	-0.016***	-0.002	0.011***	-0.016***	0.004*	0.014***	-0.014***	0.000
		(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
E-cigarette available flavor	Tobacco, menthol, fruit/sweet/candy	-0.047***	0.051***	-0.004	-0.000	0.006	-0.006	-0.054***	0.063***	-0.010	-0.002	0.010	-0.009
		(0.012)	(0.011)	(0.009)	(0.011)	(0.009)	(0.008)	(0.011)	(0.011)	(0.009)	(0.010)	(0.009)	(0.008)
	Tobacco and menthol	-0.035***	0.038***	-0.003	-0.020*	-0.007	0.027**	-0.040***	0.048***	-0.008	-0.009	-0.004	0.012
		(0.013)	(0.012)	(0.010)	(0.011)	(0.008)	(0.008)	(0.011)	(0.011)	(0.010)	(0.010)	(0.007)	(0.009)
E-cigarette available nicotine level	Up to 20mg	0.003	-0.015	0.012	-0.011	0.017**	-0.007	0.002	-0.009	0.007	-0.008	0.005	0.003
		(0.010)	(0.010)	(0.008)	(0.009)	(0.008)	(0.007)	(0.010)	(0.010)	(0.009)	(0.008)	(0.007)	(0.007)
	Up to 50mg	0.016	-0.020**	0.004	0.009	-0.004	-0.005	-0.002	-0.007	0.009	0.001	0.005	-0.006
		(0.010)	(0.009)	(0.008)	(0.010)	(0.008)	(0.008)	(0.010)	(0.010)	(0.010)	(0.009)	(0.008)	(0.008)
E-cigarette warning	Are not completely risk free	0.000	-0.016	0.016	0.015	0.001	-0.017*	-0.006	-0.003	0.009	0.009	0.004	-0.013
		(0.013)	(0.013)	(0.011)	(0.011)	(0.009)	(0.010)	(0.013)	(0.013)	(0.013)	(0.012)	(0.010)	(0.011)
	Contain nicotine, which is addictive	0.024*	-0.023*	-0.001	0.040***	-0.020*	-0.019*	0.011	-0.000	-0.011	0.019	-0.006	-0.013
		(0.015)	(0.014)	(0.012)	(0.013)	(0.011)	(0.011)	(0.015)	(0.015)	(0.014)	(0.014)	(0.011)	(0.013)
	May expose users to chemicals and toxins	0.011	-0.016	0.004	0.017	-0.021**	0.003	0.003	-0.006	0.003	0.010	-0.018*	0.008
		(0.013)	(0.013)	(0.012)	(0.012)	(0.010)	(0.010)	(0.014)	(0.013)	(0.013)	(0.012)	(0.010)	(0.011)
	Constant	0.701***	0.261***	0.038	0.695***	0.190***	0.114**	0.600***	0.222***	0.179**	0.531***	0.202***	0.267**
		(0.036)	(0.033)	(0.026)	(0.043)	(0.030)	(0.029)	(0.037)	(0.032)	(0.034)	(0.042)	(0.029)	(0.035)
Observations		6,216	6,216	6,216	7,488	7,488	7,488	6,216	6,216	6,216	7,488	7,488	7,488

Adjusted R-squared	0.081	0.032	0.037	0.080	0.041	0.025	0.075	0.022	0.031	0.048	0.023	0.014

Notes: The reference category of e-cigarette available flavor “tobacco only”, the reference category of e-cigarette available nicotine level is “up to 5mg”, the reference category of e-cigarette warning is “no warning”. Standard errors clustered at respondent level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.