A Longitudinal Study of Menthol Cigarette Use and Smoking Cessation among Adult Smokers in the US: Assessing the Roles of Racial Disparities and E-cigarette Use

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Abstract

Using nationally representative longitudinal data from Wave 1 to Wave 4 of the Population Assessment of Tobacco and Health Study in the United States, we examined whether the association between menthol cigarette use and smoking cessation was modified by race/ethnicity and e-cigarette use. Multivariable discrete-time survival models were fit to an unbalanced person-period data set (person n=7423, risk period n=18,897) for adult respondents (ages 25+) who were current established cigarette smokers at baseline. We found that adults who smoke menthol cigarettes had lower odds of smoking cessation, but the effect was modified by race/ethnicity as non-Hispanic (NH) Black menthol smokers had lower odds of quitting smoking than NH White or Hispanic menthol smokers. We also found that e-cigarette use was associated with higher odds of smoking cessation among both menthol and non-menthol smokers, but the association was stronger among menthol smokers. Our results suggest that a menthol smoking ban may have a favorable impact on smoking cessation for NH Black adults. In addition, our results also suggest that a menthol smoking ban may be more effective if menthol smokers have access to e-cigarettes as a way to quit cigarette use.

Keywords

Menthol; Cessation; Disparities; E-cigarettes

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Conflicts of Interest

The authors declare that they have no known or competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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INTRODUCTION

Despite large decreases in the prevalence of cigarette smoking in recent decades, tobacco use remains the leading cause of preventable death in the United States.[1] Further reducing cigarette use therefore remains a key priority for improving population health. One way the Food and Drug Administration (FDA) may achieve this reduction is by banning menthol in cigarettes.[2] In the US, menthol cigarette use accounts for nearly 40% of cigarette smoking,[3] and the market share for menthol cigarettes has grown by 10% since 2000.[4] Because menthol cigarettes are designed to mask the harshness of smoking, it is believed that menthol cigarette use facilitates smoking initiation, leads to higher levels of smoking dependence and decreases the likelihood of smoking cessation.[5]

Several studies have examined the association between menthol cigarette use and smoking cessation in the United States. While the strength of this association has come into question,[6,7] the weight of evidence suggests that menthol cigarette use is associated with a lower likelihood of smoking cessation.[8–11] Research from clinical trials and cessation clinics provides additional evidence suggesting that smoking cessation may be lower for menthol smokers than for non-menthol smokers.[12–14]

There also appears to be racial/ethnic disparities in the association between menthol cigarette use and smoking cessation. These disparities are reflected in the FDA's 2013 evaluation of the scientific literature where they concluded that the impact of menthol flavoring on cigarette use cessation was strongest among Black menthol smokers who were the least likely to quit.[5] Other research has drawn similar conclusions,[8,14–16] providing further evidence that racial/ethnic differences in smoking cessation for menthol smokers result in tobacco use disparities. A recent meta-analysis found that 47% of the explainable heterogeneity between studies on the menthol-cessation association was due to racial/ethnic differences and that smoking cessation was 12% lower among non-Hispanic (NH) Black smokers than NH White smokers.[17]

While a relatively large body of evidence has associated menthol cigarette use with lower levels of cessation, especially among NH Black smokers, very little research has established this relationship using nationally representative longitudinal data. However, two longitudinal studies using data from the Population Assessment of Tobacco Health Study (PATH) have recently been published. In the first study, Schneller et al[18] examined the longitudinal association between different menthol delivery systems (i.e., menthol in cigarette tobacco, crushable menthol capsules in the cigarette filter) and smoking cessation for adult smokers over a one-year interval (Waves 1 and 2). They found no statistically significant differences in cessation for menthol and non-menthol smokers after adjusting for sociodemographic characteristics, but they did not test for effect modification by race/ethnicity.[18] In the second study, Mills et al[19] used data from Waves 1 through 4 of PATH to examine the relationship between menthol cigarettes, cessation and relapse for non-daily and daily adult smokers. They found that smoking cessation (measured as non-current past 30-day cigarette use) was lower among daily menthol smokers but not among non-daily menthol smokers, and menthol smokers were no more likely than non-menthol smokers to relapse. The authors also stratified the results by race/ethnicity, and found that the odds of smoking cessation was

lower among non-Hispanic Black and non-Hispanic White daily menthol smokers but not for Hispanic or Other racial/ethnic group members.[19]

Much of the research on the menthol-cessation association has focused on identifying disparities in cessation while very little research has examined whether other characteristics, such as e-cigarette use, can affect smoking cessation among menthol smokers. There is conflicting epidemiological evidence on the role of e-cigarette use in smoking cessation,[20,21] but a growing body of research has found that e-cigarette use facilitates smoking cessation.[22–25] Studies have yet to explore the differential role that e-cigarette use may play in smoking cessation for menthol and non-menthol smokers, although one community-based study found that menthol smokers were more likely to consider using e-cigarettes to help them quit smoking compared to non-menthol smokers.[26] These findings are consistent with the results from a discrete choice experiment where menthol smokers reported they would be willing to switch to e-cigarettes, but only if flavored e-cigarettes are not banned.[27] Recent population-based evidence further demonstrates that menthol cigarette users switched to e-cigarettes at high rates, especially for menthol/mint flavored e-cigarettes, relative to non-menthol smokers.[28] Given that one of the primary motivations for e-cigarette use among adults smokers is to help facilitate smoking cessation,[29,30] it is plausible that menthol smokers may find e-cigarettes more appealing than non-menthol smokers, and thus use them more effectively as a smoking cessation aid.

Our study uses data from the first four waves of the PATH Study, an ongoing longitudinal cohort study, to examine the association between menthol cigarette use and smoking cessation. Our study adds to the literature on menthol cigarette cessation by: (1) examining whether smoking cessation differs by race/ethnicity using a nationally representative longitudinal sample of US adults; (2) testing whether e-cigarette use has a differential impact on smoking cessation for menthol and non-menthol smokers. To our knowledge, this is the first study to investigate whether the menthol-cessation relationship is modified by e-cigarette use, accounting for time-varying patterns of menthol smoking and e-cigarette use.

MATERIALS AND METHODS

Data

The PATH Study is a nationally representative, longitudinal cohort study of the civilian US population. Wave 1 data were collected from September 2013 to December 2014; Wave 2 data were collected from October 2014 to October 2015; Wave 3 data were collected from October 2015 to October 2016; Wave 4 data were collected from December 2016 to January 2018. Further details about the design of the PATH Study are available elsewhere.[31] Since we used de-identified publicly available PATH data, this study was classified as not regulated human subjects research by the University of Michigan Institution Review Board.

The analytic sample for the current study was restricted to adult respondents age 25 or older at Wave 1 (to capture respondents' highest level of education and to exclude ages during which smoking patterns have not yet been established),[32] who were current established smokers and responded to at least one of the subsequent follow-up interviews.

Current established cigarette smokers were defined as respondents who smoked at least 100 cigarettes in their lifetime and reported smoking every day or some days at the baseline interview. A flowchart summarizing the stages of sample selection can be found in Figure 1.

Measures

We operationalized smoking cessation as discontinued cigarette smokers who self-reported completely quitting smoking. Discontinued smoking status was defined as current established cigarette smokers at baseline (Wave 1) who reported no past 30-day cigarette use at any follow-up. Discontinued cigarette smokers were also asked the following question, *"have you completely quit smoking cigarettes?"* Respondents were categorized as continuing smokers if they reported current smoking at follow-up or if they were discontinued smokers who reported they had not completely quit smoking at follow-up (n=225). Discontinued cigarette smokers who reported they completely quit smoking were considered to have successfully quit smoking cigarettes.

Menthol cigarette flavoring was the exposure variable, and consistent with other research,[8,13,17,33] respondents were classified as menthol cigarette smokers if their regular brand was "flavored to taste like menthol or mint." Current smokers were asked this question at each wave, and we found evidence that menthol cigarette use did change over time as 4.4% of nonmenthol smokers transitioned to menthol cigarette use, while 8.3% of menthol smokers transitioned to non-menthol cigarette use between Wave 1 and Wave 4. To capture changes in cigarette flavoring preference, menthol cigarette use was included as a time-varying measure that was lagged (t-1) to ensure that the menthol exposure variable preceded the outcome.

To examine sociodemographic differences, we included age (25–34, 35–54, 55+), sex (0=female, 1=male), race/ethnicity (NH White, NH Black, NH Other, Hispanic), education (high school/GED or less, some college, college degree or higher), and household income (0=less than $49,999, 1 = $50,000 +) as baseline sociodemographic variables. Missing values for baseline sociodemographic variables were updated with data from other waves when available to reduce item non-response. We also included tobacco dependence, derived based on a validated 16-item scale,[34] at baseline to control for differences in nicotine addiction among respondents. The tobacco dependence scale was standardized with a mean of 0 and a standard deviation of 1. As is commonly done in other research[21], we examined current e-cigarette use, which was then included as a time-varying covariate to allow for changes in e-cigarette use over time. We found that 7.3% of non-cigarette users transitioned to e-cigarette users, while 57.5% of e-cigarette users at baseline transitioned away from e-cigarette use between Wave 1 and Wave 4. Respondents who reported using e-cigarettes every day or some days were defined as current e-cigarette users at each wave (0=no e-cigarette use; 1=every day or some days). For a sensitivity analysis, we also included current frequent e-cigarette use (measured as 10+ days in the past 30 days).

Statistical Analysis

Descriptive statistics were first calculated for sociodemographic and tobacco-related characteristics according to respondent's menthol cigarette use at baseline. Chi-square tests

or Fisher's exact tests were used to test for statistically significant differences between these groups. Lifetables were then used to describe the distribution of event occurrence.[35] The lifetable provides unweighted counts of smoking cessation or censoring at each time interval and unadjusted survival and hazard probability estimates.

We fitted a series of multivariable discrete-time survival models predicting smoking cessation over three one-year time intervals through Wave 2 to Wave 4 (W2-W4). Discrete-time models are appropriate when the exact timing until an event is not known.[35] Our models were fit to an unbalanced person-period data set where each individual contributed a number of rows equal to the time period until they quit smoking or were censored.[36] Respondents were removed from the risk set at the time of quitting and respondents who did not quit smoking were right censored at their last observation point. This means that each of the 7423 respondents in our study had a separate row of data for each risk period, with a maximum of three rows per person, resulting in a person-period dataset with 18,897 observations. The structure of the reorganized person-period dataset allowed for an examination of the conditional probability of smoking cessation at each discrete time interval. Four discrete-time survival models were estimated using a general linear modelling (GLM) approach with a binomial distribution and logit link function on the person-period data set. Model 1 included a measure for the main effect of time (i.e., baseline hazard) and the menthol cigarette exposure variable. Model 2 added the sociodemographic control variables and Model 3 added tobacco dependence and e-cigarette use. Model 4 tested the interactions between menthol cigarette use and both race/ethnicity and e-cigarette use separately. The marginal interactive effects represent whether the change in the probability of smoking cessation was statistically different across the categorical independent variables.[37] We graphed the predicted probabilities for the statistically significant interactions ($P<0.05$).

Data were weighted using Wave 1 weights, including full-sample and 100 replicate weights, to ensure that our respondents were representative of non-institutionalized adult population in the United States at baseline.[38] As a sensitivity analysis, the multivariable models were also estimated with the longitudinal cohort of respondents who participated in all waves of the PATH Study using the "all waves weights" (person-period n=5741, risk period n=15,869). Additionally, we conducted a second sensitivity analysis including all respondents aged 18–24 (person-period n=9468, risk period n=23,890) to ensure that restricting our analytic sample to adults aged 25 and older at baseline did not bias the results. For all analyses, variances were computed using the balanced repeated replication methods with Fay's adjustment set to 0.3 as recommended by the PATH study.[38,39] All analyses were conducted using Stata 16.1.

RESULTS

Table 1 shows the population weighted sociodemographic characteristics and smoking behaviours at baseline. Current established smokers were most likely to be between 35 and 54 years old (45.9%), male (53%), and NH White (67.8%). The majority of current established smokers also reported a household income of less than $50,000 (74.5%) and did not report any postsecondary education (54.5%). At baseline, approximately one third of

current established smokers (36.2%) reported menthol cigarette use, and one fifth (20.3%) reported using e-cigarettes some days or every day.

Lifetables describing the distribution of smoking cessation are shown in Table 2. The overall rate for continued smoking among established smokers at baseline was 78.8% through Wave 4 (95% CI 77.8,79.7), and differences in the rate were observed for menthol and non-menthol smokers. At the end of Wave 4, 77.8% (95% CI: 76.5,79.0) of non-menthol smokers continued smoking cigarettes while 80.4% (95% CI: 78.8,81.9) of menthol smokers continued smoking cigarettes. The hazard rate for smoking cessation decreased for both menthol and non-menthol smokers over time, meaning that the conditional probability of cessation was lower at each subsequent wave regardless of baseline menthol status.

Table 3 presents the results from four multivariable discrete-time survival analyses models predicting smoking cessation. The exposure variable, menthol cigarette use in the prior year, was associated with decreased odds of smoking cessation in Model 1 (AOR=0.83; 95% CI: 0.73,0.94). This association was attenuated once we added sociodemographic and tobacco-related control variables in Model 2 (AOR=0.89; 95% CI: 0.78,1.02) and e-cigarette use and tobacco dependence in Model 3 (AOR=0.88; 95% CI: 0.76,1.00). Several other covariates were also associated with smoking cessation. In the multivariable main effect model (Model 3), we found that respondents between ages 35 and 54 at baseline (compared to 25–34) had lower odds of reporting smoking cessation (AOR=0.76; 95% CI: 0.66,0.87), and that having a family income of $50,000 or more (AOR=1.28; 95% CI: 1.13,1.45) and having started (AOR=1.35; 95% CI: 1.17,1.57) or completed a college education (AOR=1.62; 95% CI: 1.37,1.92) were associated with higher odds of smoking cessation, compared to having a family income of less than $50,000 or high school education or less, respectively. In addition, for every standard deviation increase in tobacco dependence, the odds of smoking cessation were reduced by 36% (AOR=0.64; 95% CI: 0.59,0.69).

We examined effect modification of the association between menthol smoking and cessation by race/ethnicity and e-cigarette use in Model 4. We found statistically significant differences by race/ethnicity (F=3.72, P<0.05) and by e-cigarette use (F=6.82, P<0.05). Displayed in Figure 2, we found that the predicted probability of smoking cessation was lower for NH Black and NH Other adults who used menthol versus non-menthol cigarettes, while there were no differences in cessation for menthol versus non-menthol cigarette use for NH White or Hispanic adults. We also found that current everyday/someday e-cigarette use increased the predicted probability of smoking cessation among both non-menthol and menthol smokers, but that the association was more pronounced among menthol smokers (Figure 3). In the sensitivity analysis, the association of e-cigarette use on smoking cessation was greater when we defined e-cigarette use as 10+ days in the past 30 days rather than every day or someday use. However, the menthol by e-cigarette interaction using both e-cigarette definitions produced similar results (see Figure A1 and Table A1, Appendix).

As a sensitivity analysis, the multivariable discrete-time models were estimated using the longitudinal cohort with the 'all waves' weights,' which resulted in a reduced sample size because participation was required for all four waves (see Table A2, Appendix). The substantive results were nearly identical compared to the models estimated with Wave 1

weights with one notable exception. In the longitudinal cohort sample, the odds of smoking cessation for menthol smokers were slightly lower after controlling for sociodemographic factors (Model 2; AOR=0.82, 95% CI: 0.70,0.95) and tobacco dependence and e-cigarette use (Model 3; AOR=0.81, 95% CI: 0.69,0.94) compared to the model using Wave 1 weights. The results for the menthol by race/ethnicity interaction and menthol by e-cigarette interaction were nearly identical regardless of the analytic sample. As a secondary sensitivity analysis, discrete time-models were estimated with all adult respondents aged 18 or older at baseline (see Table A3, Appendix). While the main effect of menthol cigarette use on smoking cessation was a bit more conservative (AOR=0.88, p<0.05 vs AOR=0.92, p>0.05), the substantive interpretation of the interaction effects remained unchanged. The predicted probability of smoking cessation was lower for NH Black and NH Other respondents and the predicted probability of smoking cessation was more pronounced for menthol than for non-menthol smokers.

DISCUSSION

This study examined the longitudinal relationship between menthol cigarette flavoring and smoking cessation among a representative sample of US adults who smoke. We found that menthol smokers had lower odds of smoking cessation relative to non-menthol smokers, but the strength of this relationship was reduced when sociodemographic and tobacco-related controls were included in multivariable models. Moreover, we identified low odds of smoking cessation among NH Black and NH Other smokers, annual household income (less than $50,000), and education (high school or less). These findings remained after controlling for tobacco dependence and verify the important role those sociodemographic characteristics play in smoking cessation using nationally representative longitudinal data.

Previous research has demonstrated a considerable amount of heterogeneity in the menthol–cessation relationship,[17] and we found that this relationship was modified by race/ethnicity. NH Black and NH Other menthol smokers had lower odds of quitting smoking than NH White or Hispanic menthol smokers, relative to non-menthol smokers in their respective racial/ethnic groups. These findings are consistent with other studies of racial/ethnic differences in smoking cessation for menthol smokers[8,17,40] and provide further evidence that the impact of menthol cigarette use on cessation varies across racial/ethnic groups.[17] Longitudinal analyses that adjust for race/ethnicity without testing for effect modification may conceal potentially important racial/ethnic disparities,[18] and the findings from our study reaffirm the need to carefully test for these disparities. While it is expected that a menthol cigarette ban will generally reduce the prevalence of cigarette use for menthol smokers,[41] the impact of a menthol ban may be strongest among NH Black smokers, which may improve cessation for this group. In addition, our findings highlight the continued need for identifying culturally-specific cessation programs that incorporate ethnocultural factors[42] to help facilitate cessation across all groups and ameliorate racial/ethnic disparities in cessation.

We also found that current e-cigarette use was associated with a higher odds of smoking cessation among both menthol and non-menthol adult smokers. These findings are consistent with research showing that many smokers use e-cigarettes as an aid to help them quit

smoking,[22–24] at least in the short-term.[43] However, a key finding in our study was that the association between e-cigarette use and smoking cessation was stronger for menthol smokers than for non-menthol smokers, even after adjusting for racial/ethnic and other determinants of menthol smoking. We also examined this association using a measure of regular e-cigarette use (10+ days used in the past 30 days) as a sensitivity analysis and we obtained similar results for the effect modification. These results suggest that e-cigarettes may be an especially important cessation aid for menthol smokers who want to quit smoking. E-cigarettes may be an alternative product for menthol smokers, and their availability to current smokers may help to reduce the public health harms associated with tobacco use. Furthermore, a menthol ban may be particularly effective in reducing smoking among menthol smokers, especially if mint and menthol flavored e-cigarettes are available as an option for menthol smokers affected by such a ban. Further research is needed to substantiate these findings as more recent data on transitions between products and patterns of dual and exclusive use becomes available.

The findings from this study are not without limitation, and several caveats are important to note when interpreting the results. First, our study examined short-term smoking cessation, and we did not examine longer term smoking cessation or relapse. While recent longitudinal research did not identify differences in smoking relapse for former menthol and non-menthol smokers,[19] future research would benefit from examining disparities in both smoking relapse and smoking cessation for menthol smokers. Future research would also benefit from incorporating longer-term measures of smoking cessation. Second, while we identified racial/ethnic disparities in cessation for menthol smokers, small sample sizes prevented us from disentangling differences within the NH Other group [44] which includes NH American Indian/Alaskan Native, Asian, Native Hawaiian/Pacific Islander, and multiracial individuals. Future research, with bigger sample sizes, is needed to disaggregate the NH Other group to understand its racial/ethnic heterogeneity in smoking cessation among menthol smokers. Third, our measure of e-cigarette use was a dichotomous predictor based on past 30-day use and did not capture heterogeneity in frequency of e-cigarette use, which may also impact the likelihood of smoking cessation.[25] However, we accounted for time-varying use, which is important as e-cigarette use has been shown to be transient.[45] While the data in this study were collected at a time when rates of e-cigarette use were beginning to rise (2013–2017)[46], the data are largely prior to the widespread use of pod-based devices; the prevalence of e-cigarette use has continued to increase among adult smokers, especially among those trying to quit smoking.[47] More recent longitudinal data is needed to better understand how the frequency of e-cigarette use is associated with smoking cessation for menthol smokers in this rapidly evolving marketplace. Future research would also benefit from assessing the impact of frequency and intensity of e-cigarette use on smoking cessation outcomes. Finally, all longitudinal studies carry a risk that attrition is selective rather than random, and survival analysis techniques assume that right censoring is non-informative. We included a sensitivity analysis using the sample of respondents who participated at all waves because the 'all-waves weights' adjust for respondent non-response. While the results were nearly identical, giving us confidence that there were not any systematic non-response biasing our results, it remains possible that they still may be unaccounted for selection bias due to non-random attrition.

Conclusions

Using nationally representative longitudinal data among adult smokers in the US, we found that smoking cessation varied across racial/ethnic groups and by e-cigarette use status. These results contribute to the existing literature on the role of menthol on smoking cessation among adult smokers in two ways. First, the results provide longitudinal evidence that a menthol smoking ban may have a favorable impact on smoking cessation for NH Black and NH Other racial/ethnic groups. These results also point to the need for culturally specific public health strategies to help menthol smokers quit smoking. Second, the results from this study suggest that menthol smokers who use e-cigarettes are more likely to quit smoking. This finding suggests that a menthol smoking ban may be more effective if menthol smokers have access to e-cigarettes as a way to quit cigarette use or as a way to transition to exclusive e-cigarette use.

Disclosure of Funding

Appendix

Table A1.

Discrete time Models Predicting Smoking Cessation with Regular E-Cigarette Use (10 + Days Per Month), PATH Adult (25+) W1-W4

	Model 1[a]		Model 2[b]		Model 3[c]		Model 4[d]	
	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI
Period 1	0.10[***]	[.09–.11]	0.08[***]	[.07–.10]	0.07[***]	[.06–.08]	0.07[***]	[.06–.08]
Period 2	0.09[***]	[.08–.10]	0.07[***]	[.06–.09]	0.06[***]	[.05–.07]	0.06[***]	[.05–.07]
Period 3	0.08[***]	[.07–.09]	0.07[***]	[.05–.08]	0.06[***]	[.05–.07]	0.06[***]	[.05–.07]
Menthol cig use TVC	0.83[**]	[.73–.94]	0.89	[.78–1.02]	0.86[*]	[.76–.99]	0.87	[.72–1.05]
Age group								
25–34			REF	REF	REF	REF	REF	REF
35–54			0.69[***]	[.61–.80]	0.78[***]	[.68–.91]	0.79[***]	[.68–.91]
55+			0.88	[.75–1.03]	1	[.85–1.18]	1	[.85–1.19]
Sex (male=1)			1.1	[.97–1.24]	1.03	[.92–1.16]	1.03	[.92–1.17]
Race/Ethnicity								
Hispanic			1.46[***]	[1.22–1.74]	1.27[*]	[1.06–1.52]	1.23	[.98–1.54]
NH White			REF	REF	REF	REF	REF	REF
NH Black			0.77[*]	[.61–.99]	0.76[*]	[.59–.97]	0.98	[.65–1.48]
NH Other			1.05	[.83–1.34]	1.03	[.92–1.16]	1.28	[.96–1.69]
Education								
High School or less			REF	REF	REF	REF	REF	REF

	Model 1[a]		Model 2[b]		Model 3[c]		Model 4[d]	
	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI
Some college			1.41***	[1.22–1.63]	1.33***	[1.14–1.54]	1.33***	[1.15–1.54]
College or more			1.95***	[1.63–2.32]	1.62***	[1.36–1.92]	1.61***	[1.36–1.91]
Household Income								
<$49,999			REF	REF	REF	REF	REF	REF
50,000 >			1.35***	[1.19–1.53]	1.27***	[1.12–1.44]	1.27***	[1.12–1.42]
Tobacco Dependence					0.62***	[.58–.68]	0.62***	[.58–.67]
E-cigarette use (10+ days)					3.40***	[2.86–4.05]	2.90***	[2.33–3.61]
Menthol*e-cig Interaction							1.59**	[1.14–2.22]
Menthol*race/ethnicity								
Hispanic							1.04	[.71–1.45]
NH White							REF	REF
NH Black							0.65*	[.41–.98]
NH Other							0.45*	[.23–.86]

Notes: Person N =7423; Risk Period N= 18,897

*
 p<0.05
**
 p<0.01
***
 p<0.001

[a]Tobacco use exposure

[b]sociodemographic variables added

[c]tobacco dependence added

[d]interaction model

Table A2.

Discrete Time Models Predicting Smoking Cessation on Longitudinal Cohort ('all waves weights'), Path Adult (25+) W1-W4

	Model 1[a]		Model 2[b]		Model 3[c]		Model 4[d]	
Variable	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI
Period 1	0.10***	[.09–.11]	0.09***	[.07–.10]	0.08***	[.06–.09]	0.08***	[.06–.09]
Period 2	0.09***	[.08–.10]	0.08***	[.06–.09]	0.07***	[.06–.09]	0.07***	[.06–.09]
Period 3	0.08***	[.07–.09]	0.07***	[.05–.08]	0.06***	[.05–.08]	0.06***	[.05–.08]
Menthol cig use TVC	0.78**	[.68–.89]	0.82**	[.70–.95]	0.81**	[.69–.94]	0.84	[.73–1.07]
Age group								
25–34			REF	REF	REF	REF	REF	REF
35–54			0.64***	[.55–.74]	0.70***	[.60–.81]	0.7***	[.61–.82]
55+			0.82*	[.69–.98]	0.89	[.74–1.07]	0.9	[.74–1.08]

Variable	Model 1[a] AOR	95% CI	Model 2[b] AOR	95% CI	Model 3[c] AOR	95% CI	Model 4[d] AOR	95% CI
Sex (male=1)			1.07	[.94–1.23]	1.03	[.90–1.18]	1.04	[.91–1.19]
Race/Ethnicity								
Hispanic			1.43 ***	[1.18–1.74]	1.18	[.97–1.45]	1.21	[.95–1.55]
NH White			REF	REF	REF	REF	REF	REF
NH Black			0.79	[.60–1.02]	0.73 *	[.56–.95]	1.04	[.67–1.62]
NH Other			1.15	[.87–1.51]	1.11	[.83–1.47]	1.38 *	[.99–1.92]
Education								
High School or less			REF	REF	REF	REF	REF	REF
Some college			1.45 ***	[1.23–1.72]	1.40 ***	[1.19–1.65]	1.41 ***	[1.16–1.66]
College or more			1.94 ***	[1.61–2.34]	1.60 ***	[1.33–1.94]	1.59 ***	[1.31–1.92]
Household Income								
<$49,999			REF	REF	REF	REF	REF	REF
50,000 >			1.36 ***	[1.17–1.58]	1.29 ***	[1.11–1.50]	1.28 **	[1.12–1.49]
Tobacco Dependence					0.65 ***	[.60–.71]	0.65 ***	[.60–.71]
E-cigarette use (every/some days)					1.47 ***	[1.20–1.79]	1.27	[.99–1.65]
Menthol*e-cig Interaction							1.49 *	[1.10–2.02]
Menthol*race/ ethnicity								
Hispanic							0.91	[.61–1.36]
NH White							REF	REF
NH Black							.57 *	[.34–.97]
NH Other							0.37 **	[.17–.77]

Notes: Person N =5741; Risk Period N=15,869

*
p<0.05

**
p<0.01

***
p<0.001

[a]Tobacco use exposure

[b]sociodemographic variables added

[c]tobacco dependence added

[d]interaction model

Table A3.

Discrete Time Survival Analysis Predicting Smoking Cessation Among Adult Respondents (18+), PATH W1-W4

Variable	Model 1[a] AOR	95% CI	Model 2[b] AOR	95% CI	Model 3[c] AOR	95% CI	Model 4[d] AOR	95% CI
Period 1	0.11***	[.10–.12]	0.10***	[.09–.12]	0.09***	[.08–.11]	0.09***	[.08–.10]
Period 2	0.09***	[.08–.10]	0.09***	[.07–.10]	0.08***	[.07–.10]	0.08***	[.07–.09]
Period 3	0.08***	[.07–.09]	0.08***	[.07–.10]	0.08**	[.06–.09]	0.07***	[.06–.09]
Menthol cig use TVC	0.89*	[.80,1.00]	0.93	[.82–1.04]	0.92	[.81–1.03]	0.93	[.80–1.09]
Age group								
18–24			REF	REF	REF	REF	REF	REF
25–34			0.80**	[.69–.94]	0.88	[.75–1.03]	0.88	[.76–1.03]
35–54			0.56***	[.49–.65]	0.66***	[.58–.76]	0.67***	[.59–.78]
55+			0.71***	[.60–.84]	0.83*	[.70–.98]	0.84*	[.71–.99]
Sex (male=1)			1.08	[.97–1.20]	1.02	[.92–1.14]	1.03	[.92–1.15]
Household Income								
<$49,999			REF	REF	REF	REF	REF	REF
50,000 >			1.30***	[1.17–1.46]	1.24***	[1.11–1.39]	1.24**	[1.11–1.39]
Race/Ethnicity								
Hispanic			1.44**	[1.24–1.68]	1.19*	[1.02–1.40]	1.18	[.96–1.46]
NH White			REF	REF	REF	REF	REF	REF
NH Black			0.79*	[.64–.98]	0.72**	[.58–.90]	1	[.68–1.46]
NH Other			0.95	[.76–1.18]	0.91	[.72–1.14]	1.09	[.85–1.41]
Education								
High School or less			REF	REF	REF	REF	REF	REF
Some College			1.49***	[1.32–1.68]	1.42***	[1.26–1.61]	1.43***	[.1.26–1.61]
College or more			2.05***	[1.74–2.41]	1.70***	[1.44–2.00]	1.69***	[1.43–1.98]
Tobacco Dependence					0.65***	[.61–.70]	0.65***	[.61–.70]
E-cigarette use (every/some days)					1.23**	[1.08–1.41]	1.09	[.9–1.32]
Menthol*e-cig Interaction							1.39*	[1.06–1.82]
Menthol*race/ethnicity								
Hispanic							1	[.74–1.36]
NH White							REF	REF
NH Black							0.62*	[.42–.91]
NH Other							0.53*	[.32–.88]

Notes: Person N =9,468 ; Risk Person N =23,890

*
  p,0.05
**
  p<0.01
***
  p<0.001
a
Tobacco use exposure

b
sociodemographic variables added

c
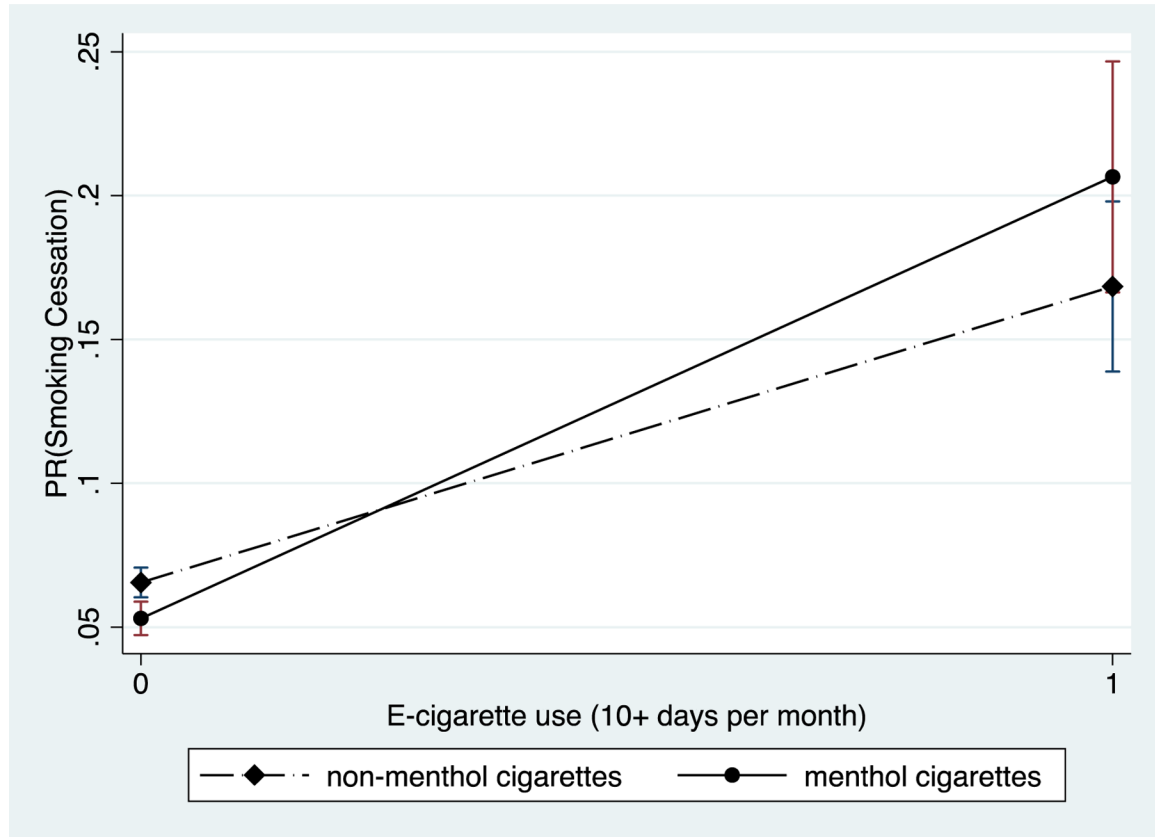tobacco dependence added

d
interaction model

Figure A1.
Predicted Probability of Smoking Cessation for Menthol and Non-Menthol Smokers by
Regular E-cigarette Use (10+ Days Per Month)

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Highlights

- We found disparities in smoking cessation among adults who smoke menthol cigarettes

- Non-Hispanic Black menthol smokers had low odds of smoking cessation

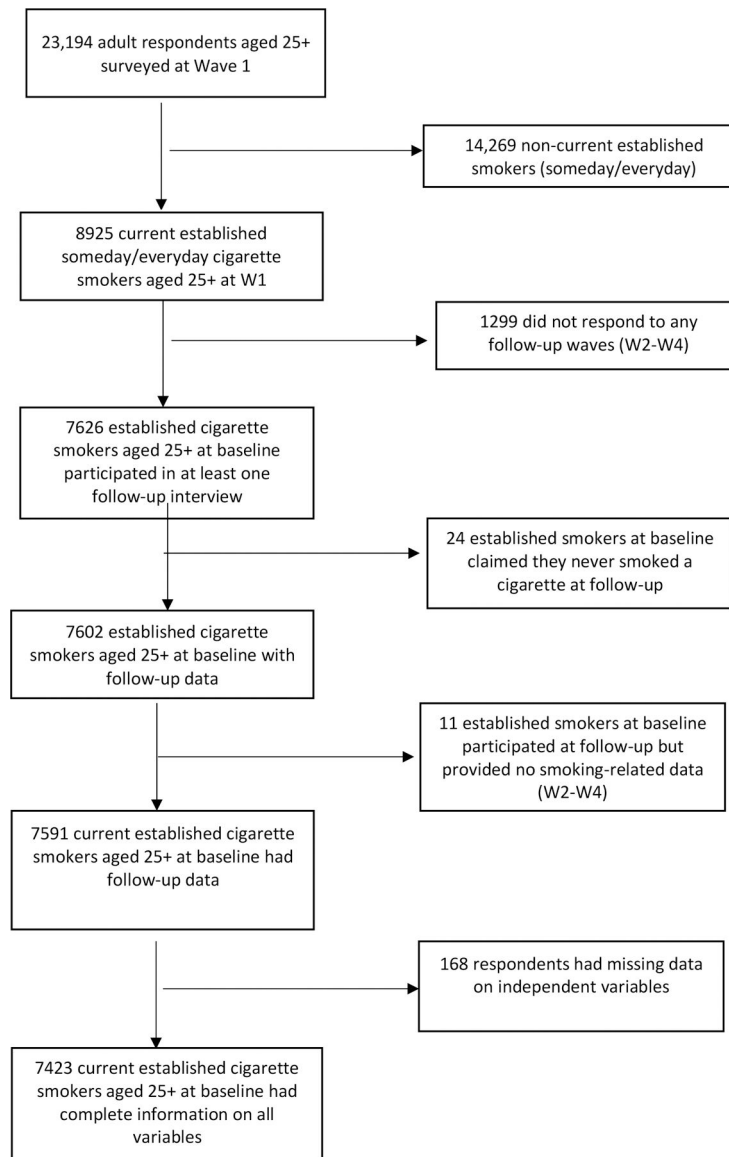- Smoking cessation was higher for menthol smokers who used e-cigarettes

23,194 adult respondents aged 25+ surveyed at Wave 1

14,269 non-current established smokers (someday/everyday)

8925 current established someday/everyday cigarette smokers aged 25+ at W1

1299 did not respond to any follow-up waves (W2-W4)

7626 established cigarette smokers aged 25+ at baseline participated in at least one follow-up interview

24 established smokers at baseline claimed they never smoked a cigarette at follow-up

7602 established cigarette smokers aged 25+ at baseline with follow-up data

11 established smokers at baseline participated at follow-up but provided no smoking-related data (W2-W4)

7591 current established cigarette smokers aged 25+ at baseline had follow-up data

168 respondents had missing data on independent variables

7423 current established cigarette smokers aged 25+ at baseline had complete information on all variables

Figure 1.
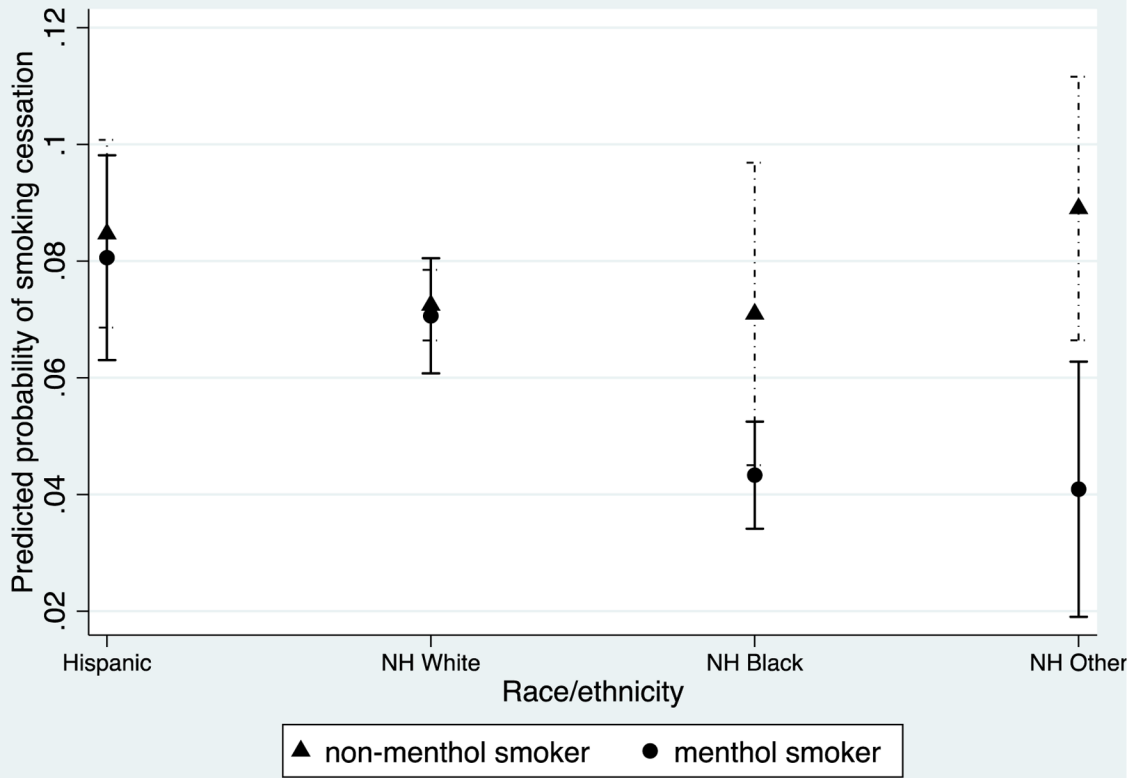Flowchart of Sample Selection, PATH Adult (W1-W4)

Figure 2.
Predicted Probability of Smoking Cessation for Menthol and Non-Menthol Smokers by Race/Ethnicity.
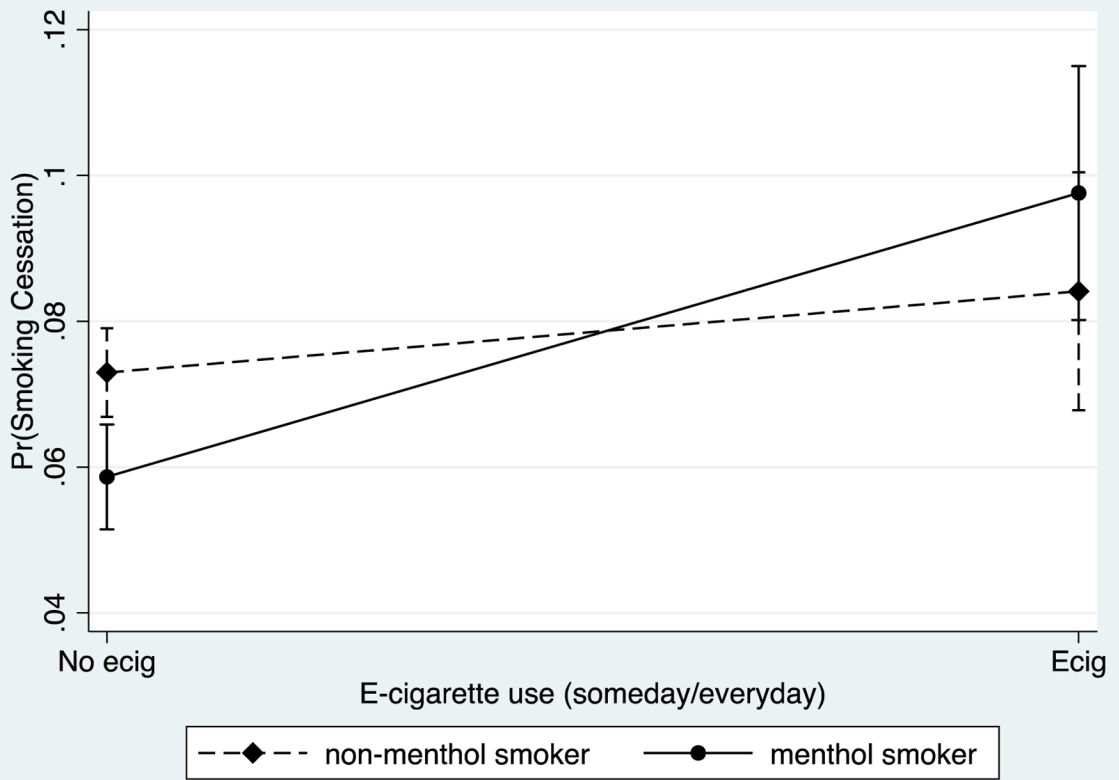
Figure 3.
Predicted Probability of Smoking Cessation for Menthol and Non-Menthol Smokers by E-cigarette use

Table 1.

Weighted Sociodemographic and Smoking Behaviors of Current, Established Adult (25+) Cigarette Smokers at baseline in the Population Assessment of Tobacco Health (PATH) Study (n=7423)

	N	%	95% CI
Age Group			
25–34	2177	28.6%	[27.4–29.8]
35–54	3452	45.9%	[44.7–47.1]
55+	1794	24.3%	[24.3–26.8]
Sex			
Female	3731	47.0%	[45.7–48.2]
Male	3692	53.0%	[51.8–54.3]
Race/Ethnicity			
Hispanic	858	10.4%	[9.6–11.3]
NH White	4094	67.8%	[68.3–71.3]
NH Black	1075	14.4%	[13.4–15.5]
NH Other			
Education	496	5.4%	[4.9–6.0]
HS degree or less	3817	54.5%	[53.2–55.9]
Some college	2710	33.5%	[32.2–34.8]
College or more	896	12.0%	[11.2–12.8]
Household Income			
$49,999 or less	5613	74.5%	[59.7–63.5]
$50,000 or more	1811	25.5%	[67.9–72.4]
E-cigarette use (every/someday)			
No	5883	79.7%	[78.6–80.7]
Yes	1540	20.3%	[19.3–21.4]
Menthol Smoking Status			
No	4672	63.8%	[62.3–65.3]
Yes	2751	36.2%	[34.7–37.7]

Table 2:

Life Table Describing Quitting Smoking for Menthol and Nonmenthol Smokers (n=7423)

Interval	Smokers	Cessation	Censored	Survival (95% CI)	Hazard Rate (95% CI)
Non-Menthol Smokers					
Period 1 (W1-W2)	4671	406	642	0.913 [.905–.921]	0.087 [.079–.096]
Period 2 (W2-W3)	3923	320	415	0.839 [.828–.849]	0.082 [.073–.091]
Period 3 (W3-W4)	3188	231	2957	0.778 [.765–.790]	0.073 [.063–.082]
Menthol Smokers					
Period 1 (W1-W2)	2752	222	168	0.919 [.908–.929]	0.087 [.070–.092]
Period 2 (W2-W3)	2362	162	206	0.856 [.842–.869]	0.069 [.058–.079]
Period 3 (W3-W4)	2007	121	1873	0.804 [.788–.819]	0.061 [.050–.072]
Total Sample					
Period 1 (W1-W2)	7423	628	510	0.915 [.909–.922]	0.085 [.078–.091]
Period 2 (W2-W3)	6285	482	621	0.845 [.837–.853]	0.077 [.070–.084]
Period 3 (W3-W4)	5182	352	4830	0.788 [.778–.797]	0.068 [.061–.075]

Table 3.

Discrete Time Survival Analysis Predicting Smoking Cessation (W1 Weights), PATH Adult (25+) W1-W4

	Model 1[a]		Model 2[b]		Model 3[c]		Model 4[d]	
	AOR	CI	AOR	95% CI	AOR	95% CI	AOR	95% CI
Period 1	0.10 ***	[.09–.11]	0.08 ***	[.07–.10]	0.08 ***	[.06–.09]	0.08 ***	[.06–.09]
Period 2	0.09 ***	[.08–.10]	0.07 ***	[.06–.09]	0.07 ***	[.06–.08]	0.07 ***	[.06–.08]
Period 3	0.08 ***	[.07–.09]	0.07 ***	[.05–.08]	0.06 ***	[.05–.08]	0.06 ***	[.05–.08]
Menthol cig use TVC	0.83 **	[.73–.94]	0.89	[.78–1.02]	0.88 *	[.76–1.00]	0.89	[.73–1.07]
Age group								
25–34			REF	REF	REF	REF	REF	REF
35–54			0.69 ***	[.61–.80]	0.76 ***	[.66–.87]	0.76 ***	[.66–.88]
55+			0.88	[.75–1.03]	0.95	[.81–1.11]	0.95	[.81–1.12]
Sex (male=1)			1.1	[.97–1.24]	1.05	[.93–1.19]	1.05	[.93–1.19]
Race/Ethnicity								
Hispanic			1.46 ***	[1.22–1.74]	1.20 *	[1.00–1.43]	1.17	[.92–1.48]
NH White			REF	REF	REF	REF	REF	REF
NH Black			0.77 *	[.61–.99]	0.72 **	[.56–.92]	0.97	[.64–1.46]
NH Other			1.05	[.83–1.34]	1.01	[.78–1.29]	1.25	[.94–1.66]
Education								
High School or less			REF	REF	REF	REF	REF	REF
Some college			1.41 ***	[1.22–1.63]	1.35 ***	[1.17–1.57]	1.36 ***	[1.17–1.57]
College or more			1.95 ***	[1.63–2.32]	1.62 ***	[1.37–1.92]	1.61 ***	[1.36–1.91]
Household Income								
<$49,999			REF	REF	REF	REF	REF	REF
50,000 >			1.35 ***	[1.19–1.53]	1.28 ***	[1.13–1.45]	1.28 ***	[1.13–1.45]
Tobacco Dependence					0.64 ***	[.59–.69]	0.64 ***	[.59–.69]
E-cigarette use (every/some days)					1.34 **	[1.13–1.59]	1.17	[.94–1.45]
Menthol*e-cig Interaction							1.49 *	[1.10–2.02]
Menthol*race/ethnicity								
Hispanic							1.02	[.71–1.45]
NH White							REF	REF
NH Black							0.64 *	[.41–.98]
NH Other							0.45 *	[.23–.86]

Notes: Person N =7423; Risk Period N= 18,897

*
 p<0.05

**
 p<0.01

***
 p<0.001

[a]Tobacco use exposure

[b]sociodemographic variables added

[c]tobacco dependence added

[d]interaction model