Original Investigation

A Longitudinal Examination of Behavioral Transitions among Young Adult Menthol and Non-Menthol Cigarette Smokers Using a Three-State Markov Model

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Abstract

Introduction: Young adult cigarette smoking behaviors are complex and dynamic. Emerging research suggests a growing rate of switching from non-menthol to menthol cigarettes. Transitions across cigarette smoking states are not well understood. This research longitudinally explores transitions in cigarette smoking behaviors among 18–29 year olds.

Methods: We applied a Markov model to data collected biannually for 1542 initially 18–29 year old young adults (mean age: 20.9 years; SD = 2.6) in Texas, who provided 7021 total observations from Fall 2014 to Spring 2017. All participants were past 30 day menthol or non-menthol cigarette smokers at first observation. We examined transitions across three states of cigarette smoking (menthol, non-menthol, and nonsmoking) and compared predictors of each transition, during young adulthood.

Results: Descriptively, 22.2% of menthol and 14.3% of non-menthol smokers switched products while 25.6% of menthol and 26.0% of non-menthol smokers quit smoking. Among quitters, 20.0% relapsed via menthol and 28.2% relapsed via non-menthol cigarettes. Results from Markov model indicated that Hispanic/Latinos (Hazard Ratio [HR]: 3.69) and Asians (HR: 2.85) were significantly more likely to switch from non-menthol to menthol cigarettes, relative to non-Hispanic whites. Among recent quitters, the use of non-cigarette products was associated with increased risk of relapse via menthol (HR: 1.54) and non-menthol (HR: 1.85) cigarettes.

Conclusion: A substantial proportion of young adult cigarette smokers transitioned across cigarette smoking states over the course of 2.5 years. Other tobacco use and nicotine dependence were impediments to becoming and remaining a non-smoker. Hispanic/Latinos and Asians, relative to non-Hispanic whites, had greater odds of transitioning from non-menthol smoking to both non-smoking and to menthol smoking. Findings suggest racial/ethnic differences in cigarette smoking transitions during young adulthood.

Implications: This paper examined multidirectional transitions across cigarette smoking, including switching between menthol and non-menthol cigarettes, among young adults. Results indicate that Hispanic/Latino and Asian young adults are at increased risk of transition to menthol cigarette smoking compared with non-Hispanic white young adults. Findings highlight need for further study of Hispanic/Latino and Asian young adult smoking behaviors.

Introduction

The development of long-term cigarette smoking behaviors during young adulthood is a complex and dynamic process that encompasses transitions across several states of cigarette smoking.[1,2] For example, never smokers may transition to ever smoking (ie, initiation); current smokers may transition to become former smokers (ie, discontinuation, quitting); and former smokers may transition back to become current smokers (ie, relapse). Characterizing flavors (ie, menthol vs. non-menthol cigarettes) further complicate our understanding of these transitions. Current smokers may transition across cigarette types (eg, menthol to non-menthol) and the risk of relapse among former smokers may differ by product types.[3,4] Research is needed to describe and better understand transitions across states of cigarette smoking, accounting for flavors, during the critical development period of young adulthood.[5,6]

Menthol cigarettes were historically described as "starter products" for young smokers, who later transition to non-menthol cigarettes.[4,7,8] However, recent studies of young adults found non-menthol smokers are significantly more likely to switch to menthol cigarettes than vice versa.[9,10] Moreover, the switch from non-menthol to menthol cigarettes appears to be more stable than the switch from menthol to non-menthol cigarettes.[9] One study found 69% of non-menthol smokers who switched to menthol *remained* menthol smokers while 65% of menthol smokers who switched to non-menthol cigarettes *returned* to menthol cigarettes.[9] These data suggest the traditional understanding of menthol cigarettes as a "starter product" for young smokers may be shifting in the United States. "Sustained" use of menthol cigarettes among young smokers may now be as problematic.

Research shows patterns of switching between product types (ie, menthol to non-menthol or vice versa) may differ by race/ethnicity.[8,9] One longitudinal study found that while switching across product types was uncommon among non-Hispanic Whites (2% switched from non-menthol to menthol; 8% switched from menthol to non-menthol), 15% of African American non-menthol smokers *switched to menthol cigarettes* and 16% of Hispanic/Latino menthol cigarette smokers *switched to non-menthol cigarettes*, over a 12 month period.[9] As such, it is necessary to explore racial/ethnic differences in the role of menthol on transitions across states of cigarette smoking during young adulthood. The need for this research is exacerbated by the tobacco industry's history of aggressive marketing and product branding aimed at racial/ethnic minorities, particularly African Americans[11–13] and Hispanic/Latinos.[14]

Menthol cigarettes are linked to reduced odds of cessation and greater odds of relapse, relative to non-menthol cigarettes,[4,15] though these relationships differ by race/ethnicity.[3,10,16,17] African American and Hispanic/Latino menthol cigarette smokers are two to three times less likely to quit smoking, relative to their non-menthol cigarette smoker counterparts.[16] Conversely, studies have found that among non-Hispanic white cigarette smokers, those who smoke menthol cigarettes have similar[16] or greater[17] odds of smoking cessation, compared to those who smoke non-menthol cigarettes. Thus, while research has consistently linked menthol to lower rates of cigarette smoking abstinence during adulthood,[4] the intersection of race/ethnicity and menthol suggests the need for more complex study than is currently available.

Shifting trends in menthol cigarette smoking, particularly among young adults, increases the urgency in understanding the role of menthol cigarettes in smoking behaviors. Menthol cigarettes increased from 25.9% of all cigarette sales in 2000 to 35.4% in 2018.[18] Similarly, the proportion of young adult cigarette smokers who reported smoking menthol cigarettes grew from 32.4% in 2004 (12.9% were menthol smokers versus 26.9% non-menthol) to 51.4% in 2014 (14.8% menthol versus 14.0% non-menthol).[15] Further, menthol cigarette smoking declined significantly among 12–17 year olds over this time (from 4.6% to 2.5%) and increased slightly among older adults (ie, 26 years old or more) beginning in 2010.[15]

Research on cigarette smoking behaviors has primarily relied on unidirectional analyses (eg, logistic regression) to examine individual outcomes, such as cessation among current smokers; though multi-directional models (eg, Markov models) have been applied to examine policy measures and cessation outcomes.[19–21] A limitation of unidirectional analyses is the inability to explore multidirectional transitions. A unidirectional examination of cigarette smoking cessation (as an outcome) cannot inform the likelihood of cigarette smoking relapse among former smokers (and vice versa). This is a limitation of longitudinal observational research with multiple follow-up observations as young adult cigarette smokers frequently shift between smoking stages.[5,6] These limitations are compounded when factoring in product type (ie, menthol versus non-menthol cigarettes). Thus, there is a need for the use of analytic methods that account for the multi-directional transitions in cigarette smoking behaviors, given the use of menthol or non-menthol cigarettes, to inform public health practice and regulation. Further clarity on differences in these transitions across socio-demographic factors (eg, race/ethnicity) is needed to inform culturally appropriate interventions.

Aims and Hypotheses

This study examines longitudinal transitions across cigarette smoking behaviors and product types among a cohort of young adult college students: We investigate six specific transitions to inform Food and Drug Administration Research Priorities related to switching behaviors,[22] seen in Figure 1.

The first aim of this study was to simultaneously estimate the probability of transitioning across three states of cigarette smoking; these states are: (1) non-menthol cigarette smoker; (2) menthol cigarette smoker; and (3) non-smoker (ie, quitters who smoked at last observation). A single Markov model was used to concurrently estimate transition intensities across several states, including: switching flavors (eg, menthol to non-menthol; non-menthol to menthol) among current smokers (transitions 1 and 2); discontinuation among current smokers, by flavor (transitions 3 and 4); and relapse among former smokers, by flavor (transitions 5 and 6). Further, we compare racial/ethnic differences in these transition intensities. This study also explores additional predictors of these transitions, including biological sex, age, symptoms of nicotine dependence, and use of other tobacco products.

(1) non-menthol smoking → menthol smoking
(2) menthol smoking → non-menthol smoking
(3) non-menthol smoking → cessation
(4) menthol smoking → cessation
(5) non-smoking → non-menthol smoking
(6) non-smoking → menthol smoking

Figure 1. Transitions in Cigarette Smoking States Observed in this Study.

Methods

Study Design

This study is a prospective, secondary analysis of data collected from the Marketing and Promotions across Colleges in Texas study (Project M-PACT); a multi-wave, rapid response surveillance study of young adults in Texas.[23,24] This study utilized Markov models to analyze 2.5 years of data (2014–2017) collected every six months for young adult participants. From November 2014 through May of 2017; study participants completed bi-annual assessments of tobacco use behaviors, for up to six Waves of data and observations on cigarette smoking.

Participants

Participants were young adult college students attending 12 two- and 12 four-year institutions in Austin, Dallas/Fort Worth, Houston, and San Antonio. Eligibility criteria for inclusion in Project M-PACT included being a degree or certificate seeking student enrolled full- or part-time at a two year vocational/technical program or four year college/university. Participation was restricted to individuals aged 18–29 years old (at baseline); however, individuals aged 26–29 were required to have used a tobacco product in their lifetime (ie, ever use) in order to be eligible for participation; this requirement was not placed on participants aged 18–25 years old. The requirement of lifetime tobacco use among older participants was guided by previous research demonstrating limited tobacco use initiation after the age of 25.[25]

Eligibility criteria for the present study included reporting smoking conventional cigarettes within the past 30 days at least once over the course of the 2.5 year and six-wave study. The first time a participant reported past 30 days cigarette smoking served as the first observation for that participant. Furthermore, all past 30 day cigarette smokers had to complete at least one additional follow-up assessment in order to be eligible for inclusion in this analysis, given assumptions of the Markov model. Overall, a total of 7332 eligible observations were collected across the six waves of data. Of those, 311 (4.2%) were ultimately excluded from the study sample; 234 observations were lost to follow-up (ie, did not provide a second observation after reporting cigarette smoking) and 77 observations were lost because of missing data on study variables. As such, the final sample for this study was 7021 total observations (ie, completed surveys) from 1542 participants. Of the 1542 participants, 210 had two total observations; 211 had three observations; 230 had four observations; 298 had five observations; and 593 had six observations. Additionally, 7.6% of respondents (416 observations) were followed in non-consecutive waves.

Procedures

Study participants were recruited via email to participate in an online survey. Informed consent was given by individuals that met eligibility criteria. Overall, 13 714 students were eligible to participate in the study; 5482 (40%) provided informed consent and completed the Wave 1 survey. Participants have given a $10 electronic gift card at the completion of Wave 1 (Fall 2014) and Wave 2 (Spring 2015) and a $20 electronic gift card at completion of subsequent waves (Fall 2015, Spring 2016, Fall 2017, Spring 2107). Study design and procures are described further elsewhere.[23,24]

Retention rates ranged from 77.8% to 81.1% across study waves. Additionally, 92.1% of the original sample (*n* = 5482) completed two or more surveys. These retentions rates are considered high and comparable to other college student surveys with equivalent incentive structures.[26]

Measures

Cigarette Smoking Behaviors

Cigarette smoking behavior was the primary outcome of interest. At each wave, participants were asked: "On how many of the past 30 days did you smoke cigarettes?" Those who reported zero days were considered "non-smokers." Those who reported smoking cigarettes on one or more days were subsequently asked "Are the cigarettes you currently smoke flavored to taste like menthol or mint?" Participants who reported "no" were considered non-menthol cigarette smokers and those who reported "yes" were considered menthol cigarette smokers. These responses resulted in the following three cigarette smoking states: non-smoker; menthol cigarette smoker; non-menthol cigarette smoker.

Socio-Demographics

Socio-demographic variables were assessed at baseline and treated as time-invariant covariates. Age ranged from 18 to 29 and was analyzed continuously. Sex was a binary variable with males coded as the referent group. Race/ethnicity was categorized into mutually exclusive groups: non-Hispanic White (referent); Hispanic/Latino, African American, Asian American, and "other," which included American Indian/Alaska Native, Native Hawaiian or other Pacific Islander, any other race/ethnicity, and individuals who identified as multiracial. Institution type was a binary variable reflecting two-year college (referent group) or four-year university.

Nicotine Dependence

This study examined two measures of nicotine dependence based on the Hooked on Nicotine Checklist.[27] Participants were asked "Have you ever had a strong craving to smoke a cigarette?" and "Have you ever felt like you really needed a cigarette?" A single dichotomous item was created based on the combined responses to these questions of nicotine dependence. Individuals who reported "yes" to one or both of the Hooked on Nicotine Checklist measures were considered to have symptoms of nicotine dependence. Non-behavioral measures of nicotine dependence were selected for this study to accurately reflect the psychological elements of dependence experienced by both current and former smokers. Nicotine dependence was assessed at each observation and treated as a time-varying covariate.

Other Tobacco Product Use

This study also examined non-cigarette tobacco use. Participants self-reported use of e-cigarettes, cigar products (ie, large cigars, cigarillos, little filtered cigars), smokeless tobacco, and/or hookah in the past 30 days. Those who reported use of one or more of these products were classified as other tobacco product users. Other tobacco product use was assessed at each observation and treated as a time-varying covariate.

Statistical Analysis

For the purposes of this study, a three-state Markov[28] model was fitted to these data. The three states of this model were: (1) non-menthol cigarette smoker; (2) menthol cigarette smoker; and (3) non-smoker (ie, quitters who smoked at last observation).

The three-state Markov model reflects nine possible transitions; remaining in the same state between the two observations is treated as the referent transitional state and thus produces six interpretable transitions (Figure 1). Transition occurs between any adjacent observations (eg, from Wave 1 to Wave 3, if participant did not complete Wave 2). First, the effect of a time-dependent covariate can be estimated by assuming the measures were constant between observations (eg, time-invariant between observations).[28] As such, this analysis assumes symptoms of nicotine dependence (which is a time-varying covariate) and other tobacco use are constant between observations. Second, the hazard of transition is independent of state at a previous time point (eg, transition from Time T to Time T+ is independent of state at Time T-1 and before). Third, time-homogeneous assumption, ie, the probability of transition from time t to time s only depends on the time interval s-t and does not depend on the time t. Transition intensities for all nine (of which three are referent outcomes held constant at 1.00) possible transitions were also modeled. Transition intensities are defined as the risk for transitioning from one state (r) to another (s), at any given time (t), accounting for covariates.[28] Effects of transition covariates are reported using the hazard ratio (HR), 95% confidence interval (CI), and corresponding p-value and presented in Table 2; visualization of these transitions is available in Figure 2. All statistical analyses were conducted using R Studio (version 3.5.3), using "msm" package.[28]

Results

Descriptive Statistics

At baseline (ie, first observation), the mean age for all smokers was 20.9 years (SD = 2.6); 41.3% of participants were menthol cigarette smokers and 58.7% were non-menthol cigarette smokers. Further descriptive statistics are available in Table 1. Among the full sample (ie, all 7021 observations), 26.3% of observations were specific to menthol cigarette smoking, 38.8% to non-menthol cigarette smoking, and 34.8% to non-smoking. Among observations specific to menthol cigarette smoking ($n = 1845$), 52.2% continued menthol cigarette smoking, 22.2% switched to non-menthol cigarette smoking, and 25.6% quit cigarette smoking at the next (adjacent) observation. Among observations specific to non-menthol cigarette smoking ($n = 2727$), 59.7% continued non-menthol cigarette smoking, 14.3% switched to menthol cigarette smoking, and 26.0% stopped cigarette smoking at next observation. Among observations specific to non-smoking (ie, recent quitters), 51.8% remained non-smokers, 20.0% relapsed via menthol cigarette smoking, and 28.2% relapsed via non-menthol cigarettes at the next observation.

Markov Model

Markov Model findings are reported in Table 2. A visual representation of all transitions is available in Figure 2.

The hazard of transition from non-menthol cigarette smoking to non-smoking (ie, quitting/discontinuation) at next observation declined significantly with age (HR: 0.95; 95% CI: 0.91 to 0.98) and symptoms of nicotine dependence (HR: 0.40; 95% CI: 0.33 to 0.50). Conversely, Hispanic/Latino (HR: 1.32; 95% CI: 1.05 to 1.66) and Asian (HR: 1.77; 95% CI: 1.27 to 2.45) non-menthol

Table 1. Characteristics of Youth Adult Menthol and Non-Menthol Cigarette Smokers at First Observation (Texas, 2014–2017; $n = 1542$ Observations)

	Full sample ($n = 1542$)	Menthol cigarette smoking ($n = 636$)	Non-menthol cigarette smoking ($n = 905$)	p-value[a]
Percent of sample	100%	41.3%	58.7%	
Age				**<0.001**
Mean (SD)	21 (2.6)	21.2 (2.7)	21.3 (2.6)	
Sex				**0.001**
Male	680 (44.1%)	249 (36.6%)	431 (63.4%)	
Female	861 (55.9%)	387 (45.0%)	474 (55.0%)	
Race/Ethnicity				**<0.001**
Non-Hispanic white	612 (39.7%)	195 (31.9%)	417 (68.1%)	
Hispanic/Latino	531 (34.4%)	260 (49.0%)	271 (51.0%)	
Non-Hispanic black	81 (5.3%)	49 (60.5%)	32 (39.5%)	
Asian	201 (13.0%)	83 (41.3%)	118 (58.7%)	
Other[b]	117 (7.6%)	50 (42.7%)	67 (57.3%)	
Institution type				0.044
Two year	120 (7.8%)	60 (50.0%)	60 (50.0%)	
Four year	1422 (92.2%)	577 (40.6%)	845 (59.4%)	
Nicotine dependence				0.022
No	513 (33.3%)	191 (37.2%)	322 (62.8%)	
Yes	1029 (66.7%)	446 (43.3%)	583 (56.7%)	
Other tobacco use				0.384
No	558 (36.2%)	222 (39.8%)	336 (60.2%)	
Yes	982 (63.8%)	413 (42.1%)	569 (57.9%)	

[a]Bivariate comparison of menthol and non-menthol cigarette smoking for each study variable; T-test for continuous outcomes; chi-squared for categorical outcomes.
[b]"Other," which included American Indian/Alaska Native, Native Hawaiian or other Pacific Islander, any other race/ethnicity, and individuals who identified as multiracial.
Bold value indicates statistical significance at $p < 0.05$.

Table 2. Hazard Ratios of Transitions Across Cigarette Smoking States Among Youth Adults (Number of Observations = 7021, Texas, 2014–2017)

	Transition among menthol cigarette smokers; all relative to remaining a menthol cigarette smoker		Transition among non-menthol cigarette smokers; all relative to remaining a non-menthol cigarette smoker		Transition among non-smokers; all relative to remaining a non-smoker	
	Menthol[b] → non-menthol[a]	Menthol[c] → non-smoking[b]	Non-menthol[a] → menthol[b]	Non-menthol[a] → non-smoking[b]	Non-Smoking[a] → non-menthol[b]	Non-smoking[a] → menthol[c]
Age	0.96 (0.89–1.04)	**0.95 (0.91–0.99)**	1.01 (0.91–1.13)	**0.95 (0.91–0.98)**	**0.93 (0.88–0.99)**	**0.86 (0.78–0.94)**
Race/Ethnicity						
NH-white	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Hispanic/Latino	0.89 (0.54–1.49)	0.83 (0.61–1.11)	**3.69 (1.78–7.66)**	**1.32 (1.05–1.66)**	1.03 (0.72–1.48)	0.73 (0.45–1.21)
Non-Hispanic black	0.52 (0.15–1.80)	0.78 (0.48–1.27)	2.34 (0.63 – 8.60)	1.18 (0.73–1.92)	0.65 (0.32–1.33)	0.39 (0.14–1.12)
Asian	0.61 (0.27–1.34)	0.67 (0.43–1.06)	**2.85 (1.15–7.08)**	**1.77 (1.27–2.45)**	1.18 (0.70–2.02)	0.80 (0.42–1.50)
Other[c]	**2.61 (1.35–5.03)**	1.38 (0.74–2.60)	1.40 (0.25–1.41)	0.92 (0.61–1.41)	**0.42 (0.13–1.40)**	**2.23 (1.12–4.45)**
Sex						
Males	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Females	**1.70 (1.09–2.65)**	**0.74 (0.56–0.98)**	1.28 (0.72–2.68)	0.87 (0.71–1.06)	**1.64 (1.19–2.25)**	0.91 (0.61–1.38)
Institution						
Two year	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Four year	1.67 (0.66–4.23)	0.92 (0.59–1.44)	1.83 (0.54–6.22)	0.95 (0.65–1.38)	0.98 (0.55–1.73)	0.84 (0.44–1.63)
Nicotine dependence[d]						
No	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Yes	**0.51 (0.31–0.85)**	**0.43 (0.32–0.57)**	0.56 (0.31–1.03)	**0.40 (0.33–0.50)**	1.28 (0.91–1.80)	**1.68 (1.11–2.55)**
Other tobacco[e]						
No	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Yes	1.50 (0.96–2.35)	1.03 (0.80–1.33)	1.63 (0.89–2.99)	1.12 (0.92–1.37)	**1.85 (1.34–2.54)**	**1.54 (1.04–2.30)**

Markov models are a matrix geometric method; Bold indicates statistical significance at $p < 0.05$. Observations: $n = 210$ participants had two total observations; $n = 211$ had three observations; $n = 230$ had four observations; $n = 298$ had five observations; and $n = 593$ had six observations.

[a]Past 30 day cigarette smokers that do not report use of menthol cigarettes.

[b]Past 30 day cigarette smokers that report use of menthol cigarettes.

[c]"Other" includes American Indian/Alaska Native, Native Hawaiian/Pacific Islander, any other race/ethnicity, and individuals who identified as multiracial.

[d]Self-reported "Have you ever had a strong craving to smoke a cigarette?" or "Have you ever felt like you really needed to smoke a cigarette?"

[e]Self-reported use of combustible cigarettes, cigar products, smokeless tobacco, or hookah in the past 30 days.

cigarette smokers were significantly more likely than non-Hispanic Whites to transition to non-smokers. The hazard of transition from non-menthol cigarette smoking to menthol cigarette smoking (ie, switching) at next observation was greater for Hispanic/Latinos (HR: 3.69; 95% CI: 1.78 to 7.66) and Asian (HR: 2.85; 95% CI: 1.15 to 7.08), relative to non-Hispanic Whites. No significant differences by sex were observed.

The hazard of transitioning from menthol cigarette smoking to non-smoking (ie, discontinuation) at the next observation declined significantly with age (HR: 0.95; 95% CI: 0.91 to 0.99) and symptoms of nicotine dependence (HR: 0.43; 95% CI: 0.32 to 0.57); discontinuation was lower among males compared to females (HR: 0.74; 95% CI: 0.56 to 0.98). The hazard of transitioning from menthol cigarette smoking to non-menthol cigarette smoking (ie, switching) was greater among males than females (HR: 1.70; 95% CI: 1.09 to 2.66) and individuals who racially identified as "other" compared to non-Hispanic Whites (HR: 2.61; 95% CI: 1.35 to 5.03), but declined with symptoms of nicotine dependence (HR: 0.51; 95% CI: 0.31 to 0.85).

The hazard of transitioning from non-smoking to non-menthol cigarette (HR: 0.93; 95% CI: 0.88 to 0.99) and to menthol cigarette smoking (HR: 0.86; 95% CI: 0.78 to 0.94) declined with age. Conversely, the hazard of transitioning from non-smoking to non-menthol cigarette smoking was greater among males compared to females (HR: 1.64; 95% CI: 1.19 to 2.25) and other tobacco product

users (HR: 1.85; 95% CI: 1.34 to 2.54). Similarly, the hazard of transitioning from non-smoking to menthol cigarette smoking was greater among individuals who racially identified as "other" compared to non-Hispanic Whites (HR: 2.23; 95% CI: 1.12 to 4.45) and other tobacco product users (HR: 1.54; 95% CI: 1.04 to 2.30).

Discussion

This study examined transitions across cigarette smoking behaviors, including discontinuation, relapse, and switching between menthol and non-menthol products among a cohort of young adult college students in Texas. There was a substantial degree of switching between cigarette product types; approximately 22.5% of menthol cigarette smokers transitioned to non-menthol cigarettes and 14.3% of non-menthol cigarette smokers transitions to menthol cigarettes. Further, nearly half (48.2%) of young adult cigarette smokers who recently discontinued smoking relapsed at a subsequent observation. These figures reflect the unstable nature of young adult cigarette smoking behavior[29,30] as well as the utility and importance of applying a Markov model to examine these multidirectional transitions.

Our findings suggest the shifting between cigarette smoking behaviors during young adulthood may be considerably different than previously understood, particularly among Hispanic/Latinos and Asians. For example, Hispanic/Latinos and Asians had an increased
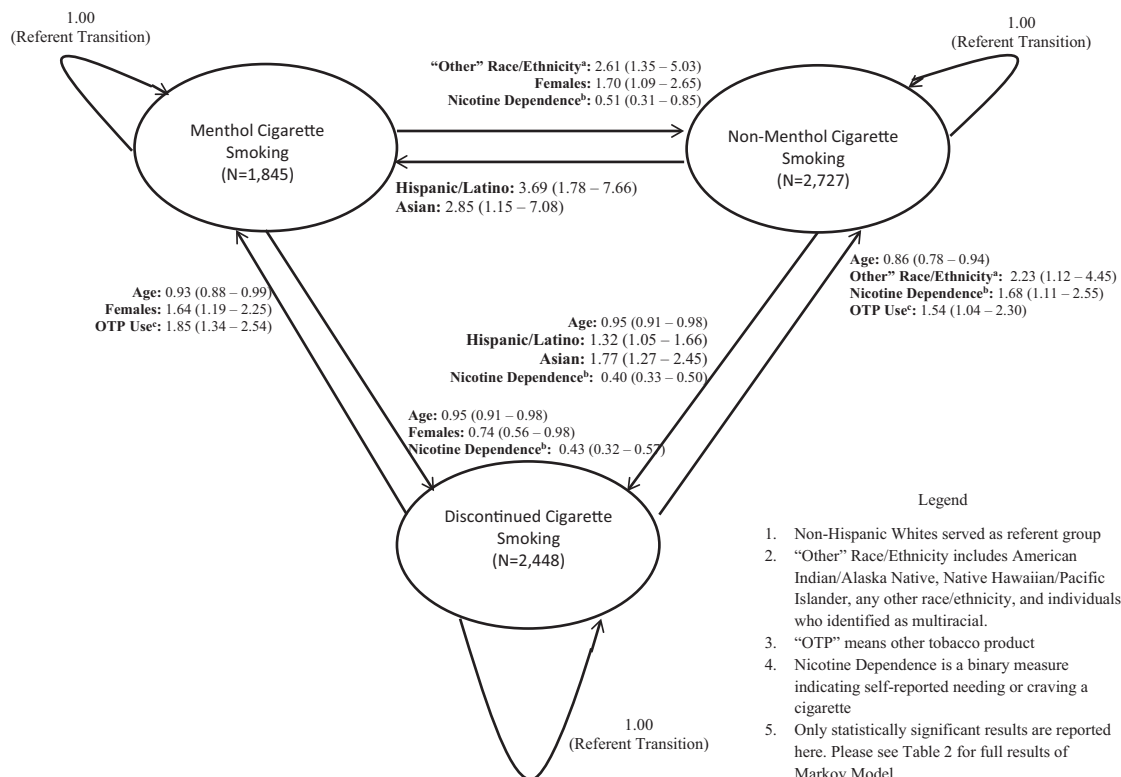
Figure 2. Transition Intensities Analyzed (*n* = 1542; observations = 7021).

risk of switching from non-menthol to menthol cigarettes compared with non-Hispanic Whites. This is in contrast to the "starter product" hypothesis, which indicates that smokers are more likely to transition to non-menthol cigarettes as they age.[4,7,8] Furthermore, Hispanic/Latinos and Asians were significantly more likely to transition from non-menthol cigarettes to non-smoking (ie, discontinuation), relative to non-Hispanic Whites. This finding is consistent with previous research showing Hispanic/Latinos and Asians were less likely to be established cigarette smokers during young adulthood than non-Hispanic Whites.[31,32] However, it is worth noting that Hispanic/Latinos who smoked non-menthol cigarettes were, in comparison to non-Hispanic Whites, more likely to switch to menthol (HR: 3.69; 95% CI: 1.78 to 7.66) than quit cigarette smoking (HR: 1.32; 95% CI: 1.05 to 1.66), as the CIs for these HRs did not overlap.

The increased risk for switching from non-menthol to menthol among Hispanic/Latinos and Asians is a notable finding. To date, there is a shortage of research, particularly longitudinal research, that closely examines cigarette smoking preferences among Hispanic/Latinos and Asians during young adulthood; what is available is often limited by sample size. This lack of research makes drawing inferences difficult. However, it is plausible the transitions towards menthol cigarettes among Hispanic/Latinos may be influenced by cigarette marketing and branding. The tobacco industry has a history of marketing different brands to different race/ethnic groups, even when they're owned by the same parent company. Consider that RJ Reynolds owns both Newport and Camel brands. Historically, Newports (a menthol brand) have been marketed to African Americans[11–13] while Camels have been marketed to Hispanic/Latinos,[14] resulting in higher rates of awareness and

preference for Camel brands by Hispanic/Latinos, relative to other race/ethnic groups.[14] In 2008, the Camel brand introduced Camel Crush, a cigarette with a mentholated capsule in the filter, which grew in popularity among young people and are disproportionately popular among Hispanic/Latinos.[33] Thus, it is possible the push for these new mentholated products by the tobacco industry – under an established brand historically marketed to Hispanic/Latinos – may be a contributing factor in the transition towards menthol products among Hispanic/Latinos. Unfortunately, most large studies categorize Asians into an "other" group, thus making it difficult to draw similar inferences on brand/flavor preferences among Asians.

Symptoms of nicotine dependence were linked to significantly lower rates of switching among non-menthol cigarette smokers and lower rates of switching for menthol cigarette smokers (this latter finding approached significance: 95% CI: 0.31 to 1.03), consistent with prior literature.[9] These findings suggest that once individuals develop symptoms of nicotine dependence, they may be less inclined to switch cigarette types. One prior study of adults showed a negative association between the Heaviness of Smoking Index score, a behavioral assessment of dependence, and switching between menthol and non-menthol cigarettes.[9] Our study builds on that finding by observing a similar relationship, but using an affective measure of nicotine dependence and by observing young adults, rather than older adults. Thus, research to date suggests that dependent smokers tend to remain with their preferred products.[9] It is plausible that any restrictions or bans on menthol cigarettes may nudge menthol smokers towards discontinuation rather than switching, particularly if this regulatory or policy change is coupled with comprehensive cessation treatments. While our study cannot directly test that hypothetical scenario, our conclusion is supported by prior research that

shows cigarette smokers, particularly menthol cigarette smokers would elect to quit smoking rather than switch products.[34–36]

Our study findings also indicated that individuals were less likely to change their cigarette smoking status as they aged, as is consistent with previous literature.[25] This expands on prior findings by demonstrating that the solidification of cigarette smoking status that comes with increased age is consistent for both menthol and non-menthol cigarette smokers. However, our study also found that the use of other tobacco products was linked to relapse of cigarette smoking among recent quitters. This builds on prior (unidirectional) studies finding no significant differences in cigarette smoking cessation rates for multiple tobacco product users, relative to exclusive cigarette smokers[37] by demonstrating a multidirectional pattern of transitions *from* cigarette smoking *to* cessation *back to* cigarette smoking (ie, relapse) among other tobacco product users. These findings expand upon previously observed relationships for young adult cigarette smoking behaviors, including highlighting a new concern of non-cigarette tobacco product use.

This study has regulatory implications. At the time of this writing, menthol is the only federally-exempt flavor permitted to be used in combustible cigarettes.[38] Our findings reveal that menthol products are appealing to young adults, particularly Hispanic/Latinos and Asians. This is a substantial public health concern given that the rate of smoking initiation observed in young adults has increased and may even outpace adolescents,[39,40] and suggests that the continued exemption for menthol flavors in combustible cigarettes may be contributing to overall young adult smoking prevalence, with disproportionate impacts on Hispanic/Latino and Asian populations. To address these public health concerns, extending the ban on characterizing flavors in cigarettes to include menthol cigarettes should be considered at the federal level.

A strength of this study is the sizable proportion of Hispanic/Latinos and Asians in our study sample. Hispanic/Latinos and Asians have been underrepresented in longitudinal studies of cigarette smoking transitions during young adulthood. For example, in two past studies examining cigarette smoking switching behavior, Hispanic/Latinos accounted for less than 10% of the total sample for both of those studies, and rates for Asians were not reported at all.[8,9] A similar study of young adults found greater rates of switching from non-menthol to menthol among *non-White* smokers, relative to White smokers.[10] In contrast, our study sample was 34.9% Hispanic/Latino and 12.4% Asian and is one of the first to explore differences across these racial/ethnic groups. While the combination of our findings and previous studies are not yet definitive on the role of menthol cigarettes in cigarette smoking trajectories among young adults, findings do underscore the need to expand research on Hispanic/Latino and Asian transitions during young adulthood.

This study has limitations. First, data are self-reported, thus subject to recall bias. Second, the measure of menthol cigarette smoking was binary, thus could not account for individuals who smoked both menthol and non-menthol cigarettes. Third, the study sample had a minimal representation of African Africans, presenting methodological concerns as the estimates for this population were less stable than other strata with larger samples. This limitation is particularly concerning as menthol cigarette smoking is most common among African Americans.[41] Fourth, the study sample consists of young adult college/university students, thus findings may not be representative of other populations. It should be noted, prior research suggests menthol switching behaviors may not differ by education levels.[42] Fifth, the statistical model assumed a time homogeneous process in all observed relationships thus there is no uniformity in time or the first observation for each participant. As such, this study cannot account for contextual factors, such as increases or decreases in cigarette prices that may vary over time and impact cigarette smoking behaviors. Sixth, the statistical model was a first-order Markov assumption, meaning transitions depends on the closest previous state, not the entire history states. And finally, the statistical model assumed values were constant between observations (ie, piece-wise constant).

Despite these limitations, this study expands our understanding of cigarette smoking behaviors during young adulthood and informs the intersection between menthol cigarette use and race/ethnicity. Findings show menthol cigarettes may be a sustaining product for Hispanic/Latino and Asian young adults. The federal exemption of menthol as a characterizing flavor for combustible cigarettes may negatively impact population health,[4,43] and increase health disparities among racial/ethnic minorities. Our findings also build on prior research[4] that demonstrates the need for restricting menthol as a characterizing flavor for combustible cigarettes in the United States.

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Declaration of Interests

All authors have no financial interests or conflicts to disclose.

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