Does menthol attenuate the effect of bupropion among African American smokers?

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ABSTRACT

Background African Americans have higher tobacco-related morbidity and mortality and are more likely to smoke menthol cigarettes than their white counterparts. This study examined differences between African American menthol and non-menthol smokers in smoking characteristics and cessation.

Methods The study sample consisted of 600 African American smokers enrolled in a clinical trial that assessed the efficacy of sustained-release bupropion for smoking cessation. Menthol (n = 471) and non-menthol (n = 129) smokers were compared on smoking-related characteristics and abstinence rates at 6 weeks and 6 months.

Results Menthol smokers were younger (41.2 versus 52.9 years), more likely to be female (73.7% versus 56.6%) and more likely to smoke their first cigarette within 30 minutes of waking up (81.7% versus 69.8%) compared to non-menthol smokers (all P < 0.01). Cigarette taste (50% versus 40%, P = 0.054) was rated non-significantly higher by menthol smokers. Seven-day point-prevalence abstinence from smoking at 6 weeks were 28% and 42% (P = 0.006) and at 6 months were 21% and 27% (P = 0.21) for menthol and non-menthol smokers, respectively. At 6 weeks follow-up, stepwise logistic regression revealed that among those younger than 50 years, non-menthol smokers were more likely to quit smoking (odds ratio = 2.0; 95% CI = 1.03–3.95) as were those who received bupropion (odds ratio = 2.12; 95% CI = 1.32–3.39).

Conclusion African American menthol smokers had lower smoking cessation rates after 6 weeks of treatment with bupropion-SR, thereby putting menthol smokers at greater risk from the health effects of smoking. Lower overall cessation rates among African Americans menthol smokers may partially explain ethnic differences in smoking-related disease risks.

KEYWORDS African American, bupropion, cigarettes, menthol, smoking cessation.

INTRODUCTION

One of the most striking differences in the smoking patterns between African American and white smokers is the preference for menthol cigarettes. Whereas approximately 80% of African American smokers smoke menthol cigarettes, the proportion among whites is only about 20% (Kabat et al. 1991). African Americans also smoke fewer cigarettes per day (Caraballo et al. 1998) and begin smoking later in life compared to whites (Kabat et al. 1991; Okuyemi et al. 2001). Despite smoking fewer cigarettes per day, African Americans experience disproportionately higher rates of smoking-related health consequences (Harris et al. 1993). African Americans have the highest incidence rates of all cancers combined, and the highest overall cancer mortality rates compared to...
other racial/ethnic groups (Harris et al. 1993). Because of their high preference for menthol cigarettes, it has been suggested that menthol cigarette smoking may contribute to the excess smoking-related morbidity experienced by African Americans.

Menthol is a naturally occurring flavoring element (Sidney et al. 1995) and one of thousands of chemicals that may be added to cigarettes during the manufacturing process. Menthol combustion produces carcinogenic compounds such as benzopyrenes (Schmeltz & Schlotzhauer 1968) which might contribute directly to higher lung cancer rates. However, research on the association between menthol cigarette use and lung cancer has produced mixed results. A case–control study consisting of 337 cases and 478 controls (Carpenter et al. 1999) did not find increased lung cancer rates among menthol smokers compared to non-menthol smokers. In contrast, a prospective study of over 11,000 patients enrolled in a health maintenance organization and followed for 6–12 years found increased risk of lung cancer among male menthol smokers (relative risk = 1.45 versus male non-menthol smokers; adjusted for age, race, education, number of cigarettes smoked per day and duration of smoking) but not in females (Sidney et al. 1995). While it remains unclear whether menthol increases the risk of lung cancer directly, it is possible that the relationship between menthol and tobacco-related morbidity is an indirect one, acting through other factors that might increase disease risk.

For example, due to its local anesthetic and cooling effects menthol may affect smoking topography in a number of ways, including puff volume and depth of smoke inhalation (Caskey et al. 1993). These factors probably increase exposure to tobacco smoke toxins and consequently disease risk. Another hypothesis is that menthol makes smoking more enjoyable. Menthol cigarette smokers may therefore be less able to quit smoking and continue smoking for longer periods of time. A longer duration of smoking would increase the risk of tobacco-related diseases.

Given the disproportionately high burden of tobacco-related health consequences experienced by African Americans and their high rates of smoking menthol cigarettes, there is a need to understand better the association between menthol and cessation in African Americans. Such an understanding is important in reducing health disparities in tobacco-related diseases between various racial/ethnic groups in the United States. To test the hypothesis that menthol smokers are less likely to quit, we conducted a secondary analysis of data from a clinical trial which tested bupropion-SR for smoking cessation in 600 African American smokers. Differences in smoking-related characteristics between menthol and non-menthol smokers were also examined.

### METHODS

#### Study design

The parent study was a double-blind, placebo-controlled, randomized trial of 600 African American smokers (Ahluwalia et al. 2002). Participants were recruited at an inner-city community health center over a 16-month period and were assigned randomly to receive a 7-week supply of placebo or bupropion SR 150 mg twice daily. Medication was dispensed by study staff during clinic visits and participants were given instruction about usage. Participants in both groups received eight brief counseling sessions and a previously developed smoking cessation guide. Eligible people described themselves as ‘African American or black’, were at least 18 years of age, smoked at least 10 cigarettes per day, were interested in quitting in the next 30 days, spoke English and had a home address and working telephone. Participants were excluded if they had a contraindication for bupropion SR (predisposition to seizures, excessive alcohol use, bulimia or anorexia nervosa, current use of bupropion), were pregnant, currently used psychoactive medication, used other forms of tobacco or nicotine replacement in the past 30 days, were in drug treatment during the past 6 months or were being treated for depression.

At the baseline visit, participants completed a battery of assessments (e.g. socio-demographics, smoking behaviors, nicotine dependence, depression, perceived stress and withdrawal symptoms) and were assigned randomly to receive either bupropion SR (Zyban, Glaxo Wellcome, Research Triangle Park, NC, USA) 150 mg once a day or placebo once a day for 3 days, followed by twice a day for a total of 7 weeks. Participants set a target quit date 1 week after the start of medication, and returned on that day (quit day) for a second in-person visit (week 0). They returned for follow-up assessments and counseling the following week (week 1) and at weeks 3 and 6 and month 6. A detailed description of study procedures is provided elsewhere (Ahluwalia et al. 2002).

Participants provided written informed consent during the first visit. The trial procedures were approved and monitored by the University of Kansas Medical Center’s Human Subjects Committee.

#### Measures

The baseline assessment included measures of demographics, health information and smoking behaviors (see Table 1). Nicotine dependence was assessed with the modified six-item Fagerström Test for Nicotine Dependence (FTND) scale, a widely used measure of nicotine dependence with established reliability (Cronbach’s alpha = 0.61) (Heatherton et al. 1991). Use of menthol cigarettes was assessed with the question, ‘Do you usually
smoke menthol cigarettes? Outcomes reported in the current analysis are 7-day point prevalence smoking cessation at 6 weeks and 6 months. Self-reported abstinence was confirmed with expired carbon monoxide (CO) assessment (<10 p.p.m.) and only in the case of discrepancies was saliva collected and used to resolve the discrepancy with salivary cotinine analysis (<20 ng ml) (Ahluwalia et al. 2002; SRNT 2002).

Statistical analysis

Surveys were double-data entered and analysis was performed with SAS version 8 (SAS Institute 1999). Subjects were classified into two groups: menthol smokers and non-menthol smokers. Categorical baseline variables were summarized by frequencies and percentages while quantitative baseline variables were summarized by means and standard deviations. The χ² test was used to determine if any of the categorical baseline variables differed between the two groups. The two-sample t-test was used to assess if any of the quantitative baseline variables differed between the two groups. Logistic regression was used to assess the effect of smoking menthol cigarettes on 7-day point prevalence smoking cessation at 6 weeks while controlling for treatment. Stepwise logistic regression and best subsets logistic regression were used to explore the joint relationship of treatment, menthol cigarette smoking and the other baseline variables on 7-day point prevalence smoking cessation at 6 weeks. All statistical analyses were performed on an intention-to-treat basis as defined by Piantadosi (Piantadosi 1997) in that subjects were analyzed in the group into which they were randomized. We did not impute those lost to follow-up as smokers because we had shown previously that missing data were missing completely at random (Ahluwalia et al. 2002).

Given the known association between age and cessation, we examined a priori the distribution of menthol smoking by age and its potential interaction with menthol use on cessation. Age 50 years corresponds to the 3rd quartile of age distribution for our study sample. Menthol cigarette use was much more prevalent in those under the age of 50 years compared to those 50 and above. Furthermore, there was a significant interaction between age dichotomized at 50 years and menthol use on cessation. Logistic regression models were therefore performed separately by two age categories, <50 years and ≥50 years. Logistic regression for 7-day point prevalence abstinence is reported for 6 weeks only, because univariate analysis did not reveal significant differences in abstinence rates between menthol and non-menthol smokers at 6 months.

RESULTS

Of the 600 smokers enrolled in the study, 471 (78.5%) smoked menthol cigarettes whereas 129 (21.5%) smoked non-menthol cigarettes. Demographic and smoking characteristics of participants are shown in Table 1. Menthol cigarette smokers were younger (41.2 years versus 52.9 years for non-menthol smokers; \( P < 0.0001 \)), more likely to be female (73.7% versus 56.6% for non-menthol smokers; \( P < 0.001 \)) and more likely to be employed (78.3% versus 65.9% for non-menthol smokers; \( P = 0.004 \)).

Although menthol and non-menthol smokers had similar scores on the Fagerstrom Test for Nicotine Dependence (FTND), menthol smokers were more likely to smoke their first cigarette within 30 minutes of waking up (81.7% versus 69.8%; \( P = 0.003 \)). Menthol smokers also rated the taste of their most recent cigarette (49.9%...
versus 40.3% for non-menthol; $P = 0.054$) non-significantly higher than non-menthol smokers. However, the rating for satisfaction with their most recent cigarette was not significantly different between the two groups (57.3% versus 50.4% for non-menthol; $P = 0.160$).

Overall 28.3% of menthol smokers were abstinent at 6 weeks (end of treatment, $n = 535$) compared to 41.5% of non-menthol smokers ($P = 0.006$). The abstinence rate at 6 months ($n = 518$) was also lower among menthol smokers but the difference was not statistically significant (21.4% versus 27.0% for non-menthol smokers; $P = 0.21$). When separated by treatment (Fig. 1; bupropion, $n = 265$; or placebo, $n = 270$), among those who received bupropion the 7-day point-prevalence abstinence rate at 6 weeks for non-menthol smokers (60.3%) was significantly higher than for menthol smokers (36.2%, $P < 0.01$). Abstinence rates did not differ by menthol status among those who received placebo (23.3% non-menthol versus 20.5% menthol; $P = 0.63$). Test for interaction between treatment and menthol status on cessation was not significant ($P = 0.07$).

Further examination of the association between age and menthol smoking revealed that the ratio of menthol to non-menthol smokers was substantially higher among those younger than 50 years of age. Among those $<50$ years ($n = 443$), 88.7% smoked menthol cigarettes whereas only 49.7% of those $\geq 50$ years ($n = 157$) smoked menthol cigarettes ($P < 0.0001$). There was also a significant interaction between categorized age ($<50$ versus $\geq 50$) and menthol status on 7-day point-prevalence abstinence at 6 weeks ($P = 0.02$). Other variables in Table 1 that were associated with menthol status (gender, employment, cigarettes smoked per day, smoking $\leq 30$ minutes of waking, satisfaction and taste of most recent cigarette) were also tested for potential interaction, but none showed significant interaction with menthol status on cessation. Because of significant interaction between age and menthol smoking on cessation, associations between menthol and cessation were further examined by two age groups, $<50$ versus $\geq 50$ years. Figure 2 shows abstinence rates at 6 weeks for non-menthol and menthol smokers by age groups.

At 6 weeks follow-up, among those $<50$ years, 44.4% of non-menthol smokers were abstinent compared to 24.9% for menthol smokers ($P < 0.01$). Abstinence rates among those $\geq 50$ years did not differ significantly by menthol status ($P = 0.57$). Two stepwise logistic regression models were constructed to predict the probability of abstinence at 6 weeks; one for those aged $<50$ years and the other for those aged $\geq 50$ years. Variables considered for inclusion in both models were those listed in Table 1 and whether they received bupropion or placebo. Among individuals $<50$ years, non-menthol smokers were twice as likely to quit smoking at the end of 6 weeks compared to menthol smokers (odds ratio = 2.02; 95% CI = 1.03–3.95). Those who received bupropion were more likely to quit (odds ratio = 2.12; 95% CI = 1.32–3.39), whereas those who smoked their first cigarette within 30 minutes of waking were less likely to quit (odds ratio = 0.37; 95% CI = 0.22–0.62). Among those $\geq 50$ years, receiving bupropion was the only predictor of abstinence at 6 weeks (odds ratio = 4.43; 95% CI = 2.17–9.04).

**DISCUSSION**

In this analysis from a clinical trial of sustained-release bupropion for smoking cessation among African Americans, menthol cigarette smokers had lower cessation rates after 6 weeks of treatment with the study drug. The lower cessation rates among menthol cigarette smokers was found only in those younger than 50 years. This difference in cessation rates between menthol and non-menthol smokers seems to be driven by treatment with bupropion as there was no significant difference in cessation rates by menthol status in the placebo group. The magnitude of the difference in quit rates was also greater when broken down by treatment received. The cessation rates at 6 months were lower for menthol smokers, but the difference was not statistically significant. Lack of significance at 6 months could be due to a number of reasons, including delayed quitting among menthol smokers, higher relapse among non-menthol smokers or,
in fact, a reflection of true finding (i.e. difference in rates at 6 weeks is a spurious finding). There was also a higher attrition rate at 6 months (14%) compared to 6 weeks (11%), which could reduce the power to detect a significant difference between menthol and non-menthol smokers even if one exists. However, there was no differential attrition at 6 months between menthol and non-menthol smokers.

To our knowledge, these are the first data from a clinical trial to show that African American menthol smokers have short-term lower cessation rates than non-menthol smokers. Because the vast majority of African American smokers smoke menthol cigarettes, lower cessation rates for menthol smokers could translate into an overall reduction in cessation rates for African Americans. A number of studies have shown that despite making more quit attempts than whites on average in a given year, African Americans are less successful in their cessation attempts compared to whites (CDC 1994, 1998). The greater difficulty with quitting experienced by African Americans have been attributed to a number of factors, including smoking high nicotine/tar cigarettes and higher levels of nicotine dependence (Royce et al. 1993). Findings from the present study suggest that smoking menthol cigarettes may be a contributory factor in the difficulty experienced by African Americans in smoking cessation. Although the literature on menthol cigarette smoking and the risks of lung cancer is inconclusive, lower cessation rates associated with smoking menthol cigarettes could explain in part the ethnic differences in smoking-related diseases.

Why would menthol smokers be less successful quitting smoking? First, menthol cigarette smokers may have greater difficulty in quitting because they are more nicotine-dependent than non-menthol smokers. Data from the current study showed that menthol smokers were more likely to smoke their first cigarette within 30 minutes of waking up, an indicator of dependence. This was similar to findings reported by Ahijevych & Parsley (1999). However, in the present study the effect of menthol on cessation persists after controlling for ‘smoking within 30 minutes of waking’, a measure of nicotine dependence. Secondly, menthol smokers in current study rated cigarette taste higher than their non-menthol counterparts. Due to the local anesthetic and cooling effects of menthol, menthol in cigarettes may allow smokers to take larger puffs, hold their breaths for longer periods of time and be able to inhale deeper compared to non-menthol smokers. The resultant effect will be increased exposure to nicotine and other tobacco smoke constituents. However, while some studies found no significant differences in the depth of inhalation or puff volume between menthol and non-menthol smokers (Sidney et al. 1989; Caskey et al. 1993; McCarthy et al. 1995; Ahijevych et al. 1996), other studies have reported that menthol cigarettes increased smokers’ carbon monoxide levels. One study of 20 male smokers (Jarvik et al. 1994) found that mentholated cigarettes decreased puff volumes but increased puff flow rates of inhaled smoke, which may increase smokers’ exposure to toxic effects of carbon monoxide. In a sample of 95 women, significantly higher puff volumes were identified in menthol compared to non-menthol smokers (45.8 versus 37.8 ml), with an equal representation of African American and white women in each menthol preference group (Ahijevych & Parsley 1999).

Thirdly, some data suggest that menthol may also affect metabolism of nicotine. Two studies showed that menthol smokers have higher cotinine/cigarette ratios (Clark et al. 1996; Ahijevych & Parsley 1999). Another study found that bupropion attenuates the effect of the enzyme CYP2B6, which has been shown to affect cessation (Lerman et al. 2002). However, it is not known if menthol affects the metabolism of bupropion. If the metabolism of other toxic/carcinogenic constituents of tobacco smoke is also slower in menthol smokers, this subgroup of smokers may potentially be exposed to relatively higher doses of toxins in tobacco smoke than non-menthol smokers with similar smoking levels. Fourthly, menthol status was determined at enrollment and we did not collect data about duration of use of menthol cigarettes or whether or not participants had switched the brand of cigarettes they smoked. If some non-menthol smokers were former menthol smokers who had switched brands in preparation for quitting, cessation rates could be biased in favor of the non-menthol group. This is a subject for further study. Furthermore, smoking of menthol cigarettes could be a marker for some other yet undetermined factor. This is all the more plausible given that the lower quit rates observed among menthol smokers in the current study were only found among those younger than 50 years of age. Menthol cigarette smoking could be a marker for some other behavior associated with young age. For example, if younger smokers, who are more likely to smoke menthol cigarettes, are less compliant with study medication, then age could be a contributing factor to the differential cessation rates found among menthol and non-menthol smokers. Finally, because cessation rates did not significantly differ between menthol and non-menthol smokers on placebo, the lower cessation rates for menthol smokers could be specific for bupropion. Additional support for this explanation is that differential cessation rates were found only during treatment (6 weeks) but not subsequently (6 months). The null finding among those who received placebo was consistent with findings from two recent studies (Hyland et al. 2002; Muscat et al. 2002) that found no association between use of mentholated cigarettes and cessation. However,
one of the studies (Muscat et al. 2002) used a cross-sectional design and had a predominantly older sample (>80% aged >45 years) while the other study (Hyland et al. 2002) had a very low proportion of menthol (24%) and African American (<10%) smokers.

Our study has some limitations. Data were derived from a study that was not designed to test whether menthol smokers have lower quit rates than non-menthol smokers. The sample was predominantly menthol smokers, reflecting an expected prevalence of menthol smoking among African Americans. A sample with equal distribution of menthol versus non-menthol smokers may reveal other factors associated with menthol smoking not found in the current study. However, having a larger sample of non-menthol smokers in the study is unlikely to change factors that were found to be significant in this study. Also, information about menthol smoking was obtained by self-report but there was no reason to believe that participants would misrepresent their menthol smoking status, and the proportions of smokers in both groups were as expected. Furthermore, this study was limited to African Americans and therefore the study’s findings may not generalize to smokers of other racial/ethnic groups in the United States and other parts of the world. Studies are needed to determine whether menthol smokers from other racial/ethnic groups also have lower cessation rates than their non-menthol smoking counterparts.

Clearly, there is a need to understand better the reason for the lower cessation rates among African American menthol smokers. Smoking cessation studies with a significant proportion of menthol smokers need to adjust for menthol status in their estimation of cessation rates. Also, because cigarette taste was rated higher by menthol smokers, studies are needed to examine whether some pharmacological interventions are more effective for menthol smokers. For example, the nicotine inhaler which contains menthol (although in small quantity), for taste and behavioral reasons, may prove to be more effective for smoking cessation among menthol smokers. Studies are also needed to assess if the lower cessation among menthol smokers is specific only to bupropion or if this pattern generalizes to other forms of pharmacotherapy. If a lower cessation rate among menthol smokers is specific for bupropion, then bupropion would not be the optimal treatment for menthol smokers.

In summary, our study shows that African American menthol smokers on sustained-release bupropion had lower smoking cessation rates after 6 weeks treatment. If these findings are confirmed in future studies, then lower overall cessation rates among African Americans may be explained partially by their predominantly smoking menthol cigarettes, which in turn may explain ethnic differences in smoking-related disease risks. Also, the higher success rate at 6 weeks in non-menthol smokers may provide a stronger basis from which to make the next quit attempt. Addressing factors contributing to lower cessation rates among menthol smokers is an important step towards eliminating health disparities due to tobacco use among various racial/ethnic groups.

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African American menthol smokers


Relationship between menthol cigarettes and smoking cessation among African American light smokers

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ABSTRACT

Aims To determine whether African American light smokers who smoked menthol cigarettes had lower cessation when treated with nicotine replacement therapy and counseling. Design Data were derived from a clinical trial that assessed the efficacy of 2 mg nicotine gum (versus placebo) and counseling (motivational interviewing counseling versus Health Education) for smoking cessation among African American light smokers (smoked ≤ 10 cigarettes per day). Participants The sample consisted of 755 African American light smokers. Measurements The primary outcome variable was verified 7-day point-prevalence smoking cessation at 26 weeks follow-up. Verification was by salivary cotinine. Findings Compared to non-menthol smokers, menthol smokers were younger and less confident to quit smoking (P = 0.023). At 26 weeks post-randomization, 7-day verified abstinence rate was significantly lower for menthol smokers (11.2% versus 18.8% for non-menthol, P = 0.015). Conclusions Among African American light smokers, use of menthol cigarettes is associated with lower smoking cessation rates. Because the majority of African American smokers use menthol cigarettes, a better understanding of the mechanism for this lower quit rate is needed.

Keywords African Americans, clinical trial, counseling, health education, light smokers, menthol, motivational interviewing, nicotine replacement therapy, secondary analysis, smoking cessation.

INTRODUCTION

Although, on average, African Americans smoke fewer cigarettes per day, they have higher cotinine levels per cigarette smoked compared to European Americans [1]. Tobacco-related morbidity and mortality are also disproportionately higher for African Americans than other racial/ethnic groups [2–7]. Because African Americans smoke predominantly menthol cigarettes (80% for African Americans versus 20% for European Americans), it has been suggested that smoking of menthol cigarettes may contribute to the increased morbidity from smoking experienced by African Americans [4,8,9]. Other studies have suggested that combustion of menthol produces carcinogenic materials [10] and that menthol may enhance salivary flow thereby increasing the possibility of absorption of harmful smoke constituents across the oral mucosa [11]. Research on the association between smoking menthol cigarettes and higher cancer risks have shown mixed results. A case–control study did not find increased lung cancer rates among menthol smokers compared to non-menthol smokers [12]. However, a large prospective study found increased risk of lung cancer among male menthol smokers but not in females [9]. Also, current evidence suggests that African American smokers are less successful with quitting cigarette smoking than their European American counterparts [7,13,14]. One possible hypothesis for lower cessation rates observed among African Americans is that smoking of menthol cigarettes makes smoking more enjoyable and cessation more difficult for menthol compared to
non-menthol smokers. One study found that menthol smokers were more likely to report that their cigarettes taste better compared to non-menthol smokers [15]. Menthol has local anesthetic and cooling properties that may affect smoking topography [16] with the potential for making smoking more enjoyable and quitting less likely. Others have suggested that, due to its effects as a sensory stimulant, menthol could enhance tobacco’s addictiveness [17,18].

Because clinical trials do not report cessation outcomes routinely by the brand of cigarettes smoked by participants, only a limited number of studies have examined the relationship between smoking of menthol cigarettes and smoking cessation. In a study [19] based on data from the Community Intervention Trial for Smoking Cessation (COMMIT), use of menthol cigarettes was assessed by self-report at baseline in 1988 and 6 months abstinence was assessed by a telephone follow-up in 1993. Use of menthol cigarettes was found to be unrelated to the likelihood of cessation. Another study [20] was a cross-sectional analysis of 480 African American (85% menthol) smokers. Although both groups did not differ by number of past quit attempts, time since most recent quit attempt, durations of most recent and longest-ever quit attempts were shorter for menthol smokers.

Recently, we reported data from a sample of 600 African American (79% smoked menthol) moderate to heavy smokers (smoked ≥ 10 cigarettes per day) enrolled in a study on the efficacy of sustained-release bupropion for smoking cessation. Seven-day abstinence rates from smoking at 6 weeks were 28% and 42% and at 6 months were 21% and 27% for menthol and non-menthol smokers, respectively. This suggests that non-menthol smokers were more likely to quit smoking than menthol smokers when treated with bupropion. Further analysis showed that the use of menthol cigarettes was more prevalent among those younger than 50 years. We concluded that African American menthol smokers had lower short-term smoking cessation rates after 6 weeks of treatment with bupropion-SR, thereby putting menthol smokers at greater risk from the health effects of smoking. However, because bupropion was the only medication used in that study, it was unclear whether the lower response to treatment would apply to other smoking treatments, such as the nicotine replacement therapies and counseling.

In order to assess whether African American smokers of menthol cigarettes have lower cessation when treated with nicotine replacement therapy, we conducted a secondary analysis of data from a study that assessed the efficacy of 2 mg nicotine gum and counseling for smoking cessation among African American light smokers (smoked ≤ 10 cigarettes per day). Studying the relationship between menthol cigarette smoking and smoking cessation among African American light smokers is important because nearly 50% of African Americans are light smokers [21–23]. In addition, the proportion of smokers in the United States who are light smokers is growing in all ethnic groups [24–26]. In the current study, we hypothesized that similar to findings among moderate and heavy smokers treated with bupropion, African American light smokers who smoke menthol cigarettes will have lower cessation rates compared to those who smoke non-menthol cigarettes following treatment with nicotine gum and counseling.

**METHODS**

**Study design and enrollment**

**Study setting and recruitment strategies**

Details of this study design, methodology and smoking abstinence outcomes for the primary study are presented in detail elsewhere [27,28]. Briefly, the primary study was a double-blind, placebo-controlled, randomized trial of African American light smokers conducted at a community-based health center serving a predominately African American population. The study used a 2 × 2 factorial design in which 755 (~189 in each arm) African American light smokers were assigned randomly to one of four study arms: 8-week treatment with placebo gum plus six health education (HE) sessions; 8-week treatment with placebo gum plus six motivational interviewing (MI) counseling sessions; 8-week treatment with nicotine gum plus six HE sessions; or 8-week treatment with nicotine gum plus six MI counseling sessions. At the randomization visit, participants were assigned randomly to receive an 8-week supply of either active 2 mg nicotine gum or placebo. Instructions given for gum usage depended on number of cigarettes smoked at baseline. Individuals who smoked eight to 10 cigarettes per day (cpd) were told to use 10 pieces of gum per day for the first 4 weeks, eight pieces per day for weeks 5 and 6 and six pieces per day during weeks 7 and 8. Those who smoked five to seven cpd were prescribed eight pieces of gum per day initially, six pieces per day during weeks 5 and 6 and four pieces per day for the last 2 weeks of treatment. Those smoking fewer than five cpd were told to use six pieces of gum per day for the first 4 weeks, four pieces per day during weeks 5 and 6 and two pieces per day during weeks 7 and 8. This dosing regimen was arrived at by expert consensus and review of the manufacturer’s recommendations for usage. In addition to gum and counseling, participants in all four arms received a culturally sensitive smoking cessation guide developed specifically for African American light smokers. Participants completed follow-up assessment and cotinine verification at 8 weeks and 26 weeks.
after randomization. The study procedures were approved and monitored by the human subjects committee at the institution where study was conducted. Recruitment for the study started in March 2003 and ended in June 2004. To be eligible for the clinical trial, participants were required to be African American or black; be 18 years of age or older; smoke ≤ 10 cigarettes per day for at least 6 months; smoke cigarettes on ≥ 25 of the last 30 days; be interested in setting a quit date within 14 days from screening; and have a home address and functioning telephone number. A total of 755 African American smokers enrolled in the study.

Baseline measures

Baseline assessment of demographic information included age, gender, marital status, income, education and employment. Standard smoking history assessment included current cpd, the use of menthol or non-menthol cigarettes, tobacco use and abstinence history. Participants self-reported use of menthol or non-menthol cigarettes. Motivation and confidence for quitting were assessed using Likert scales (0–10) with a higher score indicating greater motivation or confidence. Nicotine dependence was assessed using the Nicotine Dependence Syndrome Scale (NDSS), a 19-item multi-dimensional measure [29]. Expired air carbon monoxide and serum cotinine were assessed as biomarkers of baseline tobacco use.

Outcome measures

The primary outcome variable was cotinine-verified 7-day point-prevalence smoking cessation at week 26, defined as having smoked no cigarettes—not even a puff—for the previous 7 days. A salivary cotinine cut-off of ≤ 20 ng/ml was used to verify self-reported abstinence at 26 weeks and a cut-off of ≤ 10 parts per million (ppm) was used for CO [30].

Statistical analysis

Participants were classified into two groups: menthol smokers and non-menthol smokers. Logistic regression was conducted to assess the effect of smoking menthol cigarettes on cotinine-verified 7-day point prevalence smoking abstinence at weeks 8 and at 26 while controlling for treatment. Stepwise logistic regression and best subsets logistic regression were used to explore the joint relationship of treatment, baseline variables (except age) and menthol cigarette smoking on the abstinence outcome. All statistical analyses were performed on an intention-to-treat basis. As use of menthol cigarettes is known to differ substantially between smokers younger than 50 years (90%) and those ≥ 50 years (66%) and in order to replicate findings from a previous study of bupropion in African Americans [15] that showed association between menthol cigarette use and smoking cessation at age 50 years, we conducted separate logistic regression models for two age categories, < 50 years and ≥ 50 years.

RESULTS

Of the 755 African American light smokers enrolled in the clinical trial, 615 (81.7%) smoked menthol cigarettes. Menthol smokers were distributed evenly across all four study groups as follows: 84%, 79%, 81% and 83% for placebo + MI, placebo + HE, gum + MI and gum plus HE, respectively. Table 1 presents baseline demographic characteristics of the study participants. Compared to non-menthol smokers, menthol smokers were younger and rated themselves as less confident to quit smoking at baseline. There were no significant differences between menthol and non-menthol smokers in changes in confidence scores from baseline to weeks 8, 16 or 26 follow-up time-points. There were also no significant differences in confidence scores either by gender or age of participants. χ² analyses show that the abstinence rates (Fig. 1) at 8 weeks (end of nicotine gum treatment) were not significantly different between non-menthol (26.8%) and menthol smokers (22.6%, P = 0.291); however, at week 26 non-menthol smokers were more likely to quit than menthol (18.8% non-menthol versus 11.2% menthol; P = 0.015).

We used χ² tests to examine abstinence rates by treatment assignments at 8 weeks and 26 weeks follow-up. At 8 weeks, abstinence rates were not significantly different between non-menthol and menthol smokers regardless of drug or counseling treatment assignments. However, at week 26 (Fig. 2), non-menthol smokers who received nicotine gum (n = 67) had significantly higher abstinence rates than menthol smokers who received nicotine gum (n = 309; P = 0.031). Similarly, non-menthol smokers who received HE (n = 72) had significantly higher abstinence rates than menthol smokers who received HE (n = 304; P = 0.037). Abstinence rates among those who received placebo gum (P = 0.196) or MI (P = 0.244) were not significantly different by menthol status.

We also examined abstinence rates for the combination treatments of drug and counseling (Fig. 3). With the exception of MI + placebo combination, abstinence rates for non-menthol smokers were non-significantly higher than for menthol smokers for all other treatment combination groups. No differences were found in gum usage by menthol status or treatment assignment (active versus placebo gum). Menthol and non-menthol smokers were
also similar in the number of counseling sessions attended. Because of previously reported associations between age, menthol status and smoking cessation [15] and to replicate previous findings among moderate and heavy smokers, we examined further the associations between menthol and smoking cessation by two age groups, < 50 and ≥ 50 years, similar to analyses in a previous study.

Table 1  Socio-demographic and smoking-related characteristics of participant in the study.

<table>
<thead>
<tr>
<th>Demographic variables</th>
<th>Menthol smokers n = 615</th>
<th>Non-menthol smokers n = 138</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), mean (SD)</td>
<td>43.7 (10.0)</td>
<td>51.1 (11.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Female, % (n)</td>
<td>68 (418)</td>
<td>63 (87)</td>
<td>0.272</td>
</tr>
<tr>
<td>Married or living with partner, % (n)</td>
<td>38.9 (239)</td>
<td>31.2 (43)</td>
<td>0.098</td>
</tr>
<tr>
<td>Monthly family income, $1800, % (n)</td>
<td>40.4 (243)</td>
<td>43.9 (58)</td>
<td>0.494</td>
</tr>
<tr>
<td>High school education, % (n)</td>
<td>83.2 (511)</td>
<td>84.8 (117)</td>
<td>0.705</td>
</tr>
<tr>
<td>Employed, % (n)</td>
<td>47.5 (292)</td>
<td>49.3 (68)</td>
<td>0.707</td>
</tr>
<tr>
<td>Tobacco-related, mean (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cigarettes per day in past 7 days, mean (SD)</td>
<td>7.50 (3.29)</td>
<td>7.79 (2.85)</td>
<td>0.297</td>
</tr>
<tr>
<td>Age started smoking regularly in years, mean (SD)</td>
<td>21.16 (6.80)</td>
<td>21.14 (7.27)</td>
<td>0.972</td>
</tr>
<tr>
<td>Duration of smoking in years, mean (SD)</td>
<td>22.54 (11.31)</td>
<td>30.00 (12.85)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Number of 24-hour quit attempts in the past year, mean (SD)</td>
<td>3.25 (6.57)</td>
<td>3.07 (6.69)</td>
<td>0.783</td>
</tr>
<tr>
<td>Longest single quit period in days, mean (SD)</td>
<td>350.73 (767.30)</td>
<td>418.17 (880.57)</td>
<td>0.407</td>
</tr>
<tr>
<td>Motivation to quit, mean (SD)*</td>
<td>9.06 (1.66)</td>
<td>9.04 (1.59)</td>
<td>0.883</td>
</tr>
<tr>
<td>Confidence in quitting, mean (SD)*</td>
<td>7.04 (2.60)</td>
<td>7.57 (2.43)</td>
<td>0.023</td>
</tr>
<tr>
<td>NDSS, mean (SD)</td>
<td>–0.955 (1.04)</td>
<td>–0.986 (0.93)</td>
<td>0.744</td>
</tr>
<tr>
<td>Minnesota Withdrawal Score, mean (SD)</td>
<td>9.57 (5.85)</td>
<td>8.96 (6.41)</td>
<td>0.309</td>
</tr>
<tr>
<td>Expired CO in ppm, mean (SD)</td>
<td>13.68 (8.57)</td>
<td>14.55 (10.28)</td>
<td>0.355</td>
</tr>
<tr>
<td>Serum cotinine in ng/ml, mean (SD)</td>
<td>241.82 (144.80)</td>
<td>239.53 (144.05)</td>
<td>0.873</td>
</tr>
</tbody>
</table>

NDSS = Nicotine Dependence Syndrome Scale. *Scale of 1–10; ppm: parts per million. †Two participants did not answer the menthol question.

Figure 1 Overall cotinine-verified 7-day abstinence rates at 8 weeks and 26 weeks by menthol status

Figure 2 Seven-day abstinence rates at 26 weeks by treatment and menthol status

Smoking of menthol cigarettes was much more prevalent among those younger than 50 years of age (88.6%) compared to those 50 years or older (65.5%; \( P = 0.0001 \)). There was no significant interaction between categorized age (\(< 50\) versus \(\geq 50\)) and menthol status on 7-day point prevalence abstinence at week 26 (\( P = 0.93 \)). We therefore constructed two stepwise logistic regression models to predict the probability of abstinence at 26 weeks; one for each categorized age group. Variables included in the models were drug and counseling treatment assignments as well as confidence to quit smoking based on significant baseline differences in confidence to quit by menthol status. In the \(< 50\) age group, non-menthol smokers had marginally significantly higher cessation rate than menthol smokers (odds ratio = 2.077; 95% CI = 0.944–4.569; \( P = 0.069 \)). Among those \(\geq 50\) years, menthol smoking status did not predict abstinence (odds ratio = 1.676; 95% CI = 0.760–3.698; \( P = 0.221 \)).

**DISCUSSION**

The current study is the first to examine the association between smoking of menthol cigarettes and smoking cessation among light smokers. This study shows that, compared to non-menthol smokers, African American light smokers who smoke menthol cigarettes have lower smoking cessation rates 26 weeks after their quit date. This suggests that even among light smokers, menthol smokers were less successful with smoking cessation than non-menthol smokers. Smoking cessation rates at week 8 follow-up were similar for menthol and non-menthol smokers. The lack of significant differences in abstinence rates between non-menthol and menthol smokers at 8 weeks may be due to the fact that there was no main effect of nicotine gum versus placebo in the clinical trial [27,31]. The lower abstinence rate for menthol smokers at week 26 suggest that menthol smokers relapsed at a much higher rate than non-menthol smokers. At baseline, although levels of motivation to quit smoking were similar for both groups of smokers, the confidence for quitting smoking was lower for menthol smokers. The lower confidence at the beginning of the study may therefore be one of the reasons for higher relapse rate for menthol smokers. Confidence for quitting smoking has been shown to be associated with success for smoking cessation [32–34]. As both gender and age are known to be associated with use of menthol cigarettes, we assessed the possibility that younger age or female gender may play a role in the lower confidence to quit smoking in menthol smokers. However, our data did not show any significant associations between confidence to quit and participants’ age or gender. Interventions to increase confidence to quit smoking as well as prevent relapse could be beneficial for menthol smokers. As the current study was a secondary analysis, we did not have data on what relapse prevention strategies non-menthol smokers may have adopted that menthol smokers did not use; future studies should try to identify such strategies. Because a substantial proportion of African American smokers (up to 50%) [23,35] are light smokers, lower cessation rates for light smokers who smoke menthol cigarettes may be a contributing factor to poorer smoking cessation outcomes that have been observed for African Americans in general [7,36].

The finding of poorer smoking cessation outcome for light smokers who smoke menthol cigarettes is consistent with what we reported previously for African American moderate and heavy smokers using bupropion for smoking cessation [15]. However, while the bupropion study found lower cessation rates for menthol smokers at the end of pharmacotherapy (6 weeks), in the current study abstinence rates at the end of pharmacotherapy with nicotine gum (8 weeks) were similar for non-menthol and menthol smokers. In the bupropion study, the lower quit rate for menthol smokers was no longer significant at 6 months. The difference between the two studies could be due to the fact that menthol affects the metabolism of nicotine differently from that of bupropion. Some studies have reported that menthol smokers have higher cotinine levels [1,11] and that menthol may affect nicotine metabolism [37]. Whether menthol affects
bupropion metabolism is not known. Another study has suggested that menthol may competitively inhibit glucuronidation of nicotine and cotinine which could slow nicotine metabolism in menthol smokers [38]. In the current study, however, serum cotinine levels at baseline were not significantly different between non-menthol and menthol smokers. It is also worth noting that at 26 weeks follow-up, menthol smokers who received nicotine gum had a significantly lower cessation rate than non-menthol smokers who received nicotine gum. If the gum was more effective for non-menthol smokers, one would have expected to see the difference in cessation rates at 8 weeks when treatment with nicotine gum ended. This finding of lower cessation rates for menthol smokers at 26 weeks is therefore more suggestive of non-pharmacological effects and may be reflective of the fact that menthol smokers had lower cessation rates than non-menthol smokers regardless of the type of treatment.

Our study also suggests that the effect of menthol on cessation is limited to those under age 50 years among whom use of menthol cigarettes is more prevalent. This differential effect of menthol by age group is consistent with findings from a previous study [15] showing that among those under 50 years, non-menthol smokers were twice as likely as menthol smokers to quit smoking on bupropion. Similar to our study, there were no differences in cessation by menthol status among those aged ≥ 50. Studies have shown that cessation rates tend to be lower for younger smokers [36]. One possible hypothesis for lower cessation rates for younger smokers could be a greater proportion of them use menthol cigarettes. However, the association between age, menthol and smoking cessation is likely to be more complex and would probably include other factors such as ethnicity, gender, nicotine metabolism and genetics [39].

The current study has some limitations. First, all participants in the study were African Americans and therefore the findings may not generalize to light smokers of other ethnicities. Future studies should examine whether menthol smokers from other ethnicities in the United States and other parts of the world also have lower cessation rates. Secondly, this study was a secondary analysis that used data from a clinical trial that was not designed for testing differences in smoking cessation by menthol status. Consequently, the sample comprised primarily menthol smokers. It is possible that a sample with equal numbers of menthol and non-menthol smokers could find other factors associated with menthol status and smoking cessation that were not found in the current study. Thirdly, although the use of menthol cigarettes may partially explain lower cessation rates for African Americans in clinical trials, this is somewhat at odds with the current overall decline in smoking prevalence in African Americans to a level below that for European Americans [40]. It is possible that some smoking cessation treatments are more effective for African Americans, while others are less effective. More research is needed to address these seemingly opposing findings. Finally, because menthol use was not the primary focus of the parent study, menthol status was determined by self-report and we did not assess how long participants have used menthol cigarettes. However, because participants were not told the study was about menthol cigarettes, there were no incentives for them to report their menthol status correctly. Also, the proportion of menthol and non-menthol smokers were within the expected range. Future studies should consider using other measures to validate self-reported menthol status, which may include interviewing friends or family members and conducting biological assays of menthol or its breakdown products.

In summary, the current study has shown for the first time that, similar to what has been reported for moderate and heavy smokers, African American light smokers who smoke menthol cigarettes have lower cessation rates at 26 weeks after enrollment than menthol smokers. This finding is significant, because the study involved the use of other forms of interventions (nicotine gum, MI and HE) with light smokers different from bupropion used in the previous study with moderate and heavy smokers. This would suggest that the effect of menthol on smoking cessation may not be specific to a particular intervention. We recommend that smoking cessation studies should collect data on menthol status to be able to assess effects of menthol status in their cessation outcomes. Because of reports that the proportion of smokers who are light smokers is increasing, a better understanding of factors that affect smoking cessation among light smokers is an important step towards developing effective interventions for this understudied population of smokers. Finally, because light smoking is more prevalent among minorities, developing interventions for light smokers is an important contribution towards eliminating tobacco-related health disparities experienced by minorities.

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References


Are menthol cigarettes a starter product for youth?

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This study assessed the relationship between menthol use and nicotine dependence. Data from the National Youth Tobacco Survey indicated that menthol cigarette use was significantly more common among newer, younger smokers. Additionally, youth who smoked menthol cigarettes had significantly higher scores on a scale of nicotine dependence compared with nonmenthol smokers, controlling for demographic background and the length, frequency, and level of smoking. The study suggests that menthol cigarettes are a starter product that may be associated with smoking uptake by youth.

Introduction

This study investigated the possibility that menthol cigarettes serve as a starter product for teenagers. This issue is especially timely given the recent increase, documented here, in the proportion of adolescent smokers who use menthol cigarettes. The Federal Trade Commission (2004) reported that menthol cigarettes accounted for more than one-fourth (27%) of all cigarettes sold in 2002, up from 16% in 1963. Menthol cigarettes have long been popular among African Americans (Ahijevych & Parsley, 1999; Clark, Gautam, & Gerson, 1996; Giovino et al., 2004; Richardson, 1997). These findings are consistent with reports in earlier studies that about 75%–90% of African American adults report a preference for menthol cigarettes, compared with 23%–25% of White adults (Ahijevych & Wewers, 1993; Centers for Disease Control and Prevention [CDC], 1995; Hymowitz, Moulton, & Edkholdt, 1995; Robinson, Pertschuk, & Sutton, 1991; Wagenknecht et al., 1990).

Menthol use is particularly high among teenagers (CDC, 1994). Using data from the 2000 National Youth Tobacco Survey (NYTS), Appleyard, Messeri, and Haviland (2001) reported that 42% of youth in grades 6 through 12 who smoked usually smoked a menthol brand; 74% of African American and 58% of Asian American youth reported that their regular cigarette brand was a menthol brand.

Menthol cigarettes’ appeal to minority youth may result from a number of factors, including tobacco industry marketing strategies, the perception that menthol cigarettes are less risky and easier to smoke than regular cigarettes, and the biochemical effects of menthol in cigarettes. Cummings, Giovino, and Mendicino (1987) found that magazines targeted to minorities contained significantly more ads for cigarettes, and for menthol cigarettes, than did magazines similar in content but targeted to White readers. Menthol cigarettes have typically been marketed as being “not harsh” and “smooth,” which is consistent with the known pharmacological effects of menthol (Giovino et al., 2004; Pollay, 2000). However, Cummings, Morley, Horan, Steger, and Leavell (2002) observed that the tobacco industry has also been using additives in nonmenthol cigarettes to address low smoke tolerance in beginning smokers.

Menthol is a flavoring agent sprayed on tobacco to produce menthol cigarettes. It stimulates cold receptors, providing a sensation of coolness (Ahijevych & Parsley, 1999; Eccles, 1994; Gelal, Jacob, Yu, & Benowitz, 1999; McCarthy et al., 1995). Fang, Clausen, and Fanger (1998) found that exposing the respiratory tracts of adults to cooling increased the perception that air is fresh. Indeed, Garten and Falkner (2003) suggest that the soothing effect of
menthol may mask symptoms of respiratory disease, thereby contributing to the tendency for African American smokers, who most commonly smoke menthol cigarettes, to delay seeking medical attention for pulmonary disease.

Some researchers have suggested that menthol could increase the addictiveness of cigarettes because its cooling effect may contribute to reduced perception of irritation from cigarette smoke and alter inhalation patterns, thereby increasing overall smoke and nicotine intake (Henningfield et al., 2003; Hymowitz, Corle et al., 1995; Hymowitz, Moulton, & Edkholdt, 1995; Jarvik, Tashkin, Caskey, McCarthy, & Rosenblatt, 1994). One study found that women who smoked menthol cigarettes had significantly larger puff volumes and deeper and more frequent inhalations of cigarette smoke than did women who smoked nonmenthol cigarettes (Ahijevych & Parsley, 1999). A number of studies have found that smokers of menthol cigarettes take fewer puffs but exhale greater volumes of carbon monoxide (Ahijevych, Gillespie, Demirci, & Jagadeesh, 1996; Clark et al., 1996; Jarvik et al., 1994; McCarthy et al., 1995; Miller et al., 1994). However, other studies have found higher puff volumes among adults who smoked nonmenthol rather than menthol cigarettes (Ahijevych et al., 1996; Jarvik et al., 1994; McCarthy et al., 1995). Moreover, a small experimental study by Pickworth, Moolchan, Berlin, and Murty (2002) found no difference in the puff volumes of adults who smoked menthol versus nonmenthol cigarettes but did find that puff volumes were significantly larger in commercial cigarettes than in research cigarettes. These findings led the authors to suggest that differences in the physical characteristics of cigarettes (e.g., density of tobacco packing, paper porosity), other than mentholation, may contribute to differences in puff volumes and puffs per cigarette.

Several studies with adults have found that smoking menthol cigarettes may result in higher nicotine absorption—as evidenced by higher cotinine levels—than smoking nonmentholated cigarettes (Ahijevych & Parsley, 1999; Clark et al., 1996). The addition of menthol may increase the speed and amount of nicotine delivered through absorption enhancement effects (Clark et al., 1996; Jarvik et al., 1994), may heighten perceived sensory effects (Dessirier, O’Mahony, & Carstens, 2001), and may reinforce the effects of nicotine by interacting with it synergistically (Ahijevych & Parsley, 1999). Giovino and colleagues (2004) suggested that findings that White smokers of mentholated cigarettes smoke slightly fewer cigarettes each day than White smokers of nonmenthol cigarettes (Ahijevych et al., 1996; Ahijevych & Parsley, 1999; Clark et al., 1996; Jarvik et al., 1994) seem consistent with the notion that smoke constituents are absorbed more readily from mentholated brands.

Kandel and Chen (2000) found that adolescents in the 1991–1993 National Household Survey on Drug Abuse experienced higher levels of dependence with fewer cigarettes than did adults. However, the relationship between menthol use and level of nicotine dependence has not been assessed in adolescents. Among adults, the research on this topic has yielded mixed results. Royce, Hymowitz, Corbett, Hartwell, and Orlandi (1993) found that African American adults, who smoke predominantly menthol cigarettes, were more likely than White adults to report smoking within the first 10 min of waking up, indicating that they had greater nicotine dependence. However, a study of adults that controlled for race/ethnicity found that menthol smokers were slightly less likely than nonmenthol smokers to report smoking within 10 min of waking up (Hyland, Garten, Giovino, & Cummings, 2002). A small experimental study of adults found that nonmenthol cigarettes with a high nicotine yield reduced craving more than high-nicotine menthol cigarettes (Pickworth et al., 2002), but no difference was found in the ratings of reduction in cravings after smoking commercial menthol versus commercial nonmenthol cigarettes.

Several studies have found higher concentrations of cotinine in African American smokers than in White smokers (Caraballo et al., 1998; Clark et al., 1996; Pérez-Stable, Herrera, Jacob, & Benowitz, 1998). Clark and colleagues (1996) controlled for race/ethnicity and discovered that the use of mentholated cigarettes contributed to significantly higher cotinine concentrations, even though African Americans on average smoke fewer cigarettes per day than Whites. Their finding might lead to the speculation that, if menthol smokers absorb more nicotine, they should find it more difficult to quit. Consistent with this idea are results from a retrospective study showing that African American smokers were more likely than Whites to try to quit in a given year but less likely to maintain their cessation efforts (CDC, 1993). However, a large case-control study of older adults (Muscat, Richie, & Stellman, 2002) and a 5-year prospective study based on a follow-up of adults in the Community Intervention Trial for Smoking Cessation (COMMIT) study found no differences in cessation rates between menthol and nonmenthol smokers (Hyland et al., 2002). These issues have not been addressed among adolescents.

In this study, we investigated the use of menthol cigarettes in youth using two national school-based surveys of adolescents (the 2000 NYTS and the 2002 NYTS). Here we first document a recent increase in the use of menthol cigarettes. We then examine the
possibility that menthol cigarettes serve as a starter product to established smoking and that menthol cigarettes are more addictive and harder to quit than nonmenthol cigarettes.

Method

To investigate these issues among youth, we analyzed data from the 2000 NYTS and from the 2002 NYTS. The survey used a three-stage cluster sample design that oversampled African American, Hispanic, and Asian students. The NYTS was administered to 35,828 students in grades 6 through 12 in spring 2000 and to 26,149 students in spring 2002. The response rate was 84% in the 2000 NYTS and 75% in the 2002 NYTS (using response rate calculation number 4 of the American Association for Public Opinion Research [AAPOR]). Data were nationally weighted to adjust for nonresponse and the probability of selection. Analysis used Stata version 8 statistical software, which adjusted for survey design effects in calculating sample variances.

Our analyses focused on the subset of students who were current smokers (smoking cigarettes on one or more of the past 30 days) and who reported that they had a usual brand of cigarettes. We classified these youth as menthol or nonmenthol smokers based on their answers to two questions: (a) “During the past 30 days, what brand of cigarettes did you usually smoke?” and (b) “Is the brand of cigarettes that you usually smoked during the past 30 days mentholated?”

Because the NYTS was a self-administered survey, there were some inconsistencies in responses. We assessed the extent of possible misclassification by comparing respondents’ reports of menthol use with reports of brand used. Among the brands listed in the survey, Kool is an exclusively menthol brand, and Newport has several extremely popular menthol varieties. An analysis of AC Nielsen data on sales in grocery stores with scanners showed that more than 99% of Newport packs sold in 2000 were mentholated (Giovino et al., 2004); proprietary data from AC Nielsen indicated that this was also the case in 2002 (AC Nielsen, 2005).

In the 2000 NYTS, 88.8% and 88.1% of those who regularly smoked Kool and Newport, respectively, considered themselves menthol smokers; in the 2002 NYTS, the comparable percentages were 87.8% and 89.1%, respectively. Because most cigarette brands are available in both menthol and nonmenthol varieties, it was not possible to use the brand information in the survey to fully correct for misclassification. Nonetheless, these analyses suggest that although misclassification exists, its likely effect is to have attenuated, rather than accounted for, the relationships reported in this article.

Table 1 presents the proportion of smokers in the various subgroups, defined by identification of brand and menthol status. Our main analyses compared menthol smokers and nonmenthol smokers, shown in the shaded boxes. For these analyses, we defined menthol smokers as youth who reported that they smoked menthol cigarettes (excluding nine youth who reported that they smoked menthol cigarettes but described an exclusively nonmenthol brand).

We defined nonmenthol smokers as youth who smoked possible nonmenthol brands and youth who

| Table 1. Menthol status and brand identified by youth who smoked in the past 30 days. |
|---------------------------------|----------------|----------------|----------------|
|                                | Menthol        | Nonmenthol     | Menthol status not described |
| Brand                           | Number of subjects | Percent | Number of subjects | Percent | Number of subjects | Percent |
| Predominantly menthol brand     | 1,552           | 36.9          | 1,650           | 40.9    | 173              | 3.1     |
| Possible menthol brand          | 673             | 15.4          | 1,575           | 40.9    | 93               | 2.3     |
| Brand not described             | 9               | 0.2           | 64              | 1.5     | 326              | 6.7     |
| Exclusively non menthol brand   | “Inconsistent nonmenthol smokers” | Excluded from analysis | Excluded from analysis |

Note. For the main analyses in this paper, we considered the groups shown in the shaded boxes:

- Menthol smokers (Cells a–d–g) comprised 36.9% of current smokers (n=1,552).
- Nonmenthol smokers (Cells e–h–k) comprised 40.9% of current smokers (n=1,650).

We excluded from the main analysis (although we considered in sensitivity analyses) youths who did not describe the menthol status of the cigarettes they usually smoked (Cells a–h–l). This group comprised about 19.7% of youths who indicated that they had smoked in the past 30 days (n=970). We also excluded “inconsistent menthol smokers” (Cell b; n=113; 2.3% of current smokers) and “inconsistent nonmenthol users” (Cell j; n=9; 0.2% of current smokers) because we could not determine which response (i.e., brand or menthol status) was accurate.
reported that they smoked nonmenthol cigarettes. (Because we could not determine which response was accurate, we excluded from the main analysis youth who reported that they smoked a nonmenthol cigarette but indicated that they smoked a predominantly menthol brand [2.7% of youth who smoked at least once during the past 30 days].)

According to this definition, menthol smokers comprised 36.9% and nonmenthol smokers comprised 40.9% of youth who had smoked in the past 30 days. Altogether, the universe for our main analysis represents 77.8% of the youth who had smoked one or more times in the past 30 days; we excluded the 22.2% of youth who had smoked one or more times in the past 30 days but who did not indicate or were inconsistent in their responses about the brand and menthol status of the cigarettes they usually smoked.

Additional sensitivity analyses considered two alternative definitions: (a) A “menthol status only” classification based on the type of cigarette (menthol or nonmenthol) without consideration of brand, and (b) a “brand trumps menthol status” definition that relied on the brand designation when brand and menthol status were inconsistent.

To further assess the issue of misclassification, we conducted sensitivity analyses with the various subgroups defined by the classification of brand and menthol status:

- Menthol smokers of predominantly menthol brands (18.4% of youth who smoked in the past 30 days);
- Menthol smokers of mixed brands or menthol smokers for whom the brand was not identified (18.5% of youth who smoked in the past 30 days);
- “Inconsistent menthol smokers,” or youth who reported that they smoked predominantly menthol brands but indicated that they smoked nonmenthol cigarettes (2.3% of youth who smoked in the past 30 days);
- “Unrecognized menthol smokers,” or youth who reported that they smoked predominantly menthol brands but did not report whether they usually smoked menthol or nonmenthol cigarettes (3.1% of youth who smoked in the past 30 days).

A small number of youth smoked an exclusively nonmenthol brand (Lucky Strike) but reported that it was a menthol cigarette; however, this group had too few cases (n=9) to support analysis. In addition, approximately 6.7% of all youth who smoked in the past 30 days did not report either a regular brand or the menthol status of the cigarettes they usually smoked.

Our analysis compared menthol and nonmenthol smokers in terms of sociodemographic background, length of smoking, intentions to quit, cessation attempts, and level of nicotine dependence. In our analysis of the relationship between menthol smoking and nicotine dependence, we used the Nicotine Dependence Scale for Adolescents (Nonnemaker et al., 2004). This scale consisted of six items that asked respondents how soon they smoked after they woke up in the morning and whether they experienced cravings for cigarettes (Table 2). It combined items from two previously established nicotine dependence scales, the Fagerström Tolerance Questionnaire (Fagerström, 1978; Fagerström & Schneider, 1989) and the Nicotine Dependence Syndrome Scale (Shiffman, Hickox, Gyns, Paty, & Kassel, 1995). In an earlier longitudinal study of adolescents, the Nicotine Dependence Scale for Adolescents was found to load on a single dimension using factor analysis and to have a Cronbach’s coefficient alpha of .81. The scale was positively correlated with the level and frequency of smoking and negatively correlated with the length of the quit attempts (Nonnemaker et al., 2004).

We ran two logistic regression models in which the dependent variable was either intentions to quit (seriously thinking of quitting within the next 30 days) or nicotine dependence. Explanatory variables included whether the youth were menthol cigarette smokers, whether they had been smoking for more than a year, whether they smoked on 20 days or more during the past month, and whether they smoked six or more cigarettes per day on the days that they smoked. These models controlled for age, gender, and race/ethnicity.

### Results

**Prevalence of youth menthol cigarette use**

Although the overall prevalence of smoking among youth declined between 2000 and 2002, the percentage of smokers who regularly used menthol

---

**Table 2. Items in the Nicotine Dependence Scale for Adolescents.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Do you think you would be able to quit smoking if you wanted to?”</td>
<td></td>
</tr>
<tr>
<td>“How soon after you wake up do you usually smoke your first cigarette on a weekday?”</td>
<td></td>
</tr>
<tr>
<td>“How soon after you wake up do you usually smoke your first cigarette on a weekend?”</td>
<td></td>
</tr>
<tr>
<td>“If you are sick with a bad cold or sore throat, do you smoke cigarettes?”</td>
<td></td>
</tr>
<tr>
<td>“How true is this statement for you? ‘When I go without a smoke for a few hours, I experience cravings.’”</td>
<td></td>
</tr>
<tr>
<td>“How true is this statement for you? ‘I sometimes have strong cravings for cigarettes where it feels like I’m in the grip of a force that I can’t control.’”</td>
<td></td>
</tr>
</tbody>
</table>

Note. *The scale used the average of weekday and weekend time to first smoke.*
cigarettes increased significantly ($p<.05$) from 40.0% to 47.4%—an increase of 18.5%. Menthol cigarette use significantly increased among middle school smokers (from 51.6% to 59.6%, $p<.05$); it also increased, although not significantly, among high school smokers (from 39.6% to 43.6%; Figure 1).

Sensitivity analysis indicated a similar increase in the proportion of smokers who used menthol cigarettes with alternative definitions of menthol use. A “menthol status only” definition, based solely on respondents’ designation of menthol status, saw a relative increase of 18.5% in the proportion of menthol use (from 39.0% in 2000 to 46.2% in 2002). A “brand trumps menthol status” definition, which classified as menthol smokers the respondents who smoked a menthol brand even if they did not recognize that it was menthol, saw a relative increase of 16.2% (from 43.2% in 2000 to 50.2% in 2002).

**Menthol cigarettes as a starter product**

Menthol cigarettes were most popular among younger and newer smokers. Teens in middle school who had been smoking for less than 1 year were significantly more likely to smoke menthol cigarettes compared with middle school students who had been smoking for more than 1 year (62.4% vs. 53.3%, $p<.002$; Figure 2). A similar trend was observed for high school students (45.9% vs. 41.9%), but the difference was smaller and not statistically significant.

Overall, 51.8% of teens who had smoked for less than 1 year smoked menthol cigarettes, compared with 43.6% of those who smoked for a year or more. Sensitivity analysis found that the “menthol status only” definition yielded similar results: 49.9% of teens who smoked for less than 1 year smoked menthol, compared with 42.9% of teens who smoked for more than 1 year. However, in the “brand trumps menthol status” definition, the proportion of menthol smokers among teens who had smoked for less than 1 year was 55.8%, compared with 45.5% among teens who had smoked for a year or more. One reason for this result is that uncertain menthol groups were more likely to be new smokers. While less than half (46.4%) of menthol users had smoked for less than 1 year, 62.6% of the inconsistent menthol group and 67.0% of the unrecognized menthol group had smoked for less than 1 year (Table 3). One possible explanation for the inconsistencies is that these youth had not smoked long enough to recognize and accurately report the type of cigarette they usually smoked. (Similarly, 61.7% of youth who did not identify either the brand or the menthol status of the cigarettes they usually smoked had smoked for less than 1 year.)

For White and Hispanic youth, menthol use was higher among middle school students than among high school students (Figure 3). Among Hispanic youth, 62.9% of smokers in middle school, compared with 52.4% of smokers in high school, used menthol cigarettes. Among Whites, 53.1% of smokers in middle school, compared with 37.4% of smokers in high school, used menthol cigarettes. This result may indicate that menthol cigarettes are a starter tobacco product that adolescents smoke before they move on to other types of tobacco products. However, among African Americans, smokers in middle school (87.5%) and in high school (86.8%) smoked predominantly menthol cigarettes.

**Figure 1.** Menthol cigarette use among youth between the 2000 NYTS and 2002 NYTS. Data were based on 5,512 youth (1,206 middle school and 4,306 high school students) in the 2000 NYTS and 3,202 youth (817 middle school and 2,385 high school students) in the 2002 NYTS who had smoked on one or more of the prior 30 days and who indicated the brand and/or the menthol status of the cigarettes they usually smoked. The asterisk (*) indicates that the difference in the proportion of menthol use between 2000 and 2002 was statistically significant ($p<.05$) for middle school smokers, for high school smokers, and for all adolescent smokers.
Menthol cigarette use and intentions to quit

Menthol smokers and nonmenthol smokers were similar in terms of the frequency with which they attempted to quit smoking. However, menthol smokers were significantly more likely to have sought help in quitting smoking (Figure 4). Menthol smokers were about 1.5 times as likely to have attended a school program or visited an Internet quit site and twice as likely to have attended a community program or called a cessation helpline.

Nonetheless, significantly fewer menthol smokers than nonmenthol smokers \( (p=0.05) \) reported “seriously thinking about quitting.” Logistic regression found that menthol smokers were significantly less likely to be “seriously thinking of quitting within the next 30 days” \( (OR=0.79, p=0.012) \) after controlling for level of smoking (days smoked and number of cigarettes smoked per day) and length of smoking (less than a year)\(^1\) (see Table 4, Model 1). Additional models tested for possible interaction effects between menthol use and age and between menthol use and race/ethnicity, but these results are not shown because the interactions were not statistically significant.

Sensitivity analysis (not shown) found that the menthol smokers were less likely than the nonmenthol smokers to report “seriously thinking about quitting” when we used “menthol status only” to classify respondents \( (OR=0.77, p=0.006) \) and also when we used the “brand trumps menthol status” definition \( (OR=0.79, p=0.007) \).

Menthol use and nicotine dependence

A logistic regression model with the Nicotine Dependence Scale for Adolescents as the dependent variable and controlling for demographic background (i.e., age, gender, and race/ethnicity) and smoking behavior (i.e., length, frequency, and level of smoking) found that teens who regularly smoke menthol cigarettes have 45% higher odds \( (OR=1.45, p=0.006) \) than teens who do not regularly smoke menthol cigarettes to be above the median on nicotine dependence (see Table 5, Model 1). We also tested versions of this model that included interaction effects between menthol use and age and between menthol use and race/ethnicity, but these results are not presented because the interaction effects were not statistically significant. We found similar results (not shown) when we applied these same models using multiple regression, in which the dependent variable was the normalized distribution of the Nicotine Dependence Scale for Adolescents.

---

\(^1\)The logistic regressions on intentions to quit and nicotine dependence used the following specifications:

\[
\text{Intention to quit} = \alpha_0 + \beta_1 M + \beta_2 L + \beta_3 T + \beta_4 A + \mu_1 X + \varepsilon_1
\]

\[
\text{Nicotine dependence} = \alpha_0 + \beta_1 M + \beta_2 L + \beta_3 T + \beta_4 A + \mu_1 X + \varepsilon_1
\]

where \( M \) denotes whether respondent is a menthol smoker; \( L \) denotes whether respondent had smoked for more than a year; \( T \) denotes whether respondent had smoked on 20 or more days in the past month; \( A \) denotes whether respondent had six or more cigarettes per day in the past month; \( X \) represents covariates that are included to control for age, gender, and race/ethnicity; and \( \mu \) is the corresponding set of coefficients for \( X \). These include age (continuous variable) and race/ethnicity (African American, Hispanic, and Asian, with White the omitted category).
Table 3. Characteristics of nonmenthol and menthol smoking groups.

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Main groups</th>
<th>Menthol groups</th>
<th>Sensitivity analysis only</th>
<th>Excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nonmenthol (a)</td>
<td>Menthol (b=c+d)</td>
<td>Menthol and menthol brand (c)</td>
<td>Menthol and mixed or unidentified brand (d)</td>
</tr>
<tr>
<td>Number of subjects</td>
<td>1,650</td>
<td>1,552</td>
<td>773</td>
<td>779</td>
</tr>
<tr>
<td>Length of smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 1 year</td>
<td>36.0 [32.0–40.1]</td>
<td>43.9 [38.7–49.2]</td>
<td>41.4 [35.6–47.5]</td>
<td>46.4 [40.4–52.5]</td>
</tr>
<tr>
<td>More than 1 year</td>
<td>64.0 [59.9–68.0]</td>
<td>56.1 [50.8–61.3]</td>
<td>58.6 [52.5–64.4]</td>
<td>53.6 [47.5–59.6]</td>
</tr>
<tr>
<td>Frequency of smoking (days in past month)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1–19</td>
<td>48.6 [45.2–52.0]</td>
<td>54.9 [50.2–59.4]</td>
<td>49.0 [41.8–56.3]</td>
<td>60.6 [54.9–66.1]</td>
</tr>
<tr>
<td>Level of smoking (cigarettes/day)</td>
<td>&lt;6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 6</td>
<td>66.4 [63.1–69.7]</td>
<td>69.7 [65.4–73.7]</td>
<td>67.7 [61.0–73.9]</td>
<td>71.6 [66.9–76.0]</td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle school</td>
<td>18.5 [13.8–24.3]</td>
<td>30.2 [22.7–38.9]</td>
<td>28.9 [20.3–39.2]</td>
<td>31.5 [23.8–40.3]</td>
</tr>
<tr>
<td>High school</td>
<td>81.5 [75.7–86.2]</td>
<td>69.8 [61.1–77.3]</td>
<td>71.1 [60.8–79.7]</td>
<td>68.5 [59.7–76.2]</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>57.3 [53.9–60.7]</td>
<td>50.2 [47.0–53.4]</td>
<td>50.3 [45.7–54.8]</td>
<td>50.1 [46.1–54.1]</td>
</tr>
<tr>
<td>Female</td>
<td>42.7 [39.3–46.1]</td>
<td>49.8 [46.7–53.0]</td>
<td>49.7 [45.2–54.3]</td>
<td>49.9 [45.9–53.9]</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>87.7 [84.3–90.5]</td>
<td>68.7 [63.3–73.6]</td>
<td>62.2 [55.1–68.7]</td>
<td>75.1 [69.7–79.8]</td>
</tr>
<tr>
<td>Asian</td>
<td>1.8 [1.1–2.6]</td>
<td>2.6 [1.6–3.7]</td>
<td>1.7 [0.9–3.4]</td>
<td>3.8 [2.4–5.0]</td>
</tr>
</tbody>
</table>

Note. \(^a\)“Other” group consists of the following: Lucky Strike & menthol; Lucky Strike & menthol missing; menthol/other & menthol missing; and brand missing & menthol missing.
Sensitivity analysis (not shown) indicated that the finding that menthol smokers were more likely than nonmenthol smokers to score above the median on nicotine dependence was observed when we used the "menthol status only" definition ($OR=1.44$, $p=.004$) and also when we used the "brand trumps menthol status" definition ($OR=1.42$, $p=.01$).

Discussion

Results of the present study suggest that menthol cigarettes may pose significant risks to adolescents. First, the proportion of adolescent smokers who use menthol cigarettes is increasing, particularly among middle school students.

Second, we found significantly higher use of menthol cigarettes among younger and less experienced smokers than among more experienced smokers; in 2002, 62.4% of middle school students who had smoked for less than a year usually smoked menthol cigarettes. These findings are consistent with the possibility that because menthol cigarettes are perceived as less harsh to smoke, they may serve as a starter cigarette for adolescents.

![Figure 3. Menthol cigarette use among young smokers by race/ethnicity, 2002 NYTS. Data were based on 760 middle school students and 2,335 high school students in the 2002 NYTS who had smoked one or more times in the past 30 days and who described the brand and/or the menthol status of the cigarettes they usually smoked. The sample sizes of smokers in middle school and in high school by race/ethnicity were as follows: African Americans, 152 middle school and 206 high school smokers; Hispanics, 172 middle school and 403 high school smokers; and Whites, 399 middle school smokers and 1,595 high school smokers. The number of Asian smokers in the sample (19 middle school and 41 high school smokers) was too small to support separate estimates. The asterisk (*) indicates that the difference in the proportion of menthol use among smokers in high school versus middle school was statistically significant ($p<.05$).](image-url)

![Figure 4. Menthol use and seeking cessation help, 2002 NYTS. Data were based on 3,095 middle school and high school students in the 2002 NYTS who had smoked one or more times in the past 30 days and who described the brand and/or the menthol status of the cigarettes they usually smoked. Estimates were based on 1,497 respondents who smoked menthol cigarettes and 1,598 respondents who smoked nonmenthol cigarettes. The asterisk (*) indicates that the difference in the proportion of use of various sources of cessation help between menthol and nonmenthol smokers was statistically significant at a $p<.05$ level (for all sources of help except the nicotine patch).](image-url)
This study also provides evidence that menthol cigarettes may be more difficult to quit. Compared with nonmenthol smokers, youth who smoked menthol cigarettes were significantly less likely to report "seriously thinking about quitting." These results were statistically significant in a logistic regression that controlled for demographic background (age, race/ethnicity, and gender), length of

Table 4. Menthol use and intentions of quitting: Logistic regression results.

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Menthol vs. nonmenthol smokers [Model 1]</th>
<th>Menthol smokers and type of brand [Model 2]</th>
<th>Menthol smokers and type of brand (including inconsistent respondents) [Model 3]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds ratio</td>
<td>p-value</td>
<td>Odds ratio</td>
</tr>
<tr>
<td>Menthol smoker</td>
<td>0.79</td>
<td>.012</td>
<td>—</td>
</tr>
<tr>
<td>Menthol smokers of menthol brands</td>
<td>—</td>
<td>—</td>
<td>0.81</td>
</tr>
<tr>
<td>Menthol smokers of mixed brands</td>
<td>—</td>
<td>—</td>
<td>0.78</td>
</tr>
<tr>
<td>&quot;Inconsistent menthol&quot;a</td>
<td>Excluded</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>&quot;Unrecognized menthol&quot;b</td>
<td>Excluded</td>
<td>—</td>
<td>0.98</td>
</tr>
<tr>
<td>Smoking behavior</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoked on at least 20 of the past 30 days</td>
<td>0.47</td>
<td>.000</td>
<td>0.47</td>
</tr>
<tr>
<td>Smoked 6 or more cigarettes per day</td>
<td>0.70</td>
<td>.031</td>
<td>0.70</td>
</tr>
<tr>
<td>Have been smoking for a year or more</td>
<td>0.67</td>
<td>.005</td>
<td>0.67</td>
</tr>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.04</td>
<td>.739</td>
<td>1.04</td>
</tr>
<tr>
<td>Age</td>
<td>1.09</td>
<td>.023</td>
<td>1.09</td>
</tr>
<tr>
<td>African American</td>
<td>1.40</td>
<td>.108</td>
<td>1.39</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.72</td>
<td>.037</td>
<td>0.72</td>
</tr>
<tr>
<td>Asian</td>
<td>0.68</td>
<td>.403</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Note. a "Inconsistent menthol"=smokers of a predominantly menthol brand who described it as "nonmenthol." b "Unrecognized menthol"=smokers of a predominantly menthol brand who did not describe whether or not it was menthol. These groups were included only in Model 3.

This study also provides evidence that menthol cigarettes may be more difficult to quit. Compared with nonmenthol smokers, youth who smoked menthol cigarettes were significantly less likely to report "seriously thinking about quitting." These results were statistically significant in a logistic regression that controlled for demographic background (age, race/ethnicity, and gender), length of

Table 5. Menthol use and likelihood of being above the median on a Nicotine Dependence Scale for Adolescents.

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Menthol vs. nonmenthol smokers [Model 1]</th>
<th>Menthol smokers and type of brand [Model 2]</th>
<th>Menthol smokers and type of brand (including inconsistent respondents) [Model 3]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds ratio</td>
<td>p-value</td>
<td>Odds ratio</td>
</tr>
<tr>
<td>Menthol smoker</td>
<td>1.45</td>
<td>.006</td>
<td>—</td>
</tr>
<tr>
<td>Menthol smokers of menthol brands</td>
<td>—</td>
<td>—</td>
<td>1.42</td>
</tr>
<tr>
<td>Menthol smokers of mixed brands</td>
<td>—</td>
<td>—</td>
<td>1.47</td>
</tr>
<tr>
<td>&quot;Inconsistent menthol&quot;a</td>
<td>Excluded</td>
<td>—</td>
<td>1.21</td>
</tr>
<tr>
<td>&quot;Unrecognized menthol&quot;b</td>
<td>Excluded</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Smoking behavior</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoked on at least 20 of the past 30 days</td>
<td>4.55</td>
<td>.000</td>
<td>4.56</td>
</tr>
<tr>
<td>Smoked 6 or more cigarettes per day</td>
<td>4.09</td>
<td>.000</td>
<td>4.09</td>
</tr>
<tr>
<td>Have been smoking for a year or more</td>
<td>1.19</td>
<td>.187</td>
<td>1.19</td>
</tr>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.02</td>
<td>.870</td>
<td>1.02</td>
</tr>
<tr>
<td>Age</td>
<td>0.92</td>
<td>.014</td>
<td>0.92</td>
</tr>
<tr>
<td>African American</td>
<td>1.21</td>
<td>.256</td>
<td>1.22</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1.00</td>
<td>.999</td>
<td>1.00</td>
</tr>
<tr>
<td>Asian</td>
<td>1.37</td>
<td>.358</td>
<td>1.37</td>
</tr>
</tbody>
</table>

Note. a "Inconsistent menthol"=smokers of a predominantly menthol brand who described it as "nonmenthol." b "Unrecognized menthol"=smokers of a predominantly menthol brand who did not describe whether or not it was menthol. These groups were included only in Model 3.
time smoking, frequency of smoking, and level of smoking. Even though the menthol smokers were more likely to report that they attended cessation programs or used nicotine replacement products, they were no more likely to make one or more quit attempts than were smokers of nonmenthol cigarettes.

This study suggests a possible explanation for this finding: namely, menthol cigarettes may be more addictive than nonmenthol cigarettes. Logistic regression (controlling for demographic background and length, frequency, and level of smoking) showed that menthol smokers are significantly more likely than nonmenthol smokers to feel dependent on nicotine. This finding is consistent with the possibility that because menthol cigarettes are less harsh, smokers may find it easier to inhale from them more deeply. Hence, using mentholated cigarettes may make cessation more difficult (although other properties of menthol cigarettes, rather than mentholation itself, might contribute to the increased ratings of nicotine dependence).

The present study was not able to distinguish the contributions of various factors to menthol use or to the findings that teenagers who smoked menthol cigarettes scored significantly higher on the Nicotine Dependence Scale for Adolescents. Although it is possible that the product characteristics of menthol cigarettes that make them easier to smoke may increase nicotine dependence, other possible explanations exist. For example, menthol use may be reinforced by tobacco marketing or by peer norms. Nonetheless, the fact that menthol use is common among younger, newer smokers, and that smokers of menthol cigarettes have lower intentions of quitting and score higher on a scale of nicotine dependence, suggests that this is an area that can benefit from further investigation.

The present study had a number of limitations. Some misclassification in the reporting of menthol use may have occurred. However, the sensitivity analyses indicated similar findings using various definitions of menthol cigarettes. Moreover, any misclassification is likely to have reduced the differences between menthol and nonmenthol groups, given that the results of misclassification have been to mix actual menthol cigarette smokers with nonmenthol smokers and vice versa.

Also, differences in the smoking patterns of menthol versus nonmenthol users may not have been adequately controlled for in our models. Further, these analyses were conducted with cross-sectional data, and association does not necessarily imply causality. The evidence discussed in this article would be strengthened by longitudinal data. Although the study indicates that menthol cigarettes may be a starter product, this is not necessarily the same as being a gateway product in terms of facilitating subsequent use. Although that possibility is consistent with these data, the issue of whether menthol serves as a gateway product will require a longitudinal study. Such a study also would be able to address issues related to brand switching. Findings about nicotine dependence would be strengthened by confirmation with biochemical data on nicotine absorption.

Finally, the present study could not determine the extent to which the popularity of menthol cigarettes among younger, newer smokers is a result of product characteristics, marketing (Giovino et al., 2004), or other influences. Even so, the fact that menthol is one of the most prevalent types of cigarettes used by younger, newer smokers suggests that further investigation of the role of mentholated cigarettes deserves close attention.

Acknowledgments

Financial support for this study was provided by the American Legacy Foundation. The authors acknowledge Matthew Farrelly and Nathan Mann of RTI for their support in analysis.

References


Predictors of smoking cessation among African-Americans enrolled in a randomized controlled trial of bupropion

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Abstract

Objectives. Identification of individual characteristics that predict successful smoking cessation treatment has been limited to studies with mostly white participants. This study identifies factors that predict successful quitting among African-Americans participating in a smoking cessation trial.

Methods. Twenty-one baseline variables were analyzed as potential predictors from a double-blind placebo-controlled, randomized trial that used bupropion SR for smoking cessation among 600 African-American smokers. Chi-square tests, two sample t tests, and multiple logistic regression procedures were employed to identify predictors of 7-day abstinence among the 535 participants who completed the 7-week medication phase.

Results. Univariate predictors of cessation were receiving bupropion (P < 0.0001), not smoking menthol cigarettes (P = 0.0062), smoking after 30 min of waking (P < 0.0001), older age (P = 0.0085), smoking fewer cigarettes per day (P = 0.0038), and lower cotinine levels (P = 0.0002). Logistic regression identified three significant independent predictors. Participants who received bupropion treatment were more than twice as likely to quit smoking at the end of treatment compared to participants who received placebo (OR = 2.62; 95% CI = 1.77–3.88, P < 0.0001), while smoking within 30 min of waking (OR = 0.40; 95% CI = 0.25–0.62, P < 0.0001) and higher salivary cotinine levels at baseline (OR = 0.799; 95% CI = 0.629–0.922, P < 0.0001) reduced the likelihood of quitting.

Conclusions. This is the first report identifying predictors of smoking cessation among African-Americans participating in a clinical trial. Results indicate that, aside from bupropion treatment, various indicators of addiction were the strongest predictors. While this is similar to findings among white smokers, thresholds of addiction may need to be adjusted for African-American smoking patterns. Additional studies focused on diverse populations are needed to improve treatment approaches and to identify population-specific factors that are important for treatment-matching approaches.

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Keywords: Smoking cessation; Tobacco use disorder; Bupropion; Ethnicity; African-American

Introduction

Treatment of nicotine addiction yields less than optimal success rates. Even intensive treatment that combines pharmacotherapy and multiple counseling sessions results in only 11–34% of smokers staying quit 1 year after treatment [1,2]. Identification of individual characteristics that predict successful treatment could help match smokers with a treatment that is more likely to help them quit and to identify smokers who might need more intensive treatment.

A number of baseline factors have been reported as predictors of success in previously conducted smoking cessation studies including male gender [3–5], higher readiness to quit [6], longer prior abstinence [4,5], and indicators of lower nicotine dependence (lower number of...
cigarettes smoked per day, Fagerstrom scores, nicotine/cotinine levels, and expired carbon monoxide) [4,6–8]. However, findings about predictors have not been consistent, even across studies that use the same pharmacological treatment methods.

One limitation of prior research is that these studies have been limited to white smokers. The results of findings among white smokers have limited generalizability for African-Americans, since their smoking patterns are quite different from those of whites. African-Americans smoke fewer cigarettes per day (15 vs. 25 for whites), prefer mentholated cigarettes, are more likely to smoke within 10 min of awakening, and have higher cotinine levels per cigarette smoked than whites [9–12]. Furthermore, while the prevalence of smoking among African-Americans has decreased to levels comparable to those among whites, tobacco-related health consequences remain disproportionately higher among African-Americans [13,14]. Identifying factors predictive of smoking cessation among African-Americans would aid in making treatment decisions to increase the smoker’s odds of quitting successfully. To assess factors predictive of smoking cessation among African-Americans, we analyzed data from a double-blind placebo-controlled, randomized trial that used bupropion SR for smoking cessation among 600 African-American smokers.

### Methods

Data were obtained from a randomized double-blind, placebo-controlled trial of bupropion SR 300 mg/day for smoking cessation in African-Americans. Recruitment methods, study methodology, and outcomes of the trial are detailed elsewhere [15,16]. The trial procedures were approved and monitored by the University of Kansas Medical Center’s Human Subjects Committee.

### Participants and measures

In brief, 1,498 smokers in a mid-western city who identified themselves as black or African-American were screened, and 981 were eligible and invited to participate. The 600 African-Americans who enrolled were randomly assigned to receive 300 mg of bupropion SR or placebo for 7 weeks and were followed for a total of 27 weeks. At baseline, we collected demographic information and data on current and former smoking patterns, smoking restrictions, and satisfaction from smoking. We used the 20-item Center for Epidemiologic Studies Depression Scale (CES-D) [17], the Perceived Stress Scale [18], and a modified 11-item Hassles Index [19]. Cotinine levels from saliva samples were also assessed at baseline.

Twenty-one baseline variables listed in Tables 1 and 2 were considered as potential predictors of cessation, including several variables that prior research has identified as

### Table 1

Analysis of potential categorical level predictors of 7-day cessation at end of medication phase

<table>
<thead>
<tr>
<th>Predictors</th>
<th>n</th>
<th>% Abstinent</th>
<th>P value a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group assignment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placebo</td>
<td>270</td>
<td>21.11</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Bupropion</td>
<td>265</td>
<td>41.51</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>369</td>
<td>30.08</td>
<td>0.3988</td>
</tr>
<tr>
<td>Male</td>
<td>166</td>
<td>33.73</td>
<td></td>
</tr>
<tr>
<td>Smokes menthol cigarettes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>118</td>
<td>41.53</td>
<td>0.0062</td>
</tr>
<tr>
<td>Yes</td>
<td>417</td>
<td>28.30</td>
<td></td>
</tr>
<tr>
<td>Other smokers in the home</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>362</td>
<td>33.43</td>
<td>0.1197</td>
</tr>
<tr>
<td>Yes</td>
<td>172</td>
<td>26.74</td>
<td></td>
</tr>
<tr>
<td>Smokes within 30 min of waking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>115</td>
<td>48.70</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Yes</td>
<td>420</td>
<td>26.43</td>
<td></td>
</tr>
<tr>
<td>Married or living with partner</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>330</td>
<td>31.21</td>
<td>0.9986</td>
</tr>
<tr>
<td>Yes</td>
<td>205</td>
<td>31.22</td>
<td></td>
</tr>
<tr>
<td>High school graduate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>59</td>
<td>30.51</td>
<td>0.8679</td>
</tr>
<tr>
<td>Yes</td>
<td>272</td>
<td>31.62</td>
<td></td>
</tr>
<tr>
<td>Prior use of pharmacotherapy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>288</td>
<td>32.99</td>
<td>0.3397</td>
</tr>
<tr>
<td>Yes</td>
<td>247</td>
<td>29.15</td>
<td></td>
</tr>
<tr>
<td>Satisfaction from recent cigarette</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not or a little satisfying</td>
<td>228</td>
<td>29.82</td>
<td>0.5498</td>
</tr>
<tr>
<td>Moderately to quite satisfying</td>
<td>307</td>
<td>32.25</td>
<td></td>
</tr>
<tr>
<td>Taste of recent cigarette</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not or a little good</td>
<td>276</td>
<td>32.97</td>
<td>0.3655</td>
</tr>
<tr>
<td>Very to extremely good</td>
<td>259</td>
<td>29.34</td>
<td></td>
</tr>
<tr>
<td>All 5 best friends smoke</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>416</td>
<td>33.17</td>
<td>0.0676</td>
</tr>
<tr>
<td>Yes</td>
<td>119</td>
<td>24.37</td>
<td></td>
</tr>
<tr>
<td>Home smoking rules</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking restricted</td>
<td>196</td>
<td>34.18</td>
<td>0.2598</td>
</tr>
<tr>
<td>No rules</td>
<td>339</td>
<td>29.50</td>
<td></td>
</tr>
<tr>
<td>Work smoking rules</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking restricted</td>
<td>64</td>
<td>40.62</td>
<td>0.0834</td>
</tr>
<tr>
<td>No rules</td>
<td>471</td>
<td>29.93</td>
<td></td>
</tr>
</tbody>
</table>

a Chi-square test.

### Table 2

Analysis of potential continuous-level predictors of 7-day cessation at end of medication phase

<table>
<thead>
<tr>
<th>Baseline predictors</th>
<th>Abstinent</th>
<th>Smoker</th>
<th>P value a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD)</td>
<td>46.52 (11.71)</td>
<td>43.70 (10.74)</td>
<td>0.0085</td>
</tr>
<tr>
<td>Cigarettes per day, mean (SD)</td>
<td>15.28 (6.92)</td>
<td>17.29 (8.33)</td>
<td>0.0038</td>
</tr>
<tr>
<td>Cotinine level, mean (SD)</td>
<td>256.78 (137.04)</td>
<td>305.61 (143.44)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Years smoked, mean (SD)</td>
<td>27.56 (11.96)</td>
<td>25.64 (10.86)</td>
<td>0.0792</td>
</tr>
<tr>
<td>Number of quit attempts, mean (SD)</td>
<td>2.23 (5.27)</td>
<td>2.22 (4.31)</td>
<td>0.9812</td>
</tr>
<tr>
<td>Depression, CES-D, mean (SD)</td>
<td>11.54 (9.39)</td>
<td>11.95 (8.29)</td>
<td>0.6301</td>
</tr>
<tr>
<td>Hassle score, mean (SD)</td>
<td>3.07 (2.37)</td>
<td>3.33 (2.25)</td>
<td>0.2237</td>
</tr>
<tr>
<td>Perceived stress scale, mean (SD)</td>
<td>20.57 (8.40)</td>
<td>21.33 (7.84)</td>
<td>0.3235</td>
</tr>
</tbody>
</table>

a t test.
measures of nicotine addiction (such as smoking within 30 min waking, number of cigarettes smoked per day) [20]. These analysis predicted short-term abstinence, defined as 7-day point prevalence abstinence from smoking at the end of medication phase (week 7). Cessation at week 7 was selected as the outcome of interest in this analysis because more participants were quit at week 7 compared to any later time point and the higher quit rates increased our power to detect predictors. Abstinence from smoking was defined as no smoking in the past 7 days confirmed by carbon monoxide level < 10 ppm, or carbon monoxide >10 ppm but salivary cotinine < = 20 ng/ml.

**Statistical analysis**

Potential categorical predictors were summarized by frequencies and percentages, and continuous-level predictors were summarized by means and standard deviations. Categorical variables (Table 1) were compared between smoking status using the chi-square test and continuous variables (Table 2) were compared using the two sample t tests. Logistic regression was employed to assess the 21 factors as potential predictors of abstinence from smoking for participants in both study arms. Multiple logistic regression analysis with full stepwise and best subset variable selection procedures were performed to identify a set of multiple predictors of abstinence from smoking at 7 weeks. Main effect terms for all potential predictors were included in the first step of model selection process. All two-way interactions were assessed for the final set of predictors that were identified. The predictors of the subset in the final selected model were all statistically significant (P < 0.05).

**Results**

Of the 535 participants with complete data at 7 weeks (65 were lost to follow-up), 167 (31.21%) were abstinent from smoking whereas 368 (68.79%) were smoking. As discussed elsewhere [16], compared to other randomized trials of bupropion [21,22], the quit rates for the primary outcome of the main trial (7-day cessation at 6 months) was slightly lower in the bupropion group but similar in the placebo group. Tables 1 and 2 show the results of analysis of potential baseline categorical and continuous-level predictors of 7-day cessation at 7 weeks. The predictors that were found to be significantly different between the abstinence and smoking groups were being on bupropion SR (P < 0.0001), not smoking menthol cigarettes (P = 0.0062), not smoking within 30 min of waking (P < 0.0001), older age (P = 0.0085), lower number of cigarettes smoked per day (P = 0.0038), and lower cotinine levels (P = 0.0002).

All 21 potential baseline predictors were included in the multiple logistic regression analysis to produce a multivariable model for predicting abstinence from smoking at the end of the medication phase. After a stepwise model selection procedure, the subset of predictors included treatment (P < 0.0001), smoking within 30 min of waking (P < 0.0001), and baseline cotinine level (P = 0.0021). This subset of predictors was the same subset that resulted from the best subset model selection procedure. When the two-way interactions were assessed for the final subset of predictors, none of the two-way interactions were significant. As can be seen in Table 3, participants who received bupropion treatment were more than twice as likely to quit smoking at the end of treatment compared to participants who received placebo (OR = 2.62; 95% CI = 1.77–3.88). Characteristics that reduced the odds of quitting included smoking within 30 min of waking (OR =0.40; 95% CI = 0.25–0.62) and higher salivary cotinine levels at baseline (OR = 0.799; 95% CI = 0.629–0.922).

**Discussion**

Among African-Americans participating in a randomized trial of bupropion SR 300 mg for smoking cessation, independent baseline predictors of cessation were: assignment to bupropion condition, not smoking within 30 min of waking, and lower cotinine levels. Univariate predictors of cessation also included not using mentholated cigarettes, smoking fewer cigarettes per day, and being older in age. Two of the three independent predictors suggest that those who have higher levels of nicotine addiction (as measured by smoking right after awaking) or higher nicotine adsorption or consumption (as measured by high cotinine levels) are less likely to quit even when receiving intensive treatment.

Although use of bupropion increased the odds of quitting by more than 2.5 times independent of individual characteristics, participants who were more addicted to nicotine may have needed additional support to increase their likelihood of achieving cessation. Longer use of bupropion, combined pharmacotherapy (e.g., bupropion and nicotine replacement), and more intensive counseling may prove helpful for these smokers. Matching treatment strategies (e.g., dosage and/or type of pharmacotherapy) to smokers based on their smoking or demographic characteristics have been discussed widely as a promising approach [23,24]. With the exception of some studies matching the dose of nicotine

### Table 3

<table>
<thead>
<tr>
<th>Variables</th>
<th>Estimate (SD)</th>
<th>Odds ratio (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>−0.9007 (0.2611)</td>
<td>0.0006</td>
<td></td>
</tr>
<tr>
<td>Treatment (bupropion = 1)</td>
<td>0.9642 (0.2004)</td>
<td>2.623 (1.771–3.884)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Smoking within 30 min of waking</td>
<td>−0.9255 (0.2261)</td>
<td>0.396 (0.254–0.617)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Cotinine level</td>
<td>−0.224 (0.0730)</td>
<td>0.799 (0.692–0.922)</td>
<td>0.0021</td>
</tr>
</tbody>
</table>

*a The odds ratio shown is for a 100-unit change (e.g., increase of cotinine level from 100 to 200).
replacement with smoking rates [25,26] little controlled research has tested the efficacy of treatment matching.

Our findings that indicators of nicotine dependence (smoking within 30 min of waking and higher cotinine levels) predicted continued smoking is consistent with prior studies of bupropion treatment among predominantly white smokers [7,8]. Common measures of nicotine dependence (Fagerstrom nicotine questionnaires) [20] use cigarettes smoked per day to classify dependence levels. However, compared to whites, African-Americans smoke fewer cigarettes per day. Our findings suggest that African-Americans who smoke within 30 min of waking or have high cotinine levels may have difficulty quitting, regardless of the numbers of cigarettes smoked per day. Thus, if cigarettes smoked per day are used to classify level of dependence, African-Americans may be at risk of being incorrectly classified as having low nicotine dependence. Lower thresholds on dependence measures or measures not based on cigarettes per day may be necessary to identify African-American smokers who are less likely to quit with standard treatment.

In the univariate analysis, fewer African-Americans who smoked menthol cigarettes quit (28.3% vs. 41.54%). Further analyses reported elsewhere showed that this finding held in multivariate models for African-Americans under 50 years old [27]. We found no other treatment studies that tested use of menthol cigarettes as a predictor of treatment success. This is probably because only 20% of whites smoke menthol cigarettes. While it is not clear from our study why menthol smokers had lower cessation rates, researchers have proposed a number candidate explanations including that the local anesthetic and cooling effects of menthol may facilitate deeper inhalation and result in more exposure to nicotine [28]. Furthermore, smoking of menthol cigarettes could be a marker for some other yet undetermined factor that are also associated with cessation such as gender or age.

In contrast to some prior studies, we found that men were only slightly more likely to quit compared to women (33.73% vs. 30.8%). Even though 70% of the participants in our study were women, there were sufficient number of men enrolled to detect a meaningful difference in quit rates if one existed. One possible explanation for this finding is that bupropion, compared to nicotine replacement products, may be particularly useful in helping women remain abstinent [29]. However, quit rates at 7 weeks in other trials using bupropion are inconclusive. A dose-response study found men were more likely to quit [4], while the relapse prevention trial found men were more likely to quit only at the end of the open label period (7 weeks) in the univariate analysis [5]. Alternatively, our failure to find a gender difference may be due to the ethnicity of the participants. Prior studies have found that despite having higher body mass, African-American women are more satisfied with their body weight compared to white women [30,31]. Although 40% of the women in our study reported that they were trying to loose weight, perhaps African-American women may be less likely than whites to abandon their cessation attempts if they experience weight gain.

Not having all five best friends smoke (P = 0.067) and the presence of work smoking rules (P = 0.083) approached statistical significance in predicting cessation in the univariate analysis but not in the multivariate analysis. To our knowledge, studies similar to ours did not assess these potential predictors. Since we used single items to assess the smokers’ social and environmental conditions, it is likely that we did not adequately measure these characteristics. Our findings suggest that the smokers’ social networks and environmental conditions may warrant more precise assessment in future studies.

An interesting negative finding of our study was that psychosocial variables, particularly the stress and hassles measures, were not predictive of quitting. This may be somewhat surprising among a sample of urban African-American smokers who may be exposed to more stress [19]. Our findings may be because of inadequate assessment of pertinent psychosocial factors that are particularly relevant to African-Americans. For example, measures of perceived racism or neighborhood crime might be superior indices of stress experienced by African-American smokers.

A number of limitations should be considered in interpreting our results. First, this constitutes a secondary analysis for which the original study was not primarily designed. There may be important predictor variables that were not included in our baseline measures (e.g., neighborhood stress, perceived racism) that may be particularly important for African-American smokers. Nevertheless, we were able to examine most of the variables that prior studies have found to be important. Caution should be used in generalizing our results to other groups of smokers. The participants in our study were not only African-American, but were also predominantly female and middle aged. Similar results may not have been observed in younger male smokers for example. Participants also needed to be relatively highly motivated to quit smoking to make the necessary efforts to enroll and stay in the program. It is likely, however, that our sample would be similar to most groups of African-American smokers who would choose to respond to advertisements for a smoking cessation program.

This is the first report that identifies predictors of successful cessation among African-American smokers participating in a clinical trial. Additional studies focused on diverse populations are needed to improve treatment approaches and to identify population-specific factors that are important for the use in treatment-matching approaches that may increase the odds of smokers quitting.

Acknowledgments

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References


[12] Kabat GC, Morabia A, Wynder EL. Comparison of smoking habits of this research possible.


**Tobacco Industry Control of Menthol in Cigarettes and Targeting of Adolescents and Young Adults**


The future of the tobacco industry depends on maintaining current users and recruiting new users to replace older smokers who quit or die from tobacco-related diseases. The industry develops product innovations to encourage experimentation and use among targeted groups. Although the primary goal is to promote or maintain nicotine addiction, new products can also enhance appeal, facilitate nicotine dosing (the amount, method, and frequency of nicotine ingestion that is characteristic of cigarette smoking), and mask toxic and irritating effects.

Menthol, a monocyclic terpene alcohol that acts as a stimulant for cold receptors, is used as an additive in approximately 90% of cigarettes manufactured in the United States. Most of these cigarettes contain imperceptible amounts of menthol (approximately 0.03% of cigarettes’ tobacco weight), but tobacco companies promote specific brands as mentholated. These brands, which contain between 0.1% and 1.0% of their tobacco weight in menthol, impart a noticeable cooling sensation and minimize flavor when inhaled. Brands marketed as menthol cigarettes composed 27% of the US cigarette market in 2005.

Herscy et al. found that menthol use among adolescents increased between 2000 and 2002, with the highest use among younger, newer smokers, and suggested that menthol cigarettes may be a starter product for adolescents. Younger smokers may tolerate menthol cigarettes, with their milder sensory properties, better than harsher nonmenthol cigarettes. In cigarettes formulated with lower levels of menthol, so that the menthol flavor and effect are less dominant, the menthol primarily masks harshness, making smoking initiation easier. Adolescents who experience fewer adverse physiological effects from smoking are more likely to progress from experimentation to regular smoking.

It is not known whether tobacco companies have systematically altered menthol content in brands to target and recruit new smokers. Few published studies have examined differences in the physical design of menthol cigarettes. Celebucki et al. characterized levels of menthol in 48 commercial cigarette varieties, and a recent paper by Kreslake et al. described factors associated with preferred menthol levels among smokers, including age, race/ethnicity, and duration of menthol use.

Three major brands (Kool, Salem, and Newport) have dominated the menthol market, and each features distinct sensory attributes targeted to specific groups. Kool has traditionally been the strong menthol brand, smoked primarily by older (aged ≥35 years) African American men who are long-term smokers. Salem is used primarily by older smokers and female smokers. Newport has lower levels of menthol and is the most popular brand among younger African American smokers (69% of smokers in middle school and high school used Newport in 2000); it is the second leading brand after Marlboro among all adolescents.

We explored tobacco industry manipulation of menthol in brands as a strategy to appeal to adolescents and young adults and the repercussions in product design, advertising trends, and usage. We reviewed internal tobacco industry documents, conducted laboratory tests, examined industry marketing reports for advertising expenditures (for mentholated vs nonmentholated brands), and analyzed a national survey on usage.

**METHODS**

**Internal Tobacco Industry Documents**

We identified internal tobacco industry documents in databases at Tobacco Documents Online and the Legacy Tobacco Documents Library. We used a snowball sampling design for text-based and index searches, with an initial set of keywords (e.g., menthol level, menthol preferences, age) that led to further search terms.

Relevant documents included (1) product development activities that referred to preferred levels of menthol content or delivery and (2) strategic plans and marketing objectives related to menthol products. Of the approximately 8,000,000 documents available in the archives, we analyzed approximately 580 documents dating from 1985 to 2007, 66 of which informed our research question and are cited in this article.
Laboratory Tests

Laboratory analyses were conducted by Arista Laboratories (Richmond, Virginia) on Kool Full Flavor, Kool Milds, Salem Full Flavor Green Label, Salem Full Flavor Black Label, Newport Full Flavor, Camel Menthol, Marlboro Menthol, and Marlboro Milds. We selected menthol brands with historically high market shares (Kool, Salem, Newport) as well as menthol varieties of brands known to be popular among adolescents (Marlboro, Camel). Cigarettes were analyzed for tar, nicotine, carbon monoxide, water, and menthol in smoke, as well as menthol and nicotine in the cigarette rod.

Machine smoking was conducted under Federal Trade Commission and more intensive Health Canada smoking conditions. Smoke condensate was collected on a Cambridge filter pad and analyzed by gas chromatography. Data were reported in milligrams per cigarette for each smoke sample. Smoke menthol and smoke nicotine were measured for the total cigarette as well as per puff, and brands were ranked according to these measures.

Menthol content in cigarettes was determined as a percentage of the weight of the tobacco in the cigarette rod. The concentration of menthol was determined in milligrams per milliliter, and then sample mass and extraction volume were used to calculate results in milligrams per gram.

Survey Data

We analyzed data on menthol brand use by age and race/ethnicity from the National Survey on Drug Use and Health. This nationally representative survey provides annual estimates of the use of illicit drugs, alcohol, and tobacco among persons 12 years and older residing in US households. We performed cross-tabulations for age group and brand used most often among current smokers. A dichotomous menthol-use variable determined use among brands with menthol and nonmenthol varieties (Marlboro and Camel). In calculating confidence intervals and standard errors, we accounted for the complex sampling design of the survey with Survey Documentation and Analysis software, version 3.0 (Computer-Assisted Survey Methods Program, University of California, Berkeley).

RESULTS

Strategic Use of Menthol Level

Internal tobacco industry documents revealed that menthol levels in cigarettes (measured as a percentage of tobacco weight) fall along a continuum that elicits differences in consumer perception. For example, R. J. Reynolds developed and tested a low-level menthol product (Salem Gold) with 0.12% menthol; at the other extreme, Lorillard explored a “super shot” menthol prototype with more than 1% menthol. Most commercial full-flavor menthol products fall between these extremes. For cigarettes at the lower end of this continuum, the sensory effects of menthol consist primarily of masking the taste of tobacco and reducing uncomfortable sensations at the back of the throat; as menthol content is increased, the cigarette provides a more intense menthol taste and characteristic coolness during respiration. Individuals apparently select their personal optimal menthol levels to create desired sensory effects while smoking.

Tobacco companies researched how controlling menthol levels could increase brand sales among specific groups. They discovered that products with higher menthol levels and stronger perceived menthol sensations suited long-term smokers of menthol cigarettes, and milder brands with lower menthol levels appealed to younger smokers. According to R. J. Reynolds,

All three major menthol brands (Salem, Kool, Newport) built their franchise with YAS (younger adult smokers) using a low menthol product strategy. However, as smokers acclimate to menthol, their demand for menthol increases over time. . . . Responsive brands whose strategy is to maximize franchise acceptance invariably increase menthol levels over time.

Newport. Introduced in 1957, Newport was “developed to appeal to consumer demand for a lightly mentholated product,” according to its manufacturer, Lorillard. It achieved steady market growth throughout the 1970s and 1980s, while maintaining low menthol levels, in contrast to the strategy of its main competitors, Kool and Salem. By 1992, Newport had gained the top position in the menthol market, with particular success among younger adults. R. J. Reynolds attributed the appeal of Newport among younger adults to its lower menthol content, observing in 1987 that “the want for less menthol does indeed skew younger adult.”

Newport maintained a lower level of menthol during the 1970s and early 1980s, and Newport’s competitors attributed its historical success among younger adults to its lower menthol content.

Salem. In 1987, R. J. Reynolds identified marketing low-level menthol varieties as a new brand strategy to persuade consumers to switch from nonmenthol brands and to recruit new, young smokers, noting, “First-time smoker reaction is generally negative. . . . Initial negatives can be alleviated with a low level of menthol.” To reposition Salem to appeal to a younger market, and in particular to younger African Americans, R. J. Reynolds re-formulated all of its Salem-brand varieties to have lower menthol levels and then evaluated the unannounced change in a test market in 1990. Despite survey problems, the company concluded that Salem sales were not negatively affected by the new formulation.

Today, 2 Salem full-flavor varieties are available nationally: Salem Green Label and Salem Black Label. Introduced in 2003, Salem Black Label is promoted as a lower- menthol choice to young adults; Salem Green Label has a highly mentholated taste that maintains its appeal to older women.
provide a bridge between the nonmenthol and menthol segments and thereby foster an enlarged menthol segment.\textsuperscript{63,64} Menthol loading refers to the percentage of menthol in the cigarette (referred to in this article as menthol level or content). In 1998, the company identified a lower-level menthol product in its long-term marketing strategies intended to encourage smokers aged 21 to 25 years to switch from nonmenthol to menthol cigarettes and to appeal to consumers of competitive products with lower levels of menthol.\textsuperscript{64}

Brown and Williamson concluded that Newport and, increasingly, Marlboro Menthol had stolen Kool’s popularity among beginning smokers. Kool Milds, available since 1972, were identified in a 1990 Brown and Williamson strategic plan as a milder product intended to increase the importance, popularity, and sales of the parent brand to young adult smokers.\textsuperscript{65} In 1994, Milds were repackaged along with Kool Lights and Ultra Lights and positioned to attract Newport smokers.\textsuperscript{66,67}

\textit{Marlboro}. Marlboro was the leading nonmenthol brand, but its share of the menthol market remained negligible through the mid-1980s.\textsuperscript{67} Philip Morris employed a 2-pronged strategy to increase Marlboro’s share in the menthol market by targeting young adults as well as older smokers (≥35 years).\textsuperscript{68} Marlboro needed a lower-menthol product that would cater to younger smokers’ sensory needs, as well as a higher-menthol cigarette for older smokers. Marlboro Milds were introduced nationally in March 2000 and became popular among young smokers, particularly White young adults.\textsuperscript{69} The entry of Marlboro Milds into the market coincided with an increase in the menthol level of the regular Marlboro Menthol brand, intended for older smokers.

### Menthol Levels and Nicotine Yields

Laboratory analysis demonstrated a broad range of menthol levels among popular commercial menthol brands. Newport, Marlboro Milds, and Salem Black Label cigarettes had the lowest levels of menthol, measured as a percentage of tobacco weight (Table 1).

<table>
<thead>
<tr>
<th>Brand</th>
<th>Menthol Content in 2007\textsuperscript{a}</th>
<th>Changes in Menthol Concentration Since 2000\textsuperscript{b}</th>
<th>Target Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newport\textsuperscript{c}</td>
<td>0.32 Decreased menthol concentration by 16% (from 0.38)</td>
<td>Younger smokers\textsuperscript{45-46}</td>
<td></td>
</tr>
<tr>
<td>Marlboro Milds\textsuperscript{d}</td>
<td>0.36 Maintained menthol concentration since introduction in 2000</td>
<td>Younger smokers\textsuperscript{49}</td>
<td></td>
</tr>
<tr>
<td>Salem Black Label\textsuperscript{e}</td>
<td>0.37 Decreased menthol concentration by 23% (from 0.48) from Salem parent brand</td>
<td>Modern urban smokers aged 21–34 years; Newport and Kool smokers\textsuperscript{14,15,16}</td>
<td></td>
</tr>
<tr>
<td>Salem Green Label\textsuperscript{f}</td>
<td>0.44 Decreased menthol concentration by 8% (from 0.48) from Salem parent brand</td>
<td>Salem smokers; Marlboro Menthol smokers\textsuperscript{14}</td>
<td></td>
</tr>
<tr>
<td>Camel Menthol\textsuperscript{g}</td>
<td>0.47 Increased menthol concentration by 9% (from 0.43)</td>
<td>Younger smokers; Newport and Marlboro smokers\textsuperscript{17}</td>
<td></td>
</tr>
<tr>
<td>Kool\textsuperscript{h}</td>
<td>0.48 Decreased menthol concentration by 7% (from 0.52)</td>
<td>Urban, multicultural young adults\textsuperscript{72,79}</td>
<td></td>
</tr>
<tr>
<td>Marlboro Menthol\textsuperscript{i}</td>
<td>0.55 Increased menthol concentration by 25% (from .044) after introduction of Milds</td>
<td>Smokers aged ≥35\textsuperscript{60,61}</td>
<td></td>
</tr>
<tr>
<td>Kool Milds\textsuperscript{j}</td>
<td>0.63 Decreased menthol concentration by 5% (from 0.66)</td>
<td>Younger smokers\textsuperscript{76}</td>
<td></td>
</tr>
</tbody>
</table>

Note. All brands were full-flavor king size.

\textsuperscript{a}Measured as a percentage of tobacco weight.

\textsuperscript{b}Data from internal industry documents.\textsuperscript{66,67}

\textsuperscript{c}Lowest menthol level of all brands tested.

\textsuperscript{d}Lowest menthol loading of Marlboro mentholated varieties.

\textsuperscript{e}Lower menthol style; split from Salem parent in 2003 and rebranded.

\textsuperscript{f}Higher menthol style; split from Salem parent in 2003.

\textsuperscript{g}Introduced in 1997, used advertising rather than lowering menthol levels to attract younger smokers.

\textsuperscript{h}One of 2 R.J. Reynolds priority brands; marketing plan included price promotions.

\textsuperscript{i}Introduction of Marlboro Milds enabled Philip Morris to increase menthol levels in Marlboro Menthol to appeal to long-term smokers.

\textsuperscript{j}Relaunched in 1994 with higher menthol loading than parent product. Two additional varieties were introduced to market in 2007 with the same machine-measured smoke nicotine and tar yields (Federal Trade Commission measurement) as Kool Milds, but with lower menthol loading (Kool Flow, 0.45; Kool Groove, 0.47; Arista Laboratories, Richmond, VA). Under Federal Trade Commission smoking conditions, the 2 Milds brands and Newport had the lowest menthol in smoke (Marlboro Milds, 0.27 mg/cigarette; Kool Milds, 0.34 mg/cigarette; Newport, 0.45 mg/cigarette), followed by Salem Black Label (0.52 mg/cigarette), Kool Full Flavor (0.56 mg/cigarette), Camel Menthol (0.59 mg/cigarette), and Salem Green Label (0.65 mg/cigarette). Under intensive Health Canada smoking conditions, Marlboro Milds, Newport, and Salem Black Label had the least menthol in the smoke for both total and per-puff measures (Marlboro Milds, 0.80 mg/cigarette, 0.09 mg/puff; Newport, 0.88 mg/cigarette, 0.10 mg/puff; Salem Black Label, 0.96 mg/cigarette, 0.09 mg/puff). Kool Milds had the most menthol per puff (0.14 mg), followed by Marlboro Menthol and Camel Menthol (both 0.12 mg). Overall, the smoke menthol rankings were comparable to the menthol content analysis, with Newport and Marlboro Milds consistently lowest in menthol ranking.

Menthol content and menthol in smoke varied more than nicotine smoke yields. Under Federal Trade Commission conditions, nicotine per puff ranged from 0.11 mg (Marlboro Milds) to 0.16 mg (Newport); nicotine per cigarette ranged from 0.82 mg (Marlboro Milds) to 1.20 mg (Newport). Under intensive smoking conditions, nicotine per puff ranged from 0.22 mg (Marlboro Milds) to 0.26 mg (Camel Menthol and Newport); nicotine per cigarette ranged from 1.91 mg (Marlboro Milds) to 2.56 mg (Camel Menthol). Tests of the ratios of menthol to nicotine in smoke within brands did not show a correlation between Federal Trade Commission and Health Canada smoking conditions (data not shown).
Promotion of Modified Menthol Brands

Although cigarette sales in the United States declined 22% from 2000 to 2005, sales of menthol cigarettes remained stable. Among major menthol brands, Newport grew by 15%, for a one-third share of the menthol cigarette market in 2006, continuing a decades-long growth trend. Kool and Salem were stable or slightly declined in market share after 2001, each capturing approximately 10% of the market (Figure 1).

Marlboro, a minor menthol brand as recently as 15 years ago (<2% market share), grew to account for more than 15% of the menthol market in 2006 and became the second leading menthol brand. Marlboro Menthol had consistent market share growth throughout the 1990s, particularly among young adult menthol smokers. By 2000, Marlboro Menthol held 6.7% of the total young adult smoker market, Newport had 18.4%, and Kool and Salem had only 1.0% and 0.3%, respectively. Menthol products accounted for half of Marlboro's total share growth in 2000, the year Marlboro Milds were introduced; the new product was responsible for almost 80% of Marlboro's menthol-category growth that year.

From 1998 to 2005, magazine advertising expenditures for menthol brands increased substantially, from 15% to 50% of all magazine ads for tobacco products (Table 2). Philip Morris reduced spending on magazine advertising after the signing of the Master Settlement Agreement between the tobacco industry and state governments in 1998. In 2004 it ended magazine advertising. The same year, Brown and Williamson merged with R.J. Reynolds and continued to advertise. As a result, all major brands introduced in 2005 were menthol (Newport, Salem, and Kool) or had significant menthol components (Camel). Advertising expenditures for nonmenthol brands declined sharply, from $309.3 million in 1998 to $39.8 million in 2005, but expenditures for menthol brands increased, from $36.5 million in 1998 to $43.8 million in 2005.

Age and Race Correlations With Cigarette Choice

National survey data showed that significantly more adolescents and young adults than older persons smoked menthol cigarettes. In 2006, 43.8% (95% confidence interval [CI]=40.6, 47.0) of current smokers aged 12 to 17 years reported that they used menthol cigarettes, as did 35.6% (95% CI=34.0%, 37.2%) of current smokers aged 18 to 24 years. By contrast, 30.6% (95% CI=28.6%, 32.6%) of smokers older than 35 years reported menthol use.

The brands that accounted for more than 80% of cigarettes smoked by adolescents aged 12 to 17 years in 2005 were Marlboro nonmenthol (36%), Newport (20%), Marlboro menthol products, including Milds (14%), Camel nonmenthol products (9%), and Camel menthol products (3%). Among smokers of brands with menthol and nonmenthol varieties (Camel and Marlboro), adolescents and young adults were more likely than were older smokers to choose the menthol option (Table 3).

Race was also a factor in use and brand choice. African American adolescents and young adult smokers used menthol as frequently as did older African American smokers, but they were more likely to choose a lower-menthol variety. For menthol smokers, Newport and Marlboro menthol brands were most popular among both African American and White adolescents and young adults. White adolescents and young adults were more likely to use Camel, and African American adolescents and young adults to use Kool (data not shown).

DISCUSSION

We found evidence that the tobacco industry manipulated menthol levels in cigarettes and introduced new menthol brands to gain market share, particularly among adolescents and young adults. Many of the most popular brands among adolescents contained menthol, and adolescents and young adults—particularly Whites—were significantly more likely to smoke menthol cigarettes than were...
older smokers. Manufacturers continued to market menthol brands in magazine advertising; ads for nonmenthol brands fell. New menthol brands were introduced into the market at a rapid pace, despite a provision in the Master Settlement Agreement that prohibited tobacco companies from directly or indirectly targeting youths.

For new or younger smokers, the primary advantage of smoking a menthol cigarette is that the menthol masks the harshness and discomfort of inhaling smoke enough to allow delivery of an effective dose of nicotine. Menthol brands with the greatest market share growth among young adults had the lowest menthol levels (Newport and Marlboro Milds) among the brands we tested. Industry documents provided insight into this phenomenon, suggesting that among adolescents and young adults, lower menthol content reduced harshness, but higher menthol content was perceived as too strong. Despite heavy marketing and promotion, Camel Menthol and Kool (brands with mid-to-high menthol levels) were only marginally successful among this group.

Descriptors such as “mild” may be used by manufacturers to indicate menthol level or menthol flavor intensity to smokers, separate from designations of tar and nicotine delivery (commonly indicated by descriptors such as “light”). Mild menthol products were positioned to appeal primarily to new menthol smokers. Other varieties provided long-term menthol smokers with a higher menthol level for a stronger menthol taste. For example, Marlboro introduced Marlboro Milds in 2000, with a lower menthol concentration, and raised the menthol content in Marlboro Menthol. Salem branched out with 2 menthol varieties: Salem Green Label had higher menthol loading and targeted older smokers than did Salem Black Label.

Research Needs

Most African American smokers in the United States use menthol cigarettes (>70%, compared with approximately 30% of White smokers). Manufacturers have used advertising and marketing to promote menthol products to African Americans for the past 3 decades. Health disparities among African American and White smokers led to speculation that menthol cigarette use confers a higher risk for tobacco-related diseases; however, the available evidence remains inconclusive. Recent studies that controlled for factors related to socioeconomic status did not find significant differences in risk for disease between menthol and nonmenthol smokers, and research on differences in cessation outcomes between these 2 groups had conflicting results. Research is needed to determine short-term outcomes, such as incidence and prevalence of smoking among target populations by menthol status, as well as long-term health and cessation consequences of increased menthol use in the United States.

Limitations

Studies of industry documents have some important limitations, including issues of availability and reliability, which were discussed in previous reports. Data on menthol brand use was taken from the National Survey on Drug Use and Health, which might be subject to misclassification bias in self-reported menthol status. This bias might be larger among certain subgroups, such as adolescents; for example, in 2006, only 83% of adolescents who smoked Newport (an exclusively mentholated brand) also reported that they were menthol smokers, compared with 95% of Newport smokers older than 35 years. We determined use of Marlboro and Camel menthol varieties by the menthol-use survey question, thus possibly underestimating the proportion of users of these varieties.

The laboratory assessment of menthol by brand focused primarily on menthol content in the cigarette, and despite machine-generated smoke data, only limited conclusions can be drawn regarding smoke delivery of menthol. Menthol delivery varies according to the intensity of smoking. Furthermore, because menthol masks irritation and increases the sensation of airflow, it may facilitate deeper inhalation and thus increase exposure to nicotine and other harmful components of tobacco smoke. However, the precise mechanism of menthol delivery in facilitating nicotine exposure is not known.

Our primary reason for limiting our study to full-flavor cigarettes was to limit the possible confounding effects of ventilation in machine-smoke data. For example, it was previously established that ventilated cigarettes contain increased menthol levels to maintain menthol in smoke. Additional studies of other types of cigarettes (e.g., “lights”) would be useful. Although we measured smoke delivery with 2 separate smoking protocols, assessment of exposure among smokers requires further research, including investigation of smoking topography and biomarkers of exposure.

Conclusions

Cigarettes are nicotine delivery devices. They are engineered to promote initiation and transition to addiction through design features that make the products more attractive and palatable. Although menthol is not addictive, it may contribute to tobacco addiction by promoting initiation and facilitating inhalation of smoke. Inactive ingredients affect the uptake and action of the active drug ingredients in cigarettes.

For decades, tobacco manufacturers have controlled levels of menthol in commercial cigarettes to promote smoking among adolescents and young adults. Manufacturers have marketed brands to this vulnerable population by manipulating sensory elements of cigarettes to promote initiation and dependence. To protect public health, tobacco products should be federally regulated, and

### TABLE 3—Preference for Menthol Varieties of Marlboro and Camel, by Age: 2006

<table>
<thead>
<tr>
<th>Smoker</th>
<th>Smokers Who Choose Menthol Cigarettes, Age, y % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marlboro</td>
<td></td>
</tr>
<tr>
<td>12-17</td>
<td>27.6 (24.0, 31.2)</td>
</tr>
<tr>
<td>18-25</td>
<td>23.0 (21.3, 24.6)</td>
</tr>
<tr>
<td>26-34</td>
<td>12.9 (10.0, 15.8)</td>
</tr>
<tr>
<td>≥35</td>
<td>10.8 (8.5, 13.0)</td>
</tr>
<tr>
<td>Camel</td>
<td></td>
</tr>
<tr>
<td>12-17</td>
<td>27.4 (18.7, 36.2)</td>
</tr>
<tr>
<td>18-25</td>
<td>13.1 (10.2, 16.1)</td>
</tr>
<tr>
<td>26-34</td>
<td>11.7 (4.4, 19.1)</td>
</tr>
<tr>
<td>≥35</td>
<td>6.4 (1.6, 11.2)</td>
</tr>
</tbody>
</table>

Note. CI = confidence interval.
Source. Data from the National Survey on Drug Use and Health.©
additives such as menthol should be included in that regulation.

About the Authors
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Contributors
J. M. Kreslake, G. F. Wayne, and G. N. Connolly originated and designed the project. J. M. Kreslake collected and analyzed data from internal tobacco industry documents, coordinated laboratory analysis, and conducted the analysis on the National Survey on Drug Use and Health. H. R. Alpert provided data on magazine advertising expenditures. J. M. Kreslake and G. F. Wayne wrote the article, with significant written contributions by H. K. Koh and G. N. Connolly.

Acknowledgments
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Human Participant Protection
No protocol approval was needed for this study because the survey data and tobacco documents analyzed are publicly available.

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Mentholated Cigarette Use among Multiphasic Examinees, 1979–86

Stephen Sidney, MD, Irene Tekawa, MS, and Gary D. Friedman, MD

Abstract: Mentholated cigarette use was studied in relation to age and race in 29,037 current smokers who were Kaiser Permanente Medical Care Program members. The percentages of mentholated cigarette users were much higher in Blacks and Asians than in Whites, especially in the younger age groups. A marked inverse relationship between mentholated cigarette use and age was present in Blacks and Asians; mentholated cigarette use showed little difference with age in Whites. (Am J Public Health 1989; 79:1415–1416.)

Introduction

For a prospective cohort study to determine the health effects of smoking low-yield cigarettes, information was collected from 1979 to 1986 about the smoking habits of members of Kaiser Permanente Medical Care Program who participated in multiphasic health check-ups. Data from this study regarding mentholated cigarette use were analyzed for this report to determine whether previous reports of greater mentholated cigarette use in Blacks would be confirmed in our study population and to study age trends.1,2 Data regarding Asians are included in this report because of the substantial number of Asian smokers in the study population.

Methods

An automated multiphasic health checkup has been offered since 1964 to about 25,000 persons per year at the Kaiser Permanente Medical Care Program medical centers in Oakland and San Francisco.3 Starting in July 1979, examinees were asked to complete a supplementary questionnaire that explored their smoking habits in detail.4 In mid-1980 the check-up was discontinued at the San Francisco facility. By the end of 1986, the questionnaire had been completed by 114,934 examinees (approximately 86 percent of the examinees), of whom 31,428 (27.3 percent) were current smokers. Information on whether or not the cigarettes were mentholated was available for 92 percent of the current smokers. The tar yield was obtained from Federal Trade Commission estimates for each brand and type of cigarette.

If subjects had more than one check-up, only the first was included in this analysis. Age-adjusted proportions of mentholated cigarette users were obtained by the direct method, with the age distribution of the entire study population used as the standard. Mentholated cigarette use habits were examined in the 29,037 current smokers ages 15–79 years of Black, White, or Asian race.

Results

The sex, race, and age distribution of the current smokers is shown in Table 1. The percentage of mentholated cigarette use was higher in women than in men in all age groups for Blacks and Whites, and in most age groups for Asians (Figure 1). There was a marked inverse relationship between age and mentholated cigarette use in Blacks and in Asians, while there was relatively little difference in mentholated cigarette use with age in Whites. Blacks had the highest age-adjusted proportion of mentholated cigarette users (55.5 percent for females, 49.9 percent for males), Asians the second highest (47.9 percent, females, 35.7 percent, males), and Whites the lowest (27.1 percent, females, 18.1 percent, males).

The mean number of cigarettes smoked per day (adjusted for age, race, and sex) was slightly lower in mentholated than in nonmentholated users: 16.2 versus 17.1; 95% confidence interval of the difference = −1.2, −0.7. Mentholated cigarette users were similar to nonmentholated users in their reports of how often they inhaled, depth of inhalation, and how much of the cigarette they smoked. Although the mean tar yield of mentholated cigarettes was lower than that of nonmentholated cigarettes for both Blacks (15.5 mg vs 16.0 mg) and Whites (13.8 mg vs 14.0 mg), the mean tar yield of cigarettes smoked by Blacks (adjusted for age and sex) was greater than that of Whites (15.9 mg vs 14.1 mg, 95% CI of the difference 1.7, 2.0).

The switching patterns between mentholated and nonmentholated brands were examined in the 1,688 Black smokers under the age of 40 years for whom follow-up information regarding smoking habits was obtained by a mailed questionnaire (mean interval between baseline questionnaire and follow-up was 4.5 years). Follow-up information was obtained on a slightly greater proportion of nonmentholated than mentholated cigarette users (32 vs 28 percent). The percentage of quitters was slightly higher in nonmentholated users than in mentholated users (17.5 vs 15.4 percent), while the percentage of switchers (from nonmentholated to mentholated or vice-versa) was much higher in the nonmentholated users (14.6 vs 3.6 percent). Using a proportional hazards model to adjust for age and sex and to account for varying length of follow-up, nonmentholated users were 4.2 times more likely to switch than mentholated users (95% CI 2.8, 6.4), while quitting was equally likely in both groups.

Discussion

As others have reported, we found a much higher proportion of mentholated cigarette use in Black smokers than in White smokers. There is a very strong inverse relationship between age and mentholated cigarette use in Blacks. The data suggest that

<table>
<thead>
<tr>
<th>TABLE 1—Number of Current Cigarette Smokers by Age, Sex, and Race</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Black</td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>Asian</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Black</td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>Asian</td>
</tr>
</tbody>
</table>

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the steep decline in the proportion of mentholated cigarette users with age in Blacks can be explained predominantly as a cohort effect, since the findings regarding switching from cigarettes of one mentholation status to another in this study suggest that the prevalence of mentholated cigarette use increases over time in younger Black smokers.

There are few data on the health effects of mentholated cigarettes. A recent case-control of esophageal cancer showed no significant change in risk due to mentholated cigarette use.3 Our findings have potentially important implications for research into the health effects of mentholated cigarettes. The rates of some smoking-related cancers (e.g., esophagus, lung) are more common in Blacks, at least in part because Blacks are more likely to be smokers.4 A theoretical basis for a causal relationship between mentholation and cancer exists in that menthol combustion produces carcinogenic compounds such as benzo[a]pyrenes.5 It has also been hypothesized that the cooling sensation due to menthol may allow deeper, prolonged inhalation of cigarette smoke, thereby increasing the effective yield of tar and other toxic chemicals from the cigarette.6 This study did not show self-reported differences in inhalation habits between Blacks and Whites, but that may well be due to the anesthetizing effects of menthol.

If mentholation does cause cancer, it may contribute substantially to the excess incidence of certain smoking-related cancers in Blacks relative to Whites. A potential consequence of the very large differences in the prevalence of mentholated cigarette use in younger Blacks relative to Whites would be a widening of the difference between Blacks and Whites of these incidence rates in the future, when younger Blacks reach the higher risk age range for cancer.

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REFERENCES


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State-Specific Progress Toward the 1990 Objective for the Nation for Cigarette Smoking Prevalence

Patrick L. Remington, MD, MPH, Thomas E. Novotny, MD, David F. Williamson, MS, PhD, and Robert F. Anda, MD, MS

Abstract: We predicted the smoking prevalences for 1990 for each state in the US, assuming that the decline in each state from 1985–1990 would be the same as the decline in the US from 1965–1985. In 1985, only three states had smoking prevalences less than 25 percent. Based upon the observed decline in smoking in the US from 1965–1985 of 0.5 percent per year, we predict that only seven states will have smoking prevalences less than 25 percent by 1990. States need to consider current smoking prevalence and achievable rates of decline when setting objectives for 1990 and beyond. (Am J Public Health 1989; 79:1416–1419.)

Introduction

As part of its 1990 Health Objectives for the Nation, the US Public Health Service has established a goal that by 1990 the proportion of adults who smoke should be reduced to less than 25 percent.1 A recently published midcourse review indicated that this objective likely will be met.2 Despite the apparent success at the national level, however, the variation in the prevalence of smoking from state to state3 suggests that a prevalence of smoking of less than 25 percent may not be an achievable objective for all states. To address this issue, we predicted 1990 smoking prevalences for all 50 states and the District of Columbia by applying a range of estimates of decline in smoking prevalence to the observed state-specific smoking prevalences for 1985.

Methods

The state-specific smoking prevalence estimates were based on data obtained in September 1985 from the Current

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Lower quit rates among African American and Latino menthol cigarette smokers at a tobacco treatment clinic

K. K. Gandhi,1,2 J. Foulds,1,2 M. B. Steinberg,1,2 S.-E. Lu,3 J. M. Williams1,2

SUMMARY

Background: Lower rates of smoking cessation and higher rates of lung cancer in African American (AA) smokers may be linked to their preference for mentholated cigarettes. Aim: This study assessed the relationship between menthol smoking, race/ethnicity and smoking cessation among a diverse cohort of 1688 patients attending a specialist smoking cessation service. Results: 46% of the patients smoked mentholated cigarettes, but significantly more AA (81%) and Latino (66%) patients than Whites (32%) smoked menthols. AA and Latino menthol smokers smoked significantly fewer cigarettes per day (CPD) than non-menthol smokers (15.7 vs. 20.3, for AA, and 17.0 vs. 22.1, for Latinos), with no differences among White menthol and non-menthol smokers. At 4-week follow up, AA, Latino and White non-menthol smokers had similar quit rates (54%, 50% and 50% respectively). In contrast, among menthol smokers, AA and Latinos had lower quit rates (30% and 23% respectively) compared with Whites (43%, p < 0.001). AA and Latino menthol smokers had significantly lower odds of quitting [odds ratio (OR) = 0.48; 95% CI = 0.25, 0.9].

Conclusions: Despite smoking fewer CPD, AA and Latino menthol smokers experience reduced success in quitting as compared with non-menthol smokers within the same ethnic/racial groups.

Introduction

Menthol added to cigarettes may influence nicotine dependence and health risks via increased nicotine and smoke intake (1–4), or via interference with nicotine metabolism (5,6). Lower short-term quit rates and higher relapse rates have been reported in some studies of menthol smokers and minority smokers who preferentially use menthol cigarettes (2,3,7–10), whereas others have not found this effect (11,12). A recent study found that African American (AA) light smokers [≤ 10 cigarettes per day (CPD)] who smoked mentholated cigarettes had significantly lower quit rates as compared with non-menthol smokers (13).

Few studies have examined the influence of menthol on 6-month smoking cessation outcomes among minority smokers in treatment and the inconsistent results in existing studies remain unexplained. It has been previously found that racial/ethnic minorities are less likely to participate in smoking cessation programs and to receive counselling from healthcare providers (14). This study aimed to provide a detailed analysis of the characteristics of menthol smokers seeking treatment and to assess the relationship between menthol smoking, race/ethnicity, socioeconomic status (SES) and smoking cessation among a diverse cohort of patients attending a smoking cessation service.

Methods

Study population

This is a retrospective cohort analysis of 1688 consecutive patients who set a quit date and attended a specialist smoking cessation treatment service based in an urban setting.

What’s known

Studies have found lower short-term quit rates or higher relapse rates among menthol smokers or groups with a preference for menthol cigarettes. However, no previous studies have documented significantly lower long-term (i.e. 6 months) quit rates among menthol smokers while controlling for potential confounding variables. This study examined data from 1688 consecutive smokers who set a quit date and attended a specialist smoking cessation treatment service based in an urban setting.

What’s new

We found significantly lower short-term (4 weeks) and long-term (i.e. 6 month) quit rates among certain subgroups of menthol smokers while controlling for potential confounding variables. Future studies of menthol effects on health and smoking cessation outcomes should also examine the socioeconomic context in which the study takes place.

Disclosures

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Following an initial assessment, an individualised treatment plan was established, and target quit-date set, usually within 1–2 weeks of assessment. Patients were encouraged, but not required, to attend a closed group treatment (16) and use Food and Drug Administration (FDA)-approved tobacco-dependence treatment medications. The clinic was able to provide counselling and nicotine replacement to patients at no cost. The average number of appointments attended was 4.5 per patient, and 88% of patients used at least one FDA-approved tobacco treatment medication.

Measures
Data collected during the initial assessment included demographic information, tobacco use history, a brief medical history and a measure of exhaled carbon monoxide (CO) using an EC-50 Smokerlyzer (Bedfont Scientific, Williamsburg, VA, USA). Current employment status and level of education completed were recorded as indicators of SES. Data collected at the 4-week and 6-month follow-up visits included tobacco use over the past 7 days, amount smoked in the past 7 days, days since last tobacco use, number of contacts with the clinic and use of medications for smoking cessation. The primary outcome was self-reported 7-day point prevalence abstinence rate (answering ‘no’ to the question, ‘Have you used any tobacco in the past 7 days?’). Exhaled CO (in ppm) was measured at all appointments. Patients who were lost to follow up at the 4-week and 6-month follow-up visits were included in analyses and counted as continuing smokers, as is standard practice in smoking cessation research (17).

Analysis
Baseline variables were compared between menthol and non-menthol smokers using Chi-square (Χ²) tests (for categorical variables) and two-sample t-tests (for continuous variables). Logistic regression models were built to study the 4-week and 6-month cessation outcomes, using the backward stepwise procedure, where all variables were initially entered into the model and removal of variables from the model occurred one at a time (least significant first), with the criterion for eliminating set at p ≥ 0.10. A significant two-way interaction between smoking mentholated cigarettes and race/ethnicity (p = 0.04) was found. We subsequently conducted statistical analyses separately for each race/ethnicity subgroup, excluding the subgroup ‘others’ (defined in Table 1) from all further analyses because of a small size (n = 79). Mantel–Haenzel estimates were used for obtaining crude odds ratios (ORs) for the 4-week and 6-month outcome, and logistic regression was used to adjust for covariates as described above. All statistical analyses were performed using SPSS 16.0 (Chicago, IL, USA) and SAS 9.1 (Cary, NC, USA).

Results
Participants
The baseline characteristics of the participants are described in Table 1 by type of cigarettes smoked (menthol or non-menthol). Forty-six per cent of the patients were menthol cigarette smokers, with a higher proportion of AA and Latino smokers smoking menthols as compared with Whites (non-Latino). A higher proportion of women smoked menthol cigarettes than men. Menthol smokers were also younger, smoked fewer CPD, and they were less educated and less likely to be married, have health insurance or have a full-time job. More menthol smokers smoked their first cigarette within 5 min of awakening in the morning and reported awakening at night to smoke a cigarette as compared with non-menthol smokers.

Biochemical verification and follow-up rates
Seventy-four per cent (1242) of patients completed a 4-week follow up and 58.2% (982) completed a 6-month follow up. At 4-week follow up, 499 (40%) of those followed up were seen in person and the rest were contacted by phone. Among these patients seen in person at the follow-up, 376 (75%) reported no tobacco use for at least the previous 7 days, and of those, 374 (99.4%) had a measured exhaled CO of < 10 ppm (average = 1.4 ppm). All of those who attended the 6-month follow up in person and claimed to be abstinent had a measured exhaled CO of < 10 ppm (27/27), with an average of 1.1 ppm. All of those claiming abstinence at a telephone follow up provided a low (< 10 ppm) exhaled CO sample at a prior clinic visit (typically during the first 4 weeks) when CO was measured.

Cigarette consumption by type of cigarette smoked (menthol vs. non-menthol) among different race/ethnicity subgroups
White smokers smoked more CPD than other groups (23.3 vs. 17.2, p < 0.001), and menthol cigarette smokers smoked fewer CPD than non-menthol smokers, among AAs (15.7 vs. 20.3, p < 0.001) and Latinos (17 vs. 22.1, p = 0.017) but not among Whites (22.5 vs. 23.7, p = 0.094) (Table 2).

Smoking cessation rates among menthol and non-menthol smokers by race/ethnicity
At 4-week follow up, AA menthol smokers showed a lower quit rate as compared with AA non-menthol smokers, among AAs (15.7 vs. 20.3, p < 0.001) and Latinos (17 vs. 22.1, p = 0.017) but not among Whites (22.5 vs. 23.7, p = 0.094) (Table 2).
Table 1 Characteristics of menthol and non-menthol cigarette smokers in the Clinic from 2001 to 2005*†

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Current cigarette type</th>
<th></th>
<th></th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mentholated</td>
<td>Non-mentholated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total N</td>
<td>Count (%)</td>
<td>Count (%)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Age in years</td>
<td>38.81 (13.2)</td>
<td>43.79 (13.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age first used tobacco</td>
<td>14.87 (4.0)</td>
<td>15.21 (4.16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cigarettes per day</td>
<td>18.96 (10.1)</td>
<td>23.12 (11.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Female</td>
<td>488 (62.7)</td>
<td>493 (54.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>290 (37.3)</td>
<td>417 (45.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whites</td>
<td>348 (44.7)</td>
<td>738 (81.1)</td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>African Americans</td>
<td>302 (38.8)</td>
<td>72 (7.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>99 (12.7)</td>
<td>50 (5.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (Asians, Pacific Islanders,</td>
<td>29 (3.7)</td>
<td>50 (5.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>native Americans, mixed race,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>declined to answer</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Education (N = 1687)</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>&lt; HS, HS Diploma</td>
<td>358 (46.0)</td>
<td>281 (30.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associate degree</td>
<td>304 (39.1)</td>
<td>348 (38.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bachelors degree or higher</td>
<td>116 (14.9)</td>
<td>280 (30.8)</td>
<td></td>
<td></td>
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<tr>
<td>Marital status (N = 1684)</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Married or living with someone</td>
<td>247 (31.8)</td>
<td>390 (43.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separated, divorced or widowed</td>
<td>192 (24.7)</td>
<td>241 (26.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never married</td>
<td>337 (43.4)</td>
<td>277 (30.5)</td>
<td></td>
<td></td>
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<tr>
<td>Employment status (N = 1682)</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Full-time employed</td>
<td>319 (41.2)</td>
<td>443 (48.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time student</td>
<td>91 (11.7)</td>
<td>73 (8.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sick or disabled</td>
<td>91 (11.7)</td>
<td>106 (11.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td>155 (20.0)</td>
<td>114 (12.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (include homemaker,</td>
<td>119 (15.4)</td>
<td>171 (18.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>part-time employed/student, retired</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of insurance (N = 1665)</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Private insurance</td>
<td>387 (50.4)</td>
<td>569 (63.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicare</td>
<td>59 (7.7)</td>
<td>98 (10.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicaid</td>
<td>153 (19.9)</td>
<td>85 (9.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No insurance</td>
<td>169 (22.0)</td>
<td>145 (16.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to use first cigarette after waking up</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N = 1664)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within 5 min</td>
<td>187 (24.3)</td>
<td>178 (19.9)</td>
<td></td>
<td>0.021</td>
</tr>
<tr>
<td>6–30 min</td>
<td>435 (56.6)</td>
<td>566 (63.2)</td>
<td></td>
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<tr>
<td>After 30 min</td>
<td>146 (19.0)</td>
<td>152 (17.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awaken at night to smoke (N = 1673)</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>No</td>
<td>343 (44.7)</td>
<td>499 (55.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>425 (55.3)</td>
<td>406 (44.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior attempts to quit (N = 1641)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 attempts</td>
<td>80 (10.6)</td>
<td>74 (8.4)</td>
<td></td>
<td>0.010</td>
</tr>
<tr>
<td>1–5 attempts</td>
<td>532 (70.2)</td>
<td>590 (66.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6–20 attempts</td>
<td>133 (17.5)</td>
<td>186 (21.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 20 attempts</td>
<td>13 (1.70)</td>
<td>33 (3.7)</td>
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</tbody>
</table>
Reduced unadjusted quit rates were also seen among White and Latino menthol smokers (43% vs. 50%, p = 0.031; 23% vs. 50%, p = 0.001 respectively). This trend was very similar at 6-month follow up, with AA and Latino menthol smokers obtaining lower quit rates (18% vs. 36%, p = 0.001 for AA; 11% vs. 28%, p = 0.009 for Latinos) (Figure 1).

Logistic regression analyses to examine abstinence rates at 4 weeks among menthol and non-menthol smokers resulted in a significant two-way interaction between race/ethnicity and menthol ($\chi^2[3] = 8.095$, ***p < 0.001; **p < 0.01; *p < 0.05)
We therefore analysed the role of mentholation on abstinence for each race/ethnicity group separately. Table 3 shows the crude and adjusted ORs for each race/ethnicity group separately. At 4 weeks, AA and Latino menthol smokers had significantly lower unadjusted and adjusted odds of quitting as compared with non-menthol smokers. At 6 months, the pattern was similar and the quit rate remained significantly lower for menthol smokers vs. non-menthol smokers of AA origin, even after adjusting for all other variables that were significantly related to outcome (e.g., gender, education and employment status).

Further sub-analysis indicated that the strength of the ‘menthol effect’ was related to SES, even within different ethnic/racial groups. Table 3 shows the crude and adjusted ORs for each race/ethnicity group separately. At 4 weeks, AA and Latino menthol smokers had significantly lower unadjusted and adjusted odds of quitting as compared with non-menthol smokers. At 6 months, the pattern was similar and the quit rate remained significantly lower for menthol smokers vs. non-menthol smokers of AA origin, even after adjusting for all other variables that were significantly related to outcome (e.g., gender, education and employment status).

Table 3 Adjusted and unadjusted odds ratios for abstinence at 4 weeks and 6 months among menthol and non-menthol cigarette smokers*

<table>
<thead>
<tr>
<th></th>
<th>All (N = 1609)</th>
<th>White</th>
<th></th>
<th>African American</th>
<th></th>
<th>Hispanic/Latino</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unadjusted</td>
<td>Adjusted</td>
<td>Unadjusted</td>
<td>Adjusted</td>
<td>Unadjusted</td>
<td>Adjusted</td>
</tr>
<tr>
<td>4-week</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Menthol vs. non-menthol</td>
<td>0.75**</td>
<td>0.96</td>
<td>0.34**</td>
<td>0.32**</td>
<td>0.30**</td>
<td>0.43**</td>
<td></td>
</tr>
<tr>
<td>OR (95% CI)</td>
<td>(0.58, 0.97)</td>
<td>(0.72, 1.20)</td>
<td>(0.17, 0.69)</td>
<td>(0.16, 0.62)</td>
<td>(0.14, 0.62)</td>
<td>(0.1, 0.9)</td>
<td></td>
</tr>
<tr>
<td>6-months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Menthol vs. non-menthol</td>
<td>0.88</td>
<td>1.0</td>
<td>0.40**</td>
<td>0.48**</td>
<td>0.32**</td>
<td>0.64</td>
<td></td>
</tr>
<tr>
<td>OR (95% CI)</td>
<td>(0.66, 1.10)</td>
<td>(0.8, 1.40)</td>
<td>(0.23, 0.70)</td>
<td>(0.25, 0.9)</td>
<td>(0.13, 0.77)</td>
<td>(0.2, 1.80)</td>
<td></td>
</tr>
</tbody>
</table>

*Variables entered into the initial model – age in years, education, gender, employment status, type of insurance, cigarettes per day, age smoked for first time, awaken at night to smoke, time to use first cigarette of day, previous attempts to quit smoking, use of mentholated cigarettes and the presence of a disease caused or aggravated by smoking. **Significance (p < 0.05).

Figure 2 Unadjusted 4-week abstinence rates among employed and unemployed smokers by race and mentholation of cigarettes smoked. Error bars represent standard error bars.

Figure 2 Unadjusted 4-week abstinence rates among employed and unemployed smokers by race and mentholation of cigarettes smoked. Error bars represent standard error bars.

p = 0.04). We therefore analysed the role of mentholation on abstinence for each race/ethnicity group separately. Table 3 shows the crude and adjusted ORs for each race/ethnicity group separately. At 4 weeks, AA and Latino menthol smokers had significantly lower unadjusted and adjusted odds of quitting as compared with non-menthol smokers. At 6 months, the pattern was similar and the quit rate remained significantly lower for menthol smokers vs. non-menthol smokers of AA origin, even after adjusting for all other variables that were significantly related to outcome (e.g., gender, education and employment status).

Further sub-analysis indicated that the strength of the ‘menthol effect’ was related to SES, even within different ethnic/racial groups. Taking employment status as an example (unemployed vs. full-time employed), the difference between quit rates in menthol and non-menthol smokers was greater among those who were unemployed as compared with those who were employed. Among Whites, 4-week quit rates were identical for menthol and non-menthol smokers who were fully employed (56%), whereas among unemployed white smokers, the quit rate was non-significantly lower for menthol smokers (23% vs. 37%, $\chi^2[1] = 3.160$, p = 0.07). Similarly, the 4-week quit rate was significantly lower for menthol smokers than non-menthol smokers among unemployed AAs (16% vs. 43%, $\chi^2[1] = 4.38$, p = 0.03), but the effect of mentholation was not significant for full-time employed AAs (42% vs. 56%, p = 0.20) (Figure 2).

**Discussion**

This study found lower short-term (4-week follow-up) quit rates among AA and Latino menthol smokers as compared with non-menthol smokers within the same racial/ethnic subgroups. At 6-month follow up, the quit rate was significantly lower among AA menthol smokers as compared with AA non-menthol smokers, even after controlling for factors...
associated with cessation. Similar (but non-significant) results were observed among Latinos at 6-month follow up.

Our results also demonstrated that among different race/ethnicity subgroups, Whites smoked more CPD as compared with AA and Latino smokers, yet had higher quit rates, which is consistent with previous literature (9,18,19). In addition, AA and Latino menthol smokers smoked significantly fewer CPD as compared with non-menthol smokers, making their lower quit rates all the more surprising. In addition, about half the smokers in both groups reported awakening at night to smoke with menthol smokers having a significantly higher frequency as compared with non-menthol smokers. Our previous study identified awakening during the night to smoke as a very common behaviour among smokers seeking help to quit, and is an independent marker of nicotine dependence (7).

The 4-week and 6-month abstinence rates among different racial/ethnic groups demonstrated a trend towards lower quit rates among menthol smokers, with significantly poorer cessation outcome among AA and Latino menthol smokers. This is not the first study to report lower quit rates among menthol smokers, but the results have not been consistent across studies (2,7,9,11,20). Hyland et al. (11) evaluated quitting in the context of a community intervention trial, and concluded that use of mentholated cigarettes was not associated with quitting. This may be attributable to the inclusion of community smokers who did not try to quit and very few who engaged in treatment. Our study, like a recently published study reporting lower quit rates among menthol smokers, focused on smokers undertaking clinical tobacco dependence treatment. However, some clinical treatment studies (13,20) have failed to find an effect of menthol smoking on cessation. We suspect that the differences in outcomes across studies may relate to differences in sociodemographic characteristics of the participants (and possibly the relative cost of cigarettes) in these different studies. For example, in the Fu et al. (20) study, 77% of AA participants were aged over 50 years and therefore may be different with respect to socioeconomic factors when compared with younger AA smokers. Furthermore, we noticed that the effect of mentholation on smoking cessation was more marked in groups with markers of lower SES (e.g. unemployment) in our study. Mentholation has no relationship with quit rates among employed Whites, but for unemployed Whites, menthol smokers have lower quit rates at 4 weeks than non-menthol smokers. There is a similar pattern for the other racial/ethnic groups, and for other indices of SES such as insurance coverage and education (not shown).

Menthol smokers obtain higher levels of nicotine and nicotine metabolites than non-menthol smokers regardless of race (5,18). We have previously shown that menthol smokers obtained higher exhaled CO, blood nicotine and cotinine levels than non-menthol smokers (4), suggesting that they inhale more smoke per cigarette. This pattern of results leads us to hypothesise that the effects of menthol on smoking cessation (and possibly smoking-caused illnesses) may be more apparent in situations where the smoker has to reduce the cigarette consumption (e.g. because of high/rising cigarette prices, as in New Jersey). In such circumstances, unemployed or low-income smokers may compensate for the inability to afford to purchase many cigarettes by increasing their nicotine intake per cigarette by changing characteristics of their puffing behaviour. The menthol in the cigarette may facilitate increased inhalation of nicotine and other toxins per cigarette by cooling the otherwise harsh effect produced by larger or more frequent puffs. Other studies (21) have also noted that menthol smokers inhale more smoke per cigarette, particularly when their daily cigarette consumption is restricted (as it may be because of financial reasons in lower SES smokers). Larger nicotine and toxin intake per cigarette may result in greater addiction (and in turn difficulty quitting) and greater adverse health impact per cigarette.

Limitations of this study include a ‘real-world’ clinic patient (rather than research volunteer) follow-up rate at 6 months of 58%. We assumed those lost to follow up were still smoking, and this conservative assumption is unlikely to be a major cause of bias. Lack of biochemical verification of all self-reported abstainers is also a weakness, although we have biochemical evidence that supports the accuracy of self-reported abstinence earlier in treatment in this cohort. We also did not assess SES in a comprehensive fashion. Indicators such as employment status and education act as proxies for SES, but each has weaknesses and can be influenced by other demographic factors (e.g. age). Socioeconomic deprivation has been linked to higher nicotine and cotinine exposure per cigarette and lower quit rates in a previous study (22). Given that smoking cessation outcomes are closely associated with SES and potentially interact with the effects of menthol smoking, we recommend the use of a valid and reliable index of SES in future studies of this type (23,24). The results from this clinic may not be generalised to other tobacco treatment situations. Strengths of this study were a diverse cohort receiving state-of-the-art treatment that was mainly provided at no financial cost to the patients, and the collection of a comprehensive set of baseline data that could be used to control
for confounding in multivariate analyses. These results suggest that smokers of menthol cigarettes may be more nicotine dependent than smokers of regular cigarettes, with similar daily cigarette consumption. Other indices (such as awakening at night to smoke and time to use first cigarette of the day), may be better measures of dependence than daily cigarette consumption.

In conclusion, this study found that despite smoking fewer CPD, AAs and Latinos who smoke mentholated cigarettes have lower cessation rates than non-menthol smokers within the same ethnic/racial groups, even when receiving evidence-based treatment. This study adds to the evidence suggesting that menthol, rather than being a benign flavouring, alters the way the cigarette is smoked in a way that increases its addictiveness. Future studies of menthol effects on health and smoking cessation outcomes should also examine the socioeconomic context in which the study takes place and other factors that may restrict daily cigarette consumption.

Acknowledgements
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Author contributions

References


Menthol Cigarettes, Smoking Cessation, Atherosclerosis, and Pulmonary Function

The Coronary Artery Risk Development in Young Adults (CARDIA) Study

Mark J. Pletcher, MD, MPH; Benjamin J. Hulley; Thomas Houston, MD; Catarina I. Kiefe, MD, PhD; Neal Benowitz, MD; Stephen Sidney, MD, MPH

Background: African American smokers are more likely to experience tobacco-related morbidity and mortality than European American smokers, and higher rates of menthol cigarette smoking may contribute to these disparities.

Methods: We prospectively measured cumulative exposure to menthol and nonmenthol cigarettes and smoking cessation behavior (1985-2000), coronary calcification (2000), and 10-year change in pulmonary function (1985-1995) in African American and European American smokers recruited in 1985 for the Coronary Artery Risk Development in Young Adults Study.

Results: We identified 1535 smokers in 1985 (972 men; 663 women): 89% of African Americans preferred menthol vs 29% of European Americans (P < .001). After adjustment for ethnicity, demographics, and social factors, we found nonsignificant trends in menthol smokers toward lower cessation (odds ratio [OR], 0.71; 95% confidence interval [CI], 0.49-1.02; P = .06) and recent quit attempt (OR, 0.77; 95% CI, 0.56-1.06; P = .11) rates and a significant increase in the risk of relapse (OR, 1.89; 95% CI, 1.17-3.05; P = .009). Per pack-year of exposure, however, we found no differences from menthol in tobacco-related coronary calcification (adjusted OR, 1.27; 95% CI, 1.01-1.60 for menthol cigarettes and 1.33; 95% CI, 1.06-1.68 for nonmenthol cigarettes per 10-pack-year increase; P = .75 for comparison) or 10-year pulmonary function decline (adjusted excess decline in forced expiratory volume in 1 second, 84 mL; 95% CI, 32-137 for menthol cigarettes and 80 mL; 95% CI, 30-129 for nonmenthol cigarettes, per 10-pack-year increase; P = .88 for comparison).

Conclusion: Menthol and nonmenthol cigarettes seem to be equally harmful per cigarette smoked in terms of atherosclerosis and pulmonary function decline, but menthol cigarettes may be harder to quit smoking.

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provides a unique opportunity to evaluate the long-term effects of smoking menthol cigarettes. The CARDIA Study has collected detailed longitudinal data on smoking habits during 15 years of follow-up in a large cohort of young African American and European American men and women in 4 US cities. The CARDIA Study also measured pulmonary function directly on 2 occasions 10 years apart and coronary calcification (a marker for atherosclerosis) at the year 15 examination. To determine whether menthol cigarettes are harder to quit smoking or more harmful than nonmenthol cigarettes, we measured the association between menthol cigarette exposure and smoking cessation behavior, coronary calcification, and pulmonary function decline in CARDIA smokers.

**METHODS**

### STUDY DESIGN AND SAMPLE

The CARDIA Study is a longitudinal study of risk factors for coronary artery disease in 5115 African American and European American women and men aged 18 to 30 years and healthy at the time of enrollment in 1985. After informed consent was obtained from participants and approval was provided by the institutional review board at each site (Oakland, Chicago, Ill; Minneapolis, Minn; and Birmingham), participants underwent a baseline examination and then follow-up examinations at years 2, 5, 7, 10, and 15, with 74% retention of the surviving cohort at year 15 (2000). Details of the study design, recruitment, and procedures have been published elsewhere. For this investigation, we identified CARDIA smokers and measured associations between menthol/nonmenthol exposure and smoking cessation behaviors during follow-up, the prevalence of coronary calcification in 2000, and changes in pulmonary function test results between 1985 and 1995.

### MENTHOL PREFERENCE AND EXPOSURE

Current smoking, number of cigarettes smoked per day, and menthol preference (“Is [your current brand of cigarettes] mentholated or nonmentholated?”) were assessed at each CARDIA examination. These data, along with data on past years of smoking at baseline, were used to estimate cumulative exposure to cigarettes in terms of pack-years. We partitioned pack-year exposure into menthol pack-years and nonmenthol pack-years, assuming that participants smoked only menthol or nonmenthol cigarettes at any one time.

### OUTCOME MEASURES

The following smoking cessation behaviors were assessed at each examination: not currently smoking, recent quit attempts (“Have you [tried, made any attempts] to quit smoking in the past [2, 3, 5] years?”), and cessation if recent quit attempt (successful smoking cessation among participants who reported a recent quit attempt). We also examined longitudinal patterns of cessation behavior, including sustained smoking cessation (no current smoking the past 2 times they were examined in The CARDIA Study) and documented relapse (baseline smokers who reported no current smoking at a subsequent examination and then current smoking the final time they were examined).

Coronary calcification was measured in consenting CARDIA participants in 2000. Participants underwent computed tomography scanning using an electron beam scanner (GE Imatron C-150; GE Healthcare, Chalfont St Giles, England) or a multidetector scanner (GE LightSpeed; GE Healthcare; or Siemens VZ series; Siemens AG, Munich, Germany). A committee of expert cardiologists, radiologists, and a physicist developed a scanning protocol to standardize scan acquisition across these slightly different technologies. Two scans were obtained for each participant using a hydroxyapatite model for standardization. Scans were electrocardiographically gated at 80% (GE Imatron) or 50% (GE LightSpeed and Siemens VZ) of the R-R interval, with an image thickness of 3 (GE Imatron) or 2.5 (GE LightSpeed and Siemens VZ) mm, and completed within 100 (GE Imatron), 520 (GE LightSpeed), or 360 (Siemens VZ) milliseconds. Specialized image-processing software was used to identify all potential calcific foci composed of at least 4 adjacent pixels (an area \( \geq 1.87 \text{ mm}^2 \)) with a density greater than 130 Hounsfield units. Each potential focus was then confirmed or deleted by a blinded cardiovascular radiologist based on knowledge of coronary artery anatomy, and the presence or absence of coronary calcium was determined. Between- and within-reader reproducibility was high. Pulmonary function testing was performed in 1985 and in 1995 using a Collins Survey B-L water-sealed spirometer and an Eagle II microprocessor (Warren E. Collins Inc, Braintree, Mass). Trained technicians performed frequent calibrations of the instruments and coached participants through 3 to 5 trials of forced expiration to obtain 3 trials meeting minimal quality standards (no clear errors in execution) and showing reproducibility of forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1) within 5% and 100 ml, respectively. Among the multiple expiratory trials recorded for each participant, we used maximum FEV1, maximum FVC, and maximum midexpiratory flow (MMEF, defined as the average flow between the points at which 25% and 75% of the total FVC has been expired) for analyses per CARDIA protocol. The primary outcome was the change in FEV1 between the 1985 and 1995 examinations; secondary analyses examined change in FVC and MMEF.

### OTHER COVARIATES

Sex, ethnicity, and date of birth were recorded at baseline. Educational grade attained, family income, current alcohol consumption (number of drinks per week), physical activity level (Likert-type scale), and marital, employment, and insurance status were measured by means of self-report at each examination (except income is not available from the baseline examination). Glucose intolerance (defined by the use of diabetes mellitus medication or by a fasting blood glucose level >110 mg/dL [>6.1 mmol/L]), systolic and diastolic blood pressure, plasma levels of low- and high-density lipoprotein cholesterol and triglycerides, and body mass index (calculated as weight in kilograms divided by the square of height in meters) were measured directly.

### STATISTICAL ANALYSIS

For the first 3 cessation behavior outcomes (not currently smoking, recent quit attempt, and cessation if recent quit attempt), we performed repeated-measures analyses using logistic models that included each examination of each participant as a separate observation, and we used robust estimates of standard errors to take into account clustering by participant. For the longitudinal cessation pattern analyses (sustained smoking cessation and documented relapse outcomes), we used logistic regression with 1 observation per participant. We used logistic regression to assess the independent contributions of menthol and nonmenthol exposure to the risk of having coronary calcium. We simultaneously estimated odds ratios (ORs) for each additional 10-pack-year increase in cumu-
lative lifetime exposure to menthol and nonmenthol cigarettes. To compare the putative effects of menthol vs nonmenthol cigarettes, we used Wald tests of the null hypothesis that the coefficients for menthol and nonmenthol exposure were equal.

For the pulmonary function analysis, we used linear regression to assess the independent contributions of menthol and nonmenthol exposure to change in pulmonary function (FEV1, FVC, and MMEF) in the 10 years between 1985 and 1995. We simultaneously estimated coefficients for each additional 10-pack-year increase in the interval exposure (during the same 10 years) to menthol and nonmenthol cigarettes. To compare the putative effects of menthol vs nonmenthol cigarettes, we used Wald tests of the null hypothesis that the coefficients for menthol and nonmenthol exposure were equal. For each regression, we present a series of models sequentially adjusting for demographic and socioeconomic factors, habits, and potential mediators related to each outcome.

Of the original 5115 CARDIA participants, 74% reported for the 2000 examination. To take into account differential dropout we estimated visit-specific probabilities of participating in any given examination using smoking status, age, sex, ethnicity, education, income, and marital status measured at the previous examination. We used these probabilities, inverted, as probability weights in all the models except the sustained smoking progression, we present a series of models sequentially adjusting for demographic and socioeconomic factors, habits, and potential mediators related to each outcome.

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STUDY SAMPLE AND MENTHOL PREFERENCE

Of 5115 CARDIA participants enrolled in 1985, 1544 reported current smoking; 972 current smokers (63%) preferred menthol cigarettes and 563 (36%) nonmenthol. Menthol preference was unknown for 9 smokers (0.6%). Menthol preference was stable (11%-12% switched preference during follow-up) and was strongly related to ethnicity, with 89% of African Americans preferring menthol compared with only 29% of European Americans (P<.001). Baseline menthol preference was also associated with younger age, female sex, lower educational level, unemployment, lower alcohol intake, higher body mass index, and fewer cigarettes smoked per day (Table 1).

SMOKING CESSATION BEHAVIOR

Baseline menthol smokers were more likely to still be smoking during follow-up examinations than baseline nonmenthol smokers (69% vs 54% in 2000; P<.001). However, stratification by ethnicity attenuates this association, as African Americans are more likely to smoke menthol cigarettes and less likely to quit smoking during follow-up (Figure 1). Before adjustment, menthol smokers were less likely to be noncurrent smokers at follow-up examinations (OR, 0.61; 95% confidence interval [CI], 0.49-0.76); after adjustment, the association is weaker (OR, 0.90; 95% CI, 0.68-1.19) (Table 2).

Among smokers who tried to quit, menthol seemed unrelated to quitting (adjusted OR, 1.00; 95% CI, 0.71-1.42), but menthol was associated with a lower likelihood of trying to quit in the first place (adjusted OR, 0.77; 95% CI, 0.56-1.06; P=.11). In longitudinal analyses, menthol smokers were less likely to exhibit sustained smoking cessation (adjusted OR, 0.71; 95% CI, 0.49-1.02; P=.06) and nearly twice as likely to relapse after an examination during which they reported no current smoking (adjusted OR, 1.89; 95% CI, 1.17-3.05; P=.009) (Table 2). Results were similar among African Americans and European Americans and after additional adjustment for cigarettes smoked daily at baseline.

CORONARY CALCIFICATION

The prevalence of coronary calcification (14% overall in these smokers) was strongly associated with cumulative exposure to tobacco smoke, but the association seemed to be equivalent among baseline menthol smokers and nonmenthol smokers (Figure 2). Logistic models showed no difference in the associations between menthol and nonmenthol exposure and coronary calcification before or after adjustment for demographics, socioeconomic status, or other habits. Further adjustment for physiologic mediators of coronary disease led to attenuation in each smoking– coronary calcium association consistent with partial mediation by those measured factors (Table 3). Results were similar in African Americans and European Americans.

PULMONARY FUNCTION DECLINE

The FEV1 declined by an average of 180 mL between 1985 and 1995 in CARDIA smokers, and the magnitude of decline was strongly associated with interval exposure to menthol and nonmenthol cigarettes.
baclofensmoke among menthol and nonmenthol smokers (Figure 3 and Table 4). Regression models showed no detectable difference in the magnitude of association between menthol- and nonmenthol-associated decline in FEV1, FVC, or MMEF before or after adjustment. European Americans tended to have larger declines associated with menthol cigarettes ($P = .05$ for FEV1), whereas African Americans showed the opposite tendency ($P = .35$ for FEV1).

In this longitudinal analysis of smoking behavior across 15 years, we looked for differences between menthol and nonmenthol smokers in smoking cessation behavior, coronary calcification, and pulmonary function decline. We found some evidence that menthol smokers are less likely to attempt cessation, more likely to relapse after successfully quitting, and less likely to report sustained smok-
Smoking is known to be a major risk factor for coronary artery disease, and the present findings demonstrate a strong dose-response relationship with coronary calcification, a marker of atherosclerosis. Per cigarette, however, menthol and nonmenthol exposure seem to be equally harmful. Previous studies of menthol vs nonmenthol cigarette smoking show no effects of mentholation on blood pressure or heart rate, although one study showed a small difference in heart rate associated with menthol candy/tea ingestion. We are unaware of any previous studies of menthol and atherosclerosis. Although the present study does not rule out a difference in thrombosis or other nonatherosclerotic mechanisms leading to coronary events, we found no evidence that it plays a role in coronary heart disease disparities between African Americans and European Americans.

Pulmonary function decline and obstructive lung disease are also known to be strongly associated with tobacco smoke exposure, and the present study demonstrated this dose-response relationship. Per cigarette, however, menthol and nonmenthol exposure again seem to be equally harmful. There are few published studies of menthol and pulmonary function and no previous longitudinal studies of menthol and pulmonary function in humans, to our knowledge. One tobacco industry–funded study of rats exposed to menthol and nonmenthol cigarette smoke for 13 weeks showed histopathologic changes consistent with smoking that seemed to be equivalent between menthol- and nonmenthol-exposed rats. Another industry document hints at “an adverse effect on the respiratory function” associated with mentholation of cigarettes without providing details, but several small trials of menthol vapor inhalation (not in a cigarette) suggest improved mucociliary clearance, less airway reactivity, fewer wheezing episodes and less need for bronchodilator dosing, bronchodilation, and “easier breathing” among patients with asthma, chronic obstructive lung disease, or acute upper respiratory tract illness. Menthol seems unlikely to be a contributor to the pulmonary function decline associated with tobacco smoke exposure.

This study is limited somewhat by sample size, particularly when we attempt to tease apart the effects of ethnicity and menthol preference. The limited numbers of European American menthol smokers (n = 189) and African American nonmenthol smokers (n = 95) make ethnicity-specific analyses and (to a lesser extent) adjusted analyses somewhat imprecise. Inherent random variation and measurement error also limit precision and bias measures of association toward the null so that we could have missed small differences between menthol and nonmenthol cigarettes. Loss to follow-up in this cohort may theoretically bias results, but selection bias does not occur with-

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Table 3. Cumulative Exposure to Menthol and Nonmenthol Cigarettes and the Prevalence of Coronary Calcification: The CARDIA Study, 2000

<table>
<thead>
<tr>
<th>Type of Cigarette Exposure*</th>
<th>Unadjusted</th>
<th>Adjusted for Age, Sex, and Ethnicity</th>
<th>Also Adjusted for Socioeconomic Status§ and Habits$</th>
<th>Also Adjusted for Physiologic Mediators of Coronary Artery Disease ¶</th>
</tr>
</thead>
<tbody>
<tr>
<td>Menthol cigarettes, per 10–pack-year increase</td>
<td>1.53 (1.24-1.89)</td>
<td>1.35 (1.09-1.67)</td>
<td>1.27 (1.01-1.60)</td>
<td>1.16 (0.91-1.47)</td>
</tr>
<tr>
<td>Nonmenthol cigarettes, per 10–pack-year increase</td>
<td>1.51 (1.25-1.82)</td>
<td>1.38 (1.11-1.71)</td>
<td>1.33 (1.06-1.68)</td>
<td>1.23 (0.98-1.55)</td>
</tr>
</tbody>
</table>

P value comparing strength of association**: .91 .87 .75 .67

Abbreviations: CARDIA, Coronary Artery Risk Development in Young Adults; Cl, confidence interval.

*Cumulative tobacco exposure was partitioned into menthol and nonmenthol exposure based on menthol preference at each examination (see the “Methods” section). Odds ratios are estimated per 10 pack-years of cigarette exposure, equivalent to 1 pack per day. For example, we could interpret the first result in this table as follows: “Smoking menthol cigarettes at a rate of 1 pack per day for 10 years (or 2 packs per day for 5 years) is associated, on average, with a 1.53-fold increase in the odds of having coronary calcification.”

**All models, including the “unadjusted model,” are adjusted for both measures of cumulative exposure to cigarettes (menthol and nonmenthol) and for differential loss to follow-up using inverse probability weighting (see the “Methods” section). Analyses are restricted to smoking participants attending each CARDIA examination with nonmissing coronary calcium scores (n = 838). Analyses including all smoking participants with nonmissing coronary calcium scores (n = 1033) without weighting for differential follow-up show nearly identical results.

§Socioeconomic status indicators included education and income, measured in 2000.

$Habits included alcohol consumption and exercise, measured in 2000.

¶Physiologic mediators of coronary artery disease included body mass index, glucose intolerance, systolic and diastolic blood pressure, plasma levels of low- and high-density lipoprotein cholesterol, and triglycerides, measured in 2000.

P values refer to Wald tests of the null hypothesis that the coefficients for menthol and nonmenthol exposure were equal. For example, for the unadjusted analysis, P = .91 refers to a test comparing 1.53 (the odds ratio for menthol) and 1.51 (the odds ratio for nonmenthol).
Figure 3. Ten-year change in forced expiratory volume in 1 second (FEV₁) in relation to interval pack-year exposure to cigarette smoke among baseline menthol and nonmenthol smokers, The Coronary Artery Risk Development in Young Adults Study, 1985-1995.

Table 4. Interval Exposure to Menthol and Nonmenthol Cigarettes and 10-Year Decline in Pulmonary Function: The CARDIA Study, 1985-1995

<table>
<thead>
<tr>
<th>Measure of Pulmonary Function and Type of Cigarette Exposure*</th>
<th>Excess Decline in Pulmonary Function (95% CI) Associated With an Increase in Cumulative Exposure to Menthol and Nonmenthol Cigarettes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Unadjusted†</strong></td>
</tr>
<tr>
<td>FEV₁, mL</td>
<td></td>
</tr>
<tr>
<td>Menthol cigarettes, per 10–pack-year increase</td>
<td>106 (59 to 153)</td>
</tr>
<tr>
<td>Nonmenthol cigarettes, per 10–pack-year increase</td>
<td>94 (49 to 139)</td>
</tr>
<tr>
<td>*P value comparing strength of association¶</td>
<td>.64</td>
</tr>
<tr>
<td>FVC, mL</td>
<td></td>
</tr>
<tr>
<td>Menthol cigarettes, per 10–pack-year increase</td>
<td>112 (53 to 170)</td>
</tr>
<tr>
<td>Nonmenthol cigarettes, per 10–pack-year increase</td>
<td>103 (44 to 161)</td>
</tr>
<tr>
<td>*P value comparing strength of association¶</td>
<td>.79</td>
</tr>
<tr>
<td>MMEF, mL/s</td>
<td></td>
</tr>
<tr>
<td>Menthol cigarettes, per 10–pack-year increase</td>
<td>201 (76 to 326)</td>
</tr>
<tr>
<td>Nonmenthol cigarettes, per 10–pack-year increase</td>
<td>69 (−47 to 185)</td>
</tr>
<tr>
<td>*P value comparing strength of association¶</td>
<td>.06</td>
</tr>
</tbody>
</table>

Abbreviations: CARDIA, Coronary Artery Risk Development in Young Adults; CI, confidence interval; FEV₁, forced expiratory volume in 1 second; FVC, forced vital capacity; MMEF, maximal midexpiratory flow.

*The predictors herein are interval tobacco exposures (partitioned into menthol and to nonmenthol pack-years based on menthol preference at each examination); ie, the number of pack-years of exposure accumulated during the 10 years between pulmonary function tests (1985-1995). Regression coefficients are given in terms of decline per 10 pack-years of cigarette exposure, equivalent to 1 pack per day during the 10 interval years. For example, we could interpret the first result in this table as follows: “Smoking menthol cigarettes at a rate of 1 pack per day for 10 years is associated, on average, with an excess decline of 106 mL in FEV₁.”

†All models, including the “unadjusted model,” are adjusted for both measures of cumulative exposure to cigarettes (menthol and nonmenthol) and for differential loss to follow-up using inverse probability weighting (see the “Methods” section). Analyses are restricted to smoking participants attending all the CARDIA examinations until 1995 with nonmissing pulmonary function tests (n = 982 for FEV₁ and FVC and n = 844 for MMEF). Analyses including all smoking participants with nonmissing pulmonary function tests (n = 1212 for FEV₁ and FVC and n = 1042 for MMEF) without weighting for differential follow-up were nearly identical.

‡Socioeconomic status indicators included education and income, measured in 1995.

§Habits included alcohol consumption and exercise, measured in 1995.

‖Body mass index (calculated as weight in kilograms divided by the square of height in meters) was measured in 1995.

¶P values refer to Wald tests of the null hypothesis that the coefficients for menthol and nonmenthol exposure were equal. For example, for the unadjusted FEV₁ analysis, *P = .64 refers to a test comparing 106 mL (the estimate for menthol) and 94 mL (the estimate for nonmenthol).
out differential effects simultaneously by menthol preference and the outcome, and sensitivity analyses show essentially no differences between analyses with and without inverse probability weighting despite the fact that we could predict dropout with some accuracy. Some investigators have raised concerns that individuals may switch to menthol cigarettes when they develop preclinical disease. This could theoretically bias the coronary calcification or pulmonary function results (but not the cessation results, which use only baseline menthol preference); however, this tendency would lead to a bias toward finding more harm from menthol, which is essentially a conservative bias in relation to these conclusions. There is also a concern that other cigarette characteristics (tar, nicotine content, or other additives) could be different in menthol cigarettes and thereby confound our results; we cannot adjust directly for these other characteristics owing to limited data in The CARDIA Study. We note, however, that the most popular menthol (Newport and Kool) and non-menthol (Marlboro and Camel) cigarette brands are similar at least in terms of tar and nicotine content. Finally, this analysis does not address lung cancer, nonatherosclerotic heart disease, or other potential harms from cigarette smoking that may be facilitated or amplified by the presence of menthol. Ischemic heart disease and chronic airway obstruction, however, are the 2 most common causes of smoking-attributable mortality in the United States after lung cancer.

In summary, the preference for mentholated cigarettes among US smokers is highly associated with ethnicity and seems to be relatively stable across time. Mentholation of cigarettes does not seem to explain disparities in ischemic heart disease and obstructive pulmonary disease between African Americans and European Americans in the United States but may partially explain lower rates of smoking cessation among African American smokers. It is possible, therefore, that switching from menthol cigarettes to nonmenthol cigarettes might facilitate subsequent smoking cessation, especially in African Americans, and thereby reduce tobacco-related health disparities. At a policy level, regulation of tobacco additives, such as menthol, has been proposed as a way to reduce tobacco addiction in the United States and as one step in a long-term strategy designed to replace tobacco with “clean” sources of nicotine to reduce the health consequences of nicotine addiction in the United States. Our results provide some support for this strategy, although the primary goal of public health officials, physicians, and patients should be to reduce all tobacco smoke exposure regardless of menthol content.

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Previous Presentation: An abstract containing a preliminary analysis of these data was presented at the American Heart Association’s 45th Annual Conference on Cardiovascular Disease Epidemiology and Prevention; May 2, 2005; Washington, DC.

REFERENCES