



Evaluating the association between menthol cigarette use and the likelihood of being a former versus current smoker



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ABSTRACT

Menthol in cigarettes has been examined for its potential to affect smoking dependence, measured primarily as number of cigarettes smoked per day and time to first cigarette after waking; the ability to quit smoking constitutes an additional measure of dependence. Successful quitting among menthol compared to non-menthol cigarette smokers is difficult to determine from the literature, due in part to the various definitions of quitting used by researchers. Nevertheless, intervention and follow-up studies of smoking cessation treatments generally indicate no differences in quitting success among menthol compared to non-menthol smokers, while cross-sectional studies suggest some differences within race/ethnicity groups. The association between menthol cigarette use and likelihood of being a former versus current smoker was examined based on data from the National Health Interview Survey and Tobacco Use Supplement to the Current Population Survey. Analyses stratified by race/ethnicity and limited to smokers who had quit at least one year prior to survey participation provided inconsistent results with regard to menthol cigarette use and quitting, both within surveys (*i.e.*, comparing race/ethnicity groups) and between surveys (*i.e.*, same race/ethnicity group across surveys). Evidence suggesting the existence or direction of an association between menthol in cigarettes and quitting depended on the data source.

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1. Introduction

Menthol in cigarettes has been previously examined for its potential to affect smoking dependence, measured primarily as number of cigarettes smoked per day and time to first cigarette after waking (Curtin *et al.*, 2014); the ability or inability to quit smoking constitutes an additional measure of dependence. Evidence on whether menthol in cigarettes adversely affects a smoker's ability to quit smoking is provided by intervention

studies, cohort studies and cross-sectional analyses. Intervention and cohort studies may not be generalizable to the U.S. population overall, but are potentially valuable due to their longitudinal nature. Conversely, cross-sectional analyses are limited by lack of a time dimension, but can have the advantage of being generalizable to a larger population, depending upon the sampling strategy used.

This paper reviews the available evidence from intervention studies, cohort studies and cross-sectional analyses on menthol versus non-menthol cigarette use and quitting smoking, and presents original findings from cross-sectional analyses that examine the association between menthol cigarette use and likelihood of being a former versus current smoker. The new analyses are based on data from the National Health Interview Survey (NHIS) and Tobacco Use Supplement to the Current Population Survey (TUS-CPS), which are the only U.S. government surveys that provide relatively detailed information on past smoking habits among former smokers, including the use of menthol or non-menthol cigarettes and time since quitting.

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; HSI, Heaviness of Smoking Index; NHIS, National Health Interview Survey; CPD, number of cigarettes smoked per day; TTFC, time to first cigarette after waking; TUS-CPS, Tobacco Use Supplement to the Current Population Survey.

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2. Methods

2.1. Literature review

The U.S. National Library of Medicine's PubMed database was actively searched using the terms "menthol" and "cigarette" to identify pertinent literature (1990 to present). Articles found on screening to be relevant to menthol cigarette use and quitting smoking were reviewed and evaluated for methodological quality, particularly with respect to adequate control for confounding and likelihood of bias, and generalizability to the U.S. population. For this paper, studies are categorized according to their design and purpose (e.g., evaluation of smoking cessation treatments, general population surveys), and their particular strengths and weaknesses are described.

2.2. Statistical materials and methods

Analyses of two nationally representative surveys examine whether menthol cigarette use is associated with an increased or decreased likelihood of being a former versus current smoker. NHIS and TUS-CPS provide data on current and past smoking habits, including usual cigarette type (menthol or non-menthol), among adult current and former smokers, respectively. The current analyses focused on recent administrations of each survey, *i.e.*, 2005 and 2010 (combined) for NHIS and 2010/11 for TUS-CPS. Data from 2006/07 TUS-CPS were evaluated, but differences from the 2010/11 administration in the wording of key questions and requirements for duration of smoking cessation¹ would have introduced extra variability into the results without adding information; thus, these data were not included.

One-way frequency distributions and cross-tabulations based on menthol versus non-menthol cigarette use were performed to determine whether there were adequate numbers of current and former smokers within socio-demographic strata to complete the regression analyses, as well as to create response categories. Consistent with findings from previous studies (Gundersen et al., 2009; Hyland et al., 2002; Lawrence et al., 2010; Muscat et al., 2002; Stahre et al., 2010), these analyses indicated that menthol versus non-menthol cigarette use is strongly associated with race/ethnicity, and that race/ethnicity is associated with the likelihood of being a former versus current smoker. Thus, separate logistic regression models were developed for each of the identified race/ethnic groups to estimate the association between menthol cigarette use and being a former versus current smoker independent of race/ethnicity. Analyses compared current smokers with former smokers who had quit smoking at least one year prior to survey participation in order to focus on those former smokers most likely to remain abstinent (e.g., Gilpin et al., 1997).

For each race/ethnicity category, potential confounders independently associated with menthol versus non-menthol cigarette use and being a former versus current smoker were identified using two-variable models, consisting of the menthol indicator and each potential covariate. All covariates with a *p*-value of ≤ 0.20 were included in the first candidate multi-variable model; terms with *p*-values > 0.05 in the candidate multi-variable model were then sequentially excluded, with the covariates having the highest *p*-values being excluded first. This process was repeated until only covariates with a *p*-value of ≤ 0.05 remained in the multi-variable model. Each of the removed covariates was then

returned to the model, individually, and the percent change in the regression coefficient for menthol was calculated. Those covariates resulting in at least a 15% change in the menthol coefficient were reinstated (Hosmer and Lemeshow, 1989).

Prior to modeling, highly correlated variables were identified ($R \geq 0.50$), and one member of each correlated pair was chosen for inclusion in the model building process. As a last step, the final multi-variable model was run with the alternate member of the correlated pair of covariates included (*i.e.*, instead of the original variable), and differences in the results were described (Hosmer and Lemeshow, 1989). Definitions of the parameters used in the current analyses are provided in Table 1.

All analyses employed survey methods to account for the sample design, as specified in the analytic guidelines for each data set, including the use of replicate weights for the TUS-CPS. The use of these survey methods and weights allowed for proper variance estimation, and the estimation of nationally representative summary statistics.

3. Results of literature review

3.1. Intervention studies

Examination of short-term versus long-term abstinence, continuous versus point-prevalence of abstinence (*i.e.*, measured at differing intervals after the conclusion of treatment), and biochemically verified versus self-reported abstinence were considered during this evidence review, as quitting may have been defined differently across studies. For intervention studies, it was also important to assess whether differences in treatment-seeking behaviors may be correlated with factors that are likewise associated with cigarette type preference, and whether the efficacy or effectiveness of a given intervention translates directly to the likelihood of quitting smoking among a population of smokers not seeking treatment. Nevertheless, differences in intervention success among menthol versus non-menthol cigarette smokers may provide some insights regarding the association between cigarette type and quitting success.

Two intervention studies that provide data on menthol versus non-menthol cigarette use and quitting were based on the same population of treatment-seeking African-American smokers ($n = 600$) participating in a cessation trial at an inner-city health center (Harris et al., 2004; Okuyemi et al., 2003). Okuyemi et al. (2003) reported that 7-day point-prevalence of abstinence at 6 weeks was statistically significantly lower among menthol versus non-menthol cigarette smokers, but not statistically significantly different at 6 months. This suggests that menthol cigarette smokers may be somewhat slower to quit (*i.e.*, within the first weeks of attempting to quit) than non-menthol smokers, but that longer-term quitting success is not different between these groups. A subsequent study (Harris et al., 2004), using logistic regression to assess 21 factors as potential predictors of short-term abstinence (*i.e.*, 7-day point-prevalence of abstinence following 7 weeks of treatment), did not identify menthol cigarette use as a statistically significant independent predictor of abstinence. Neither study evaluated long-term quitting success (*i.e.*, longer than 6 months) among menthol versus non-menthol cigarette smokers; and, the evidence provided on whether menthol cigarette use adversely affects short-term quitting success was inconsistent. Thus, it is not possible to conclude from these studies that menthol cigarette use affects either short- or long-term quitting success.

A second set of studies reported findings from somewhat larger populations of treatment-seeking smokers attending the same regional cessation clinics (Foulds et al., 2006; Gandhi et al., 2009). Based on analyses that controlled for variables statistically

¹ In the 2006/07 administration of TUS-CPS, detailed information on prior smoking habits was collected from former smokers who had quit smoking up to five years prior to the survey; for the 2010/11 administration, information on prior smoking habits was collected for those who had quit smoking up to three years prior to the survey.

Table 1
Parameter definitions.

Parameter	Definition
Current smoker	Smoked ≥ 100 cigarettes (lifetime)
Regular smoker	Current smoker, smoked ≥ 10 days during past month
Daily smoker	Current smoker, smoked daily during past month
Former smoker	Quit ≥ 1 year ^{a, b}
Menthol	Current or former smokers who reported their usual cigarette type or brand was menthol
Current age	Self-reported at the time of the survey
Gender	Male, female
Race/ethnicity	Self-reported, categorized as non-Hispanic White, non-Hispanic Black or “other”
Smoking initiation age	Self-reported age, in years, at which individuals first reported smoking on a “fairly regular” basis
Time since quitting smoking	Self-reported by former smokers
Duration of smoking ^c	Calculated, in years; for current smokers, current age minus smoking initiation age; for former smokers, current age minus (smoking initiation age plus time since quitting smoking)
Number of cigarettes smoked per day (CPD)	Estimated by current and former smokers
Use of quit aids	Categorized as any/none; pharmaceutical (yes/no) and non-pharmaceutical (yes/no) ^d
Time to first cigarette after waking (TTFC)	TUS-CPS only: categorized as ≤ 5 , 6–30, 31–60 or >60 min
Night waking to smoke	TUS-CPS only: categorized as yes/no
Heaviness of Smoking Index (HSI) ^e	TUS-CPS only: calculated by adding category values for CPD and TTFC; categorized as low dependence for values 0–2, moderate dependence for values 3–4, and high dependence for values 5–6

^a To exclude those most likely to relapse, per [Gilpin et al. \(1997\)](#).

^b In TUS-CPS, former smokers are only presented with detailed questions regarding their prior smoking habits if they had quit smoking within the last 3 years; thus, former smokers are identified as those individuals who quit between one and three years prior to the survey (i.e., short-term quitters). NHIS does not impose this limitation, so analyses were completed for both short-term quitters (i.e., former smokers who quit 1–3 years prior to the survey) and long-term quitters (i.e., all former smokers who quit ≥ 1 year prior to the survey, including those who may have quit more than 3 years prior to the survey).

^c For a small number of respondents, this calculation results in a negative value; in these cases, the duration of smoking is set to missing, and the observation is not used in the analysis.

^d Non-pharmaceutical quit aids include, for example, counseling, accessing quit lines, and use of support groups.

^e HSI integrates data from number of cigarettes smoked per day and time to first cigarette after waking; values assigned for number of cigarettes smoked per day ≤ 10 , 11–20, 21–30 and >30 cigarettes are 0, 1, 2 and 3, respectively; and, values assigned for time to first cigarette ≤ 5 , 6–30, 31–60 and >60 min after waking are 3, 2, 1 and 0, respectively.

significantly correlated with abstinence, [Foulds et al. \(2006\)](#) presented evidence for a trend towards lower abstinence among menthol versus non-menthol cigarette smokers at 4-weeks and 26-weeks follow-up; however, differences between menthol and non-menthol cigarette smokers were not statistically significant. [Gandhi et al. \(2009\)](#) reported statistically significantly lower odds of quitting at 4-weeks and 6-months follow-up among African-American menthol versus non-menthol cigarette smokers; no differences were indicated among White menthol versus non-menthol smokers, with inconsistent findings among Latino smokers. These latter analyses ([Gandhi et al., 2009](#)) also suggested the potential for effect modification, whereby the strength of the “menthol effect” was related to socio-economic status. For example, the 4-week quit rate was statistically lower among African-American menthol versus non-menthol cigarette smokers who were unemployed, but not different among those who were employed full-time.

Six cessation trials were conducted within restricted populations, and thus provide findings that were not generalizable to the U.S. population overall ([Cropsey et al., 2009](#); [D'Silva et al., 2012](#); [Faseru et al., 2013](#); [Fu et al., 2008](#); [Reitzel et al., 2011](#); [Reitzel et al., 2013](#)). Evidence of statistically significant effect modification by race/ethnicity was provided based on data from a clinical trial examining post-partum smoking abstinence among a small sample of women who had stopped smoking during or just prior to pregnancy ([Reitzel et al., 2011](#)). Specifically, White women using menthol versus non-menthol cigarettes were less likely to be continuously abstinent for the three weeks following the intervention, but a similar correlation was not observed among African-American women. In contrast, findings from a cessation trial comparing short-term, continuous and 30-day abstinence rates among under-insured smokers seeking telephone-based treatment indicated no differences in quitting success among menthol versus non-menthol cigarette smokers, and no effect modification by race/ethnicity ([D'Silva et al., 2012](#)).

Findings from the remaining four cessation trials indicated no adverse association between menthol versus non-menthol cigarette use and quitting success. [Faseru et al. \(2013\)](#) examined predictors of quitting success based on 26-week cessation in a placebo-controlled trial of bupropion, restricted to African Americans who smoked ≤ 10 cigarettes per day. [Fu et al. \(2008\)](#) compared 7-day point-prevalence of abstinence among a population of military veterans making a pharmacotherapy-aided quit attempt. [Cropsey et al. \(2009\)](#) examined the effect of cigarette type preference on quitting based on data from a female prison population. Finally, [Reitzel et al. \(2013\)](#) compared short-term abstinence (i.e., up to 3 weeks post-quit) based on data from a small community-based study of primarily minority smokers willing to quit in the next 7 days.

3.2. Intervention studies with long follow-up and cohort studies

Four studies provide data from large samples of U.S. smokers, and included longer follow-up periods compared to the intervention trials described above ([Blot et al., 2011](#); [Hyland et al., 2002](#); [Murray et al., 2007](#); [Pletcher et al., 2006](#)).

[Hyland et al. \(2002\)](#) presented findings from a randomized community-based intervention trial ($n = 13,268$), conducted in 11 matched pairs of communities with 5 years of follow-up. The authors noted high agreement (98%) between self-reported cigarette type and UPC label information for the subset of respondents with both types of data; and while cigarette type data were only collected at baseline, other data sources were cited to suggest only low rates of switching between menthol and non-menthol cigarette use. Regression models examining the association between menthol cigarette use and quitting success based on point-prevalence and six-month abstinence were adjusted for socio-demographic characteristics, descriptors of smoking habit (e.g., interest in quitting and quit attempts), and concurrent use of cigarettes and non-cigarette tobacco products. Findings from these analyses

indicated no statistically significant association between menthol cigarette use and quitting success, overall or within strata based on race/ethnicity; moreover, there were no evident interactions.

The Coronary Artery Risk Development in Young Adults Study provides longitudinal data on smoking habits (15 years follow-up) among a cohort of 1535 African-American and European-American males and females (aged 18–30 years at baseline), recruited in four cities (Pletcher et al., 2006). Analyses that adjusted for demographic and social factors indicated that baseline menthol cigarette use was not associated with “not currently smoking”, “cessation if recent quit attempt” or “sustained smoking cessation”, but was associated with “documented relapse”; findings were similar among African-American and European-American smokers. A key strength of this study was its ability to identify relapse to smoking and its multiple assessments of smoking status throughout the follow-up period.

Murray et al. (2007) examined data from the Lung Health Study, which included adult smokers ($n = 5887$) enrolled in a smoking cessation trial, with 15-years follow-up; differences in quitting success were compared over a 5-year period among those who reported menthol versus non-menthol cigarette use at baseline, by gender. In analyses of mortality outcomes (but not smoking cessation) covering a 14.5-year follow-up period, the authors reported that switching between menthol and non-menthol cigarette use was uncommon; thus, misclassification of exposure was considered unlikely. Findings from this study indicated that the proportions of sustained quitters (*i.e.*, biochemically confirmed at 5 annual visits), intermittent quitters (*i.e.*, biochemically confirmed at some annual visits) and continuing smokers (*i.e.*, identified as smoking at all annual visits) were not statistically different among menthol versus non-menthol cigarette smokers. Although the study included a large cohort with intensive follow-up for smoking status, no multi-variable analyses were reported; also, only 3.8% of the population was African American, compared to 12% of the U.S. population at the time of the study, indicating a non-representative sample from which results may not be generalizable to the U.S. population overall, or to African Americans specifically.

Results from the last of the large cohort studies indicated that African Americans who used menthol cigarettes were no less likely to be former smokers at enrollment compared to those who used non-menthol cigarettes; in contrast, non-Hispanic White menthol smokers were statistically significantly more likely than non-menthol smokers to have quit at enrollment (Blot et al., 2011). In prospective analyses, the odds of quitting smoking during an average of 4.3 years follow-up were similar among menthol versus non-menthol cigarette smokers, with no differences by gender or race. These results were based on data from the 12,373 adults, ages 40–79 years at baseline, who participated in the longitudinal component of the Southern Community Cohort Study, carried out in 12 southern states. The strengths of this study were its size, its inclusion of large numbers of both African Americans and non-African Americans of similar socio-economic status, and its prospective design.

Collectively, evidence based on cohort studies and intervention studies with long follow-up periods does not indicate a difference in quitting success among menthol compared to non-menthol cigarette smokers (Table 2).

3.3. Cross-sectional analyses

Findings from cross-sectional analyses may be limited by their lack of a time dimension, which can make it difficult to determine whether menthol cigarettes were a long-term preference or selected, for example, to assist with quitting. For instance, Muscat et al. (2002) provided findings based on a secondary

analysis of data among current and former smokers who participated in a case-control study of tobacco-related cancers; adjusted analyses indicated that menthol cigarette use was not associated with continued smoking.

Limitations due to uncertain temporal relationships in cross-sectional data may be offset by the benefits due to use of nationally representative samples; two such studies (Gundersen et al., 2009; Stahre et al., 2010) examined data from NHIS (2005), and two others (Delnevo et al., 2011; Levy et al., 2011) provided analyses based on data from TUS-CPS (2003 and 2006/07). Among the U.S. government surveys, NHIS and TUS-CPS alone provide relatively detailed information on current and past smoking habits among current and former smokers, respectively, including usual cigarette type and time since quitting.

Gundersen et al. (2009) presented findings from NHIS (2005) based on analyses that were restricted to current and former smokers ($n = 7815$) who indicated no other tobacco product use and having previously made a quit attempt. Current smokers were defined as lifetime smokers (*i.e.*, having smoked ≥ 100 cigarettes) who smoked some days or every day, while former smokers were defined as lifetime smokers who were not currently smoking (*i.e.*, no minimum abstinence period). Regression models that controlled for demographics (including race/ethnicity), number of cigarettes smoked per day, and a measure of smoking-related risk perception indicated that menthol cigarette smokers were no less likely to be former smokers compared to non-menthol smokers. There was, however, evidence of statistically significant interactions, with patterns of menthol cigarette use and quitting that depended on race/ethnicity group. Specifically, menthol cigarette use was positively associated with being a former smoker among non-Hispanic Whites; and, inversely associated with being a former smoker among Hispanics alone and among non-Hispanic Black and Hispanic respondents combined, but not among non-Hispanic Blacks alone (Gundersen et al., 2009).

A subsequent analysis of data from NHIS (2005) did not provide sufficient information on the inclusion criteria for current and former smokers to classify quitters, except that former smokers had quit during the past year (Stahre et al., 2010). Unadjusted analyses, stratified by race/ethnicity, suggested no statistically significant differences in quit ratios among non-Hispanic White, Asian-American or Hispanic smokers who used menthol versus non-menthol cigarettes, but did suggest a statistically lower quit ratio among non-Hispanic Black smokers. Quit ratios are calculated as the number of former smokers divided by the number of current plus former smokers in the sample; as such, their magnitude is dependent on the prevalence of smoking within the sample and the specific definitions used to define current and former smokers, which can differ substantially from one study to another.² Regression analyses also indicated that non-Hispanic Black smokers who used menthol cigarettes were significantly less likely than non-Hispanic White non-menthol smokers to have quit smoking, after controlling for demographic and smoking-related variables (Stahre et al., 2010).

Delnevo et al. (2011) examined data from TUS-CPS (2003 and 2006/07), and defined current smokers as lifetime smokers (*i.e.*, had smoked ≥ 100 cigarettes lifetime) who smoked some days or every day; former smokers were defined as lifetime smokers who had quit within the past five years. Model estimates indicated that

² Current smokers may (or may not) be limited to those individuals who have smoked ≥ 100 cigarettes in their lifetime; may (or may not) be limited to those individuals who smoke daily; and/or, may (or may not) include non-daily smokers with or without a specified, minimum number of days smoked during the past month. Likewise, former smokers may (or may not) be defined according to a duration of abstinence, with (or without) biochemical confirmation; and/or, include those individuals who consider themselves to be “not currently smoking” on the day of the survey.

Table 2

Summary of intervention studies with long follow-up and cohort studies.

First author, publication year	Study design ^a (sample size)	Summary of key results
Hyland et al. (2002)	Intervention study, 5-yr follow-up (n = 13,268)	No statistically significant association between menthol cigarette use and quitting success, overall or within strata based on race/ethnicity
Pletcher et al. (2006)	Cohort study, 15-yr follow-up (n = 1535)	Menthol cigarette use not associated with “not currently smoking”, “cessation if recent quit attempt” or “sustained smoking cessation”; positively associated with “documented relapse”
Murray et al. (2007)	Intervention study, 5-yr follow-up (n = 5887)	Proportions of “sustained quitters”, “intermittent quitters” and “continuing smokers” not statistically different based on menthol versus non-menthol cigarette use
Blot et al. (2011)	Cohort study, >4-year follow-up (n = 12,373)	Odds of quitting smoking similar among menthol versus non-menthol smokers, with no differences by gender or race/ethnicity

^a See text for study design details.

menthol cigarette smokers overall were statistically less likely to be former smokers compared to non-menthol smokers. In stratified analyses, non-Hispanic White and non-Hispanic Black menthol versus non-menthol cigarette smokers were statistically less likely to be former smokers, with no differences among Hispanic smokers. Results were similar when the sample was restricted to past-year smokers who had tried to quit or succeeded in quitting during the preceding 12 months, with corresponding statistically significant differences. Menthol cigarette effects were summarized by the authors as being of “small magnitude” (Delnevo et al., 2011).

For the last of the cross-sectional analyses based on a nationally representative sample, Levy et al. (2011) combined individual-level data from TUS-CPS (2003 and 2006/07) with state-level data on tobacco control policies. However, a recent review of this study (FDA, 2013) identified limitations that likely impact interpretability of the findings, including issues related to data transformations and the calculation of prevalence differences. A subsequent re-analysis of these data (FDA, 2013) suggested that menthol cigarette smokers overall had a lower prevalence of quitting compared to non-menthol smokers. In addition, quitting prevalence was suggested to be lower among non-Hispanic White smokers who used menthol versus non-menthol cigarettes, with no differences among non-Hispanic Black or Hispanic smokers.

Thus, cross-sectional analyses that examine the association between menthol cigarette use and the likelihood of being a former versus current smoker, based on two nationally representative samples, provide inconsistent findings (Table 3). For example, the available evidence indicates either a statistically lower likelihood of being a former versus current smoker among non-Hispanic Black menthol compared to non-menthol smokers (Delnevo et al., 2011, based on TUS-CPS; Stahre et al., 2010, based on NHIS) or no statistically significant difference (Gundersen et al., 2009, based on NHIS; FDA, 2013, based on TUS-CPS). Three of these studies (Delnevo et al., 2011; FDA, 2013; Gundersen et al., 2009) imposed no minimum time since quitting smoking, while Stahre

et al. (2010) defined former smokers as those who had quit within the preceding year. Therefore, all four studies may have categorized as former smokers some individuals who were likely to resume smoking (e.g., Gilpin et al., 1997), which would shift the effect estimates towards the null value if menthol cigarette use is associated with quitting success.

4. Results of statistical analyses

4.1. Descriptive analyses

Table 4 provides weighted frequency distributions for menthol versus non-menthol cigarette use among current and former smokers, based on data from NHIS (2005 and 2010) and TUS-CPS (2010/11). Estimates based on data from NHIS suggest that 28.9% and 29.2% of daily and regular smokers, respectively, report current use of menthol cigarettes, and 25.2% of former smokers used menthol cigarettes prior to quitting smoking. Similar findings are indicated based on estimates from TUS-CPS; specifically, 30.0% and 30.9% of daily and regular smokers report current use of menthol cigarettes, and 24.3% of former smokers used menthol cigarettes prior to quitting. The mean time since quitting smoking among former smokers participating in NHIS is approximately 18 years (ranges from 1 to >70 years), with approximately 14% of former smokers having quit 1–3 years prior to the survey (data not shown).

Frequency distributions for covariates of interest for current and former adult smokers are shown in Table 5 (NHIS, 2005 and 2010) and Table 6 (TUS-CPS, 2010/11). The distributions are similar for all covariates in both surveys, suggesting that the two data sets are comparable despite employing different sampling strategies. The NHIS sample (2005 and 2010 combined, and after weighting) is comprised of 79.3% non-Hispanic Whites, 9.5% non-Hispanic Blacks and 11.2% other race/ethnicity, while the 2010/11 TUS-CPS weighted sample is comprised of 78.8% non-Hispanic Whites,

Table 3

Summary of the four cross-sectional analyses.

First author, publication year	Study design ^a (sample size)	Summary of key results
Gundersen et al. (2009)	NHIS, 2005 (n = 7815)	Regression analyses indicate menthol versus non-menthol smokers no less likely to be former smokers; evidence of statistically significant interactions
Stahre et al. (2010)	NHIS, 2005 (n = 12,005)	Unadjusted analyses indicate no statistical differences in quit ratios among non-Hispanic White or Hispanic menthol versus non-menthol smokers, but statistically lower quit ratio among non-Hispanic Black smokers
Delnevo et al. (2011)	TUS-CPS, 2003 and 2006/07 (n = 24,465 to 71,193)	Menthol versus non-menthol smokers overall statistically less likely to be former smokers; non-Hispanic White and non-Hispanic Black menthol smokers statistically less likely to be former smokers, with no differences among Hispanic smokers
FDA (2013) (unpublished data)	TUS-CPS, 2003 and 2006/07	Menthol versus non-menthol smokers overall have lower prevalence of quitting; quitting prevalence lower among non-Hispanic White menthol smokers, with no differences among non-Hispanic Black or Hispanic smokers

^a See text for study design details.

Table 4

Distribution of current and former adult smokers based on cigarette type preference.

Cigarette type preference	Daily smokers ^a		Regular Smokers ^b		Former Smokers ^c	
	Weighted frequency ^d	Percent (%)	Weighted frequency ^d	Percent (%)	Weighted frequency ^d	Percent (%)
NHIS (2005 and 2010)						
Menthol	9,533,093	28.9	10,884,619	29.2	9,694,718	25.2
Non-menthol	23,397,764	71.1	26,420,126	70.8	28,847,662	74.8
Total	32,930,857	100.0	37,304,745	100.0	38,542,380	100.0
TUS-CPS (2010/11)						
Menthol	8,115,695	30.0	9,889,272	30.9	8,146,055	24.3
Non-menthol	18,953,876	70.0	22,121,514	69.1	25,378,056	75.7
Total	27,069,571	100.0	32,010,786	100.0	33,524,111	100.0

^a Daily smoker defined as having smoked ≥ 100 cigarettes, and having smoked daily during the past month.^b Regular smoker defined as having smoked ≥ 100 cigarettes, and having smoked ≥ 10 days during the past month.^c Former smoker defined as having smoked ≥ 100 cigarettes, but not having smoked during the past year.^d Frequency among survey respondents, weighted to represent the U.S. population.**Table 5**

Variable distribution among current and former adult smokers based on usual cigarette type (NHIS, 2005 and 2010).

Variable	Menthol		Non-menthol	
	Weighted frequency ^a	Percent (column) (%)	Weighted frequency ^a	Percent (column) (%)
Current age category (years)				
20–25	2,318,175	11.3	4,008,066	7.3
26–30	1,901,534	9.2	4,131,752	7.5
31–35	1,378,311	6.7	4,693,504	8.5
36–40	1,368,763	6.7	4,680,200	8.5
41–45	1,983,449	9.6	5,110,135	9.3
46–50	2,653,232	12.9	5,803,279	10.5
51–55	2,529,926	12.3	5,568,797	10.1
56–60	1,921,018	9.3	5,225,413	9.5
61–84	4,346,044	21.1	15,078,450	27.3
≥ 85	178,887	0.9	968,193	1.8
Gender				
Male	9,066,294	44.1	32,520,185	58.8
Female	11,513,044	55.9	22,747,603	41.2
Race/ethnicity				
Non-Hispanic White	12,865,796	62.5	47,284,223	85.6
Non-Hispanic Black	5,312,225	25.8	1,856,082	3.4
Other	2,401,317	11.7	6,127,483	11.1
Smoking initiation age (years)				
<10	209,132	1.0	853,632	1.5
10–14	3,414,017	16.6	9,327,754	16.9
15–19	11,028,718	53.6	31,493,247	57.2
20–24	3,559,772	17.3	8,440,746	15.3
25–39	1,715,932	8.3	3,190,039	5.8
40–59	169,752	0.8	425,267	0.8
≥ 60	6,134	0.03	11,526	0.02
Other response ^b	475,881	2.3	1,425,579	2.6
Number of cigarettes smoked per day				
<10	6,553,404	31.8	13,300,824	24.1
10–19	6,267,048	30.5	14,555,054	26.3
20–29	5,141,997	25.0	17,794,515	32.2
30–39	938,627	4.6	3,112,313	5.6
≥ 40	1,257,310	6.1	5,040,871	9.1
Missing	420,952	2.0	1,464,213	2.6

^a Frequency among survey respondents, weighted to represent the U.S. population.^b Never smoked, refused to answer or don't know.

8.9% non-Hispanic Blacks and 12.3% other race/ethnicity (data not shown).

The use of quit aids was among the covariates considered in these analyses; however, less than 1% of former smokers in NHIS reported using any quit aids, with low use of pharmaceutical and non-pharmaceutical quit aids also indicated among former smokers in TUS-CPS (*i.e.*, 5% and 7%, respectively; data not shown). Due to the small number of former smokers using quit aids and the large number of observations with missing data on quit aids (*e.g.*, 95% and 80% among former smokers in NHIS and TUS-CPS, respectively), this covariate was not used.

4.2. Correlation analyses

Correlation analyses based on data from NHIS and TUS-CPS indicate that smoking initiation age, current age and duration of smoking are associated with one another; duration of smoking is calculated from the other two variables (Table 7). Smoking initiation age and current age were initially selected for inclusion in the regression models, and any final model that included either smoking initiation age or current age was re-run, with smoking duration substituted for the alternate covariate. Differences in the results are described.

Table 6

Variable distribution among current and former adult smokers based on usual cigarette type (TUS-CPS, 2010/11).

Variable	Menthol		Non-menthol	
	Weighted frequency ^a	Percent (column) (%)	Weighted frequency ^a	Percent (column) (%)
Current age category (years)				
20–25	1,944,490	10.8	2,961,228	6.2
26–30	1,733,065	9.6	3,453,821	7.3
31–35	1,363,407	7.6	3,671,915	7.7
36–40	1,046,444	5.8	3,891,653	8.2
41–45	1,333,005	7.4	4,149,223	8.7
46–50	2,081,073	11.5	4,942,410	10.4
51–55	2,339,739	13.0	5,181,018	10.9
56–60	1,878,450	10.4	4,723,587	9.9
61–84	4,155,250	23.0	13,587,003	28.6
≥85	160,405	0.9	937,713	2.0
Gender				
Male	7,799,713	43.3	27,868,506	58.7
Female	10,235,614	56.7	19,631,064	41.3
Race/ethnicity				
Non-Hispanic White	11,469,381	63.6	40,191,516	84.6
Non-Hispanic Black	4,287,840	23.8	1,543,040	3.3
Other	2,278,107	12.6	5,765,014	12.1
Smoking initiation age (years)				
<10	164,326	0.9	570,928	1.2
10–14	2,481,624	13.7	7,130,455	15.0
15–19	10,083,993	55.9	27,573,922	58.1
20–24	3,276,858	18.2	7,835,480	16.5
25–39	1,428,414	7.9	2,662,936	5.6
40–59	142,595	0.8	336,102	0.7
≥60	6,394	0.04	8,196	0.02
Other response ^b	451,123	2.5	1,381,552	2.9
Number of cigarettes smoked per day				
<10	4,828,960	26.8	8,867,467	18.7
10–19	5,465,878	30.3	12,951,108	27.3
20–29	4,472,397	24.8	14,486,763	30.5
30–39	663,482	3.7	2,618,483	5.5
≥40	767,450	4.3	3,100,065	6.5
Never smoked daily ^c (6 mos)	1,531,317	8.5	4,726,851	9.9
Other response ^d	305,843	1.7	748,832	1.6
Time to first cigarette after waking (current smokers only)				
≤5 min	1,551,437	15.7	3,587,938	16.2
6–30 min	3,002,840	30.4	7,473,286	33.8
31–60 min	2,186,991	22.1	4,875,849	22.0
>60 min	2,374,942	24.0	4,706,078	21.3
Other response ^e	773,063	7.8	1,478,363	6.7
Night waking to smoke (current smokers only)				
Yes	1,364,207	13.8	2,553,983	11.6
No	8,367,770	84.6	19,206,384	86.8
Don't sleep at night	37,061	0.4	60,512	0.3
Use other tobacco product	4,620	0.05	32,289	0.2
Other response ^e	115,614	1.2	268,345	1.2

^a Frequency among survey respondents, weighted to represent the U.S. population.^b Don't know, refused to answer or never smoked regularly.^c Former smokers who reported never smoking daily for at least six months were not asked to report usual numbers of cigarettes smoked per day.^d Don't know, refused to answer or no response.^e Don't know, refused to answer, varies or no response.**Table 7**

Pearson correlation coefficients of select variables.

	Smoking initiation age (yrs)	Current age (yrs)	Duration of smoking (yrs)
NHIS (2005 and 2010)			
Smoking initiation age (yrs)	–	0.11	–0.20
Current age (yrs)	0.11	–	0.61
Duration of smoking (yrs)	–0.20	0.61	–
TUS-CPS (2010/11)			
Smoking initiation age (yrs)	–	0.12	–0.18
Current age (yrs)	0.12	–	0.56
Duration of smoking (yrs)	–0.18	0.56	–

TUS-CPS includes several additional measures of smoking dependence (i.e., time to first cigarette after waking, night waking

to smoke and Heaviness of Smoking Index, HSI), all of which are highly correlated (Table 8). HSI integrates both number of

cigarettes smoked per day and time to first cigarette after waking, and thus was initially selected for inclusion in the regression models. Final models that included HSI were re-run with other measures of smoking dependence substituted for HSI to identify any differences in results due to the substitution.

4.3. Regression models

4.3.1. NHIS (2005 and 2010), long-term former smokers (quit 1 to >70 years)

Table 9 provides adjusted odds ratios (AOR) and corresponding 95% confidence intervals (95% CI) for the association between menthol cigarette use and being a long-term former (*i.e.*, any quit duration ≥ 1 year) versus current regular or daily smoker among NHIS participants in each of the three categories of race/ethnicity.

Regression models for non-Hispanic White and other race/ethnicity smokers (*i.e.*, regular or daily smokers) indicate no statistically significant associations for menthol cigarette use and being a long-term former versus current smoker, irrespective of whether current age (Model 1) or duration of smoking (Model 2) is included as a covariate (Table 9). Point estimates range from 0.81 (*i.e.*, non-significant, 19% lower odds of being a former versus current regular smoker among other races/ethnicities who use menthol versus non-menthol cigarettes, with the upper 95% CI equal to 1.00; Model 2) to 1.07 (*i.e.*, non-significant, 7% higher odds of being a former versus current regular smoker among non-Hispanic Whites who use menthol versus non-menthol cigarettes; Model 1).

Among non-Hispanic Blacks, there is no statistically significant association between menthol cigarette use and being a long-term former versus current smoker when current age is included as a covariate in the model (regular smoker: AOR 1.12, 95% CI: 0.88, 1.42; daily smoker: AOR 1.04, 95% CI: 0.82, 1.33). However, when the highly correlated covariate, duration of smoking, is substituted for current age (Model 2), there is a statistically significant inverse association for menthol cigarette use and being a long-term former versus current smoker (regular smoker: AOR 0.56, 95% CI: 0.45, 0.69; daily smoker: AOR 0.54, 95% CI: 0.44, 0.68). Alternatively stated, non-Hispanic Black menthol versus non-menthol smokers are statistically significantly less likely to be long-term former smokers when controlling for duration of smoking. The association is not statistically significant when current age is substituted for duration of smoking, even though these two terms are highly correlated (Table 9).

4.3.2. TUS-CPS (2010/11), short-term former smokers (quit 1–3 years)

There is a statistically significant inverse association between menthol cigarette use and being a short-term former versus current regular or daily smoker among non-Hispanic Whites and non-Hispanic Blacks who participated in TUS-CPS, irrespective of whether HSI (Model 1) or night waking to smoke (Model 2) is included as a covariate (Table 10). For example, point estimates suggest 21–25% lower odds of being a short-term former versus current daily smoker among non-Hispanic Blacks who use menthol versus non-menthol cigarettes; and, a 10% lower odds of being a short-term former versus current daily smoker among non-Hispanic Whites who use menthol versus non-menthol cigarettes.

Table 9

Adjusted odds of being a long-term former^a versus current smoker based on menthol compared to non-menthol cigarette use (NHIS, 2005 and 2010).

	Model 1		Model 2	
	AOR ^b	95% CI ^b	AOR ^b	95% CI ^b
Former versus regular smoker ^c				
Non-Hispanic White ^d	1.07	0.96, 1.19	0.98	0.88, 1.08
Non-Hispanic Black ^e	1.12	0.88, 1.42	0.56	0.45, 0.69
Other ^e	0.90	0.73, 1.12	0.81	0.66, 1.00
Former versus daily smoker ^c				
Non-Hispanic White ^f	1.06	0.95, 1.18	0.96	0.87, 1.06
Non-Hispanic Black ^g	1.04	0.82, 1.33	0.54	0.44, 0.68
Other ^h	0.89	0.71, 1.11	0.82	0.66, 1.02

^a Long-term former smoker defined as having smoked ≥ 100 cigarettes, but not having smoked during the past year; duration of quitting ranges from 1 to >70 years and average duration of quitting is 18 years.

^b Adjusted odds ratio, 95% confidence interval.

^c Regular smoker defined as having smoked ≥ 100 cigarettes, and having smoked ≥ 10 days during the past month; daily smoker defined as having smoked ≥ 100 cigarettes, and having smoked daily during the past month.

^d Model 1: menthol cigarette use + cigarettes smoked per day + current age; model 2: menthol cigarette use + cigarettes smoked per day + duration of smoking.

^e Model 1: menthol cigarette use + cigarettes smoked per day + smoking initiation age + current age; model 2: menthol cigarette use + cigarettes smoked per day + smoking initiation age + duration of smoking.

^f Model 1: menthol cigarette use + gender + smoking initiation age + current age; model 2: menthol cigarette use + gender + smoking initiation age + duration of smoking.

^g Model 1: menthol cigarette use + gender + cigarettes smoked per day + current age; model 2: menthol cigarette use + gender + cigarettes smoked per day + duration of smoking.

^h Model 1: menthol cigarette use + cigarettes smoked per day + smoking initiation age + current age; model 2: menthol cigarette use + cigarettes smoked per day + smoking initiation age + duration of smoking.

Table 10

Adjusted odds of being a short-term former^a versus current smoker based on menthol compared to non-menthol cigarette use (TUS-CPS, 2010/11).

	Model 1 ^b		Model 2 ^c	
	AOR ^d	95% CI ^d	AOR ^d	95% CI ^d
Former versus regular smoker ^e				
Non-Hispanic White	0.90	0.84, 0.96	0.90	0.85, 0.96
Non-Hispanic Black ^f	0.77	0.62, 0.96	0.71	0.57, 0.89
Other ^f	1.15	0.99, 1.35	1.13	0.97, 1.32
Former versus daily smoker ^e				
Non-Hispanic White	0.90	0.84, 0.96	0.90	0.85, 0.96
Non-Hispanic Black	0.79	0.63, 0.99	0.75	0.60, 0.94
Other	1.18	1.01, 1.38	1.16	0.99, 1.35

^a Short-term former smoker defined as having smoked ≥ 100 cigarettes, and having abstained from smoking for 1–3 years.

^b Model 1: menthol cigarette use + current age + HSI.

^c Model 2: menthol cigarette use + current age + night waking to smoke.

^d Adjusted odds ratio; 95% confidence interval.

^e Regular smoker defined as having smoked ≥ 100 cigarettes, and having smoked ≥ 10 days during the past month; daily smoker defined as having smoked ≥ 100 cigarettes, and having smoked daily during the past month.

^f Models exclude current age.

Among other race/ethnicity smokers, there is no statistically significant association between menthol cigarette use and being a short-term former versus current regular smoker, irrespective

Table 8

Spearman correlation coefficients of select variables (TUS-CPS, 2010/11).

	Time to first cigarette after waking	Night waking to smoke	Heaviness of Smoking Index
Time to first cigarette after waking	–	0.79	–0.94
Night waking to smoke	0.79	–	–0.83
Heaviness of Smoking Index	–0.94	–0.83	–

of whether HSI (Model 1) or night waking to smoke (Model 2) is included as a covariate (AOR 1.15, 95% CI: 0.99, 1.35; and, AOR 1.13, 95% CI: 0.97, 1.32, respectively). There is a statistically significant positive association between menthol cigarette use and being a short-term former versus current daily smoker among other races/ethnicities when HSI is included in the model (AOR: 1.18, 95% CI: 1.01, 1.38); substituting night waking to smoke for HSI provides nearly identical results (AOR: 1.16, 95% CI: 0.99, 1.35). Alternatively stated, other race/ethnicity menthol versus non-menthol smokers are statistically more likely to be former smokers when controlling for HSI, but not when night waking to smoke is substituted for HSI (Table 10).

4.3.3. NHIS (2005 and 2010), short-term former smokers (quit 1–3 years)

Although TUS-CPS provides data on prior smoking habits only among those smokers who had quit 1–3 years prior to survey participation, NHIS provides data among all former smokers who had quit an average of 18 years, and up to 70 years, prior to survey participation. To examine whether the restriction to short-term former smokers might explain differences in regression model estimates provided by the two surveys, new models were constructed that limited former smokers participating in NHIS to those who had quit smoking 1–3 years prior to survey participation. Irrespective of whether current age (Model 1) or duration of smoking (Model 2) is included as a covariate (Table 11), model estimates indicate no statistically significant associations between menthol cigarette use and being a short-term former versus current regular or daily smoker for any of the three race/ethnic groups (*i.e.*, non-Hispanic Whites, non-Hispanic Blacks or other races/ethnicities).

4.3.4. TUS-CPS (2010/11), short-term former smokers (quit 1–3 years) and limited smoking dependence measures

TUS-CPS provides data on several variables used to evaluate smoking dependence, while NHIS only provides data on number of cigarettes smoked per day and duration of smoking (calculated). To evaluate whether including the additional dependence measures in regression models based on data from TUS-CPS might explain differences in estimates provided by NHIS and TUS-CPS data sets, new models were constructed for TUS-CPS using only the variables also provided by NHIS, *i.e.*, gender, current age, num-

ber of cigarettes smoked per day, calculated duration of smoking and smoking initiation age (Table 12).

Among non-Hispanic White and other race/ethnicity smokers (*i.e.*, regular or daily smokers), there are no statistically significant associations between menthol cigarette use and being a short-term former versus current smoker when current age is included as a covariate (Model 1) (*e.g.*, non-Hispanic White daily smoker: AOR 0.98, 95% CI: 0.95, 1.01; other race/ethnicity daily smoker: AOR 1.00, 95% CI: 0.92, 1.09). However, when the highly correlated covariate, duration of smoking, is substituted for current age (Model 2), there are statistically significant inverse associations between menthol cigarette use and being a short-term former versus current smoker among non-Hispanic Whites and other races/ethnicities (*e.g.*, non-Hispanic White daily smoker: AOR 0.86, 95% CI: 0.84, 0.89; other race/ethnicity daily smoker: AOR 0.81, 95% CI: 0.75, 0.88). Among non-Hispanic Blacks, there are statistically significant inverse associations between menthol cigarette use and being a short-term former versus current regular or daily smoker, irrespective of which of the highly correlated covariates (*i.e.*, current age or duration of smoking) is included in the model. Point estimates for non-Hispanic Blacks vary considerably, depending on the covariate (*i.e.*, current age or duration of smoking) selected for inclusion in the model (Table 12).

5. Conclusions and discussion

The current analyses are based on data from two nationally representative surveys, *i.e.*, NHIS (2005 and 2010, combined) and the TUS-CPS (2010/11). While the two surveys are similar in their content, there are key differences between them that complicate the direct comparison of results. Specifically, NHIS captures information on past smoking habits among all respondents who identified themselves as former smokers at the time of the survey, with the mean time since quitting in this group being 18 years. In contrast, TUS-CPS presents questions regarding past smoking habits only to those who had quit smoking up to three years prior to the survey, but includes additional questions aimed at measuring smoking dependence beyond those included in NHIS. Regression models were constructed in an attempt to elucidate whether the inconsistent results from the two surveys could be explained by the differ-

Table 11

Adjusted odds of being a short-term former^a versus current smoker based on menthol compared to non-menthol cigarette use (NHIS, 2005 and 2010; limited quit duration).

	Model 1		Model 2	
	AOR ^b	95%CI ^b	AOR ^b	95% CI ^b
Former versus regular smoker ^c				
Non-Hispanic White ^d	1.00	0.82, 1.21	–	–
Non-Hispanic Black ^d	0.71	0.45, 1.11	–	–
Other ^e	0.84	0.60, 1.18	0.82	0.59, 1.15
Former versus daily smoker ^c				
Non-Hispanic White ^f	0.98	0.81, 1.19	–	–
Non-Hispanic Black ^d	0.70	0.45, 1.10	–	–
Other ^g	0.85	0.60, 1.20	0.83	0.59, 1.17

^a Short-term former smoker defined as having smoked ≥ 100 cigarettes, and having abstained from smoking for 1–3 years.

^b Adjusted odds ratio; 95% confidence interval.

^c Regular smoker defined as having smoked ≥ 100 cigarettes, and having smoked ≥ 10 days during the past month; daily smoker defined as having smoked ≥ 100 cigarettes, and having smoked daily during the past month.

^d Model includes only menthol cigarette use indicator.

^e Model 1: menthol cigarette use + smoking initiation age + current age; model 2: menthol cigarette use + smoking initiation age + duration of smoking.

^f Model 1: menthol cigarette use + cigarettes smoked per day.

^g Model 1: menthol cigarette use + smoking initiation age + current age; model 2: menthol cigarette use + smoking initiation age + duration of smoking.

Table 12

Adjusted odds of being a short-term former^a versus current smoker based on menthol compared to non-menthol cigarette use (TUS-CPS, 2010/11; limited smoking dependence measures).

	Model 1		Model 2	
	AOR ^b	95%CI ^b	AOR ^b	95% CI ^b
Former versus regular smoker ^c				
Non-Hispanic White ^d	0.97	0.94, 1.00	0.86	0.83, 0.88
Non-Hispanic Black ^d	0.87	0.80, 0.95	0.51	0.46, 0.56
Other ^d	0.99	0.91, 1.08	0.79	0.72, 0.85
Former versus daily smoker ^c				
Non-Hispanic White ^d	0.98	0.95, 1.01	0.86	0.84, 0.89
Non-Hispanic Black ^e	0.89	0.81, 0.98	0.50	0.46, 0.55
Other ^d	1.00	0.92, 1.09	0.81	0.75, 0.88

^a Short-term former smoker defined as having smoked ≥ 100 cigarettes, and having abstained from smoking for 1–3 years.

^b Adjusted odds ratio; 95% confidence interval.

^c Regular smoker defined as having smoked ≥ 100 cigarettes, and having smoked ≥ 10 days during the past month; daily smoker defined as having smoked ≥ 100 cigarettes, and having smoked daily during the past month.

^d Model 1: menthol cigarette use + smoking initiation age + gender + cigarettes smoked per day + current age; model 2: menthol cigarette use + smoking initiation age + gender + cigarettes smoked per day + duration of smoking.

^e Model 1: menthol cigarette use + gender + cigarettes smoked per day + current age; model 2: menthol cigarette use + gender + cigarettes smoked per day + duration of smoking.

ences in the available covariates or the required duration of quitting among former smokers; a qualitative summary is presented in Table 13.

Similar to inferences that can be drawn from the published literature, the collective findings from the new analyses provide inconsistent evidence regarding the presence or direction of an association between menthol cigarette use and the odds of being a former versus current smoker, within and between categories of race/ethnicity. Data from the NHIS (2005 and 2010) generally suggest no statistically significant association between menthol cigarette use and being a former versus current smoker for any of the three race/ethnic groups, while data from TUS-CPS (2010/11) generally suggest a statistically significant inverse association between menthol cigarette use and having quit smoking, particularly among non-Hispanic Blacks. For both data sets, the presence or absence of an association among at least one of the three race/ethnic groups examined depends on which of a pair of correlated covariates was included in the analysis. Different elements or measures of smoking dependence may be captured by the correlated covariates.

Limitations of the new analyses are related to the use of cross-sectional studies to examine the inherently time-dependent process of quitting smoking (*i.e.*, former smokers consist of individuals with different amounts of time since quitting), the reliance on self-reported quitting behaviors, and the challenges of defining successful quitting. Restricting all analyses to those who had quit at least one year prior to participating in each survey should have excluded those former smokers most likely to relapse to smoking (*e.g.*, Gilpin et al., 1997). Similarly, limiting the analyses to those who quit 1–3 years prior to the survey should have reduced both the variability among former smokers who were abstinent for different lengths of time and inaccuracies in recall of long-past smoking habits. There is no reason to expect differences in accuracy of recall among former smokers of menthol compared to non-menthol cigarettes; thus, there is little risk of bias influencing the direction of the observed associations.

These nationally representative surveys provide estimates for each of the three race/ethnicity groups. There are reasonable numbers of current and former smokers of both menthol and non-menthol cigarettes, allowing the use of multi-variable regression models to adjust for previously observed confounders, as well as stratified analyses to account for known differences by race/ethnicity in menthol cigarette use and likelihood of having quit smoking. The inconsistent patterns of results observed between data provided by NHIS and TUS-CPS are neither explained by differences in the definitions of former smokers (*i.e.*, long-term versus short-term quitters) nor by the inclusion or exclusion of additional indicators of smoking dependence.

Table 13

Qualitative summary of regression modeling results, adjusted odds of being a former versus current smoker based on menthol compared to non-menthol cigarette use.

	Race/ethnicity		
	Non-Hispanic White	Non-Hispanic Black	Other
NHIS (2005 and 2010; quit ≥ 1 years)			
Former versus regular	Null	Null or Inverse ^a	Null
Former versus daily	Null	Null or Inverse ^a	Null
NHIS (2005 and 2010; quit 1–3 years)			
Former versus regular	Null	Null	Null
Former versus daily	Null	Null	Null
TUS-CPS (2010/11; quit 1–3 years)			
Former versus regular	Inverse	Inverse	Null
Former versus daily	Inverse	Inverse	Null or Positive ^b
TUS-CPS (2010/11; quit 1–3 years, limited dependence measures)			
Former versus regular	Null or Inverse ^a	Inverse	Null or Inverse ^a
Former versus daily	Null or Inverse ^a	Inverse	Null or Inverse ^a

^a Depending on whether the model includes current age (at time of survey) or duration of smoking.

^b Depending on whether the model includes HSI or night waking to smoke.

Data from published studies employing various designs are likewise inconsistent, with some short-term intervention studies and cross-sectional studies reporting small positive or negative associations, and others reporting no association between menthol cigarette use and the likelihood of quitting smoking. Reports in the literature of positive or negative associations between menthol cigarette use and quitting smoking or being a former smoker, either overall or within particular race/ethnicity subgroups, likely reflect variations between study populations or inadequate control for confounding; such associations may likewise reflect the use of different or heterogeneous definitions of successful quitting (*i.e.*, inclusion of short-term rather than sustained success, or a combination of short and long-term quitters). Findings from cohort studies and intervention studies with larger sample populations and longer follow-up periods (Blot et al., 2011; Hyland et al., 2002; Murray et al., 2007; Pletcher et al., 2006) are generally consistent in indicating that menthol compared to non-menthol cigarette use is not associated with reduced quitting. Thus, despite some inconsistencies that will require additional evaluation based on more detailed data than are currently available, evidence from published studies and data from the new analyses presented here indicate no clear association between ability to quit smoking and menthol cigarette use.

Conflict of interest

Financial support for this work was provided through a contract between RAI Services Company (Winston-Salem, NC, USA) and ENVIRON International Corporation (Amherst, MA, USA). Sandra I. Sulsky, William G. Fuller and Cynthia Van Landingham are employees of ENVIRON International Corporation; Michael W. Ogden, James E. Swauger and Geoffrey M. Curtin are employees of RAI Services Company.

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