

Assessing the evidence on the differential impact of menthol versus non-menthol cigarette use on smoking cessation: A systematic review

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Abstract

Background: This systematic review followed PRISMA guidelines to examine the Key Question: *Does menthol cigarette use have a differential impact on smoking cessation compared with non-menthol cigarette use?*

Methods: The original protocol was registered on March 22, 2016 (updated January 10, 2019; PROSPERO: CRD42019119301). Six databases were queried from inception to December 14, 2018.

Results: Fifty-seven studies (27 rated “good”, 27 rated as “fair”, and three studies rated as “poor” individual study quality) that compared menthol and non-menthol smokers were qualitatively synthesized across the following cessation measures (total adjusted studies; strength of evidence grade): duration of abstinence (2; low); quit attempts (14; insufficient); rate of abstinence/quitting (28; moderate); change in smoking quantity/frequency (3; insufficient); and return to smoking/relapse (2; insufficient). Overall, the qualitative synthesis failed to show a consistent trend for the association of menthol cigarette use and smoking cessation across the outcomes. Further, meta-analytic results found no difference between menthol and non-menthol cigarette use and the two measures of quit attempts and duration of abstinence.

Implications: The overall strength of evidence for an association between menthol cigarette use and smoking cessation was graded as “low”, based on deficiencies of indirectness and inconsistency in the available body of evidence. Therefore, there is no consistent, significant, or differential association between menthol cigarette use and smoking cessation.

Background

Several literature reviews examining the potential association between menthol cigarette use and smoking behaviors have been conducted (1–3); however, review methods, included studies, and overall findings and conclusions have been inconsistent. Some of the discord may reflect the complicated constructs related to smoking behaviors and the varying measurements across studies (4, 5).

A recent meta-analysis examined the association between menthol cigarette use and the likelihood of smoking cessation (6). The study concluded that among Blacks/African Americans in the U.S. (one sample including respondents from Canada and the U.S.), menthol smokers had approximately 12 percent lower odds of smoking cessation compared to non-menthol smokers. However, the meta-analysis from Smith et al. was not based on a full systematic review of the available evidence and, therefore, did not provide a comprehensive or clear synthesis of the available evidence.

The purpose of this systematic review was to assess the potential association between menthol cigarette use and smoking cessation, with attention paid to the measures and methods used by the included studies.

Materials And Methods

Overview

The methods used for this review were applied to a larger systematic review of the association between menthol cigarette use and three smoking behaviors (**Figure 1**). Current results assess the Key Question (KQ), “Does menthol cigarette use have a differential impact on smoking cessation compared to non-menthol cigarette use?” The protocol for this systematic review was registered with the PROSPERO international prospective register of systematic reviews on March 22, 2016 and updated on January 10, 2019. The record is available at: https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=119301.

The literature search identified 851 potentially relevant articles across sources with 838 articles from online databases and 13 additional articles through other sources. After independent review of titles and abstracts by two members of the research team, 428 references were excluded, resulting in 423 articles being screened at the full-text level (provided in **SUPPLEMENTAL SECTION 1: References Included for Full-Text Review (n=423)**). An additional 305 articles were excluded at the full-text level (provided in **SUPPLEMENTAL SECTION 2: Excluded Studies Table (studies excluded at level 2 with reason for exclusion)**), resulting in 118 relevant articles eligible for inclusion (provided in **SUPPLEMENTAL SECTION 3: Included Studies List (n=118)**). The weighted overall kappa for inter-rated reliability at level 2 screening was 0.96. Fifty-seven studies (seven of which were reported in paired studies) evaluated the association between menthol cigarette smoking and smoking cessation.

Conceptual Framework

Smoking behaviors can vary across different population subgroups, suggesting that both individual and environmental factors influence smoking (7, 8). This review applied the Socio-Ecological Model created by McLeroy et al. (9) to guide consideration of the interrelationships between individuals and their social (micro-), physical (meso-), and policy (macro-) environments. This framework guided the sensitive analyses and further details on the conceptual framework are provided in **SUPPLEMENTAL SECTION 4: Conceptual Framework**.

Literature Search Methods

The search strategy included sources of published, peer-reviewed literature, theses and dissertations, and government and industry documents. The complete list of databases and search terms is provided in **SUPPLEMENTAL SECTION 5: Search Strategy Overview**.

Terminology

Detailed descriptions of terminology used to organize and synthesize this review are provided in **SUPPLEMENTAL SECTION 6: Terminology**.

Inclusion and Exclusion Criteria

Inclusion and exclusion criteria were developed with review and input from external subject matter experts in tobacco research and systematic reviews. Reasons for exclusion of individual studies are provided in full in **SUPPLEMENTAL SECTION 7: Inclusion/Exclusion**.

Outcomes and Related Psychometrics

Included studies reported on at least one of the following outcomes: duration of abstinence, quit attempts (any quit attempts; number of quit attempts per person), rate of abstinence/quitting, change in smoking quantity/frequency, and return to smoking/relapse. Recognizing that not all the outcome measures are likely to be equally valid and reliable, this review examined the following Contextual Question (CQ) to provide additional information and context for the results, “*Have measures used to examine cigarette smoking cessation been psychometrically assessed as valid and reliable?*” Further details are provided in **SUPPLEMENTAL SECTION 8: Contextual Question**.

Study Designs

Complete study and sample characteristics are provided in the Evidence Tables in **SUPPLEMENTAL SECTION 9: Study, Data Set, and Sample Characteristics** and **SUPPLEMENTAL SECTION 10: Evidence Tables, Sample Characteristics (Unadjusted [Table 10-1 and Table 10-2] and Adjusted [Table 10-3 and Table 10-4])**.

ASSESSMENT OF INDIVIDUAL STUDY METHODOLOGY

Quality Assessment

The quality of the studies included in this systematic review was assessed at the study level using the Downs and Black checklist (10), as recommended by the Cochrane Collaboration (11) and provided in **Table 12-1**. Further details on the Downs and Black checklist and study quality are provided in **SUPPLEMENTAL SECTION 11: Study Quality Assessments** and **SUPPLEMENTAL SECTION 12: Additional Study Quality Methods**.

Evidence Synthesis

The strongest evidence to assess whether menthol cigarette use has a differential impact on smoking cessation compared to non-menthol cigarette use would be expected to be provided by longitudinal analyses that adjusted or controlled for key confounding factors – age, race/ethnicity, and gender – by inclusion criteria, modeling, or stratification. Longitudinal analytic results were considered the highest available evidence and, as such, were weighed more heavily in the strength of evidence analysis and qualitative synthesis below. In the absence of longitudinal analytic results, the highest level of available evidence was synthesized according to studies that controlled for the predefined demographic factors.

STRENGTH OF EVIDENCE EVALUATION

The overall strength of the body of evidence was assessed and graded as “high,” “moderate,” “low,” or “insufficient” using the Evidence-Based Practice Center (EPC) approach. Full details are provided in **SUPPLEMENTAL SECTION 13: Strength of Evidence**.

RESULTS: SMOKING CESSATION OR QUITTING BEHAVIORS

A total of 57 studies, reported in 64 unique references, evaluated the potential association between menthol cigarette use and smoking cessation. **Table 1** below presents the five specific outcome measures for smoking cessation reported across adjusted and unadjusted studies; however, adjusted studies are considered a higher level of evidence in this synthesis. An overview of the psychometric findings for the measures of smoking cessation is presented in **Table 8-1**. A CQ evidence table, including reliability and validity data identified for each of the smoking-related outcome measures, is provided in **Table 8-2**.

Empirical data regarding reliability or validity qualified four of the five smoking cessation measures (duration of abstinence, quit attempts, rate of abstinence/quitting, change in smoking quantity/frequency) as “Acceptable.” Further detail on the non-systematic literature synthesis for psychometric assessment is provided in **SUPPLEMENTAL SECTION 8: Contextual Question**.

Synthesis of the Best Available Evidence

Summaries of the best available evidence – controlling for age, race/ethnicity, and gender – are presented by outcome measure below. Adjusted results by age, race/ethnicity, and gender subgroups are presented in **SUPPLEMENTAL SECTION 14: Adjusted Subgroup Analyses by Outcome**; unadjusted results from both the full sample and subgroups of age, race/ethnicity, and gender are presented in **SUPPLEMENTAL SECTION 15: Unadjusted Results**. Outcome measures are presented with a corresponding overview table for each outcome in the following order: duration of abstinence; quit attempts; rate of abstinence/quitting; change in smoking quantity/frequency; and return to smoking/relapse. Where two references reported the same data, the most recent publication was used as the data source.

Duration of Abstinence

Two studies, presented in **Table 2**, reported duration of abstinence.

Levy et al. (19) reported statistically significant lower odds of being a “recent” and “long-term” quitter for menthol compared with non-menthol smoking, across all models (AORs ranged from 0.92 to 0.97 across models). Cubbin et al. (20) reported duration of abstinence for six gender-race/ethnicity interactions, yielding only one significant finding that suggests that White female menthol smokers had been abstinent statistically significantly longer than White female non-menthol smokers (14.8 years vs. 12.5 years; $p < 0.01$). Given the limited number of studies and the inconsistent findings reported for this measure, an association between menthol cigarette use and duration of abstinence is unclear and undefined in the evidence base.

Quit Attempts (Any quit attempts; Number of quit attempts per person)

Fourteen studies, as presented in **Table 3**, reported measures of quit attempts.

Kahende et al. (34) reported White menthol smokers had statistically significant lower odds than White non-menthol smokers of having made a past-year quit attempt (AOR=0.91, 95% CI: 0.84 to 0.99; $p < 0.05$).

Nine studies found no difference between menthol and non-menthol smokers in terms of having made at least one quit attempt (within various timeframes), across all models and subgroup analyses/stratifications performed (14, 20, 31, 35-37, 40, 41, 46). In addition, Stahre et al. (32) found no significant difference in the odds of using any type of quit aid between menthol and non-menthol current smokers, and menthol and non-menthol former smokers.

Three studies reported mixed findings. Levy et al. (19) reported that menthol users had statistically significant higher odds of past-year quit attempts than non-menthol users (AOR=1.03, 95% CI: 1.02 to 1.03; $p < 0.001$); this result remained unchanged when adding nicotine dependence to the model. However, a third model (adjusting for additional, unspecified covariates) reported statistically significant lower odds of past year quit attempts among menthol users (AOR=0.98, 95% CI: 0.98 to 0.98). In Keeler et al. (29), the overall odds of past-year quit attempts between menthol and non-menthol smokers were no different. Both the 2017 and 2018 studies by Keeler et al. (29, 30) found Black menthol smokers were statistically significantly more likely to report past-year quit attempts than Black non-menthol smokers (2018: AOR=1.39, 95% CI: 1.16 to 1.67; $p < 0.001$; 2017: AOR=1.37, 95% CI: 1.16 to 1.61; $p = 0.0002$); however, no such differences were reported for other racial/ethnic subgroups.

The majority of the results from these fourteen studies reported no differences between menthol and non-menthol smoking in terms of quit attempts.

Rate of abstinence/quitting (including but not limited to prolonged abstinence [PA], point prevalence abstinence [PPA], identifiable cigarette type [menthol versus non-menthol] smoked before quitting, and being a former smoker [versus current smoker])

Twenty-eight studies (from 31 references), presented below in **Table 4**, reported on rate of abstinence/quitting outcomes.

Four studies found that menthol smokers had statistically significantly lower odds of quitting than non-menthol smokers: two studies reported 7-day PPA (between weeks 14 and 26 (62); and at the previous 7 days and at week 7 (27)). Additionally, two studies examined cessation at different time points (one year abstinence from purchasing a pack of cigarettes (53); and abstinence at three to six week follow-up (43)).

Fifteen studies (from 16 references) found no difference in the rate of abstinence between menthol and non-menthol smokers, both overall and within subgroup analyses, in terms of: 7-day PPA in six studies (23, 24, 63-66); 30-day PPA in one study (42); quit rates from baseline to follow-up in three studies from four references (41, 46, 50, 61); cessation of greater than 3 months in two studies (29, 30); PA in two studies (69, 70); and, past-year abstinence in one study (55).

Nine studies (from 11 references), reported mixed significance (47, 49, 52, 54, 56-59, 68, 71, 75). Using NHIS data, Sulsky et al. (54) found that White menthol and non-menthol regular and daily smokers were no different in odds of past-year abstinence; similar results were observed in Black menthol and non-menthol daily smokers. Using TUS-CPS data, the authors found no significant difference in one- to three-year abstinence between White menthol and non-menthol smokers (both regular and daily). For other race/ethnicities, no difference was detected between menthol and non-menthol use in terms of abstinence among regular and daily smokers. However, for Black daily (AOR=0.89, 95% CI: 0.81 to 0.98) and regular (AOR=0.87, 95% CI: 0.80 to 0.95) smokers, menthol use was statistically significantly associated with lower odds of abstinence.

Reitzel et al. (68) found that menthol and non-menthol smokers were no different in terms of short-term abstinence for the overall sample. However, among White participants, menthol use predicted a statistically significant decrease in short-term abstinence ($\beta = -1.56$, $SE = 0.79$; $\chi^2 = 3.96$; $p = 0.05$) as well as 7-day PPA ($\beta = -1.60$, $SE = 0.79$; $\chi^2(1) = 4.06$; $p = .04$; $n = 132$). No such differences were reported for either outcome among Black participants (short-term abstinence: $\beta = 0.54$, $SE = 0.55$; $p = 0.33$; and 7-day PPA: $\beta = 1.00$, $SE = 0.67$; $p = 0.11$).

Blot et al. (56) found that White menthol smokers had statistically significant greater odds of having quit compared with non-menthol smokers (AOR=1.55, 95% CI: 1.41 to 1.70); however, Black menthol and non-menthol smokers were no different.

Trinidad et al. (52) reported that, among White, Black, Asian-American/Pacific Islander, and Hispanic participants, menthol smoking was associated with statistically significant lower odds of abstinence greater than 6 months (AORs ranged from 0.28 to 0.48). However, among Native American/Alaskan native participants, menthol and non-menthol smokers were no different in terms of the odds of abstinence greater than 6 months.

Delnevo et al. (57, 58) reported on the odds of being a former smoker across five racial/ethnic subgroups and the following five sample restrictions (according to past and current smoking status): Former smokers who quit within the past 5 years and all current smokers (regardless of quit attempt history); former smokers who quit within the past 5 years and all current smokers (regardless of quit attempt history), both of whom currently do not use other tobacco products; former smokers who quit within the past 5 years and current smokers who reported ever having made a quit attempt; former smokers who quit within the past 5 years and current smokers who reported ever having made a quit attempt, both of whom currently do not use other tobacco products; and, past 12-month cigarette smokers who made a quit attempt or quit (i.e., former smokers). Among the overall sample, across four of the five restrictions, menthol cigarette smokers were statistically significantly less likely than non-menthol smokers to be former smokers with AORs ranging from 0.90 to 0.92.

Black menthol smokers were statistically significantly less likely to be former smokers compared to Black non-menthol smokers in all five restrictions with AORs ranging from 0.68 to 0.81. White menthol, versus non-menthol, smokers were statistically significantly less likely to be a former smoker across three restrictions. However, Hispanic menthol and non-menthol smokers were no different across four of the five restrictions; and, were statistically significantly less likely to be a former smoker in one restriction.

In Reitzel's 'Project Mom' (71, 75), menthol cigarette use did not predict continuous abstinence from smoking. However, among White women, menthol smokers were statistically significantly less likely to maintain continuous abstinence compared to non-menthol smokers (AOR=0.19, 95% CI: 0.04 to 0.89).

Gandhi et al. (47) found no difference between White menthol and non-menthol smokers in odds of abstinence at both four weeks and six months. Black menthol smokers had statistically significant lower odds of abstinence compared to Black non-menthol smokers at both time points, four weeks (measured by 7-day PPA) (AOR=0.32, 95% CI: 0.16 to 0.62) and at 6 months post-quit (AOR=0.48, 95% CI: 0.25 to 0.90). Hispanic menthol smokers had statistically significant lower odds of abstinence at four weeks compared to Hispanic non-menthol smokers (AOR=0.43, 95% CI: 0.1 to 0.9); at six months, Hispanic menthol and non-menthol smokers were no different in odds of abstinence.

Gundersen et al. (59) suggested no significant difference in being a former smoker between menthol and non-menthol smokers in the overall sample, nor among Black smokers. However, odds of being a former smoker were statistically significantly higher for White menthol compared to White non-menthol smokers (AOR=1.17, 95% CI: 1.00 to 1.36; $p<0.05$). Odds of being a former smoker were statistically significantly lower for Hispanic menthol compared to Hispanic non-menthol smokers (AOR=0.61, 95% CI: 0.39 to 0.97; $p=0.04$), and for non-White menthol compared to non-White non-menthol smokers (AOR=0.55, 95% CI: 0.43 to 0.71; $p<0.01$).

Okuyemi et al. (49) reported no significant difference in odds of quitting between menthol and non-menthol smokers among adults ≥ 50 years of age; however, in adults < 50 years of age, the odds of quitting for menthol smokers were statistically significantly lower for menthol smokers (AOR=2.02, 95% CI: 1.03 to 3.95).

Across the 28 studies, the majority of studies (15 studies) found no difference between menthol and non-menthol smokers in the rate of abstinence. Four studies reported that menthol smokers were statistically significantly less likely to quit smoking and nine studies reported results of mixed significance based on various stratifications. Overall, the evidence for this outcome was inconsistent for the association between menthol cigarette use and the rate of abstinence/quitting.

Change in Smoking Quantity/Frequency

Two studies (from four references), presented in **Table 5**, provided adjusted analysis of change in smoking quantity/frequency.

One study, from two references (46, 50) reported no difference between menthol and non-menthol cigarette users for changes in smoking frequency. One study (from two references) reported mixed significance. Reitzel et al. (71, 75) found that Black female menthol, versus non-menthol, smokers reported substantially less cigarette reduction (measured by CPD) over the course of 26 ($\beta=3.82$, $SE=3.77$; $p=0.02$; $n=71$). But no difference was found in changes in smoking frequency for the overall sample.

The overall evidence base for this outcome was limited by the small number of included studies, and the mixed significance of findings across studies precludes clear conclusions from the available evidence.

Return to Smoking/Relapse

Two studies, presented in **Table 6**, provided analyses of return to smoking/relapse.

In Muench and Juliano (74), menthol smokers were at a statistically significant greater risk of lapsing compared with non-menthol smokers, in both the univariate regression (AOR=3.474, $p<0.05$) and lapse survival curve analyses (HR=2.798, Wald statistic=2.79; $p=0.048$). Pletcher et al. (41), reported that young adult menthol smokers had a statistically significant higher likelihood of returning to smoking, compared to non-menthol smokers (AOR=1.89, 95% CI: 1.17 to 3.05; $p=0.009$).

The results from the two included studies suggest a higher likelihood of menthol smokers returning to smoking. However, the small number of studies—neither of which is based on a nationally representative sample—limit the generalizability of the association between menthol cigarette use and returning

to smoking/relapse.

SENSITIVITY ANALYSES (ADJUSTED RESULTS)

Three sensitivity analyses were conducted in order to test whether the results differed after more stringent inclusion and exclusion criteria were applied. Overall, results from the sensitivity analyses suggested little to no change. Full details on the sub-group analysis and sensitivity analyses are provided in **SUPPLEMENTAL SECTION 16: Sensitivity Analyses (Adjusted Results)**.

RESULTS OF META-ANALYSIS

All studies considered for meta-analyses controlled, at minimum, for age, gender, race/ethnicity. Menthol cigarette use was defined as either self-reported menthol use, current use, usual cigarette/brand used, or remaining with menthol cigarettes through the length of the study. Subgroup analyses were conducted to compare differences between study designs (prospective cohort and cross-sectional designs in abstinence [no duration]) and differences in measures (past year and ever quit attempt [ever quit attempts, any quit attempts between 2001 and 2005, and any quit attempts in the past 2, 3, or 5 years]). Further, sensitivity analyses were also completed according to race/ethnicity and abstinence verification (eCO verified), when possible. Pooled adjusted odds ratios (AORs) and 95% confidence intervals (CIs) with two-sided P values are reported from random-effects models utilizing the DerSimonian and Laird method (76) to measure the likelihood of reporting quit attempts and abstaining among menthol compared to non-menthol smokers. Pooled data for the meta-analyses were extracted for two outcome measures: quit attempts and duration of abstinence.

After screening all included adjusted studies, nine studies were included in the meta-analyses for quit attempts (14, 19, 29, 31, 34-36, 41, 46) and 12 studies for abstinence (23, 24, 27, 41, 47, 49, 56, 57, 59, 62, 64, 66). Full details are provided in **SUPPLEMENTAL SECTION 17: Characteristics, Definitions, and Covariates of Studies Included in the Meta-Analysis** and **SUPPLEMENTAL SECTION 18: Forest Plots of Meta-Analyses**.

Adjusted Odds of Reporting a Quit Attempt (Past Year or Ever)

Results from five studies (**Figure 18-1**) were pooled to measure the association of menthol use and past year quit attempts. Pooled results showed a statistically significant association between menthol, versus non-menthol, cigarette use and the increasing odds for past year quit attempts (OR=1.02, 95% CI: 1.01 to 1.03, p-value=0.003, I²=1%). However, the pooled result (**Figure 18-2**) from studies measuring ever quit attempts, any quit attempts between 2001 to 2005, and any quit attempt in the past 2, 3, or 5 years found no significant difference in the odds of making a quit attempt when comparing menthol and non-menthol smokers (OR=0.93, 95% CI, 0.82 to 1.05, p=0.23, I²=0%) (14, 41, 46). Results from two studies were pooled to measure for the association of menthol cigarette use and quit attempts (past year and quit attempts between 2001 and 2005) among Black participants (29, 46). Pooled results (**Figure 18-4**) showed a significant increase in the odds of Black menthol, versus non-menthol, smokers reporting quit attempts (OR=1.37, 95% CI: 1.17 to 1.61, p=0.00001, I²=14%). In contrast, among White menthol respondents in three studies (**Figure 18-5**), the odds of making a quit attempt were statistically significantly lower for menthol compared to non-menthol smokers (OR=0.95, 95% CI: 0.91 to 0.99, I²=0%) (29, 34, 46).

Adjusted Odds of Abstinence (No definition and 7-day PPA)

Data from four studies were pooled to measure the association of menthol use and abstinence (self-reported) with no specified duration of abstinence (41, 56, 57, 59). Recognizing the high heterogeneity balanced by the narrow confidence intervals, the pooled results showed no difference between menthol and non-menthol smokers in the odds of abstinence with no defined duration (**Figure 18-6**) (OR=0.96, 95% CI: 0.84 to 1.10, p=0.58, I²=71%).

Pooled data from three studies measuring the association of menthol use and abstinence with no specified duration of abstinence for Black and White menthol and non-menthol smokers were no different in terms of abstinence (56, 57, 59) (**Figures 18-7 and 18-8**) (OR=0.90, 95% CI: 0.73 to 1.10, p=0.29, I²=73%). Again, the heterogeneity was noted to be high. Individual meta-analysis results from four cohort studies measuring the association of menthol use and smoking abstinence measured by 7-day PPA are presented in **Figure 18-9**. When pooling results across these four studies, Black menthol smokers had statistically significantly lower odds of smoking abstinence 7-day PPA (OR=0.52, 95% CI: 0.38 to 0.70, p<0.0001, I²=0%) (**Figure 18-10**) (24, 27, 47, 49). These pooled results suggest an unclear association between cigarette type and abstinence. This may be due to the high heterogeneity among studies measuring this association, even when stratifying by study design and abstinence measures with specified duration.

STRENGTH OF EVIDENCE

Table 7a provides the SOE for the outcomes used in the current review to examine the association between menthol cigarette use and cessation outcomes. The adjusted data, treated as the higher level of evidence, were the primary source of data for this evidence synthesis and meta-analyses. Most measures were "indirect" and limited by the varying and/or undefined measures of abstinence. As presented in **Table 7b**, the overall strength of evidence for an association between menthol cigarette use and smoking cessation was graded as "low" based on deficiencies in the available evidence base.

Limitations

This systematic review was conducted according to established methodological standards and with inherent limitations. For example, the variation in the definitions of several outcome measures made it challenging to summarize results, which limited the reviewers' ability to draw confident conclusions. Most of the smoking behavior data were self-reported. However, any differential impact of reliance on self-reported data was expected to be minimal. The Downs and Black checklist has some limitations when applied across a variety of study designs. Furthermore, a study's quality score on the Downs and

Black checklist may reflect the quality of *reporting* rather than the quality of the study *as conducted*. Finally, the conclusions in this review are based on studies conducted in the U.S. and may or may not be generalizable to other countries due to the potential impact of important influences, such as cultural norms, smoking policies, and taxes on smoking behaviors outside of the U.S.

Discussion And Conclusions

Studies in the qualitative synthesis of this review were considered as providing the best available evidence on the differential impact of menthol versus non-menthol cigarette use on smoking cessation. Across studies, a variety of sampling and recruitment methods were used with varying definitions of current smoking and abstinence, and a range of study designs that, in many instances, did not directly address the current research question. Further, the available studies provided evidence that was inconsistent and imprecise—both across studies and within the same study.

Analyses of large cross-sectional studies yielded inconsistent findings. Among studies that used data from nationally representative samples, TUS-CPS and NHIS, population and sub-population results were mixed, based on modeling variation or definitions used; specifically, statistically significantly positive and negative associations between menthol cigarette use and smoking cessation were reported, as well as numerous non-significant findings.

Clinical trials are designed to assess associations between interventions and outcomes, providing the temporal component that cross-sectional data lack. No clinical trials included this review were designed with menthol as the “intervention” to which participants were assigned. Therefore, these studies were re-classified as short-term prospective cohort studies. There was no consistent pattern of a differential impact of menthol versus non-menthol cigarette use on smoking cessation, even when data were stratified by type of cessation intervention, duration of intervention and follow up, or definition of outcome (including biochemical validation of self-reported abstinence). Both the shortest (6 weeks) and the longest (12 months) clinical studies found mixed or equivalent results. In addition, trials of cessation inherently include self-selected participants at least interested or motivated to quit smoking. Relying solely—or mainly—on clinical trial data to draw conclusions about the association between menthol cigarette use and smoking cessation will yield a result with limited generalizability to the overall smoking population.

The included prospective studies varied in follow-up duration — a critical factor in assessing the durability of cessation. Of the ten prospective cohort studies that reported cessation, eight reported outcomes at six months or longer post-baseline. Specifically, three reported outcomes at six to twelve months, one followed participants for three to five years, and four assessed outcomes beyond five years post-baseline. Two of the three 6- to 12-month cohort studies included a cessation intervention of some form — 7-day and 30-day PPA. The third 6- to 12-month cohort study reported continuous abstinence.

In the longer-term cohort studies, results were of mixed significance. COMMIT (a community-based public health intervention conducted in 11 matched pairs of communities) assessed menthol smoking at baseline in 1988; participants were interviewed again in 1993, 1998, 2001, and 2005. Investigators found no difference between menthol, versus non-menthol, smokers and smoking cessation during 17 years of follow up. The CARDIA study, a cohort of young adults at baseline, found no association between menthol cigarette use and cessation at 15-year follow up. However, a statistically significant positive association between menthol cigarette use and the risk of smoking relapse was identified. Finally, a study that investigated the association between menthol smoking and quit rate found that menthol smokers had a statistically significant lower likelihood of quitting compared with non-menthol smokers.

Return to smoking/relapse and change in smoking quantity/frequency were each reported by only two studies, even with consideration of unadjusted results. Data were too limited to draw a reliable conclusion about the association between menthol cigarette use and either measure. Quit attempts — making at least one attempt and the number of quit attempts per person — were reported by several studies, but the measure does not reflect actual cessation. Given the lack of a significant difference between menthol and non-menthol smokers on either measure of quit attempts and the empirical uncertainty of the association between making a quit attempt or the number of quit attempts and actual cessation, there is no confident conclusion that can be drawn regarding an association with menthol smoking.

Pooled data for the meta-analyses were extracted for two outcome measures: quit attempts and abstinence. Pooled results from five studies suggested a statistically significant association between menthol cigarette use and increased odds for *past year quit attempts*. However, pooled data from three studies measuring *ever quit attempts* found no difference between menthol and non-menthol smokers in the odds of making a quit attempt. Pooling data from all eight studies revealed no consistent differences.

Additional analysis of pooled data from two studies presenting results on quit attempts among Black participants showed a statistically significant increase in odds for that Black menthol, versus non-menthol, smokers were statistically significantly more likely to make a quit attempt. Further, pooled data from three studies suggested that White menthol, versus non-menthol, smokers were statistically significantly less likely of making a quit attempt.

Four cohort studies presented results for examining the association between menthol use and abstinence, with no specified duration. Pooled results showed no difference between menthol and non-menthol smokers in terms of abstinence, even in sub-analyses of Black and White participants, using data from three of the four studies.

Across all four cohort studies, pooled results on the association between menthol use and abstinence, again with no specified duration, showed no difference between menthol and non-menthol smokers, overall, in the odds of abstinence. However, when measuring abstinence by 7-day PPA, pooled data suggest that Black menthol smokers were statistically significantly less likely than Black non-menthol smokers to be abstinent. Recognizing inconsistent results were reported across studies in the qualitative synthesis, meta-analytic results, generally, showed no difference between menthol

cigarette use and quit attempts (pooled results from ever, past year quit attempts, any quit attempts between 2001 to 2005, and any quit attempt in the past 2, 3, or 5 years), abstinence with no defined duration, and 7-day PPA.

The above conclusions contradict several existing literature reviews on this topic. The 2013/2015 FDA Report/Addendum (2, 3) concluded that menthol in cigarettes was “*likely associated with reduced success in smoking cessation, especially among Black menthol smokers.*” That finding was not supported by this newer, more comprehensive review. Similarly, the evidence that contributed to this review does not support the conclusion in the 2011 Report by the FDA’s Tobacco Products Scientific Advisory Committee (1) that “[e]vidence is sufficient to conclude that a relationship is more likely than not that the availability of menthol cigarettes results in lower likelihood of smoking cessation in Blacks.”

In summary, this review included nearly three times the number of studies as the 2013 FDA Report and 2015 Addendum, including 16 studies that analyzed data among Black smokers only, and the evidence is not strong or consistent enough to support a clear association—positive or negative—between menthol cigarette use and smoking cessation. Four of this review’s 16 studies that reported rates of abstinence/quitting among Black smokers reported that Black menthol smokers were statistically significantly less likely to become abstinent, compared with Black non-menthol smokers. However, ten studies found no difference between Black menthol and non-menthol cigarette smokers in terms of cessation, and two studies reported mixed or unclear results. Given the heterogeneity of study designs, applied measures, and the low strength of evidence, the available literature does not demonstrate a clear and confident differential association between menthol, versus non-menthol, cigarette use and smoking cessation.

Declarations

AUTHORS’ CONTRIBUTIONS: M.K. and G.M. co-lead the conceptualization of this review and served as subject matter experts throughout the review process. M.K. led the preparation and finalization of the manuscript. G.C. served as the second author for all aspects of the manuscript preparation process including critically revising the manuscript and reviewing accuracy of all technical details. The corresponding author attests that the listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Abbreviations

Abbreviation	Definition
AOR	adjusted odds ratio
BRFSS	Behavioral Risk Factor Surveillance System
CARDIA	Coronary Artery Risk Development in Young Adults
CI	confidence interval
COMMIT	Community Intervention Trial for Smoking Cessation
CPD	cigarettes per day
CQ	Contextual Question
EPC	Evidence-Based Practice Center
HR	hazard ratio
ITC-4	International Tobacco Control Four Country Survey
KIS	Kick it at Swope
KQ	Key Question
LYAC	Legacy Young Adult Cohort Study
NA	Not Applicable
NHIS	National Health Interview Survey
NHIS-CCS	National Health Interview Survey Cancer Control Supplement
PA	prolonged abstinence
POR	prevalence odds ratio
PPA	point (or period) prevalence abstinence
PR	prevalence ratio
SE	standard error
SOE	Strength of Evidence
TUS-CPS	The Tobacco Use Supplement to the Current Population Survey
U.S.	United States
WSHS	Wisconsin Smokers Health Study

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Tables

Table 1: Outcome Measures for Smoking Cessation across Adjusted and Unadjusted Studies

Measure and definition	Studies
Duration of abstinence	
Longest period of abstinence in past 12 months among current smokers	(12)
Longest period of abstinence among current smokers	(13), (14), (15), (16)
Duration of most recent quit attempt among current smokers	(15)
Percent reporting longest quit time longer than 90 days among current smokers	(17)
Quit within past year vs. at least 1 year among former smokers	(18)
Quit between 3 months and 1 year; quit between 3 months and 5 years among former smokers	(19)
Time since quit (continuous measure) among former smokers	(20), (21), (22)
Quit attempts (any quit attempts; number of quit attempts per person)	
Number of times during the past 12 months [respondent] stopped smoking for at least 24 hours because [respondent was] trying to quit	(14), (12), (23), (24), (25)
Number of times participant went at least 24 hours without smoking (no time period reported)	(26), (27)
Tried to quit smoking in the past 12 months	(28), (29), (30), (31), (32)
At least 24 hours without smoking in the past 12 months because [respondent was] trying to quit smoking	(25), (33), (34), (19), (35), (14), (12), (36)
At least 24 hours without smoking <i>ever</i> because [respondent was] trying to quit smoking	(14), (37)
Intentionally abstained for at least 24 hours in the past 3 months	(38), (39)
At least 24 hours without smoking in the past 6 months	(37)
Any attempts (undefined) to quit smoking [since previous interview]	(40), (41)
24-hour abstinence	(42)
Use of a cessation program or aid	(43), (27), (26), (32), (44)
Other or definition not reported (number of quit attempts)	(45), (17), (13), (46), (47), (48), (49), (50), (51), (16)
Other or definition not reported (number/percent who made a quit attempt)	(20), (46), (47), (50)
Other or definition not reported (time since most recent quit attempt)	(15)
Rate of abstinence/quitting (including but not limited to prolonged abstinence (PA), point prevalence abstinence (PPA), identifiable cigarette type [menthol versus non-menthol] smoked before quitting, and being a former smoker [versus current smoker])	
Not smoking at all in past 6 months	(46), (52), (50)
Not smoking at all in the past 3 months	(29), (30)
Not purchasing a pack in past year	(53)
Former smoker vs. current smoker	(54), (55)
Ever-smokers identifying as “non-smoker” or smoking “not at all” or “not currently” at interview/survey	(18), (56), (57), (58), (22), (59), (41)
Quit ratio: number of former smokers / number of current plus number of former smokers	(32)
Not smoking ≥ 1 CPD in past year	(55)
Abstinence over the past 5 years with mean smoking ≤ 1 CPD	(60)
Transition from non-established smoking to non-smoking	(61)
7-day PPA	(62), (45), (27), (63), (26), (64), (65), (47), (23), (24), (66), (48), (49)
30-day PPA	(42)
Salivary cotinine– verified cessation (≤ 20 ng/ml) at week 26	(67)
PA for 30 or more days during the 7 month follow-up period	(42)
PA since baseline or quit date	(68), (69), (70), (71)

Measure and definition	Studies
Menthol cigarette use prior to quitting	(54), (46), (50)
Rate of abstinence/quitting (abstinence definition not reported)	(43), (56), (72), (73)
Change in smoking quantity/frequency	
Difference/change in CPD	(67), (46), (71)
Change from smoking “every day” to smoking “some days”	(18)
Return to smoking/relapse	
(Rate of) return to smoking	(18), (71), (12), (41), (74)
Achieved PA but used tobacco in the past 30 days	(42)

CPD=cigarettes per day; ng/ml=nanograms per milliliter; PA=prolonged abstinence; PPA=point (or period) prevalence abstinence

Table 2: Summary of Evidence Related to Duration of Abstinence

Study	Sampling / Recruitment Strategy ^a , Data Collection Period	Study Findings	Study Quality
Decreased Duration of Abstinence with Menthol Cigarette Use			
(19)	TUS-CPS, 2003,2006/2007	Menthol cigarette use was associated with statistically significant lower odds of being a “recent” quitter (those who quit in the past year and had been abstinent for at least 3 months; AOR=0.97, 95% CI: 0.96 to 0.97; p<0.001) and a “long-term” quitter (those who quit in the past 5 years and had been abstinent for at least 3 months; AOR=0.94; 95% CI: 0.94 to 0.94; p<0.001), compared with use of non-menthol cigarettes. Further controlling for nicotine dependence resulted in nearly identical odds ratios for being a “recent” quitter (AOR=0.97, 95% CI: 0.96 to 0.97; p<0.001) and a “long-term” quitter (AOR=0.95; 95% CI: 0.95 to 0.95; p<0.001). A third adjusted model detected similar odds ratios for “recent” quitters (AOR=0.92, 95% CI: 0.91 to 0.92; p<0.001) and “long-term” quitters (AOR=0.95; 95% CI: 0.95 to 0.95; p<0.001).	Good
Results of Mixed Significance for Duration of Abstinence			
(20)	NHIS-CCS; 2005	<u>Increase in Duration of Abstinence with Menthol Cigarette Use</u> Among the six gender-race/ethnicity interactions, White female former menthol smokers reported statistically significantly longer abstinence than White female former non-menthol smokers (14.8 years vs. 12.5 years, respectively; p<0.01). <u>No Difference</u> For the other interactions (White males, Black females, Black males, Hispanic females, and Hispanic males), no difference was found.	Good

^a Details of sampling and recruitment strategies for the data sources can be found in **SUPPLEMENTAL SECTION 9: Study, Data Set, and Sample Characteristics, National Survey Details.**

Abbreviations: AOR=adjusted odds ratio; CI=confidence interval; NHIS-CCS=National Health Interview Survey Cancer Control Supplement; TUS-CPS=The Tobacco Use Supplement to the Current Population Survey.

Table 3: Summary of Evidence Related to Quit Attempts

Study	Sampling / Recruitment Strategy ^a , Data Collection Period	Study Findings	Study Quality
Decreased Quit Attempts with Menthol			
(34)	TUS-CPS; 2003, 2006/2007	White menthol smokers had statistically significant lower odds of having made a quit attempt in the past year (AOR=0.91, 95% CI: 0.84 to 0.99; p<0.05).	Fair
No Difference in Quits Attempt with Menthol Cigarette Use			
(31)	Dual frame random-digit dialing sample; October 2012 to July 2013	No difference between menthol and non-menthol smokers in the likelihood of a past-year quit attempt (AOR=1.19, 95% CI: 0.97 to 1.46; p=0.92).	Good
(37)	LYAC; 2011-2012	No difference between menthol and non-menthol smokers in ever having made a quit attempt (AOR=0.84, 95% CI: 0.43 to 1.63) or having made a quit attempt in the past 6 months (AOR=0.62, 95% CI: 0.30 to 1.27).	Fair
(40)	ITC-4, 2002-2011	No difference between smokers who switched from menthol to non-menthol cigarettes compared to smokers who continued smoking menthol cigarettes in quit attempts during (AOR=1.09, 95% CI: 0.78 to 1.52) or after (AOR=1.03, 95% CI: 0.66 to 1.60) the switch. Switchers from non-menthol to menthol cigarettes were also no different from smokers who attempted to quit but continued with non-menthol cigarettes during (AOR=1.12, 95% CI: 0.80 to 1.57) or after (AOR=0.91, 95% CI: 0.57 to 1.44) the switch.	Fair
(35)	BRFSS subsample from Florida; April 2007 – January 2008	No difference between menthol and non-menthol smokers in past year quit attempts (AOR=0.96, 95% CI: 0.81 to 1.15).	Good
(14)	TUS-CPS, 2006-2007	No difference between menthol and non-menthol smokers in the odds of making a quit attempt (AOR=0.98, 95% CI: 0.83 to 1.15).	Good
(20)	NHIS-CCS, 2005	No differences between menthol and non-menthol smokers across all six gender-race/ethnicity interactions in predicted past year quit attempts.	Good
(46)	COMMIT cessation trial; 1988-1993	No differences between menthol and non-menthol smokers in the odds of having made a quit attempt (AOR=0.91, 95% CI: 0.72 to 1.15); similarly, no differences were found when analyzing subgroups of Black and White smokers.	Good
(32)	NHIS-CCS, 2005	No differences between menthol and non-menthol current smokers (AOR=1.05, 95% CI: 0.80 to 1.36) or former smokers (AOR=1.29, 95% CI: 0.74 to 2.26) in using any type of quit aid.	Fair
(36)	TUS-CPS; young adults age 18 to 30; 2003	No differences between menthol and non-menthol current smokers (AOR=1.00, 95% CI: 0.89 to 1.16), current daily smokers (AOR=1.00, 95% CI: 0.85 to 1.18), or non-daily smokers (AOR=0.93, 95% CI: 0.62 to 1.41) in the odds of past-year quit attempts. Moreover, no difference was found in the odds of past-year quit attempts between menthol and non-menthol non-daily smokers who reported an intention to quit (AOR=1.35, 95% CI: 0.60 to 3.03).	Fair
(41)	CARDIA; men and women age 18-30 at baseline; 1985-2000	Adjusting for various factors in 3 models, results across all models were similar in direction, significance, and magnitude and found no difference between menthol and non-menthol smokers in the likelihood of having made a quit attempt in the period preceding each interview (AOR=0.77, 95% CI: 0.56 to 1.06; most restrictive model, adjusting for age, race/ethnicity, gender, social factors, and CPD at baseline).	Good
Results of Mixed Significance in Quit Attempts			
(30)	Probability sampling of stratified clusters of U.S. households; May/August 2006 to January 2007, and May/August 2010 to January 2011	<u>Increase with Menthol Cigarette Use</u> Black menthol, compared to non-menthol, smokers were statistically significantly more likely to report any past-year quit attempts (AOR=1.39, 95% CI: 1.16 to 1.67; p<0.001). <u>No difference</u> No difference between White menthol and non-menthol smokers in the odds of past-year quit attempts (AOR=0.95, 95% CI: 0.89 to 1.01; p=NS).	Fair

Study	Sampling / Recruitment Strategy ^a , Data Collection Period	Study Findings	Study Quality
(29)	Probability sampling of stratified clusters of U.S. households; 2006 to 2007 and 2010 to 2011	<p><u>Increase with Menthol Cigarette Use</u></p> <p>Black menthol smokers were statistically significantly more likely to report past-year quit attempts than non-menthol smokers (AOR=1.37, 95% CI: 1.16 to 1.61; p=0.0002).</p> <p><u>No difference</u></p> <p>No difference between menthol and non-menthol smokers in past-year quit attempts (AOR=0.99 95% CI: 0.94 to 1.04; p=0.6690).</p> <p>Similarly, no difference in the odds of past-year quit attempts between: White menthol and non-menthol smokers (AOR=0.97, 95% CI: 0.91 to 1.02; p=0.2450); Asian menthol and non-menthol smokers (AOR=0.91, 95% CI: 0.62 to 1.34; p=0.6470); or Hispanic menthol and non-menthol smokers (AOR=1.09, 95% CI: 0.91 to 1.30; p=0.3540).</p>	Fair
(19)	TUS-CPS; current smokers and former smokers who quit between 3 months and 5 years prior to the survey interview; 2003, 2006/2007	<p><u>Increase with Menthol Cigarette Use</u></p> <p>Menthol, versus non-menthol, smokers who were smoking 1 year prior to the interview had a statistically significant higher likelihood of past year quit attempts (AOR=1.03, 95% CI: 1.02 to 1.03; p<0.001). Further controlling for nicotine dependence resulted in a nearly identical and statistically significant higher likelihood of a past year quit attempt for menthol, versus non-menthol, smokers who were smoking 1 year prior to the interview (AOR=1.02, 95% CI: 1.02 to 1.03; p<0.001).</p> <p><u>Decrease with Menthol Cigarette Use</u></p> <p>A third adjusted model reported statistically significant lower odds of past-year quit attempts for menthol, versus non-menthol, smokers (AOR=0.98, 95% CI: 0.98 to 0.98).</p>	Good

^a Details of sampling and recruitment strategies for the data sources can be found in **SUPPLEMENTAL SECTION 9: Study, Data Set, and Sample Characteristics, National Survey Details.**

Abbreviations: AOR=adjusted odds ratio; BRFSS=Behavioral Risk Factor Surveillance System; CARDIA=Coronary Artery Risk Development in Young Adults; CI=confidence interval; COMMIT=Community Intervention Trial for Smoking Cessation; ITC-4= International Tobacco Control Four Country Survey; LYAC=Legacy Young Adult Cohort Study; NHIS-CCS=National Health Interview Survey Cancer Control Supplement; TUS-CPS=The Tobacco Use Supplement to the Current Population Survey

Table 4: Summary of Evidence Related to Rate of Abstinence/Quitting

Study	Sampling / Recruitment Strategy ^a , Data Collection Period	Study Findings	Study Quality
Decreased Rate of Abstinence/Quitting with Menthol Cigarette Use			
(43)	New York City Nicotine Patch and Gum Program; 2012	Smoking menthol cigarettes was associated with a 10% lower prevalence of quitting (PR=0.90, 95% CI: 0.83 to 0.97) after 3 to 6 weeks.	Poor
(53)	Nielsen Homescan Panel; January 2004-December 2009	Menthol smokers had a statistically significant lower likelihood of quitting compared with non-menthol smokers (HR=0.79, 95% CI: 0.64 to 0.99).	Fair
(62)	A trial of 166 weight-concerned smokers who smoked at least 10 CPD for at least a year and had at least one prior quit attempt; 2005-2009	Menthol smokers were statistically significantly less likely to be abstinent; specifically, non-menthol smokers were 2.4 times more likely to report 7-day PPA Weeks 14 and 26 (Week 14: AOR=2.40, 95% CI: 1.04 to 5.55; Week 26 AOR=2.47, 95% CI: 1.40 to 5.90; p=0.04).	Good
(27)	KIS-III trial; community-based clinic sample serving a predominantly Black population; 2007-2010	Menthol cigarette use was associated with statistically significant lower odds of cotinine-verified 7-day PPA at the end of 7 weeks of treatment compared to non-menthol cigarette use; specifically, non-menthol, compared to menthol, smokers had 84 percent greater odds of 7-day PPA at week 7 (AOR=1.84, 95% CI: 1.01 to 3.36; p<0.05).	Good
No Difference in Rate of Abstinence/Quitting with Menthol Cigarette Use			
(30)	Probability sample of U.S. households; personal and telephone interviews; May/August 2006 to January 2007, and May/August 2010 to January 2011	No difference between Black menthol and non-menthol smokers in the rate of successful cessation (≥ 3 months) (AOR=1.01, 95% CI: 0.70 to 1.45; p=NS). Similarly, no difference was found for the rate of successful cessation (≥ 3 months) between White menthol and non-menthol smokers (AOR=0.94, 95% CI: 0.84 to 1.07).	Fair
(29)	Probability sample of U.S. households; personal and telephone interviews; 2006 to 2007 and 2010 to 2011	No difference between menthol and non-menthol smokers in the odds of cessation (≥ 3 months) (AOR=0.92 95% CI: 0.83 to 1.03; p=0.1470). Similarly, no difference for the odds of cessation in subgroup analyses of: Black menthol and non-menthol smokers (AOR=1.03, 95% CI: 0.73 to 1.44; p=0.8630); White menthol and non-menthol smokers (AOR=0.94, 95% CI: 0.84 to 1.06; p=0.3190); Asian menthol and non-menthol smokers (AOR=0.98, 95% CI: 0.44 to 2.19; p=0.9540); and Hispanic menthol and non-menthol smokers (AOR=0.88, 95% CI: 0.60 to 1.28; p=0.4980).	Fair
(63)	Randomized trial of U.S. substance use outpatient treatment program participants receiving smoking cessation treatment; Feb 2010-July 2012	No difference in effect for smoking cessation (as measured by 7-day PPA at week 10) between menthol and non-menthol cigarette type among either the cocaine-dependent (p=0.81) or methamphetamine-dependent (p=0.9) participants.	Fair
(42)	ClearWay Minnesota phone line; September 2009 – July 2011, 7-month post-registration follow-up survey March 2010-February 2011	No difference between menthol and non-menthol smokers in the odds of quitting (as assessed by 30-day PPA) (AOR=1.29, 95% CI: 0.77 to 2.15).	Fair
(61)	ALLTURS; U.S. school-based survey of middle and high school youth; 2000-2002	No difference between those who initiated smoking with menthol and non-menthol in quit rates (AOR=1.18, 95% CI: 0.78 to 1.80; ref=NM).	Good
(70)	Project BREAK FREE; Houston metro area; 2005-2007	No difference between menthol and non-menthol cigarette use in predicting prolonged abstinence from smoking among Black smokers in adjusted analyses ($\beta=.33$, SE=.32; $\chi^2=1.06$; p=.30; n=457).	Fair

Study	Sampling / Recruitment Strategy ^a , Data Collection Period	Study Findings	Study Quality
(69)	Project CARE; Texas; 2005-2007	No difference between menthol and non-menthol cigarette use in predicting prolonged abstinence from smoking in adjusted analyses ($\beta=0.05$, $SE=0.25$; $\chi^2=0.04$; $p=0.84$).	Fair
(64)	Cessation study that enrolled 723 smokers age 16-78	No difference between menthol and non-menthol smokers in the odds of abstinence (7-day PPA) at 6 months after target quit date (AOR=1.02, 95% CI: 0.66 to 1.58).	Good
(46)	COMMIT cessation trial; modified random-digit-dial method of approximately 5,400 HHs with focus on communities with the highest prevalence of non-Whites; 1988-2001	No differences in quit rates between menthol and non-menthol smokers who were smoking from 1988 to 2001 and had not attempted to quit (AOR=0.84, 95% CI: 0.61 to 1.15), who had attempted to quit (AOR=1.03, 95% CI: 0.71 to 1.48), or among the corresponding White sub-samples (no quit attempts: AOR=0.79, 95% CI: 0.56 to 1.11; quit attempts: AOR=0.96, 95% CI: 0.65 to 1.41). Also, no difference in quitting between menthol and non-menthol cigarette use in 1988 among: smokers in 1993 (AOR=1.00, 95% CI: 0.90 to 1.11); White smokers (AOR=0.94, 95% CI: 0.83 to 1.05); Black smokers (AOR=1.04, 95% CI: 0.73 to 1.47); and Hispanic smokers (AOR=1.22, 95% CI: 0.80 to 1.87).	Good
(65)	Female prison sample; June 2004-June 2006	No differences between menthol and non-menthol smokers in smoking cessation (as evaluated by 7-day PPA) (Wald chi-square=1.2; $p=0.272$; and with interaction of race X menthol: Wald chi-square=0.1; $p=0.27$).	Fair
(23)	VA medical center sample; February-October 2002	No difference between menthol and non-menthol smokers in smoking abstinence (as assessed by self-reported 7-day PPA) (AOR=1.31, 95% CI: 0.95 to 1.82).	Good
(24)	KIS trial; cessation program of an inner-city health center mostly serving a low-income Black population; March 2003-June 2004	No difference was found for 7-day PPA at week 26 ($p=0.93$) between categorized age (< 50 versus ≥ 50 years) and menthol status. Further, among the <50 years of age group, no difference between menthol and non-menthol smokers in cessation rates (AOR=2.077, 95% CI: 0.944 to 4.569; $p=0.069$). Likewise, among those ≥ 50 years, no difference between menthol and non-menthol cigarette use in abstinence (AOR=1.676; 95% CI: 0.760 to 3.698; $p=0.221$).	Good
(66)	Convenience sample of patients attempting to quit at a specialist tobacco dependence treatment outpatient clinic; 2001-2006	At the four-week follow up, was no difference between menthol and non-menthol smokers in 7-day PPA (AOR=1.36, 95% CI: 1.0 to 1.86).	Good
(41)	CARDIA; men and women in the U.S. age 18-30 at baseline with follow-up data through year 19; 1985-2000	No different between menthol and non-menthol smokers in quit rate (i.e., not currently smoking at any examination) (AOR=0.90, 95% CI: 0.68 to 1.19). There was also no difference in quitting between menthol and non-menthol smokers who tried to quit (AOR=1.00, 95% CI: 0.71 to 1.42). In longitudinal analyses, no difference between menthol and non-menthol smokers in sustained smoking cessation (AOR=0.71, 95% CI: 0.49 to 1.02; $p=0.06$).	Good
(55)	Newly diagnosed, non-surgical cancer patients; 1981-1999	In adjusted analyses, no difference was found between menthol and non-menthol cigarette use in continued smoking among Black participants (POR=1.1, 95% CI: 0.8 to 1.4) and White participants (POR=1.1, 95% CI: 1.0 to 1.3).	Fair
Results of Mixed Significance in Rate of Abstinence/Quitting			
(54)	NHIS; 2005,2010; TUS-CPS; 2010/2011	<u>Decrease with Menthol Cigarette Use</u> According to the TUS-CPS data, menthol cigarette use among Black regular and daily smokers was statistically significantly lower for the adjusted odds of abstinence for 1-3 years (regular smokers: AOR=0.87, 95% CI: 0.80 to 0.95; daily smokers: AOR=0.89, 95% CI: 0.81 to 0.98). <u>No Difference</u> According to the NHIS data, among White participants, there was no difference between menthol regular and daily smokers in the adjusted odds of past-year abstinence (regular smokers: AOR=1.06, 95% CI: 0.95 to 1.18; daily smokers: AOR=1.04, 95% CI: 0.82 to 1.33). No difference between White menthol and non-menthol regular and daily smokers in the adjusted odds of abstinence for 1-3 years (regular smokers: AOR=0.97, 95% CI: 0.94 to 1.00; daily smokers: AOR=0.98, 95% CI: 0.95 to 1.01). For participants whose race/ethnicity was other than White or Black, no difference for abstinence for 1-3 years between menthol and non-menthol smokers (regular smokers: AOR=0.99, 95% CI: 0.91 to 1.08; daily smokers: AOR=1.00, 95% CI: 0.92 to 1.09).	Good

Study	Sampling / Recruitment Strategy ^a , Data Collection Period	Study Findings	Study Quality
(68)	Texas; lung cancer case-control study; February 1996-July 2001	<p><u>Decrease with Menthol Cigarette Use</u></p> <p>Menthol cigarette use was statistically significantly associated with a lower probability of short-term continuous smoking abstinence among White participants ($\beta=-1.56$, $SE=0.79$; $\chi^2=3.96$; $p=0.05$). Racially stratified analyses also found a statistically significant association of menthol cigarette use with 7-day PPA smoking abstinence through post-quit Week 3 among White participants ($\beta=-1.90$, $SE=0.82$; $p=0.02$).</p> <p><u>No difference</u></p> <p>No significant effect of menthol cigarette use status on continuous short-term smoking abstinence ($\beta=-0.31$, $SE=0.40$; $\chi^2=0.60$; $p=0.44$).</p> <p>Moreover, no difference between Black menthol, versus non-menthol, smokers for short-term continuous smoking abstinence ($\beta=0.54$, $SE=0.55$; $\chi^2=0.95$; $p=0.33$); even after racially stratifying analyses, no difference between Black menthol and non-menthol smokers according to 7-day PPA ($\beta=1.00$, $SE=0.67$; $p=0.11$).</p>	Fair
(56)	40-79 year olds living in southern U.S. states; March 2002 – September 2009	<p><u>Increase with Menthol Cigarette Use</u></p> <p>Adjusting for age and other covariates, White menthol, versus non-menthol, cigarette smokers were more likely to have quit smoking prior to study enrollment (AOR=1.55, 95% CI: 1.41 to 1.70).</p> <p><u>No difference</u></p> <p>No difference between Black menthol and non-menthol cigarette smokers in the likelihood of quitting smoking prior to study enrollment (AOR=1.03, 95% CI: 0.96 to 1.11).</p>	Fair
(57, 58)	TUS-CPS, 2003,2006/2007	<p>Adjusted odds of being a former smoker (menthol versus non-menthol) was measured across five sample restrictions: cigarette smokers and former smokers who quit in the past 5 years (restriction 1); cigarette smokers and former smokers who quit in the past 5 years who do not currently use other tobacco products (restriction 2); cigarette smokers and former smokers who quit in the past 5 years who have made a quit attempt (restriction 3); cigarette smokers and former smokers who quit in the past 5 years who have made a quit attempt and do not currently use other tobacco products (restriction 4); and past-year smokers (restriction 5, also adjusting for past-year cigarette tax increase).</p> <p><u>Decrease with Menthol Cigarette Use</u></p> <p>The odds of being a former smoker were statistically significantly lower among menthol, versus non-menthol, smokers in the overall sample with the least restrictions (restriction 1; AOR=0.91, 95% CI: 0.87 to 0.96). The same statistically significant difference was consistently found across restrictions 2, 3, and 4 with AORs ranging from 0.90 to 0.92.</p> <p>Black menthol smokers were statistically significantly less likely to be former smokers with restriction 1 (AOR=0.81, 95% CI: 0.67, 0.98) and across all four additional sample restrictions with the range of AORs from 0.68 to 0.81.</p> <p>White menthol smokers had statistically significant lower odds of being a former smoker (AOR=0.93, 95% CI: 0.88, 0.98) across three of the five sample restrictions (1, 2 and 3).</p> <p>Puerto Rican menthol smokers were consistently and statistically significantly less likely to be former smokers across all five sample restrictions, with AORs ranging from 0.42 to 0.63.</p> <p><u>Increase with Menthol Cigarette Use</u></p> <p>Two of the five sample restrictions (2 and 4) reported statistically significant higher odds of being a former smoker among Mexican menthol, versus non-menthol, smokers with AORs of 1.34 and 1.35, respectively.</p> <p><u>No difference</u></p> <p>No difference between menthol and non-menthol smokers was found in the adjusted odds of being a former smoker for the overall sample (AOR =0.922, 95% CI: 0.847 to 1.004).</p> <p>Also, no difference between White menthol and non-menthol smokers in the odds of being a former smoker (restrictions 4 and 5); likewise, no difference between Hispanic menthol and non-menthol smokers (restrictions 1 to 4); and, no difference between Mexican menthol and non-menthol smokers (restrictions 1, 3, and 5).</p>	Good

Study	Sampling / Recruitment Strategy ^a , Data Collection Period	Study Findings	Study Quality
(71, 75)	Project MOM; 2005-2007	<p><u>Decrease with Menthol Cigarette Use</u></p> <p>Adjusting for age, partner status, income, and educational achievement, time, treatment group, CPD, and time to the first cigarette of the day, White female menthol, versus non-menthol, cigarette smokers were statistically significantly less likely to maintain continuous abstinence ($\beta=-1.62$, $SE=0.76$; $\chi^2=4.49$; $p=0.03$; $AOR=0.19$, 95% CI: 0.04 to 0.89).</p> <p><u>No Difference</u></p> <p>Across the entire sample, no difference between menthol and non-menthol use in continuous abstinence from smoking through 26 weeks postpartum ($\beta=-0.32$, $SE=0.30$; $p=0.29$; $n=297$).</p> <p>No difference between Black female menthol and non-menthol smokers in continuous abstinence ($\beta=-1.12$, $SE=.64$; $c^2=3.06$; $p=.08$; $n=96$); likewise, no difference between Latina female menthol and non-menthol smokers in continuous abstinence ($\beta=.46$, $SE=.50$; $c^2=.86$; $p=.35$; $n=93$).</p>	Good
(52)	TUS-CPS; 2003, 2006-2007	<p><u>Decrease with Menthol Cigarette Use</u></p> <p>The odds of successful quitting for ≥ 6 months among former smokers was statistically significantly less likely in menthol, versus non-menthol, smokers, across all race/ethnicity subgroups evaluated: White smokers ($AOR=0.28$, 95% CI: 0.25 to 0.33); Black smokers ($AOR=0.23$, 95% CI: 0.17 to 0.31); Asian-American/Pacific Islander smokers ($AOR=0.22$, 95% CI: 0.11 to 0.45); and Hispanic/Latino smokers ($AOR=0.48$, 95% CI: 0.34 to 0.69).</p> <p><u>No Difference</u></p> <p>No difference between Native American/Alaskan Native former menthol and non-menthol smokers in the odds of successful quitting for ≥ 6 months ($AOR=0.49$, 95% CI: 0.14 to 1.71).</p>	Good
(47)	Outpatient tobacco treatment clinic patients; January 2001-June 2005	<p><u>Decrease with Menthol Cigarette Use</u></p> <p>The odds of Black menthol, versus non-menthol, smokers' abstinence were statistically significantly lower at 4 weeks (measured by 7-day PPA) ($AOR=0.32$, 95% CI: 0.16 to 0.62) and at 6 months post-quit ($AOR=0.48$, 95% CI: 0.25 to 0.90).</p> <p>Hispanic menthol, versus non-menthol, smokers' odds of abstinence at 4 weeks post-quit were also statistically significantly lower ($AOR=0.43$, 95% CI: 0.1 to 0.9).</p> <p><u>No Difference</u></p> <p>No difference between White menthol and non-menthol smokers in the likelihood of abstinence at 4 weeks ($AOR=0.96$, 95% CI: 0.72 to 1.20) or 6 months post-quit ($AOR=1.0$, 95% CI: 0.8 to 1.4). Also, no difference between Hispanic menthol and non-menthol smokers in the odds of abstinence at 6 months ($AOR=0.64$, 95% CI: 0.2 to 1.80).</p>	Fair
(59)	NHIS-CCS; 2005	<p><u>Decrease with Menthol Cigarette Use</u></p> <p>Subgroup analysis found that Hispanic menthol, versus non-menthol, smokers were statistically significantly less likely to have quit smoking ($AOR=0.61$, 95% CI: 0.39 to 0.97; $p=0.04$).</p> <p>When Black and Hispanic smokers were combined (defining a "non-White" subsample), non-White menthol, versus non-menthol, smokers were statistically significantly less likely to have quit smoking ($AOR=0.55$, 95% CI: 0.43 to 0.71; $p<0.01$).</p> <p><u>Increase with Menthol</u></p> <p>Subgroup analysis found that White menthol, versus non-menthol, smokers were statistically significantly more likely to have quit smoking ($AOR=1.17$, 95% CI: 1.00 to 1.36; $p<0.05$).</p> <p><u>No difference</u></p> <p>Without stratifying for race/ethnicity, no difference between menthol and non-menthol smokers in smoking cessation ($AOR=1.05$, 95% CI: 0.92 to 1.21).</p> <p>Subgroup analysis: no difference between Black menthol and non-menthol smokers in the odds of smoking cessation ($AOR=0.78$, 95% CI: 0.56 to 1.09).</p>	Good
(49)	KIS trial; August 2000-November 2000.	<p><u>Decrease with Menthol Cigarette Use</u></p> <p>Although biochemically verified 7-day PPA abstinence was measured at both six weeks and six months, authors only modeled for six weeks "because univariate analysis did not reveal significant differences in abstinence rates between menthol and non-menthol smokers at 6 months." In addition, overall modeled results were not presented.</p> <p>Among adults < 50 years of age, non-menthol, versus menthol, smokers had statistically significantly higher odds of quitting ($AOR=2.02$, 95% CI: 1.03 to 3.95).</p> <p><u>No Difference</u></p> <p>No difference between menthol and non-menthol smokers >50 years of age in abstinence rates ($p=0.57$).</p>	Good

^a Details of sampling and recruitment strategies for the data sources can be found in **SUPPLEMENTAL SECTION 9: Study, Data Set, and Sample Characteristics, National Survey Details.**

Abbreviations: AOR=adjusted odds ratio; CI=confidence interval; CPD=cigarettes per day; HR=hazard ratio; KIS=Kick it at Swope; NHIS=National Health Interview Survey; POR=prevalence odds ratio; PPA=point (or period) prevalence abstinence; SE=standard error; PR=prevalence ratio; TUS-CPS=The Tobacco Use Supplement to the Current Population Survey; WSHS=Wisconsin Smokers Health Study

Table 5: Summary of Evidence Related to Change in Smoking Quantity/Frequency

Study	Sampling / Recruitment Strategy ^a , Data Collection Period	Study Findings	Study Quality
No Difference in Change in Smoking Quantity/Frequency with Menthol Cigarette Use			
(50); (46)	COMMIT; 1988-2001	No difference between menthol and non-menthol smokers in the odds of reducing daily cigarette use over 3 years (AOR=0.83, 95% CI: 0.64 to 1.07); subgroup analyses of Black and White smokers also found no difference. Similarly, change in CPD in 1993 according to cigarette type smoked in 1988 was no different in the overall sample (β -coefficient=0.11, 95% CI: -0.38 to 0.60), nor in Black, White, or Hispanic subgroups.	Good
Results with Mixed Significance in Smoking Quantity/Frequency			
(71, 75)	Project MOM; 2005-2007	<u>Decrease with Menthol Cigarette Use</u> Black female menthol, versus non-menthol, smokers reported substantially less cigarette reduction (measured by CPD) over the course of 26 weeks (β =3.82, SE=3.77; p=0.02; n=71). <u>No Difference</u> No difference among female menthol and non-menthol smokers, overall, in changes in smoking frequency over the 26-week period (β =-0.38, SE=1.15; t=-.33; p=.74; n=222).	Good

^a Details of sampling and recruitment strategies for the data sources can be found in **SUPPLEMENTAL SECTION 9: Study, Data Set, and Sample Characteristics, National Survey Details.**

Abbreviations: AOR=adjusted odds ratio; COMMIT=Community Intervention Trial for Smoking Cessation; CI=confidence interval; SE=standard error

Table 6: Summary of Evidence Related to Return to Smoking/Relapse

Study	Sampling / Recruitment Strategy ^a , Data Collection Period	Study Findings	Study Quality
Increased Return to Smoking/Relapse with Menthol Cigarette Use			
(74)	Sample was recruited from the Washington DC metropolitan area through flyers, word of mouth, and online advertisements	According to logistic regression model results, menthol cigarette use was statistically significantly associated with greater lapse risk (AOR=3.474, p<0.05). Similarly, menthol, versus non-menthol, use was statistically significantly higher for risk of lapsing within the first 48 hours of abstinence (HR=2.798, Wald statistic=2.79; p=0.048).	Good
(41)	CARDIA; 1985-2000	The odds of returning to smoking post-cessation were statistically significantly higher for menthol, versus non-menthol, smokers (AOR=1.89, 95% CI: 1.17 to 3.05; p=0.009).	Good

^a Details of sampling and recruitment strategies for the larger and/or national surveys can be found in **SUPPLEMENTAL SECTION 9: Study, Data Set, and Sample Characteristics, National Survey Details.**

Abbreviations: AOR=adjusted odds ratio; CARDIA=Coronary Artery Risk Development in Young Adults; CI=confidence interval; HR=hazard ratio

Table 7a: Strength of Evidence Assessment by Measure

	Study limitations	Directness	Consistency	Precision	SOE	CQ assessment
Duration of abstinence						
ADJUSTED	Low	Direct	Inconsistent	Precise	Low	Acceptable
UNADJUSTED	Medium	Direct	Consistent	Imprecise	Low	Acceptable
Quit Attempts						
ADJUSTED	Low	Indirect	Inconsistent	Imprecise	Insufficient	Acceptable
UNADJUSTED	Medium	Indirect	Inconsistent	Imprecise	Insufficient	Acceptable
Rate of abstinence/quitting						
ADJUSTED	Low	Direct	Inconsistent	Imprecise	Moderate	Acceptable
UNADJUSTED	Medium	Direct	Consistent	Imprecise	Low	Acceptable
Change in quantity/frequency						
ADJUSTED	Low	Indirect	Consistent	Imprecise	Insufficient	Acceptable
UNADJUSTED	Low	Indirect	Inconsistent	Imprecise	Insufficient	Acceptable
Return to smoking/relapse						
ADJUSTED	Low	Direct	Inconsistent	Imprecise	Insufficient	Inconclusive
UNADJUSTED	Medium	Direct	Unknown*	Imprecise	Insufficient	Inconclusive
*Single-study evidence base						

CQ = Contextual Question; SOE = Strength of Evidence; NA = Not Applicable

Table 7b: Overall Strength of Evidence Assessment

Measure Name	CQ Assessment	Measure SOE	Overall SOE
Adjusted Analyses			
Duration of abstinence	Acceptable	Low	Low
Quit attempts	Acceptable	Insufficient	
Rate of abstinence/quitting	Acceptable	Moderate	
Change quantity/frequency	Acceptable	Insufficient	
Return to smoking/relapse	Inconclusive	Insufficient	
Unadjusted Analyses			
Duration of abstinence	Acceptable	Low	Low
Quit attempts	Acceptable	Insufficient	
Rate of abstinence/quitting	Acceptable	Low	
Change quantity/frequency	Acceptable	Insufficient	
Return to smoking/relapse	Inconclusive	Insufficient	

CQ = Contextual Question; SOE = Strength of Evidence

Figures

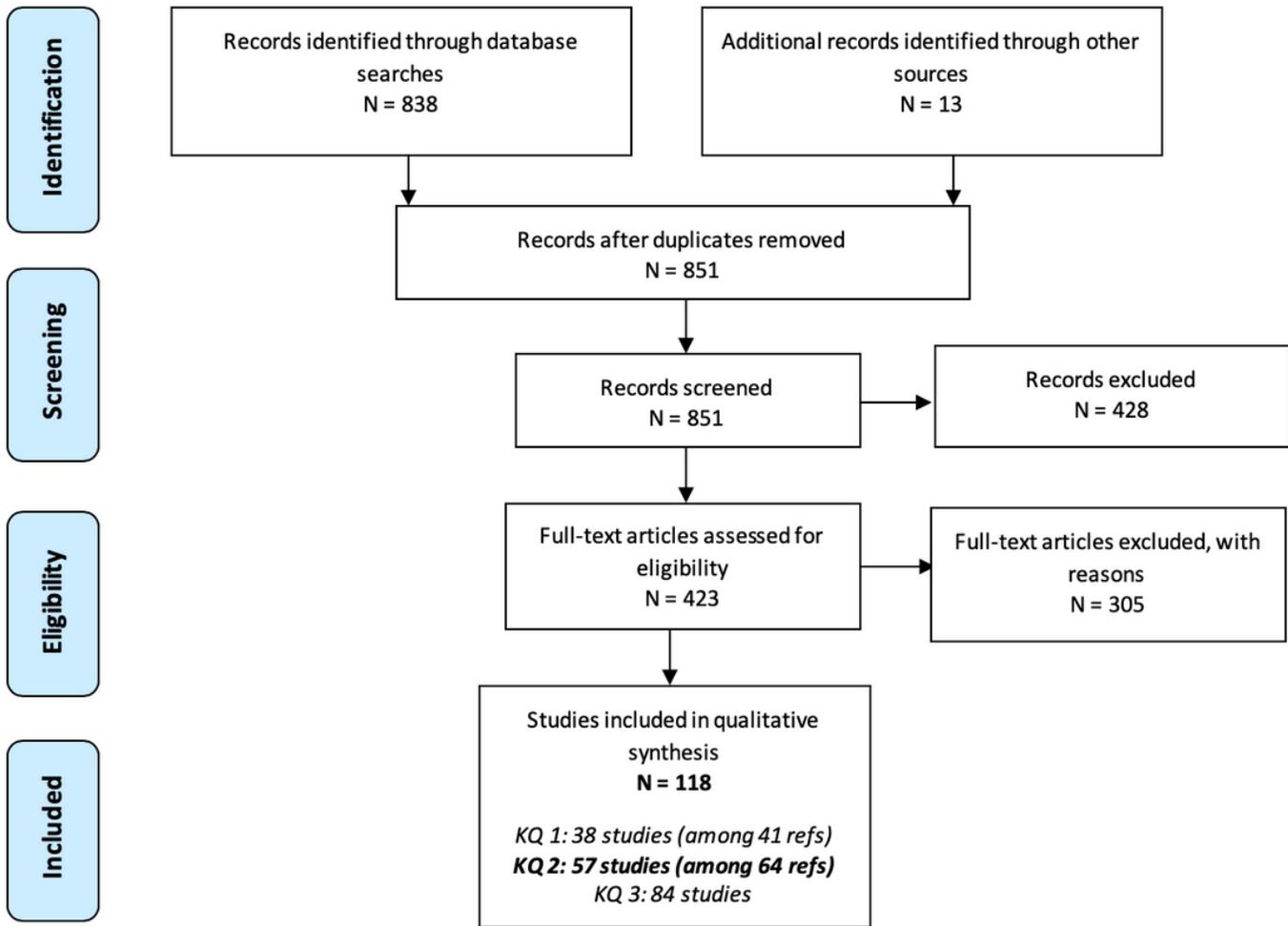


Figure 1

Literature Search Overview

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [ISSMPRISMAChecklist.pdf](#)
- [KQ2mentholHarmReductionJournalSUPPSFINALJAN202020.docx](#)