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Tobacco Withdrawal Amongst African American, Hispanic, and White Smokers

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Abstract

Introduction: Persistent tobacco use among racial and ethnic minority populations in the United States is a critical public health concern. Yet, potential sources of racial/ethnic disparities in tobacco use remain unclear. The present study examined racial/ethnic differences in tobacco withdrawal—a clinically-relevant underpinning of tobacco use that has received sparse attention in the disparities literature—utilizing a controlled laboratory design.

Methods: Daily smokers (non-Hispanic African American [*n* = 178], non-Hispanic white [*n* = 118], and Hispanic [*n* = 28]) attended two counterbalanced sessions (non-abstinent vs. 16-hour abstinent). At both sessions, self-report measures of urge, nicotine withdrawal, and affect were administered and performance on an objective behavioral task that assessed motivation to reinstate smoking was recorded. Abstinence-induced changes (abstinent scores vs. non-abstinent scores) were analyzed as a function of race/ethnicity.

Results: Non-Hispanic African American smokers reported greater abstinence-induced declines in several positive affect states in comparison to other racial/ethnic groups. Relative to Hispanic smokers, non-Hispanic African American and non-Hispanic white smokers displayed larger abstinence-provoked increases in urges to smoke. No racial/ethnic differences were detected for a composite measure of nicotine withdrawal symptomatology, negative affect states, and motivation to reinstate smoking behavior.

Conclusions: These results suggest qualitative differences in the expression of some components of tobacco withdrawal across three racial/ethnic groups. This research helps shed light on bio-behavioral sources of tobacco-related health disparities, informs the application of smoking cessation interventions across racial/ethnic groups, and may ultimately aid the overall effort towards reducing the public health burden of tobacco addiction in minority populations.

Implications: The current study provides some initial evidence that there may be qualitative differences in the types of tobacco withdrawal symptoms experienced among non-Hispanic African American, Hispanic, and non-Hispanic white smokers. Extending this line of inquiry may elucidate mechanisms involved in tobacco-related health disparities and ultimately aid in reducing the public health burden of smoking in racial/ethnic minority populations.

Introduction

Racial and ethnic minority populations experience a disproportionate burden of smoking-related diseases in the United States.[1–8] Several studies indicate that, in comparison to non-Hispanic whites, non-Hispanic African American and Hispanic smokers are less likely to initiate a quit attempt and more likely to relapse following a quit attempt.[6–16] Therefore, it is imperative to investigate racial and ethnic differences in processes that underlie smoking behavior in order to elucidate sources of smoking-related health disparities, shed light on ethnicity-specific smoking cessation treatment approaches, and ultimately reduce the public health burden of smoking in minority populations.

One distinct factor that has been widely recognized as an essential element of tobacco addiction and yet has received little attention in ethnic disparities literature is tobacco withdrawal. Tobacco withdrawal refers to the constellation of subjective (eg, depressed mood, urges to smoke, hunger), cognitive performance (eg, poor attentional control), physiological (eg, decreased heart rate and other nicotine offset effects), and behavioral (eg, drive to reinstate smoking behavior) changes that emerge upon abstinence following chronic tobacco use.[17,18] Factor analyses of measures of subjective withdrawal symptoms often yield two unique dimensions of negative affect (NA) and urge to smoke, that are distinct from other somatic withdrawal features (eg, hunger, concentration problems),[19–22] and some research demonstrates that abstinence also consistently reduces positive affect (PA).[23–25] Furthermore, urges to smoke, NA, and diminished PA during abstinence each have been shown to have incremental relations to smoking relapse risk over and above one another.[26–29] Hence, a better understanding of racial/ethnic differences in the expression of the various distinct components of withdrawal (ie, urges to smoke, diminished PA, NA, and other somatic features) is apt to be of great theoretical and clinical value.

As proposed in a recent "sociopharmacological" model of tobacco-related health disparities,[30] sociocontextual and psychobiological factors that stratify across individuals of different race or ethnicity moderate the effects of tobacco abstinence on expressions of withdrawal. For instance, non-Hispanic African American (vs. non-Hispanic white and Hispanic) individuals tend to metabolize nicotine more slowly.[31,32] Thus, acute abstinence may cause more extensive dissipation of nicotine blood levels in fast (vs. slow) metabolizers, which could magnify withdrawal effects in fast-metabolizing ethnic groups.[33,34] Additionally, individuals facing greater disadvantage (eg, racial/ethnic discrimination,[35–37] residing in communities with lower social cohesion,[38] and higher levels of neighborhood deprivation[39] and neighborhood problems[40]) may place more value on tobacco as a source of reward than more advantaged individuals who may have access to a larger diversity of alternative rewards that can substitute for tobacco.[41] Hence, the loss of reinforcement caused by smoking abstinence may be more potent determinants of withdrawal in certain racial/ethnic groups. Also, due to cultural differences in the expression of emotion across racial/ethnic groups,[42] reaction to the stress and reward loss associated with tobacco abstinence may be expressed with qualitatively different emotional reactions (eg, anger vs. sadness).

Few studies have examined racial/ethnic differences in tobacco withdrawal. Two naturalistic correlational studies have shown that non-Hispanic African American (vs. non-Hispanic white) young adult and adolescent smokers reported fewer subjective withdrawal symptoms during a prior quit attempt[43] and in a post smoking cessation treatment assessment.[44] A recent laboratory study in which abstinence was experimentally manipulated (overnight abstinence vs. *ad libitum* smoking) in middle-aged adult smokers showed that non-Hispanic African American smokers exhibited smaller abstinence-induced increases in anger, cigarette craving, and an overall composite index of nicotine withdrawal features than non-Hispanic white smokers.[45]

Several critical issues require further clarification to meaningfully extend the scant literature on tobacco withdrawal across racial/ethnic groups. First, prior work has somewhat overlooked the complex multidimensionality of affect (eg, euphoria and friendliness may be distinct manifestations of PA[42]). Given cultural nuances in the experience and expression of affect,[46] racial/ethnic differences in withdrawal-related affective changes may be apparent only for specific subtypes of emotion. Moreover, it is unclear whether racial/ethnic disparities exist in a key behavioral manifestation of withdrawal (ie, the motivation to reinstate smoking behavior during abstinence). This outcome can be modeled in the lab by evaluating abstinence-induced increases in the speed of reinstating smoking when delaying smoking is monetarily rewarded.[47] Also, to the best of our knowledge, there is no existing controlled laboratory study that has contrasted tobacco withdrawal between Hispanic smokers and other racial/ethnic groups.

The current study examined differences in tobacco withdrawal across non-Hispanic African American, non-Hispanic white, and Hispanic smokers using a controlled laboratory design that compared experimentally manipulated abstinent and non-abstinent conditions as well as a comprehensive affect assessment and an objective behavioral economic index of the motivation to reinstate smoking. Based on previous literature,[43–45] we hypothesized that non-Hispanic African American smokers would demonstrate smaller abstinence-induced changes in subjective withdrawal symptoms than non-Hispanic white smokers. Given the paucity of prior work in Hispanic smokers, we did not put forth hypotheses regarding how they might differ from the other groups.

Methods

Participants

The current report reflects a secondary analysis of a dataset, which was originally collected to examine individual differences in psychopathology as predictors of tobacco abstinence effects among smokers who were recruited from the Los Angeles area via paper and online advertisements for a tobacco withdrawal study.[48] To facilitate the distinction between race and ethnicity, the current report was limited to participants self-identifying as non-Hispanic African American (n = 178), non-Hispanic white (n = 118), and Hispanic (n = 28). Similar categorizations have been used in prior multi-ethnic studies.[49,50] Inclusion criteria for the larger study were: (1) 18 years of age or older; (2) a regular cigarette smoker for at least the past 2 years (≥10 cigs/d); (3) and fluent in English. The exclusion criteria for the larger study were: (1) current *DSM-IV* non-nicotine substance dependence; (2) current *DSM-IV* mood disorder or psychotic symptoms; (3) breath carbon monoxide (CO) levels < 10 ppm at intake; (4) use of non-cigarette forms of tobacco or nicotine products; (5) current use of psychiatric or psychoactive medications; (6) currently pregnant; and (7) planning to quit or substantially cut down their smoking in the next 30 days. The University of Southern California Internal Review Board approved the study.

Procedure

After a phone screening, participants attended a baseline session involving informed consent, CO levels analysis, structured clinical interviews, and demographic and smoking history questionnaires to assess eligibility criteria. Eligible participants then attended two counterbalanced experimental sessions starting at noon: non-abstinent (*ad libitum* smoking) and abstinent (16 hours of smoking abstinence). Mean number of days between the two experimental sessions was 11.5 (*SD* = 6.4; range 2–33 days).

At the start of the non-abstinent session, participants first smoked a cigarette of their preferred brand (to standardize smoking recency) and then were tested for breath alcohol (BrAC = 0 required for participation) and CO. The CO was collected in the non-abstinent session to serve as a comparison to the abstinent session. For abstinent sessions, participants were instructed to not smoke after 8:00 PM the night before their session and the session began with breath assessment. Participants who had a CO reading exceeding 9 ppm during their abstinent session ($N = 11$) were considered non-abstinent and were rescheduled for a second attempt to complete their session on a different day. Participants ($N = 2$) who failed to meet CO criteria for abstinence (≤9 ppm) at their second attempt discontinued from the study. For both experimental sessions, after breath analyses, participants first completed self-report measures that served as the primary subjective withdrawal outcomes prior to the behavioral smoking task and then subsequently underwent a behavioral smoking task to assess motivational value of initiating smoking that served as the behavioral withdrawal outcome (described below). Participants then completed the same self-report measures after the self-administration period of the behavioral smoking task and at the completion of session. Participants who completed the study were compensated approximately $200.

Baseline Session Measures

The Structured Clinical Interview for *DSM-IV* Research Edition[51] assessed mood disorders, psychosis, and substance use disorder for eligibility purposes. An author constructed questionnaire assessed demographic and smoking characteristics, including ethnicity (Forced choice: Hispanic or Latino vs. not Hispanic or Latino) and race (Select all that apply: American Indian or Alaskan Native, Asian, non-Hispanic African American, Middle Eastern, Pacific Islander, and non-Hispanic white). The Fagerström Test of Nicotine Dependence[52] was administered to measure nicotine dependence severity. Depression and anxiety were assessed using the Mood and Anxiety Sensitivity Questionnaire-Short Form (MASQ-SF).[53] Participants rate the extent to which they experienced each symptom during the previous week. The anxious arousal subscale focused on somatic tension and arousal specific to anxiety (17 items). The anhedonic depression subscale assessed low interest, pleasure, and PA specific to depression (22 items). Depression and anxiety measures were administered because these syndromes may modulate the expression of withdrawal and therefore were compared across ethnicities to determine whether depression/anxiety might have confounded ethnic differences in withdrawal.[43,54,55] For most participants ($N = 300$; 93.6%), their preferred brand of cigarettes were recorded and coded as menthol or non-menthol; data were not recorded for the other 6.4% of participants.

Experimental Sessions Measures

Subjective components of withdrawal, including PA and NA, urges to smoke, and withdrawal symptomatology were assessed using the following questionnaires, which have demonstrated strong psychometric properties and sufficient sensitivity to abstinence effects in prior work.[19,25] The internal consistency of each measure in the current sample is reported in Table 2.

The Brief Questionnaire of Smoking Urges

The 10-item Questionnaire of Smoking Urges[56] assessed intention and urge to smoke experienced "right now." Items were rated on 6-point Likert scales and yielded a composite index based on means for response across items.

The Minnesota Nicotine Withdrawal Scale

A variant of the 11-item Minnesota Nicotine Withdrawal Scale[17] evaluated withdrawal symptoms experienced "so far today" (craving, irritability, anxiety, concentration problems, restlessness, impatience, hunger, cardiovascular and autonomic activation, drowsiness, and headaches) on 6-point Likert scales and yielded a composite index based on means for response across items.

The Profile of Mood States

The 72-item Profile of Mood States (POMS)[57] involved rating a variety of high and low arousal PA and NA adjectives as experienced "right now" (eg, miserable, forgiving, happy, grouchy) on a 5-point Likert scale. The POMS yielded five NA (Anger, Anxiety, Confusion, Depression, and Fatigue) and three PA (Elation, Friendliness, and Vigor) subscales scores computed based on means for response across items. In addition to the individual subscales, we also calculated composite scores for NA valence (mean of NA subscale scores) and PA valence (mean of PA subscales). The POMS has been shown to be sensitive to abstinence effects in prior work.[19,23,58–63]

Behavioral Smoking Task

Following from prior literature,[47] the task began with participants receiving a tray containing eight cigarettes of their preferred brand, a lighter, and ashtray. Participants were instructed that they could commence smoking at any point within the next 50 minutes, but for each 5 minutes that they delayed smoking, they would earn $0.20 for a maximum of $2.00 (monetary values were created based on prior piloting studies among smokers from the same population). The delay period ended once the 50 minutes had elapsed or when the participant had indicated that they would like to smoke. After the delay period, participants began the self-administration period in which they were instructed that they could smoke as little or as many cigarettes as they wished for the next 60 minutes. Participants were told that they had a $1.60 credit, and each cigarette lit would cost $0.20. At task outset, participants were accurately notified that they would not have another opportunity to smoke again until the end of the session to prevent the influence of the impending opportunity to smoke on choices made during the task. Following the self-administration period, participants began a rest period (ending 2 hours and 50 minutes after the start of the delay period) during which they were not allowed to smoke.

Data Analysis

Data were analyzed using IBM SPSS Version 22.[64] Preliminary data analyses included analysis of baseline sample descriptive statistics by race/ethnicity group and examination of whether abstinence status (abstinent vs. non-abstinent) significantly affected each outcome in the overall sample using paired sample *t* tests. Primary analysis utilized one-way analysis of covariances (ANCOVAs) based on the

general linear model for unbalanced cell sizes to test race/ethnicity differences in abstinence-induced change scores on smoking urges (Questionnaire of Smoking Urges), composite withdrawal symptoms (Minnesota Nicotine Withdrawal Scale), affect states (POMS), and behavioral smoking task outcomes (time delayed, cigarettes smoked during self-administration period). Separate models were tested for each outcome. ANCOVA models adjusted for baseline characteristics (ie, demographics, smoking characteristics, depression/anxiety) significantly differing by race/ethnicity. We followed up significant (or near-significant; $P < .10$) ANCOVAs with pairwise comparisons using Fisher's LSD tests. Additionally, prior literature has illustrated differences in cigarette type preference among non-Hispanic African American, non-Hispanic white, and Hispanic smokers.[65–68] Hence, to investigate whether racial/ethnic differences in withdrawal were dependent on cigarette type (menthol vs. non-menthol), we explored cigarette type as a moderator of race/ethnicity effects on primary outcomes in supplementary ANCOVA models of interaction effects between race/ethnicity and cigarette type (menthol vs. non-menthol). We conducted similar supplementary two-way factorial ANOVAs to determine whether ethnicity/racial differences across primary outcomes were moderated by CO levels during abstinent sessions. Former racial differences in abstinence-induced changes have been of small to medium magnitude and have been shown to be present on some outcomes but not others.[45] Therefore, in order to avoid overlooking potentially meaningful small effects, we conducted separate tests for each outcome rather than a combined multivariate test with $\alpha = 0.05$ (two-tailed) without a type-I error correction with marginal effects ($P < .10$). A power analysis assuming magnitudes of these effects similar to past research ($f = 0.14$)[38] and the present sample size indicated that we would have 0.71 power with a two-tailed $\alpha = 0.05$ and 0.81 with a less stringent $\alpha = 0.10$.

Results

Preliminary Analyses

Baseline characteristics are reported in Table 1. There were no differences in demographics, smoking characteristics, and depression/anxiety across racial/ethnic groups except that non-Hispanic African American participants were significantly older and smoked fewer cigarettes per day than non-Hispanic white participants ($P < .05$; Table 1). Therefore, age and cig/d were included as covariates in primary ANCOVAs described below.

In the combined sample, abstinence significantly affected each outcome (ie, abstinence-induced change scores departed from zero) in the expected direction, with the exception of fatigue ($P \geq .10$; Table 2).

Primary Analyses

After controlling for age and cig/d, ANCOVAs yielded significant racial/ethnic differences in abstinence-induced changes on POMS PA composite, Elation, and Friendliness (Ps $< .05$) and marginal differences in Vigor ($P < .10$; Table 3). Follow up pairwise contrasts revealed that non-Hispanic African American (vs. Hispanic) participants reported significantly greater abstinence-induced decreases in Elation, Friendliness, Vigor, and PA composite (Fisher LSD; Ps $< .05$) and that non-Hispanic African American (vs. non-Hispanic white) participants reported marginally greater abstinence-induced decreases for Elation, Friendliness, and PA composite (Ps $< .10$). Hispanic and non-Hispanic white smokers did not differ in abstinence-induced changes in PA scales in pairwise tests (Ps $> .10$).

Table 1. Baseline Characteristics by Race/Ethnicity

	Full sample ($N = 324$)	African American ($N = 178$)	White ($N = 118$)	Hispanic ($N = 28$)	Omnibus test of race/ethnicity differences
	M (*SD*) or %	*M* (*SD*) or %	*M* (*SD*) or %	*M* (*SD*) or %	*F* or X^2
Demographics					
Age	44.09 (10.6)	46.43 (9.8)[a]	41.11 (11.2)[b]	41.96 (9.4)[ab]	10.07*
Gender					n.s.
Female	32.4%	32.0%	31.4%	39.3%	
Male	67.6%	68.0%	68.6%	60.7%	
Annual income					n.s.
<$15 000	49.7%	50.6%	48.3%	50.0%	
≥$15 000	50.3%	49.4%	51.7%	50.0%	
Marital status					n.s.
Not married	95.7%	94.4%	97.5%	96.4%	
Married	4.3%	5.6%	2.5%	3.6%	
Clinical characteristics					
Age onset regular smoking	19.17 (5.59)	19.44 (5.85)	19.08 (5.38)	17.89 (4.74)	n.s.
FTND	5.42 (1.92)	5.49 (1.88)	5.20 (1.98)	5.89 (1.89)	n.s.
Cigarettes/d	16.81 (6.96)	15.92 (7.60)[a]	17.99 (5.99)[b]	17.39 (5.80)[ab]	3.19*
Cigarette type					24.93*
Non-menthol	64.0%	51.2%	79.3%	77.8%	
Menthol	36.0%	48.8%	20.7%	22.2%	
Emotional symptoms					
MASQ anxious arousal	1.28 (0.40)	1.28 (0.40)	1.25 (0.35)	1.42 (0.51)	n.s.
MASQ anhedonic depression	2.41 (0.63)	2.37 (0.61)	2.44 (0.68)	2.53 (0.57)	n.s.

FTND = Fagerström Test of Nicotine Dependence (range 0–10); MASQ = Mood and Anxiety Symptom Questionnaire (range 1–4); n.s. = nonsignificant. Groups with shared superscripts are not significantly different from each other while groups with different letter superscripts demonstrated statistically significant differences when tested by pairwise post hoc Scheffe tests ($P < .05$).

*$P < .05$.

Table 2. Effects of Abstinence on Withdrawal Outcomes in Overall Sample

	Non-abstinent		Abstinent		Abstinence-induced change score	Abstinence effect	
	M (*SD*)	A	*M* (*SD*)	A	*M* (*SD*)	*t*	*d*
CO (ppm)[a]	22.68 (12.09)	—	5.55 (2.16)	—	−16.98 (11.80)	23.59	−1.44***
Measures							
QSU	1.01 (1.13)	0.95	3.33 (1.07)	0.91	2.32 (1.23)	−30.68	1.89***
MNWS	1.07 (0.94)	0.89	1.84 (1.11)	0.90	0.77 (1.05)	−11.89	0.73***
POMS							
Anger	0.38 (0.61)	0.93	0.63 (0.79)	0.92	0.25 (0.70)	−5.78	0.36***
Anxiety	0.72 (0.71)	0.88	1.15 (0.93)	0.90	0.42 (0.84)	−8.06	0.50***
Confusion	0.78 (0.63)	0.76	0.94 (0.77)	0.80	0.14 (0.71)	−2.93	0.20**
Depression	0.40 (0.61)	0.93	0.52 (0.71)	0.93	0.10 (0.64)	−2.54	0.16*
Fatigue	0.86 (0.90)	0.90	0.85 (0.89)	0.90	−0.03 (0.88)	0.73	−0.03
Elation	2.01 (0.94)	0.88	1.56 (0.92)	0.87	−0.46 (0.87)	8.49	−0.53***
Friendliness	2.71 (0.90)	0.92	2.22 (0.97)	0.91	−0.50 (0.81)	9.81	−0.62***
Vigor	2.20 (0.97)	0.92	1.84 (0.98)	0.91	−0.36 (0.84)	6.77	−0.43***
NA composite	0.63 (0.61)	0.98	0.82 (0.73)	0.98	0.18 (0.63)	−4.39	0.29***
PA composite	2.31 (0.88)	0.96	1.87 (0.90)	0.96	−0.44 (0.75)	9.28	−0.59***
Behavioral smoking task							
Time delay (min)	39.87 (17.3)	—	23.56 (23.0)	—	−16.58 (22.7)	11.52	−0.73***
Cigarettes smoked	1.22 (0.95)	—	1.53 (0.94)	—	0.32 (0.93)	−5.45	0.34***

CO = carbon monoxide levels (parts per million); QSU = Questionnaire of Smoking Urges (range 0–5); MNWS = Minnesota Nicotine Withdrawal Scale (range 0–5); NA = negative affect; PA = positive affect; POMS = Profile of Mood States (range 0–5); Time Delay (range 0–50 minutes); Cigarettes smoked (range 0–8). Abstinence-Induced Change Score = score in abstinent condition—score in non-abstinent condition.

[a]No significant interaction effects were found for CO levels during abstinent sessions and withdrawal outcomes.

*P < .05; **P < .01; ***P < .0001.

Racial/ethnic differences were also observed for abstinence-induced changes in smoking urges (Table 3). Although each individual racial/ethnic group reported robust increases in urge from non-abstinent to abstinent states (*d*s > 1.29), pairwise tests conveyed that, in comparison to Hispanic participants, non-Hispanic white and non-Hispanic African American participants reported greater abstinence-induced increases in urge to smoke (assessed with Questionnaire of Smoking Urges scores; *P*s ≤ .016), but did not differ from each other (*P* = .82; Table 3).

There were no significant racial/ethnic differences in abstinence-induced changes for composite withdrawal symptoms, POMS NA scales (Anger, Anxiety, Confusion, Depression, and Fatigue), and outcomes on the behavioral smoking task (*P*s > .10; Table 3).

Supplementary Analyses

Supplementary two-way factorial ANCOVAs involving race/ethnicity and cigarette type (menthol vs. non-menthol) yielded no significant interaction effects on any withdrawal outcome, suggesting that racial/ethnic differences in withdrawal reported above were not dependent on cigarette type. Two-way factorial ANOVAs examining interactions between CO levels during abstinent sessions and abstinence-induced change scores for all withdrawal outcomes were found to be nonsignificant, suggesting that racial/ethnic differences in tobacco withdrawal were not likely due to racial/ethnic differences in the prevalence of participants with higher CO levels while abstinent.

Discussion

The present study reports a novel, unhypothesized result suggesting that non-Hispanic African American smokers may experience greater abstinence-induced decreases in several types of PA states (ie, Elation, Friendliness, Vigor, and PA composite index) in comparison to other racial/ethnic groups. There were no racial/ethnic differences on a composite measure that amalgamated negative affective and somatic withdrawal symptoms (Minnesota Nicotine Withdrawal Scale) and on measures of NA states. The comparatively marked abstinence-induced declines in PA in African American smokers was not likely due to chance, as the results were consistent across multiple measures of PA and specific to this component of withdrawal.

These current results are contrary to previous results suggesting less subjective withdrawal in non-Hispanic African American (vs. non-Hispanic white) smokers.[43–45] Such discordant findings are notable, given that Robinson et al.[45] employed an overnight laboratory abstinence methodology similar to the present study, yet found no differences in non-Hispanic African American and non-Hispanic white smokers on a composite measure of PA. Furthermore, Robinson et al.[45] found consistently smaller abstinence effects in non-Hispanic African Americans (vs. non-Hispanic whites) on measures of urge, whereas non-Hispanic African American and non-Hispanic white smokers did not differ in abstinence-induced changes in urges to smoke in the current study. Likely due to differences in eligibility criteria across the two studies (≥10 cig/d in the present study; ≥15 cig/d in Robinson et al.[45]), the current sample was less severely nicotine dependent and smoked less cigarettes per day on average than Robinson's study (Fagerström Test of Nicotine Dependence, *M*: 5.4 vs. 6.6; cig/d *M:* 16.8 vs. 22.2). It is possible that the extent to which heavier and dependent smoking amplifies aspects of tobacco withdrawal may be more robust in non-Hispanic white (vs. non-Hispanic African American) smokers and could explain the pattern of findings across this study and Robinson et al.[45] Indeed, non-Hispanic whites tend to metabolize nicotine more quickly[31,32] and therefore could be more sensitive to deprivation (due to fast metabolism and dissipation of blood nicotine levels) if they are heavier smokers. Such an effect

Table 3. Race/Ethnicity Differences in Abstinence-Induced Changes in Withdrawal Outcomes

	African American (*N* = 178)	White (*N* = 118)	Hispanic (*N* = 28)	Omnibus test of race/ethnicity differences	
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*F*[a]	Partial[b] η^2
Measures					
QSU	2.39 (1.30)	2.36 (1.08)	1.68 (1.26)	3.61**	0.028
MNWS	0.76 (1.04)	0.82 (1.04)	0.68 (1.22)	0.13	
POMS					
Anger	0.19 (0.66)	0.37 (0.73)	0.11 (0.72)	1.18	
Anxiety	0.40 (0.83)	0.47 (0.87)	0.34 (0.78)	0.36	
Confusion	0.12 (0.72)	0.20 (0.73)	0.11 (0.62)	0.07	
Depression	0.08 (0.67)	0.14 (0.56)	0.12 (0.76)	0.003	
Fatigue	−0.05 (0.86)	−0.03 (0.95)	0.11 (0.76)	0.37	
Elation	−0.56 (0.89)	−0.39 (0.84)	−0.14 (0.78)	3.64**	0.028
Friendliness	−0.58 (0.85)	−0.44 (0.79)	−0.21 (0.64)	3.51**	0.027
Vigor	−0.43 (0.87)	−0.33 (0.81)	−0.05 (0.73)	2.36*	0.018
NA composite	0.14 (0.62)	0.23 (0.66)	0.16 (0.61)	0.06	
PA composite	−0.52 (0.77)	−0.39 (0.74)	−0.14 (0.63)	3.87**	0.030
Behavioral smoking task					
Time delay (min)	−18.01 (23.6)	−15.17 (21.8)	−13.61 (21.1)	0.54	
Cigarettes smoked	0.24 (0.73)	0.44 (1.16)	0.26 (0.96)	0.95	

QSU = Questionnaire of Smoking Urges (range 0–5); MNWS = Minnesota Nicotine Withdrawal Scale (range 0–5); NA = negative affect; PA = positive affect; POMS = Profile of Mood States (range 0–5); time delay (range 0–50 minutes); cigarettes smoked (range 0–8).

[a]Omnibus test of race/ethnicity differences in abstinence-induced changes in analysis of covariances (ANCOVAs) controlling for age and cigarettes/d.

[b]Partial η^2 values for significant ANCOVAs.

*$P < .10$; **$P < .05$.

could explain a shift in racial differences on PA and urge observed across the two studies in which diminished PA is a more salient withdrawal symptom in medium-dependence non-Hispanic African American smokers and urge is more salient in higher-dependence non-Hispanic white smokers. Hence, future research in this direction is warranted in order to investigate relations between nicotine metabolic rate and tobacco withdrawal symptomatology among non-Hispanic white and non-Hispanic African American smokers of similar dependence levels. Other factors such as cultural/regional differences by study site—Los Angeles (current study) versus Baltimore (Robinson et al.[45])—may also be possibly relevant factors that could explain inconsistent findings across studies.

There may be several reasons for the marked reduction in PA in abstinent non-Hispanic African American smokers. It is possible that reporting diminished positive mood may be a more culturally conventional expression of emotional disturbance than endorsing NA in non-Hispanic African American smokers.[46] Furthermore, non-Hispanic African American smokers tend to encounter greater hardships (ie, discrimination, harassment, and neighborhood deprivation and problems) than other racial groups,[39,40,69–71] and might be particularly sensitive to the loss of smoking-related reinforcement,[30] which could impact expressions of affective disturbance during tobacco withdrawal. Regardless of the factors underlying this finding, given that diminished PA during abstinence increases risk for relapse,[26,27] the current results may be relevant to understanding mechanisms underlying poorer cessation success reported in non-Hispanic African Americans.[8,10,13,16,72] Hence, if the current result was replicated and extended, smoking cessation strategies that focus upon cultivating PA may be particularly useful for non-Hispanic African American smokers.[73] Hispanic smokers reported smaller abstinence-induced decreases in PA states in contrast to non-Hispanic African American smokers and smaller increases in urges to smoke in comparison to the other groups. The meaning of this finding is not clear and this result should be interpreted with the caveat of the small sample of Hispanic smokers in this study. If replicated, these results could indicate that unsuccessful smoking cessation in Hispanics may be driven by other smoking-related mechanisms outside of withdrawal (ie, smoking outcome expectancies[74]; exposure and reactivity to smoking cue stimuli)[75] and/or other sociocultural or acculturative factors.[76,77]

There were no behavioral differences in abstinence-induced smoking reinstatement motivation by race/ethnicity. Indeed, each group exhibited medium-to-large magnitude abstinence-provoked increases in drive to resume smoking and small-to-medium abstinence-provoked increases in cigarettes consumed once given the opportunity to smoke. Thus, the behavioral significance for smoking behavior of any racial/ethnic variation in subjective withdrawal symptoms was not apparent in this study. Regardless of any distal effects on smoking behavior, ethnic differences in subjective withdrawal may nonetheless be a clinically-significant source of distress and impair short-term quality of life.[58]

This study had several limitations. First, the sample of Hispanic smokers was small and reduced power to detect differences between Hispanics and other ethnic groups, leaving open the possibility of a type-II error; although we did detect effects for some outcomes. In addition, abstinence was experimentally-imposed and not part of a self-motivated quit attempt. Thus, results of this study may not generalize to those who attempt to quit, although tobacco withdrawal during experimentally-manipulated abstinence has been shown to predict withdrawal after a self-initiated quit attempt within a naturalistic environment,[27] suggesting some plausible generalizability of these findings. Moreover, we used non-representative sampling from a single geographic location; thus, extrapolation to the greater US population of non-Hispanic African American, non-Hispanic white,

and Hispanic Smokers should be made with caution. Furthermore, based on prior literature showing that moderate to heavy smokers experience consistent withdrawal after overnight abstinence (≥10 cig/d)[18,24,48,78] and that light smokers may not be markedly affected by overnight abstinence, individuals who smoked less than 10 cigarettes per day were not eligible for this study. This restriction may limit the generalizability of the current findings, given that many non-Hispanic African Americans and Hispanics are light and intermittent smokers (<10 cig/d).[79] Another limitation might be the CO cutpoint to confirm abstinence, as a recent study suggested an optimal cut-off point of not more than 4 ppm for confirming 24-hour smoking abstinence,[80] leaving unclear whether more stringent cutpoints may be also required for 16-hour abstinence studies. Lastly, given that racial differences have been of small magnitude in prior work[45] and results of a power analysis indicating alpha correction may increase risk for a type-II error, we conducted a number of tests for separate individual outcomes without correcting for type-I error. Hence, we cannot rule out the possibility that certain results were due to chance, however, given that we discovered trends in racial/ethnic differences on POMS PA composite scores and three separate PA scales, it is unlikely that this key result was a false positive.

In summary, there was some evidence of racial/ethnic differences in the qualitative expression of tobacco withdrawal, whereby some components of withdrawal may be differentially manifested as a function of race/ethnicity (ie, PA/urge), but not others (eg, fatigue). These findings suggest that it may behoove clinicians and researchers to assess beyond single composite-score based measures of tobacco withdrawal symptoms in order to comprehensively capture racial/ethnic variation in withdrawal. Furthermore, the current results suggest diminished PA may be an important clinical target in the treatment of tobacco withdrawal in non-Hispanic African American smokers. We conclude that continued exploration of racial and ethnic differences in tobacco withdrawal and other putative mechanisms underlying tobacco-related health disparities may inform efforts to reduce the public health burden of tobacco use, particularly in those who are disproportionately affected.

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Declaration of Interests

None of the authors report a conflict of interest related to submission of this manuscript.

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