



HHS Public Access

Author manuscript

Mindfulness (N Y). Author manuscript; available in PMC 2016 April 01.

Published in final edited form as:

Mindfulness (N Y). 2015 April ; 6(2): 315–325. doi:10.1007/s12671-013-0263-1.

Testing a Moderated Mediation Model of Mindfulness, Psychosocial Stress, and Alcohol Use among African American Smokers

Claire E. Adams,

Department of Psychology, The Catholic University of America, 620 Michigan Ave. NE, Washington, DC 20064

Miguel A. Cano,

The University of Texas MD Anderson Cancer Center, Houston, TX

Whitney L. Heppner,

Department of Psychological Science, Georgia College & State University, Milledgeville, GA

Diana W. Stewart,

The University of Texas MD Anderson Cancer Center, Houston, TX

Virmarie Correa-Fernández,

The University of Texas MD Anderson Cancer Center, Houston, TX

Jennifer Irvin Vidrine,

The University of Texas MD Anderson Cancer Center, Houston, TX

Yisheng Li,

The University of Texas MD Anderson Cancer Center, Houston, TX

Paul M. Cinciripini,

The University of Texas MD Anderson Cancer Center, Houston, TX

Jasjit S. Ahluwalia, and

The Center for Health Equity, University of Minnesota Medical School, Minneapolis, MN

David W. Wetter

The University of Texas MD Anderson Cancer Center, Houston, TX

Claire E. Adams: adams@cu.edu

Abstract

Mindfulness-based strategies have received empirical support for improving coping with stress and reducing alcohol use. The present study presents a moderated mediation model to explain how mindfulness might promote healthier drinking patterns. This model posits that mindfulness reduces perceived stress, leading to less alcohol use, and also weakens the linkage between stress and alcohol use. African American smokers ($N = 399$, 51% female, $M_{age} = 42$) completed measures of dispositional mindfulness, perceived stress, quantity of alcohol use, frequency of

binge drinking, and alcohol use disorder symptoms. Participants with higher levels of dispositional mindfulness reported less psychosocial stress and lower alcohol use on all measures. Furthermore, mindfulness moderated the relationship between perceived stress and quantity of alcohol consumption. Specifically, higher perceived stress was associated with increased alcohol use among participants low, but not high, in mindfulness. Mindfulness may be one strategy to reduce perceived stress and associated alcohol use among African American smokers.

Keywords

Mindfulness; Alcohol Use; Stress; African Americans; Moderated Mediation

Introduction

Cigarette smoking and heavy drinking commonly co-occur (Fine et al., 2004; Kendzor, Costello et al., 2008). Although tobacco and alcohol use each independently account for significant proportions of mortality in the U.S. (Mokdad et al., 2004), their co-occurrence increases risk for chronic disease and mortality to an even greater extent (Hart et al., 2010; Lin et al., 2012; Loefer & Walach, 2012; Xu et al., 2007). Rates of co-occurring smoking and heavy drinking are highest among low-socioeconomic status (SES) individuals and some racial/ethnic minority groups (Hart et al., 2010). Compared to other racial/ethnic groups, African Americans have higher incidence and mortality rates for diseases associated with smoking and excess alcohol use, including coronary heart disease, stroke, and many cancers (Cooper et al., 2000; Fagan et al., 2007). However, little is known about risk factors for excess alcohol use among low-SES African American smokers, a group at particularly high risk for disease.

The present study focuses on mechanisms that might underlie excess alcohol use among low-SES African American smokers. Given that psychosocial stress is a common trigger for alcohol use and related problems (e.g., Beck et al., 2011; Dawson et al., 2005; Grzywacz & Almeida, 2008; Ragland et al., 2000), identifying protective factors that prevent stress or mitigate its impact on alcohol use is critical. Dispositional mindfulness may be an important protective factor that buffers smokers from the adverse effects of stress and alcohol use. We test a moderated mediation model to explain associations among mindfulness, psychosocial stress, and alcohol use.

Mindfulness is a meta-cognitive state in which individuals purposefully pay attention to their present-moment environment without judging or evaluating these experiences (Baer et al., 2006; Bishop et al., 2004; Kabat-Zinn, 1990, 1994). Mindfulness can also be measured as a trait or disposition (i.e., an individual's tendency to be attentive to and aware of present-moment experiences in daily life, and to accept them without judgment or evaluation [Baer et al., 2006; Brown & Ryan, 2003]). Dispositional mindfulness is associated with lower negative affect, anxiety, and depression (McKee et al., 2007; Smith et al., 2011), and higher positive affect, self-esteem, and life satisfaction (Brown & Ryan, 2003). Mindfulness encourages individuals to view thoughts and feelings as temporary mental events rather than facts (Bieling et al., 2012), reduces emotional reactivity in the face of unpleasant stimuli

(Arch & Craske, 2006, 2010; Britton et al., 2012; Feldman et al., 2010), and enhances brain functioning associated with positive mood (Davidson et al., 2003). Dispositional mindfulness has also been associated with lower alcohol use and fewer alcohol-related problems (Fernandez et al., 2010; Smith et al., 2011), reduced alcohol attentional bias (Garland, Boettiger, Gaylord, West Chanon, & Howard, 2012) and enhanced heart rate variability (HRV) recovery from stress-primed alcohol cue exposure (Garland, 2011).

Meta-analyses indicate that mindfulness-based treatments (e.g., Mindfulness-based Stress Reduction, Mindfulness-based Cognitive Therapy) are effective for improving mood, anxiety, and stress (Chiesa & Serretti, 2009; Grossman et al., 2004; Hofmann et al., 2010; Piet & Hougaard, 2011). Among alcohol-dependent individuals, mindfulness training appears to reduce stress and attentional bias toward alcohol-related cues, as well as enhance heart rate variability recovery from stress-primed alcohol cue-exposure (Garland et al., 2010). Preliminary research supports the use of Mindfulness-based Relapse Prevention (MBRP) for preventing relapse to substance use disorders (Bowen et al., 2009; Witkiewitz & Bowen, 2010; Witkiewitz et al., 2005). However, more research is needed on the effects of mindfulness on alcohol-related outcomes and potential mechanisms that might underlie any associations. Furthermore, potential associations between mindfulness and alcohol use among low-SES African Americans, and among smokers, are unknown.

Psychosocial stress has long been hypothesized as a key factor in the development and maintenance of alcohol use and abuse. The tension reduction hypothesis posits that individuals are motivated to consume alcohol for its stress-reducing effect and that the negative reinforcement provided through stress reduction maintains continued alcohol use (Conger, 1956). Although this model has been controversial (Cappell & Herman, 1972), there is evidence that many individuals drink alcohol as a way of coping with stress (Schroder & Perrine, 2007) and that alcohol often has a stress response dampening effect (Levenson et al., 1980). Similarly, Baker et al. (2004) proposed an affective processing model of reinforcement in addictive disorders, in which escape and avoidance of negative affect (often precipitated by psychosocial stressors) is the primary motive for drug and alcohol use. Indeed, psychosocial stress is often associated with episodes of heavy drinking (Dawson et al., 2005; Grzywacz & Almeida, 2008; Ragland et al., 2000), more alcohol-related problems (e.g., drinking and driving; Beck et al., 2011; Ragland et al., 2000), and higher risk for alcohol dependence (Lloyd & Turner, 2008; Schroder & Perrine, 2007). Psychosocial stress is also a strong predictor of lapse and relapse to alcohol use disorders (Hodgins et al., 1995; Witkiewitz & Villaruel, 2009).

Psychosocial stress may be an even stronger predictor of excess alcohol use among low-SES African Americans than in other demographic groups. African Americans often report higher social disadvantage (poverty, perceived unfair treatment, perceived racial stigma) and perceived stress than non-Latino whites (Lloyd & Turner, 2008; Mulia et al., 2008), and some evidence suggests that the stress-drinking association is stronger among low-SES individuals (Dawson et al., 2005; Grzywacz & Almeida, 2008). Although no known studies have investigated the specific role of stress in triggering alcohol use in African Americans, some research suggests that depressive symptoms (typically positively correlated with

perceived stress; Ludman et al., 2002) are more strongly related to alcohol use among African Americans than in other demographic groups (e.g., Becker & Grilo, 2007).

In sum, the extant literature suggests that psychosocial stress may play a critical role in excessive alcohol use among African Americans. As such, it is important to identify factors that might reduce alcohol use among African American smokers, as the co-occurrence of smoking and excess alcohol use poses particularly deleterious health risks. Mindfulness is one promising strategy for reducing problematic alcohol use; however, mechanisms by which mindfulness might impact alcohol-related outcomes are unclear.

Moderated Mediation Model of Mindfulness, Stress, and Alcohol Use

We propose a moderated mediation model (Figure 1) which posits that mindfulness will be associated with lower alcohol use and problems through its links with psychosocial stress in two main ways: 1) by reducing perceived stress, and 2) by changing responses to stress when it occurs (i.e., reducing the link between stress and alcohol-related outcomes). In other words, not only is stress hypothesized to mediate the association between mindfulness and alcohol use, but mindfulness is also expected to moderate (weaken) the relationship between stress and alcohol use such that more mindful individuals observe and accept stressful experiences without attempting to cope by drinking. In support of the mediation pathway, research suggests that: a) dispositional mindfulness is associated with lower alcohol use (Fernandez et al., 2010; Smith et al., 2011; although there have been some conflicting findings in college samples; see Leigh, Bowen & Marlatt [2005] and Leigh & Neighbors [2009]), b) dispositional mindfulness is associated with lower perceived stress and negative affect (Garland et al., 2012; McKee et al., 2007; Smith et al., 2011), and c) higher stress predicts greater alcohol use and related problems (Beck et al., 2011; Dawson et al., 2005; Ragland et al., 2000). Thus, mindfulness might promote healthier drinking patterns through its impact on perceived stress.

In support of the moderation hypothesis (i.e., that mindfulness reduces the tendency to react to stress with alcohol use), research suggests that mindfulness promotes more adaptive responses to stressful situations (Arch & Craske, 2006, 2010; Britton et al., 2012). Preliminary research also supports the hypothesis that mindfulness moderates the relationship between unpleasant emotional states and unhealthy behavior. Two studies (Adams et al., 2012; Bowen & Marlatt, 2009) indicated that brief mindfulness instructions weakened the association between negative affect and smoking urges among smokers. Witkiewitz and Bowen (2010) reported that MBRP reduced the relationship between depressive symptoms and craving for alcohol/other drugs among patients with substance use disorders, and this moderating effect predicted lower substance use at 4-month follow-up. Witkiewitz and colleagues (2011) reported that a mindfulness-based module for coping with cravings reduced the relationship between negative affect and heavy drinking both during treatment and at 1-year follow-up.

No known research has investigated associations among mindfulness, perceived stress, and alcohol use among smokers. Furthermore, there is a paucity of research on mindfulness among socially disadvantaged groups including low-SES and racial/ethnic minorities, who are at particularly high risk for co-occurring health risk behaviors and chronic disease

(Cooper et al., 2000; Fagan et al., 2007; Kendzor, Costello et al., 2008). Although there are very few studies of mindfulness in racial/ethnic minorities, the studies available suggest that mindfulness is beneficial for low-SES African Americans (Palta et al., 2012; Szanton et al., 2011).

The present study sought to clarify relationships among dispositional mindfulness, perceived psychosocial stress, and alcohol use in a sample of predominantly low-SES African American smokers. Given the importance of multidimensional assessment of alcohol related outcomes, three outcome variables were examined: 1) quantity of alcohol consumption (number of drinks per week), 2) frequency of binge drinking (defined as consuming > 5 drinks on one occasion), and 3) probable alcohol use disorder (Dawson & Room, 2000; Sobell & Sobell, 2003; Witkiewitz & Villarroel, 2009). Although these variables are clearly related, they are conceptually distinct. For example, whereas consumption of large quantities of alcohol is associated with a plethora of health risks, consumption alone is not sufficient to indicate an alcohol use disorder (which entails a persistent pattern of alcohol-related problems; APA, 2000).

This study tested three primary hypotheses: 1) Greater dispositional mindfulness will be associated with lower quantities of alcohol consumption, less frequent binges, and lower likelihood of an alcohol use disorder; 2) Perceived stress will mediate relationships between mindfulness and alcohol use outcomes (i.e., more mindful individuals will tend to perceive less stress, which will be associated with lower scores on alcohol use outcomes); and 3) Mindfulness will moderate relationships between perceived stress and alcohol use outcomes (i.e., perceived stress will be related to greater alcohol use among individuals lower, but not higher, in mindfulness).

Method

Participants

Data were collected as part of a randomized clinical trial examining the efficacy of a culturally tailored, palmtop computer-delivered smoking cessation treatment for African Americans (see Kendzor, Cofta-Woerpel et al., 2008 for detailed procedures). Participants were recruited via local print advertisements and were eligible if they were African American, between the ages of 21 and 65 years, had been smoking ≥ 5 cigarettes per day for ≥ 12 months, had an expired carbon monoxide level of ≥ 8 parts per million, planned to quit smoking within the next 2 weeks, possessed a functioning home telephone number and a permanent home address, and were able to understand English at least at a sixth grade literacy level. Exclusion criteria were regular use of tobacco products other than cigarettes, use of pharmacological cessation treatments other than nicotine patches supplied by the study, medical contraindication of the nicotine patch, or current pregnancy or lactation. Procedures were approved by the university's Institutional Review Board, and informed consent was obtained from all participants. Data used in the present study were collected before treatment initiation.

Procedure

Participants attended an initial orientation session (19 days before the scheduled quit day for smoking cessation), where they completed self-report questionnaires assessing demographic characteristics, smoking behaviors, dispositional mindfulness, perceived psychosocial stress, quantity of alcohol consumption, frequency of binge drinking, and alcohol-related problems.

Measures

A *Demographics Questionnaire* assessed age, partner status, education level, and income.

The *Heaviness of Smoking Index* (HSI; Heatherton et al., 1989) is a 2-item self-report measure of smoking that is supported as a reliable and valid indicator of degree of nicotine dependence. The two items are: “How many cigarettes a day do you smoke on average?” and “How soon after you wake up do you smoke your first cigarette?” (“time to first cigarette”).

The *Mindful Attention Awareness Scale* (MAAS; Brown & Ryan, 2003) is a 15-item self-report measure of dispositional mindfulness with good reliability and validity (Brown & Ryan, 2003). Example items are “I find it difficult to stay focused on what’s happening in the present” and “I could be experiencing some emotion and not be conscious of it until some time later.” Participants rate each item from 1 (Almost Always) to 6 (Almost Never). Scores are averaged so that total scores range from 1 to 6, with higher scores indicating greater mindfulness. The MAAS showed excellent internal consistency in the present sample ($\alpha = 0.92$).

The *Patient Health Questionnaire (PHQ) Psychosocial Stressors Scale* (Spitzer, Kroenke, & Williams, 1999) is a 10-item self-report measure of perceived psychosocial stress in the past 4 weeks. Participants rate the extent to which they have been bothered by each stressor from 1 (Not bothered) to 3 (Bothered a lot). Stressors include worries about health, difficulties with relationships, work-related stress, and financial problems. Total scores range from 10 to 30, and this scale showed adequate internal consistency in the present sample ($\alpha = 0.83$).

The *Patient Health Questionnaire (PHQ) Alcohol Abuse/Dependence Scale* is a self-report measure that uses DSM-IV diagnostic criteria for alcohol abuse and dependence (Spitzer et al., 1999). First, individuals indicate whether they ever drink alcohol (yes, occasionally, or no). Among those who drink, the five remaining items indicate whether or not their alcohol use has caused specific problems more than once in the past 6 months (e.g., missing work, school, or other activities; driving a car after drinking too much). A positive response on any of these 5 items indicates a probable alcohol use disorder, and the PHQ has shown high agreement with independent diagnoses made by mental health professionals (Spitzer et al., 1999).

The *Alcohol Quantity and Frequency Questionnaire* is a self-report measure of average alcohol consumption on each day of the week in the past 30 days (Sobell & Sobell, 2003). Average number of drinks per day are summed to determine the average number of drinks consumed per week. In addition, participants indicate the number of times they have engaged in binge drinking (>5 drinks on one occasion) in the past 3 months.

Statistical Analyses

Path analyses—Conditional mediation effects were tested with MPlus Version 7 using bootstrapping methods suggested by Preacher, Rucker, and Hayes (2007) for testing a similar moderated mediation model. Kline (2011) termed this “second-stage moderation,” as the second path of the indirect effect of the predictor on the dependent variable depends on the moderator (Figure 1). The hypothesized model was tested separately for the three dependent variables: 1) quantity of alcohol consumption (number of drinks per week), 2) frequency of binge drinking in the past three months, and 3) probable alcohol use disorder (yes/no). Dispositional mindfulness and perceived psychosocial stress were entered as continuous predictors. The model also tested the interaction between mindfulness and stress (the product of mean-centered mindfulness and PHQ stress), and the indirect effect of mindfulness on alcohol variables through psychosocial stress as a mediator. Covariates included in initial models were: gender, age, partner status, education, income, cigarettes per day, and time to first cigarette. Covariates that were significant in path analyses at the .10 level were retained in final models.

Path analyses predicting quantity of alcohol use and binge frequency were tested using Full Information Maximum Likelihood (FIML), which accounted for missing data. Five model fit indices with corresponding criteria indicating good fit (Hu & Bentler, 1995; Kline, 2011) were examined: (a) Chi-Square test of model fit $p > 0.05$, (b) comparative fit index (CFI) > 0.90 , (c) Tucker-Lewis Index (TLI) > 0.90 , (d) root mean square error of approximation (RMSEA) < 0.08 , and (e) standardized root means square residual (SRMR) < 0.08 . The path analysis predicting probable alcohol use disorder was estimated with Diagonally Weighted Least Squares (DWLS, or robust Weighted Least Squares), which is appropriate for use with dichotomous outcomes. The Weighted Root Mean Square Residual (WRMR), a fit index for models with dichotomous outcomes, was used to evaluate goodness of fit for DWLS models (suggested cutoff < 1.0 ; Yu, 2002). Significant interactions were probed using tests of simple effects (Aiken & West, 1991) in which all covariates were statistically controlled and outliers greater than 3.3 standard deviations from their predicted mean were excluded (Tabachnick & Fidell, 2007). Because alcohol variables were positively skewed, models predicting alcohol use quantity and binge frequency were re-run using transformed dependent variables (square root and natural log transformations). Because all results were virtually identical for untransformed versus transformed variables, results for untransformed variables are reported for ease of interpretation.

The hypothesized model was not expected to differ for men versus women. However, to explore any potential gender differences in associations among mindfulness, stress, and alcohol use, all models were re-run including the following interaction terms: gender X mindfulness (mean-centered), gender X stress (mean-centered), and the threeway interaction between gender, mindfulness (mean-centered), and stress (mean-centered). None of these interaction terms were significant, suggesting that associations among mindfulness, stress, and alcohol use did not differ as a function of gender. Accordingly, results are presented for the sample as a whole.

Results

Participant Characteristics

Three hundred ninety-nine African American smokers enrolled in a smoking cessation trial participated in this study. Participant characteristics for the total sample and by mindfulness tertiles are shown in Table 1. Participants with higher mindfulness reported lower perceived stress, lower quantities of alcohol consumed, less frequent binge drinking, and lower likelihood of an alcohol use disorder. Zero-order correlations (see Table 2) indicated that higher mindfulness was significantly related to lower scores on all alcohol variables as well as lower perceived stress. Higher perceived stress was related to higher values of all alcohol use variables.

Path Analyses

Fit indices indicated excellent fit for all models; Chi-Square test of model fit ($ps > 0.25$), CFI (0.996–0.998), TLI (0.977–0.994), RMSEA (0.017–0.032, 90% CI [0.00–0.11]), SRMR (0.012–0.013), WRMR (0.597). Covariates included in all final models were gender, partner status, and time to first cigarette. Other covariates were excluded from final models because these were not significant predictors and did not improve model fit for any of the alcohol use variables. Comparison of fully-adjusted versus final models indicated that patterns of significance were virtually identical, with only one exception (i.e., with all covariates in the model, the indirect effect of mindfulness on alcohol abuse/dependence through stress was no longer significant [$p = 0.06$] rather than being statistically significant [$p = 0.006$ in final model]).

Quantity of alcohol consumption—After controlling for covariates, mindfulness was associated with fewer drinks consumed per week ($\beta = -0.22, p = 0.02$). Mindfulness also was associated with lower perceived stress ($\beta = -0.53, p < 0.001$). Perceived stress did not mediate the relationship between mindfulness and drinks per week ($b_{\text{indirect effect}} = -0.04$, 95% CI [-0.10, 0.02], $SE = 0.03, p = 0.18$). However, there was a significant interaction between mindfulness and stress in predicting drinks per week ($\beta = -0.15, p = 0.04$). Linear regression analyses were conducted predicting drinks per week from psychosocial stress in low, medium, and high tertiles of mindfulness. Results indicated that higher psychosocial stress was significantly related to higher drinks per week in participants with low mindfulness ($t[97] = 1.98, p = 0.05, sr^2 = 0.04$) but not among those with medium ($p = 0.20$) or high ($p = 0.18$) levels of mindfulness (Figure 2).

Frequency of binge drinking—Higher mindfulness was associated with fewer episodes of binge drinking in the past 3 months ($\beta = -0.21, p = 0.045$) and lower perceived stress ($\beta = -0.53, p < 0.001$). Perceived stress did not mediate the relationship between mindfulness and number of binge episodes ($b_{\text{indirect effect}} = 0.001$, 95% CI [-0.05, 0.05], $SE = 0.03, p = 0.96$). However, the interaction between mindfulness and stress showed a non-significant trend ($\beta = -0.14, p = 0.056$). Follow-up analyses indicated that psychosocial stress was related to more frequent binge episodes in participants with low mindfulness ($t[92] = 2.30, p = 0.02, sr^2 = 0.05$) but not among those with medium ($p = 0.53$) or high ($p = 0.12$) levels of mindfulness (pattern virtually identical to that shown in Figure 2).

Probable alcohol abuse/dependence—Greater mindfulness was associated with lower likelihood of an alcohol use disorder ($\beta = -0.27, p = 0.001$) and lower stress ($\beta = -0.52, p < 0.001$). Stress was significantly related to higher likelihood of an alcohol use disorder ($\beta = 0.20, p = 0.006$). Stress mediated the relationship between greater mindfulness and lower likelihood of an alcohol use disorder ($b_{\text{indirect effect}} = -0.11, 95\% \text{ CI } [-0.18, -.03], SE = 0.04, p = 0.006$). There was not a significant interaction between mindfulness and stress ($\beta = -0.05, p = 0.44$).

Discussion

The current study evaluated a moderated mediation model of mindfulness, perceived psychosocial stress, and alcohol use. The overall hypothesized model showed excellent fit to the data in predicting quantity of alcohol use, binge frequency, and probable alcohol use disorder. There were three key findings. First, greater dispositional mindfulness was related to lower quantities of alcohol consumption, lower frequency of binge drinking, and less likelihood of an alcohol use disorder. Second, greater mindfulness was related to lower perceived stress, and perceived stress mediated the relationship between mindfulness and likelihood of an alcohol use disorder. Third, mindfulness significantly moderated the relationship of perceived stress with quantity of alcohol use, and this interaction showed a non-significant trend in predicting binge drinking. Higher perceived stress was related to higher quantity of alcohol consumption and more frequent binge drinking among participants with low, but not high, mindfulness scores.

The findings suggest that mindfulness is protective with respect to alcohol use and related problems. Whereas participants with low dispositional mindfulness reported consuming 15 drinks per week and engaging in 3.4 binge drinking episodes on average in the last 3 months, those in the highest tertile of mindfulness reported approximately 5 drinks per week and fewer than 1.5 binge episodes. Similarly, 45% of participants low in mindfulness evidenced probable diagnoses of alcohol abuse/dependence, versus only 12% for individuals high in mindfulness. Although unadjusted analyses might have been influenced by additional factors related to alcohol use (e.g., gender, nicotine dependence), these associations remained significant once these variables were controlled. These results are consistent with extant studies suggesting that mindfulness is associated with reduced at-risk drinking (e.g., Bowen et al., 2009; Fernandez et al., 2010; Smith et al., 2011; Witkiewitz & Bowen, 2010; Witkiewitz, Marlatt, & Walker, 2005).

Unexpectedly, the mediating and moderating effects pertaining to mindfulness and psychosocial stress operated slightly differently across the different alcohol-related variables. Stress mediated the relationship between mindfulness and likelihood of an alcohol use disorder. That is, mindfulness was associated with lower perceived stress, which was in turn related to lower likelihood of an alcohol use disorder. Notably, the PHQ alcohol scale focuses on alcohol-related problems (e.g., driving while intoxicated, social problems due to alcohol), rather than quantity or frequency of use. Presumably the lower level of stress perceived by more mindful individuals reduces the likelihood of alcohol-related problems. Although mindfulness is also related to lower drinking quantity and frequency, the

mechanism of action appeared slightly different. In these instances, mindfulness weakened the link between stress and drinking quantity/frequency.

Stress mediated the association between mindfulness and probable alcohol abuse, but did not mediate associations of mindfulness with chronic and binge drinking. In an effort to better understand these patterns, we conducted post-hoc analyses with individuals classified as having probable alcohol abuse ($n = 103$) and those identified as not having probable alcohol abuse ($n = 296$). Individuals with probable alcohol abuse tended to have higher stress levels (mean = 20.17, $SD = 4.44$) than those without probable abuse (mean = 17.61, $SD = 4.53$), and those differences remained after controlling for mindfulness. Individuals with probable alcohol abuse consumed more drinks per week (mean = 23.08, $SD = 32.44$) and had higher frequencies of binge drinking (mean = 5.32, $SD = 8.93$) than individuals without probable alcohol abuse (mean drinks per week = 4.73, $SD = 8.23$; mean frequency of binge drinking = 1.31, $SD = 3.30$). Importantly, the correlation between stress and drinks per week was 0.18 for individuals with probable alcohol abuse versus -0.02 among individuals without probable abuse. Therefore, because the majority of participants ($n = 296$) were not alcohol abusers, the association between stress and chronic drinking in the overall sample was reduced, thus weakening the strength of the indirect (i.e., mediational) effect. Similarly, the mediation effect of stress on the relationship between mindfulness and binge drinking was not significant because the estimated correlations between stress and frequency of binge drinking were 0.01 and 0.04 in the non-abusers and probable alcohol abusers, respectively. These post-hoc analyses suggest that stress may be more consistently associated with chronic drinking among individuals who have probable alcohol abuse (and who also tend to have lower levels of mindfulness) than among people who do not have an alcohol use disorder (and who tend to be more mindful).

Results regarding associations among mindfulness, stress, and alcohol use dovetail with recent findings on neurological mechanisms of mindfulness. While engaging in affect labeling tasks, more mindful individuals show greater widespread activation in the prefrontal cortex and reduced bilateral amygdala activity (a pattern associated with lower perceived stress and improved emotion regulation; Creswell et al., 2007; Hölzel et al., 2011; Way et al., 2010). This pattern of higher prefrontal cortex and lower amygdala activation may be a neural mechanism by which mindfulness promotes the observation of distress without acting upon it with impulsive behaviors including alcohol use. In addition to these neuroimaging findings, dispositional mindfulness is inversely associated with alcohol attentional bias (Garland et al., 2012), which mediates the association between dispositional mindfulness and enhanced HRV recovery from stress-primed alcohol cue exposure (Garland, 2011). It may be that individuals higher in dispositional mindfulness are better able to disengage their attention from alcohol cues, which enables their autonomic nervous systems to recover from perturbations to visceral homeostasis incurred by exposure to stress and alcohol cues.

The present results may help to explain why the tension reduction hypothesis has received inconsistent support. That is, some but not all individuals may drink in response to stress. Several researchers have found that individual differences (e.g., gender, expectancies, situational factors) moderate the extent to which stress is related to heavy drinking (Rutledge

& Sher, 2001; Young et al., 1990). Dispositional mindfulness might be another such factor that reduces the extent to which stress triggers heavy drinking. Further research is needed to explore exactly how mindfulness ameliorates the association between stress and drinking. For example, mindfulness may reduce the association between stress and drinking through its effects on other related variables including distress tolerance, self-efficacy, and alcohol expectancies. Perhaps mindfulness enhances tolerance for emotional distress, promotes higher self-efficacy to cope with stress without drinking, and/or lessens expectancies that drinking will relieve stress. Indeed, certain aspects of mindfulness (e.g., accepting without judgment) are associated with greater tolerance for emotional distress (Vujanovic et al., 2010). In addition, among smokers interested in quitting, those higher in dispositional mindfulness tend to have lower negative reinforcement expectancies for smoking, higher self-efficacy for quitting, and higher confidence in their ability to control their emotions without smoking (Vidrine et al., 2009). Similar relationships may exist between mindfulness and problematic drinking.

Limitations and Future Directions

The current study is limited by a cross-sectional design, precluding assumptions of causality. Without longitudinal data, it is possible that alcohol use affects perceived stress, rather than the other way around. Indeed, there are likely dynamic associations between stress and alcohol use (Witkiewitz & Villarroel, 2009). In addition, it is possible that patterns of high stress and heavy alcohol use somehow reduce individuals' abilities to nonjudgmentally observe present-moment experience, rather than vice versa. Thus, it will be important to study longitudinal relationships among mindfulness, stress, and alcohol use over time. In addition, this study utilized self-report measures of alcohol use, and under-reporting of alcohol consumption is common using self-report quantity-frequency methods (Sobell & Sobell, 2003). Future studies might employ additional methodologies including biochemical markers of alcohol use and ecological momentary assessment. Finally, generalization of findings to non-smokers and individuals from higher SES or other racial/ethnic groups must await verification. Research is needed to examine whether relations among mindfulness, stress, and alcohol use outcomes differ between demographic groups and among smokers vs. non-smokers.

Despite these limitations, this study presents a model that combines mediation and moderation to elucidate not only associations between mindfulness and alcohol use, but also the potential underlying mechanisms. The current study is strengthened by a multidimensional assessment of alcohol use (i.e., quantity of alcohol consumption, frequency of binge drinking, probable alcohol use disorder), and this work is a much-needed step toward filling the gap in mindfulness research among low-SES and racial/ethnic minority populations. The study employed a large sample size and controlled for relevant demographic and nicotine dependence constructs. Effects of mindfulness on alcohol use appear to be above and beyond these factors.

Future studies with longitudinal data will help to elucidate temporal and causal relationships among mindfulness, perceived stress, and alcohol use. In particular, randomized controlled trials investigating treatments designed to increase mindfulness will be important in

understanding the effects of mindfulness. Indeed, studies suggest that mindfulness-based treatments effectively increase levels of dispositional mindfulness, and these increases explain improvements in psychological health (e.g., Carmody & Baer, 2008; Keune et al., 2011). Studies in this field should also examine additional mechanisms (e.g., distress tolerance, emotion regulation, self-efficacy, alcohol expectancies, motivation) that may underlie the effects of mindfulness to create a broader and more comprehensive model. Research targeting specific mechanisms of action by which mindfulness promotes more effective emotional and behavioral regulation will be invaluable to inform mindfulness-based treatments that target heavy alcohol use, smoking, and other health risk behaviors.

Conclusions and Implications

Among predominantly low-SES African American smokers, greater dispositional mindfulness is related to less alcohol consumption, lower frequency of binge drinking, and less likelihood of an alcohol use disorder. Mindfulness appears not only to reduce perceived stress but also to change the relationship between perceived stress and alcohol-related outcomes (i.e., mindfulness may reduce the likelihood that stressful experiences trigger impulsive reactions including drinking). This finding is particularly striking given the long history of theoretical and empirical work suggesting the paramount role of stress in triggering heavy drinking. Given the present findings, clinical interventions that increase mindfulness might work to reduce stress, which could decrease the likelihood of alcohol-related problems. Furthermore, increasing mindfulness appears to be one promising strategy for breaking the link between stress and quantity and frequency of alcohol use/binge drinking. Future researchers and clinicians might consider applying mindfulness-based strategies to target heavy drinking among at-risk populations such as low-SES smokers.

Acknowledgements

This research was supported by the National Cancer Institute through grants R01CA94826, R25-TCA57730, the University of Texas MD Anderson Cancer Center's Support Grant CA016672, and the Latinos Contra el Cancer Community Networks Program Center Grant U54CA153505. This work was also supported by a faculty fellowship from the University of Texas MD Anderson Cancer Center Duncan Family Institute for Cancer Prevention and Risk Assessment.

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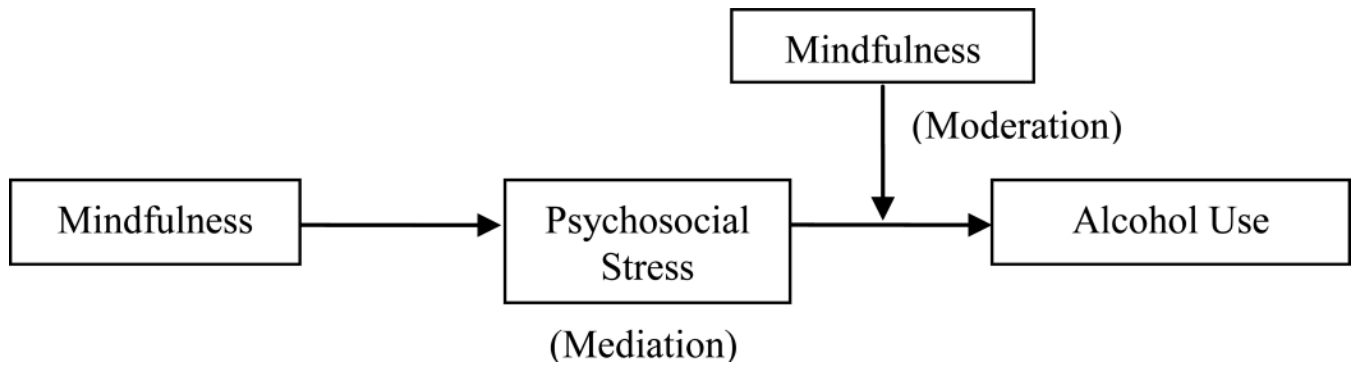


Figure 1.
The proposed moderated mediation model.

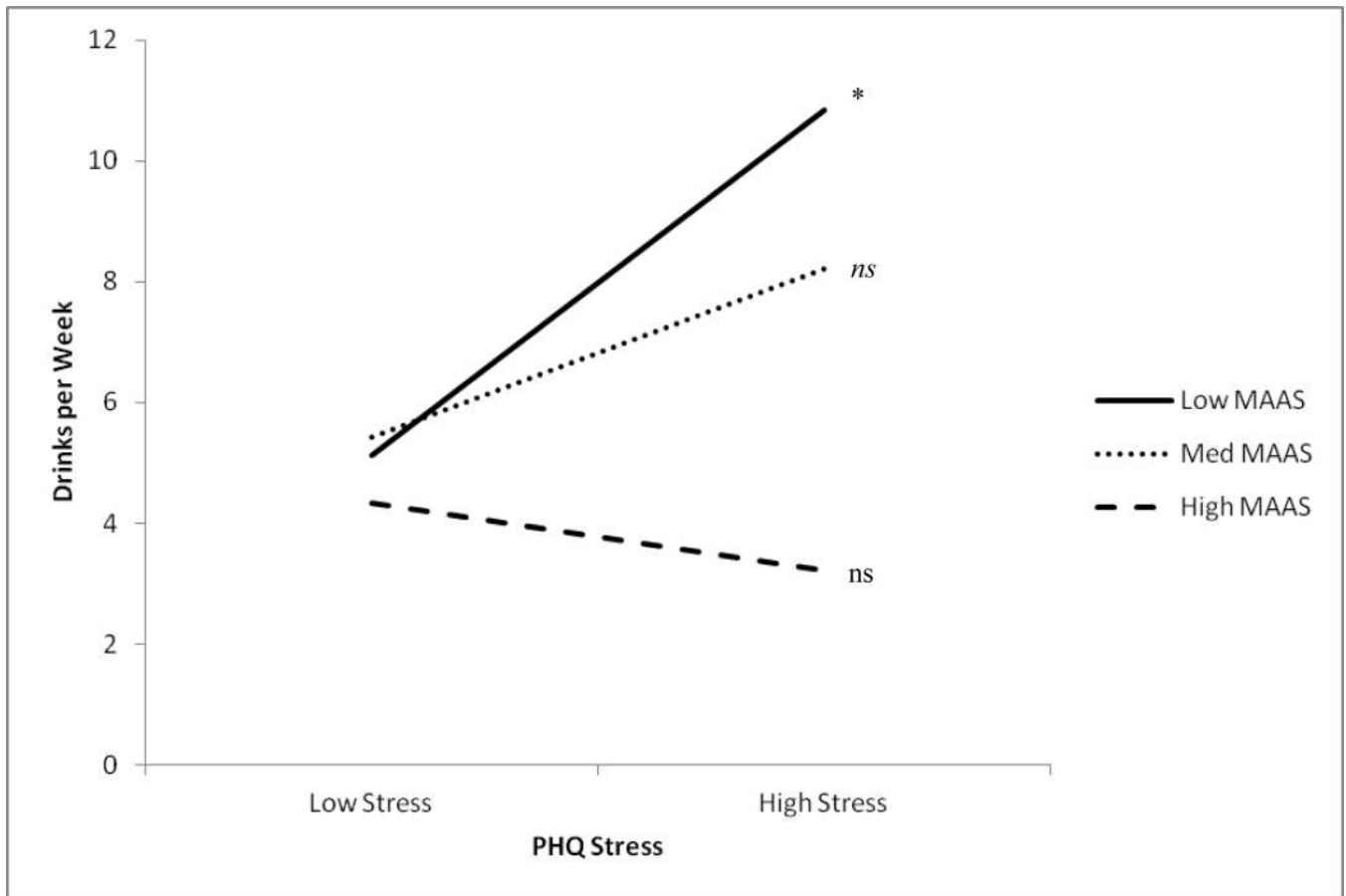


Figure 2.

Association between PHQ Stress and Drinks per Week as a Function of Dispositional Mindfulness.

Notes. The continuous bold line represents a significant positive association between stress and drinks per week among participants low in mindfulness. Dotted and dashed lines indicate nonsignificant associations among participants with medium and high mindfulness scores, respectively.

MAAS = Mindful Attention Awareness Scale; PHQ = Patient Health Questionnaire

* $p \leq .05$. ns: $p > .05$.

Table 1
Participant Characteristics for the Entire Sample and by Dispositional Mindfulness Tertiles

Variable	Total Sample (N = 399)	Low MAAS (n = 128)	Medium MAAS (n = 133)	High MAAS (n = 135)	p value
% Female (%)	50.9%	52.3%	57.1%	43.7%	.08
Age	42.44 (9.74)	40.45 (9.91)	42.92 (9.97)	43.80 (9.06)	.02
% Married or living with partner	21.3%	18.8%	15.0%	30.4%	.01
% ≤HS education	51.6%	56.3%	58.6%	40.0%	.01
% income < \$10,000/year	38.1%	50.8%	36.1%	28.9%	.02
Cigarettes per day	20.56 (12.16)	22.55 (12.50)	20.27 (10.54)	18.88 (13.09)	.05
% who smoke within 5 minutes of waking	58.6%	62.5%	63.2%	51.1%	.02
MAAS	4.29 (1.03)	3.11(.56)	4.30 (.31)	5.42 (.38)	< .001
PHQ Stress	18.29 (4.64)	21.26 (4.26)	18.25 (4.00)	15.49 (3.77)	< .001
Drinks per week	9.67 (19.93)	14.73 (29.99)	9.19 (14.15)	5.32 (8.59)	.001
Number of binge episodes (past 3 months)	2.38 (6.67)	3.42 (8.10)	2.28 (4.06)	1.47 (3.82)	.02
% PHQ Probable Alcohol Abuse/ Dependence	26.6%	45.3%	24.1%	11.9%	< .001

Note. MAAS = Mindful Attention Awareness Scale; PHQ = Patient Health Questionnaire

Table 2

Zero-order Correlations among Mindfulness, Psychosocial Stress, and Alcohol Use

	Mindfulness (MAAS)	PHQ Psychosocial Stressors
Mindfulness (MAAS)	-	-.56***
PHQ Psychosocial Stressors	-.56***	-
Drinks Per Week	-.25***	.17**
Number of Binge Episodes (Past 3 Months)	-.22***	.10*
PHQ Probable Alcohol Abuse/Dependence	-.28**	.25***

*
 $p \leq .05$ **
 $p \leq .01$ ***
 $p \leq .001$.*Note.* MAAS = Mindful Attention Awareness Scale; PHQ = Patient Health Questionnaire.

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