

CIGARETTE SMOKING PATTERNS, STRESS, AND COPING SKILLS:
EXPLORING MINDFULNESS-BASED MEDITATION FOR
UNDERSERVED FEMALE TOBACCO SMOKERS WITH CHILDREN

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by
Samantha M. Chin, MPH

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Examining Committee Members:

Bradley N. Collins, PhD, Advisory Chair, Department of Social & Behavioral Sciences
Stephen J. Lepore, PhD, Department of Social & Behavioral Sciences
Levent Dumenci, PhD, Department of Epidemiology and Biostatistics
Claire Spears, PhD, External member, Georgia State University

ABSTRACT

The purpose of the study was to investigate the acceptability, feasibility, potential efficacy, and putative mechanisms of a mindfulness-based intervention (MBI) to facilitate stress and smoking urge management that was tailored to low-income female smokers with children. Underserved maternal smokers have elevated levels of stress and depressive symptoms, and greater difficulty managing urges to smoke (key determinants of sustained smoking behavior) compared to the general population of smokers. An MBI that targets such determinants may be useful in facilitating smoking behavior change in this high-risk population.

Purposive sampling targeted mindfulness naïve, low socioeconomic status, maternal smokers recruited from dental clinics and healthcare agencies serving low-income Philadelphia neighborhoods. The initial phase of this study used formative assessments to examine the acceptability and feasibility of mindfulness practices and guide the design of a tailored MBI. Next, the study used a randomized, two-group, repeated measures design to assess between-group effects on key factors associated with sustained smoking, comparing participants receiving MBI procedures and a control group receiving a parallel parenting skills intervention. The efficacy of MBI procedures was tested using a single 5-minute audio with MBI instructions vs a child safety recording (control) to examine group differences in negative affect and smoking urge following three massed smoking cue exposure trials at baseline. Subsequently, participants initiated four weeks of either MBI or parenting skills training delivered by daily text messages with prompts and links to group-specific audio. Participants' smoking urge, perceived stress and daily cigarette consumption were assessed daily over the 4-week intervention via texted survey link and at end of treatment via telephone to examine efficacy in reducing stress and smoking urge and explore effects on daily cigarette smoking. The study also assessed attrition rate,

adherence to daily text-based survey completion, and intervention satisfaction as indices of acceptability and feasibility. We hypothesized that the MBI would be feasible, acceptable, and, compared to the control group, demonstrate greater reductions in smoking urge and negative affect (single session assessments at baseline) as well as perceived stress and strength of smoking urge over time (4-week assessments). Between group comparisons on primary and exploratory outcomes were assessed with linear mixed models (LMM). The study also explored the facets of mindfulness and process measures.

The participant sample ($N = 40$) was 88% African American, with an average age of 36 years old and 55% with a high school degree/GED or less. Mean baseline daily smoking consumption was around 10 cigarettes per day. Formative analyses suggested acceptability of mindfulness practice. The main theme that developed from the in-depth interviews was the need for tailored content such as shorter meditations, informal language, and text messages with pictures. Results of the single session MBI following cue exposure procedures showed no between group differences in urge or negative affect. Results of the 4-week MBI suggested that the intervention was feasible, with 4% attrition and an 87% response rate (~6 out of 7 days over 4 weeks). LMMs showed a significant time by condition effect for smoking urge, $F(1, 545) = 5.38$, $PE = -0.038$, $SE = 0.016$, $p = 0.021$, indicating that smoking urge declined significantly more over time in the MBI group compared to the control group, but no effect over time by condition for perceived stress. Thus, there was partial support for the primary hypotheses. Exploratory analyses showed a significant difference in mean cigs/day [$F(1,35) = 6.993$, $p = 0.012$] between groups (MBI mean = 5.51 cigs/day; Control mean = 8.12 cigs/day). Analysis of process measures showed the messages were well received and viewed as helpful, inspirational and motivational, providing further support of acceptability of MBI procedures. Together, results

suggest acceptability and feasibility of MBI procedures in this under-studied, high risk population of smokers. Results suggest potential efficacy of 4-weeks of daily guided MBI practice at reducing smoking urges and cigarettes smoked per day among current maternal smokers, even though a single session of guided MBI among mindfulness naïve smokers may not have utility in suppressing cue-elicited smoking urge and negative affect. This study adds to the growing evidence supporting mindfulness practices to aid in smoking cessation. While the generalizability of this study is limited to a highly distressed population of maternal smokers not enrolled in smoking cessation treatment, future research could determine whether initiating this tailored MBI prior to a quit attempt could facilitate preparation of smoking cessation in a population of smokers known to have greater challenges quitting smoking.

DEDICATION

To my mom, Tina Davis, who has been there for me unconditionally, encouraging me through every step of life. Thank you for supporting me through and being involved in all the adventures this life has given us.

To my husband, Matt Chin, who continually encourages me both personally and professionally, showers me in love, and knows how to make me smile even on the most stressful day. Thank you for being my rock and for being so patient and loving, especially through the dissertation process.

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DEFINITION OF TERMS

CBT: Cognitive behavioral therapy

EOT: End of treatment

FFMQ: Five facet mindfulness questionnaire

LLM: Linear Mixed Models

MBI: Mindfulness-based intervention

PANAS: Positive and negative affect scale

PSS: Perceived stress scale

QSU: Questionnaire of smoking urges

RCT: Randomized control trial

SCT: Social cognitive theory

SES: Socioeconomic status

SHSe: Secondhand smoke exposure

TLFB: Timeline follow back (self-report measure of number of cigarettes consumed)

TMSC: Transactional model of stress and coping

TSE: Tobacco smoke exposure

CHAPTER 1

INTRODUCTION

Purpose of Research

This study's effort is to test the efficacy of a tailored MBI that is acceptable in this population which could inform the use of MBI-strategies that enhance evidence-based smoking cessation treatment. Tobacco use is responsible for most preventable deaths and disease in the United States (U.S.).¹ Although nationwide smoking trends in the U.S. are decreasing, income disparities exist, with almost double the smoking prevalence for those living below the poverty line.² Low-income groups have higher tobacco-related disease risk and have greater challenges quitting smoking than the general population.³⁻⁵ Evidence-based smoking cessation interventions do exist. However, the efficacy of these interventions in underserved populations is undermined by common barriers such as greater life stress and increased depression.⁶ Gender disparities also exist, with women more likely than men to have higher rates of depression, and to smoke as a means for managing their negative affect, stress and depression.^{7,8} Elevated levels of these psychosocial factors undermine smokers' ability to achieve smoking cessation and increase risk for smoking relapse. Low-income females are particularly burdened with heightened stress, are more likely to live in social contexts that provide limited social support for managing negative affect and bear elevated tobacco-related disease burden compared to other smokers.⁹ Additionally, having children can magnify barriers to treatment uptake and success given that child rearing can exacerbate existing stress.¹⁰ Thus, public health researchers and professionals have maintained their call to address the public health priority of maternal smoking in underserved populations by testing novel interventions to help low-income smokers manage stress, mood and smoking urges as a means by which to facilitate smokers' attempts to quit.

As researchers have explored strategies to tackle the unique and elevated challenges that contribute to sustained smoking among low-income female smokers, mindfulness has emerged as a promising adjunctive strategy to supplement evidence-based smoking cessation treatment.¹¹ Mindfulness can be defined as “purposefully paying attention to the present moment in a nonjudgmental or reactive manner.”¹² Mindfulness is associated with positive effects on physical health, psychosocial factors and mental health outcomes.^{13,14} Further, practicing mindfulness may decrease depressive symptoms, enhance smoking urge coping skills, facilitate stress management, and increase positive affect.¹⁵⁻¹⁷ MBIs targeting low-income female smokers could facilitate smoking cessation, as mindfulness may mitigate stress, negative affect and urge reactivity (known barriers to cessation in this population). However, research on mindfulness in underserved populations is lacking. Research is needed to understand and address this treatment disparity and systematically adapt MBIs to underserved populations with tailored elements that can address their elevated barriers to health behavior change.¹⁸

To address these gaps in the tobacco control and mindfulness literatures, this study was designed to test the feasibility and potential efficacy of the population-tailored intervention using a two-group ($N = 40$) randomized design (mindfulness vs. control). Measurement time points included baseline, daily (during the 4-week intervention) and end of treatment. The MBI tested the potential efficacy of a text-based, tailored intervention on mitigating perceived stress and smoking urge reactivity (outcomes) which are known barriers and facilitators to smoking cessation.

The proposed project aims to understand the acceptability, feasibility and efficacy of brief mindfulness practices targeting stress and smoking urge in a population of low-income female smoking mothers. The public health significance is aimed at informing tobacco control

methods. The results of the study could also potentially inform MBI intervention design in other public health areas with outcomes related to stress (e.g., obesity, heart disease). Eliminating health disparities is a public health priority. The study targets an underserved group of women to explore acceptability of a tailored intervention and to examine intervention effects. In sum, the study is innovative, using a text-based, tailored, individual design which will add to the literature on MBI adaptation and tobacco control.

Problem Statement

Tobacco use is responsible for the most preventable deaths and disease, with low-income female mothers being particularly at risk as they are burdened with heightened stress and are more likely to live in social contexts that provide limited support for managing negative affect, stress, and urge reactivity. Further, research on mindfulness in underserved populations is lacking; there is a need to understand and address this treatment disparity and systematically adapt MBIs to underserved populations with tailored elements that can address their elevated barriers to health behavior change.

Research Questions

1. Is brief mindfulness practice acceptable and feasible in a population of low-income female mothers who smoke cigarettes?
2. Could a 5-minute mindfulness meditation compared to control (parenting tips) reduce negative affect and smoking urges following smoking cue exposure procedures among mindfulness naïve maternal smokers?
3. Could a tailored, text-based MBI with daily prompts and 5-minute guided mindfulness meditation for stress and urge management reduce subjective stress, smoking urges and

potentially daily cigarette consumption over a 4-week intervention among previously mindfulness naïve maternal smokers?

4. Are individual facets of mindfulness related to stress, smoking urge and smoking cessation self-efficacy in this population?

Aims & Hypotheses

Aim 1: To conduct a formative analysis of the acceptability and feasibility of mindfulness practices in a population of meditation naïve, low-income female smokers, using these assessments to tailor a mindfulness-based intervention (MBI) for this population.

Hypothesis 1: Mindfulness will be acceptable in this population. We hypothesize that the delivery of mindfulness practices will need to be tailored to the preferences of the population, such as a focus on daily, shorter, individual, “informal” practices.

Aim 2: To explore potential efficacy of a single session, 5-minute mindfulness meditation in reducing negative affect and smoking urges following in vitro smoking cue exposure procedures.

Hypothesis 2: Greater reduction in pre-post cue exposure smoking urge and negative affect will be observed in the MBI group compared to the control group (child safety recording).

Aim 3a: To assess potential feasibility of the 4-week tailored MBI as measured by attrition and by adherence.

Hypothesis 3a: Delivery of the 4-week daily meditation intervention will be feasible. Our sample will achieve criteria for feasibility, defined as achieving <35% attrition and $\geq 4/7$ days per week adherence.

Aim 3b: To test the potential efficacy of the MBI in mitigating baseline to end-of-treatment measures of subjective stress and smoking urges both within the MBI group and between the MBI and parent skills training control groups.

Hypothesis 3b: Greater reduction in subjective stress and smoking urges will be observed over time in the MBI group compared to the control group.

Exploratory Aim 4a: To explore relationships between smoking urge, subjective stress, and smoking cessation self-efficacy with the 5 facets of mindfulness (observe, describe, act with awareness, nonjudge, and nonreactivity) to inform theory and future intervention tailoring.

Hypothesis 4a: Higher baseline levels of acting with awareness, non-judging, and non-reactivity will be significantly related to lower subjective stress, smoking urge reactivity, and smoking cessation self-efficacy in both groups.

Exploratory Aim 4b: To explore potential efficacy of the tailored MBI in reducing negative affect, depressive symptoms and number of cigarettes smoked per day, and its efficacy in increasing smoking cessation self-efficacy and intention to quit between groups.

Hypothesis 4b: Greater reduction in negative affect, depressive symptoms, and number of cigarettes smoked per day will be observed in the MBI group compared to the control group. Greater increase in smoking cessation self-efficacy and intention to quit will be observed in the MBI group compared to the control group.

CHAPTER 2

BACKGROUND AND LITERATURE REVIEW

Adult Tobacco Use

In the United States (U.S.), tobacco use is still a major public health problem.^{5,19,20} The Centers for Disease Control and Prevention refer to tobacco use as the most preventable cause of death in the world.¹ Smoking cigarettes and using tobacco products results in consumption of nicotine, a highly addictive psychoactive substance that requires rapid re-dosing to avoid unpleasant nicotine withdrawal effects – a behavior that becomes highly reinforcing and responsive to numerous conditioned cues which serve to maintain the smoking habit, thereby making smoking cessation difficult.²¹

The first Surgeon General's Report was released in 1964 stating the dangers of smoking and concluding that cigarette smoking causes lung and laryngeal cancer, and causal roles in other illnesses, such as cardiovascular diseases.^{22,23} At the time of the report, approximately 52% of men and 35% of women smoked cigarettes in the U.S.²³ The report is one of the most influential in public health history. Smoking rates have decreased significantly since the first Surgeon General's Report to about 16% of U.S. adults reporting cigarette smoking.⁵ Cigarette use is most prevalent by individuals 25-64 years old (18%), followed by those 18-24 years old (13%) and the smallest prevalence is reported by individuals 65 years and older (9%), due to premature death of smokers.⁵ Tobacco use is higher among those in active military positions, veterans, uninsured adults, racial minorities, low socioeconomic status (SES), Medicaid users, gender minorities, and adults with mental illness, physical disabilities and HIV/AIDS compared to the general population.^{5,19}

Disparities: Tobacco Use and Tobacco Control Efforts

While smoking rates are decreasing, tobacco use and disease disparities are increasing.¹⁹ Across socioeconomic status and education, approximately 32% of American Indian/Alaska Natives (non-Hispanic), 9% of Asians (non-Hispanic), 17% of Blacks (non-Hispanic), 11% of Hispanics, 25% of multiple races (non-Hispanic), and 17% Whites (non-Hispanic) report tobacco smoking.⁵ Higher education level inversely relates to use,⁵ and the prevalence of smoking is over 10% higher for those living in poverty.⁵ Slightly more men (18%) compared to women (14%) report cigarette use. The likelihood of smoking is nearly double for individuals with mental illness²⁴ and the likelihood of smoking is further increased when a mental illness is compounded with low SES.⁵ Low SES is related to higher smoking rates among women of childbearing age.²⁵⁻²⁷ Further, low SES women have a higher likelihood of recalcitrant smoking.²⁸ Recognizing smoking prevalence by sub-group is essential in order to identify high risk groups to target for interventions to reduce disparities.²⁹

Tobacco use disparities are influenced by direct targeting and segmented marketing practices purposely carried out by tobacco companies.^{30,31} Over the last few decades, there has been substantially more marketing (e.g., point-of-sale discounts and menthol) targeting low-income and vulnerable populations as well as geographically more promotion and targeting in low-income, racial minority neighborhoods compared to White neighborhoods.³⁰ For instance, Blacks smoke menthol cigarettes more than any other group and menthol has been shown to make it easier to start and harder to quit smoking.³²

Tobacco use disparities in low SES and vulnerable populations may be a consequence of disparities in population-wide tobacco control. Tobacco control efforts, over the past four decades, have been inequitable. Often, the populations smoking the most (e.g., low SES, LBGT,

and racial minorities) receive the least amount of mass media and social media campaigns and cessation programs. They also receive the least exposure to policy changes such as mandated smokefree zones in the workplace and in public spaces.³³

Cost and Health Consequences

Tobacco use is responsible for the most preventable deaths and disease in the U.S. annually (causing > 480,000 premature deaths and burdening > 16 million smokers with disease).³⁴ At the individual level, it can impact bone health, eye health, blood pressure, complicate pregnancy outcomes, and can cause cancer in almost every part of a person's body.^{29,34} Smokers are more likely than nonsmokers to die of numerous diseases such as coronary heart disease (2-4 times more likely), stroke (2-4 times more likely), and lung cancer (25 times more likely).²⁹ Secondhand smoke and thirdhand smoke exposure are dangerous and lead to serious health concerns.³⁵⁻³⁷ Lung cancer, coronary heart disease and increased respiratory issues are associated with secondhand smoke among non-smokers.^{35,36} Children and infants are most affected by tobacco smoke exposure, which causes respiratory problems, asthma, behavior problems, sudden infant death syndrome, and other health concerns.^{35,38} From a systems level, healthcare costs are impacted by tobacco use. In the U.S., it is estimated that over \$300 billion in direct health care expenditures and productivity losses each year are attributed to tobacco use.¹⁹ Additionally, secondhand smoke impacts productivity with a loss of \$5.6 billion per year.²⁹

Disparities: Cost and Health Consequences

Disparities exist in tobacco disease risk and health outcomes. Low SES, racial/ethnic minority groups, low education level, and sex (female) are related to higher tobacco-related disease risk and death.^{5,39,40} For instance, African American and Native Hawaiian adult smokers are more at risk for lung cancer compared to other ethnic and racial groups.⁴¹ Additionally, lung

cancer death rates are nearly double for those with lower education compared to adults with a higher education level.⁴² Discrimination may be a contributor to heightened stress in vulnerable populations, which in turn can lower immunity and increase risk of cardiovascular disease, some cancers and other tobacco-related diseases.⁴³ From a systems level, taxpayers are responsible for over 60% of the cost of smoking related diseases through public programs, including Medicare and Medicaid.⁴⁴

Recently, there has been a decrease in the prevalence of secondhand smoke exposure; however, like smoking trends, disparities exist with higher rates of exposure reported among low SES, children, adults who rent their homes, and non-Hispanic blacks.³⁷ Blue collar workers are also exposed to higher levels of SHS, often due to lack of smokefree workplace policies.⁴³ Similarly, negative health outcomes exist by gender (female), ethnicity (minority) and SES (low-income), in part due to these populations having greater level of TSE and less TSE protections.⁴⁵ Maternal smoking is the main source of child TSE,⁴⁶ and child TSE is higher in underserved populations.³⁵ Maternal smoking relates to numerous health problems for both the child and mother.⁴⁷⁻⁴⁹ Research on maternal smoking is a priority, especially given the impact on children's mental and physical health.⁵⁰

Current Smoking Treatment and Interventions

Smoking interventions vary in length, scope and intensity, and can be tailored to specific high-risk target populations.⁵¹ The U.S. Department of Health and Human Services guidelines for treating tobacco use and dependence state that brief advice can be effective in promoting motivation to quit and access to services, so it is recommended that clinicians always offer smoking cessation guidance.⁵² Further, studies show that brief advice to quit from a physician or staff on medical grounds increases quit attempts and offering cessation resources is even more

effective.⁵³ Best practice guidelines suggest comprehensive cessation interventions should include a combination of cognitive behavioral therapy (CBT), either in person or via a telephone-based counseling service such as a Quitline, and nicotine replacement therapy (NRT).⁵² Emerging recommendations also suggest a grouping of counseling, combination NRT and cessation medication (e.g., varenicline) for people who have experienced difficulty quitting.⁵⁴ CBT focuses on skills to manage cravings and cues to smoke.⁵⁵ Counseling should include support to improve self-regulation and urge coping skills. Quitlines have recently emerged as a standard of care due to their broad reach and relatively low-cost to deliver intervention.⁵² Medication, NRT, and counseling are effective.⁵² However, only utilizing NRT is not recommended as a sole intervention, as 70-80% of smokers who use NRT alone relapse.⁵⁶

Over 68% of adult smokers' report wanting to quit, 52% have made at least one quit attempt in the past year, but only 6.2% report quit status.⁵⁷ Currently, researchers are investigating adjunct treatments to expand cessation interventions to better target the complex barriers to quitting. Adjunct and complimentary treatments include meditation/mindfulness, physical activity, and relaxation and stress management practices which can aid smokers in managing urges to smoking during a cessation attempt.^{11,58-60} Additionally, research is examining the efficacy of adding integrative components within multi-level, multi-modal interventions that either augment specific treatment elements or aim to extend advice and support beyond live counseling sessions to bolster coping skills training and counterconditioning strategies that can help smokers achieve and maintain abstinence.⁶¹ Mobile phone applications (apps), text messaging or web-based interventions are innovative technology platforms that may make smoking cessation interventions more accessible and effective. For instance, "just-in-time" tailored text messages around stress management are designed to target a key factor associated

with relapse. Such an approach has been shown to reduce daily cigarette consumption.⁶² However, research shows that apps often do not follow smoking cessation guidelines and more research is needed to develop and test evidence-based smoking cessation apps.⁶³ Researchers should be cautious when adding technology to an intervention, ensuring the design is based on theory and is engaging to promote and maintain use.⁶⁴ Engagement impacts the intervention through retention, adherence and effectiveness, and can be achieved in many ways (e.g., content of the message/webpage, tailoring, timing, incentives, and supportive accountability).⁶⁵ Multi-level, multi-modal interventions have potential to help smokers successfully quit, as they utilize several of the above treatments (e.g. clinic-level referral and CBT) and add in innovative features such as text messaging or Apps.^{51,66}

Over the last few decades, substantial investment has been made in research and development of pharmacological treatments to tobacco dependence. Pharmacotherapy, such as nicotine replacement, bupropion and varenicline, are useful in reducing smoking behavior, aiding in cessation and preventing relapse; yet, pharmacological approaches work best in combination with behavioral practices.^{67,68} Pharmacological approaches do not work for everyone, and may not be available to or accepted by certain groups or individuals (e.g., racial/ethnic minorities).⁶⁹ More research and investment are needed to develop evidence-based behavioral and biobehavioral strategies for tobacco control.⁷⁰ Many prominent organizations, such as the Truth Initiative, Centers for Disease Control and Prevention, and the American Cancer Society, have partnered to call for and focus on behavioral intervention research for tobacco control.⁷⁰ Clinical practice guidelines call for providers to address multiple levels of determinants when addressing tobacco use.⁷¹ Many of the determinants and barriers to cessation (e.g., stress, negative affect) would benefit from more contemporary, or potent behavioral treatment elements that better

address the myriad determinants and challenges particularly high-risk smokers face when trying to quit, and may require additional targeted intervention components.

Disparities in Current Smoking Treatment and Limitations

Low SES individuals have less successful quit attempts and lower cessation rates than the general population, even when utilizing evidence-based programs.^{4,72-77} Majority of the literature suggests there is an income and education level disparity between successful quitters (i.e., lower income/education is associated with less successful quit attempts); however, there is mixed research on if the disparity exists between intention to quit within education and income levels.⁷⁸ One study found lower SES individuals are as likely to attempt to quit compared to higher SES individuals, yet they are half as likely to succeed.⁷⁵ Yet others found no association with income and education level to quit attempts or intention to quit.⁷⁸ When comparing low and high SES smokers in a longitudinal survey, high SES individuals were both more likely to access resources (educational information, counseling, NRT) and to have a smokefree home environment; and both factors significantly related to a higher quit status at 3 year follow-up.⁷⁹ Low SES individuals and racial/ethnic minorities are less likely to use NRT.^{80,81} At the systems-level, medication, NRT, and cessation counseling are often not covered by insurance plans and majority of state Medicaid plans do not include comprehensive cessation programs with no-cost sharing.³² As barriers to access NRT and medication remain, more research is needed to explore strategies and adjuncts to CBT counseling among low SES smokers to eliminate health disparities and improve the efficacy of evidence-based counseling treatment^{75,78}

Although many of the programs, interventions, policies and campaigns used for tobacco control are shown effective in the general population (e.g., advertising bans, smokefree workplace), they are often not relevant, acceptable, or accessible within sub-groups.³¹ Harm

reduction strategies (e.g., electronic cigarettes, smokeless tobacco products) have been emerging over the last 15 years due to the increased challenges underserved populations have quitting smoking.^{82,83} Additionally, tailored approaches, which take into account the specific needs and determinants influencing sub-groups, specifically high risk groups, would be optimal to address tobacco use and tobacco-related disease risk disparities.^{23,81} For instance, women are less successful at quit attempts compared to men.⁸⁴ As discussed above, women, especially low-income women, have heightened daily stress, negative affect and life chaos (known barriers to cessation).^{9,85,86} Because of the low response of low-income females to evidence-based cessation interventions, more recent trials have been testing adjunctive components, such as physical activity or meditation, to target stress and urge coping skills to enhance comprehensive cessation interventions.

Determinants and Barriers to Cessation

Genetics, cultural norms, coping skills, social networks, habit, mental health issues and environmental cues all play an intermixed and complex role in smoking behavior.^{52,86-93} Intervention success is predicted by biological and individual level factors, such as depressive symptoms, stress, coping skills, self-efficacy, anxiety, biological sex, and nicotine dependence.⁸⁶⁻⁹⁵ For instance, smokers who use cigarettes to manage negative affect and distress are at increased risk for relapse and face additional burdens when trying to quit.⁹⁶ It may be beneficial to target affect regulation in smoking cessation treatment and interventions due to the higher prevalence of depressive symptoms, anxiety, negative affect and mood disorders observed in tobacco users.⁹⁷ Many strategies can be used to target affect regulation such as acceptance-based practices or mindfulness;⁹⁸ yet, the potential utility of these treatments in tobacco control research remains to be fully explored.

Higher perceived stress is associated with heavier smoking.⁹⁹ Moreover, stress is a biological mechanism associated with all stages of the addiction process: smoking initiation, maintenance, and relapse.¹⁰⁰ Higher stress is inversely related to smoking cessation self-efficacy and lower urge management skills.¹⁰¹ Social support (e.g., peer, family, a support network, individual or group therapy) is associated with cessation by providing informational, emotional or instrumental support and may act as a buffer for stress.¹⁰² Investigating other potential “stress buffers” and stress buffering practices (e.g., mindfulness meditation, physical activity, spirituality) may be a useful addition to current treatments for urge management, smoking cessation and relapse prevention.

Smoking cessation self-efficacy, or confidence in one’s ability to abstain from smoking, is associated with smoking behavior and cessation.⁹⁵ For example, higher smoking cessation self-efficacy is associated with future abstinence, yet the strength of the relationship varies across studies and time of assessment.⁹⁵ Building or increasing urge management skills may increase self-efficacy to quit.¹⁰³ Many approaches exist for managing smoking urges, such as CBT practices (e.g., distraction, delaying), mindfulness-based approaches (e.g., noticing and not reacting to the urge), and nicotine replacement therapy.^{17,51} Urge management skills and smoking cessation self-efficacy are two important predictors of cessation that warrant additional research.¹⁰⁴

Disparities: Additional Challenges in Low SES Females

The need to reduce female smoking, especially among low SES populations, is a public health priority^{10,105} with a recent review of women and smoking calling for more research on innovative and tailored gender specific smoking cessation interventions.⁸ Sub-groups of the population, such as low-income women, face increased barriers when trying to quit.¹⁰⁶ Smoking maintenance, cessation, and relapse are influenced by mental health and personality

characteristics, which vary by gender, with women more likely than men to smoke as a means of managing mood and stress.^{8,107} Anxiety and depression are associated with smoking, with a stronger association observed in females.¹⁰⁸ Women are more likely than men to encounter psychosocial barriers to cessation (e.g., smoking-related weight concerns, elevated levels of stress, negative affect, and sex hormone cycle), are less successful at quitting than men, and more likely to relapse after quitting.^{3,84,109,110} In female smokers, stress is a main factor linked to cigarette use, as well as, initial initiation and relapse.⁷ Women often have higher psychological or behavioral dependence (smoking triggered by state of mind or situation vs. physical dependence to nicotine) compared to men. Accordingly, interventions should be tailored to address type of dependency (e.g., intensive counseling is often more successful to help women quit smoking).^{111,112} Compared to female smokers in general, low SES women often face greater life stress, depression, discrimination, and environmental cues in their community from industry promoting tobacco use.⁹ These psychosocial and environmental factors undermine coping skills acquisition, cessation self-efficacy, and social support for cessation – factors known to facilitate cessation – and contribute to lower rates of access and uptake of standard cessation treatment in this population.^{85,113–115}

A compounding factor among female smokers of childbearing age is parenting stress, which further magnifies barriers to treatment initiation and cessation success.¹⁰ Pregnancy and parenting are not always sufficient motivations for a mother to quit smoking.¹⁰ Smoking during pregnancy is more common among low SES women.¹¹⁶ Mothers in professional and managerial roles are four times more likely to quit versus those in manual and routine positions.¹¹⁶ Low-income Black women who smoked during pregnancy are more likely to report higher stress, lower social support and have less education compared to low-income Black women who did not

smoke during pregnancy.¹¹⁷ This population may benefit from the addition of stress-relieving activities to smoking cessation interventions.¹¹⁷ Addressing elevated stress and aiding female smokers' affect regulation and stress reduction practices, especially among low-income females with children, may be useful adjunctive components to bolster self-efficacy in the cessation process and facilitate cessation success.

Mindfulness as an Adjunctive to Comprehensive Smoking Cessation Interventions

The Psychological Construct of Mindfulness

Mindfulness is a Buddhist- and Zen-originated practice that is most often defined as in secular Western societies as “paying attention in a particular way: on purpose, in the present moment, and nonjudgementally.”¹¹⁸ Mindfulness may lead to increased mental flexibility through being fully in the present moment, which can in turn lead to change in behavior.¹¹⁹ A meta-analysis on mindfulness concluded that it is useful for coping with physical, psychosomatic and psychiatric disorders.¹²⁰ Mindfulness has recently been applied as an adjunctive to health promotion treatments designed to address a wide range of health conditions, including depression, chronic pain, stress and weight management, and to improve overall quality of life and wellbeing.^{120 14,121–124}

The five main facets of mindfulness are: observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience.¹²⁵ Research has suggested the possibility that different facets of mindfulness may be more strongly associated with stress reduction and mental health. However, research on each facet and their relation to outcomes is lacking.¹²⁶ More research on these mechanisms is warranted to better tailor intervention design.. For example, higher “acting with awareness” may be a key facet that relates to lower levels of depression;^{127–129} higher “non-judging” predicts lower stress, depression, and anxiety;^{127–130} and higher non-reactivity predicts lower distress and depression.^{128,131}

Mindfulness can be used by relatively healthy individuals looking to cope with daily hassles and life stressors.^{13,120} The aim of mindfulness is not to change one's circumstances or stressors, as majority of those are external or out of an individual's control, but to change the reaction process. By bringing one's awareness to the present moment, it allows space to observe what is happening (by sensing thoughts, mood states, feelings, body sensations) and then to use skillful discernment on what needs to happen or what does not need to happen. The next layer is adding a non-judgmental and compassionate approach while being present and aware regardless of what is happening, and without reacting impulsively. We may not particularly like what is occurring (negative mood, smoking urge) but mindfulness practice is allowing it to be without the need to control, judge or act on instinct. This gentle present moment awareness allows space to observe oneself (feelings, moods, thoughts, bodily sensations) as separate from the stressor. And then, when needed, allows an individual to make a clear and present moment decision around what skillful action to choose instead of reacting, acting impulsively or absentmindedly.

There are many ways to work with and apply mindfulness. Over the last few decades in the West, many standardized, evidence-based models have emerged to provide a structure for research and replication. Jon Kabat Zin, a pioneer in mindfulness research in the United States, created an 8-week mindfulness-based stress reduction (MBSR) model, which includes weekly 2.5-hour group meetings, daily home practices (20-60 minutes of formal meditation and many informal practices such as mindful walking) and a silent retreat day (usually around week 6 or 7).^{12,120} Many other mindfulness-based interventions (MBIs) are built off of this model and use the 8-week group-based format. More recently, variations to the format and modality of MBIs are being used and researched (e.g., mindfulness mobile Apps, one-on-one treatment). More on MBI adaptations is discussed later.

Mindfulness, Stress, Depression and Negative Affect

Mindfulness has been shown effective for stress reduction in many settings and populations.¹³² For instance, MBIs are shown to reduce reported stress in individuals with chronic conditions (e.g., arthritis, coronary artery disease, back pain)¹³² and cancer patients.¹³³ Further, mindfulness practice is often used to cope with the daily stressors of life and is associated with lower stress reactivity.^{13,120} A recent systematic review found that Mindfulness-based Stress Reduction (MBSR) relates to large effects on stress reduction in healthy individuals ($N = 2668$) pre-post after 8-week MBSR, with results maintained at follow-up.¹²¹ For adults experiencing parenting stress, mindful parenting practices are effective in reducing parental stress.¹⁰⁵ Among low-income populations, qualitative studies highlight interest in mindfulness and its potential utility as a stress reduction tool.^{18,134} A recent study with a low-income women found a significant decrease in stress after 8-weeks.¹³⁵ Therefore, applying mindfulness-based practices to increase stress management and coping may be particularly useful among low-income female smokers who experience heightened daily stress, yet adaptations to current treatments are needed.¹³⁴

Depressive symptoms, negative affect, and mood disorders are higher in women, with increased prevalence in underserved, minority women.^{136,137} Mindfulness is effective in reducing depressive symptoms and negative affect.^{138,139} In a sample of low-income women, an 8-week MBI significantly decreased depressive symptoms and increased self-acceptance and well-being.¹³⁵ Depressive symptoms and negative affect are known barriers to smoking cessation, especially among low-income female smokers.⁸ Thus, mindfulness may be a potentially useful smoking cessation adjunct to reduce and manage these barriers and consequently aid in facilitating smoking cessation.

Mindfulness and Nicotine Dependence

Because of evidence of mindfulness effects on stress, depression, and negative affect (known mediators in tobacco use), researchers have begun to examine its effects and potential utility within comprehensive tobacco dependence treatment.¹⁴⁰ A systematic review (2015) of 13 clinical trials concluded that mindfulness is an effective adjunctive tool for smoking cessation, relapse prevention, aid in coping skills development, and a mediator between craving/urge and smoking.¹⁴¹ Mindfulness practice can target psychological, physiological, and behavioral processes involved in cessation and relapse,^{140,142,143} and may decrease smokers' reactivity to smoking cues, decrease intensity of smoking urges, and improve affect regulation.^{144,145} Moreover, greater mindfulness is associated with lower nicotine dependence and lower risk for relapse.¹⁴⁶ Behavioral theory suggests that mindfulness practice aids in the development of broader coping skills related to managing urges, which in turn builds self-efficacy for cessation and helps prevent relapse among smokers who have recently quit.¹⁴⁷

Currently, the majority of mindfulness-based treatments for substance use are adapted from Kabat Zin's traditional 8-week model.¹⁴⁸ The practices and meditations in these adapted programs focus heavily on urge management. For instance, "urge surfing" is a mindfulness imagery technique used to manage urges by accepting cravings as they arise, similar to a wave in the ocean.¹⁴⁹ Based on the phenomenology of the urge "experience"—they do not last forever—a person can use a mindfulness-based approach to experience and accept the urge as in urge surfing. Instead of identifying with and acting on the urge, participants are instructed to watch the urge, observing, describing and not judging the experience, and riding it out as a surfer would surf an ocean wave.¹⁴⁹ Through this exercise, participants "de-personalize" their cravings as external from themselves and as something that can come and go if not acted upon.¹⁴⁹ With this increased space

and depersonalization from craving, other skills, such as CBT-based avoidance or distraction could be added into urge management practice. Increasing urge management skills is particularly important in low-income populations due to low rates of NRT uptake.

Results are mixed within the smoking and mindfulness literature with the study design and application of mindfulness differs across studies. For instance, the types of study design of the research included in current systematic reviews varies greatly, such as, pre-post laboratory studies, studies using a single mindfulness component such a body scan meditation, cue exposure paradigms, adding mindfulness with a current treatment such as CBT, or intensive stand-alone MBIs using a model similar to Jon Kabat Zin's 8-week MBSR model. Further, control groups range from waitlist controls, active controls or cessation usual care treatment controls. Outcome measures also vary across studies, with majority of primary outcomes focusing on one of the following: cessation, reduction of number of cigarettes smoked or craving reduction.

The first randomized control trial ($N = 88$), comparing an intensive MBI only (8 sessions) to usual care control, found a significant difference with a higher decrease in cigarette consumption for the MBI group during treatment and follow-up, with a trend for differences in 7-day point prevalence abstinence rates.¹⁵⁰ Another study ($N = 198$) with intensive 7-week MBI, which included a 7-hour introduction session and 3-hour weekly meetings, reported significantly lower cessation rates (39%) for MBI compared to quit-line control (21%) at 6-month follow-up.¹⁵¹ Many other studies show no effect of mindfulness on smoking cessation outcomes and are often underpowered and poor quality. For example, a 7-week RCT found no effect of mindfulness on the primary outcome, smoking cessation, yet did find a significant decrease in smoking urge and perceived stress in the mindful group compared to control¹⁵² The efficacy of mindfulness through other modalities is mixed as well. A two-week study sent daily meditations to listen to on a mobile

device found a significant reduction in cigarette use, smoking urge and negative affect compared to sham control group.¹⁵ Yet, a recent (2018) publication reported a smartphone mindfulness App intervention had no group differences on smoking rates compared to control at six months; however, the mindfulness group did show a decrease in the relationship between craving and cigarettes per day.¹⁵³

In sum, one review (2013) lists many of the advantages of mindfulness as affordability, easy to add to current interventions, and modifiable to the specific population.¹¹ It further concluded that mindful practices are shown to assist smoking cessation; however, there are limitations due to small sample size, limited number of studies, and a lack of overall research among vulnerable populations.¹¹ The research remains mixed on the efficacy of mindfulness based interventions for smoking cessation, as well as, the mechanisms of mindfulness which play a role in cessation or relapse prevention. Research is also limited and inconclusive on the type of MBI elements needed for intended outcomes, such as dose of mindfulness (e.g., 8-weeks, amount of formal and informal practices), format (e.g., group, individual), delivery (e.g., text-based, in-person), and if population specific treatment adaptations are efficacious.

Disparities in Mindfulness Treatment Uptake and Adoption

A large (2015) epidemiological study suggests that vulnerable groups, such as low SES, in the U.S. are less likely to practice or uptake MBIs or mindfulness activities (e.g., meditation).¹⁵⁴ Research is needed to understand and address this disparity and systematically test whether adapted MBIs could demonstrate efficacy in smoking cessation in underserved populations.¹⁸ MBIs targeting low-income female smokers could potentially facilitate smoking cessation, directly and indirectly.¹⁵⁵ For example, mindfulness indirectly relates to smoking behavior change by mitigating stress and smoking cue-elicited negative affect and urge to smoke

(known barriers to smoking behavior change in this population).^{15,156} However, given the low uptake of current MBI approaches, research is needed to understand acceptability of MBIs, as well as test feasibility and potential efficacy of adapted MBIs in underserved populations.¹⁸

Underserved populations have reported mindfulness as acceptable, but do not respond as well as the general population to the traditional format of MBIs designed to mitigate their heightened daily stress.¹⁵⁷ Focus groups ($N = 32$) exploring mindfulness with low-income, predominantly African American participants, reported an overall positive response with the main theme of utility of mindfulness practice to help reduce stress.¹⁸ Some barriers noted were, not feeling comfortable closing their eyes, lack of time to sit down and do long meditations, and unsafe neighborhoods.¹⁸ An 8-week mindfulness intervention focusing on depression among low-income African American women was found acceptable, easily accessible as it was delivered in a primary care setting, and outcomes report a decrease in depression and stress at follow-up.¹³⁵ In regard to smoking cessation interventions, an intensive mindfulness intervention adapted to include simple language and visuals targeting a low-income population was acceptable and efficacious (significantly lower quit rates in MBI group), yet had high attrition due to reported barriers such as transportation issues and scheduling conflicts.¹⁵¹ Interestingly, 14% of participants in the mindfulness group opted to become “advocates” and joined future classes, with 100% of advocates maintaining abstinence at 6-month follow-up.¹⁵¹ Although research is beginning to investigate mindfulness within diverse populations such as low income female smokers, there is much work to be done. A recent article calls for mindfulness-based cessation research to prioritize the inclusion of low-income and minority populations, as initial research shows efficacy, but also states the need to adapt treatment to be culturally appropriate

and acceptable, and to include innovative delivery methods such as technology to make treatment interventions more accessible.¹⁵⁸

MBIs with underserved smokers, such as low-income mothers, should mitigate common barriers of access and participation in any behavior change intervention (e.g., transportation issues, lack of child care, participant burden) which impact recruitment, retention and adherence.¹⁵⁹ MBIs should take into account trauma histories (e.g., during the body scan mediation), potential for high noise and crowding in their daily space, and low literacy by using shorter meditations with simple language or visuals, and encouraging the use of simple informal practices throughout the day.^{18,148} An accessible and acceptable MBI should be designed for the target population based on the utility of mindfulness being a low-cost tool that requires few resources (e.g., a breath-focused urge coping meditation can be utilized anywhere).

A strategy for overcoming some of these barriers is more accessible modalities of treatment. MBI research in the general population is beginning to assess potential efficacy of variations to the standard intensive, 8-week, group-based MBI. Shorter, mobile interventions are more practical to encourage uptake and adherence of MBIs in the target population.^{18,160} Mobile health interventions could also provide just in time support to help manage craving, especially within a hard to reach, low-income population with heightened stress. A survey assessing preference of MBI format found that over 80% preferred online or individual-based mindfulness interventions compared to group.¹⁶¹ A recent study comparing three arms (8-week, 4-week and control) found both MBIs had similar effect sizes (efficacy) and were more effective than control.¹⁶² Furthermore, a study with depressed adults using 4-weeks of automated, daily meditation recordings found significant positive pre-post changes in physical and mental health.¹⁶³ Participants in a qualitative study exploring mindful text messages for smoking

cessation within a low-income population reported texts as useful and engaging, while sharing suggestions such as personalizing the messages and adding visuals.¹⁶⁴

The literature in a recent systematic review shows potential efficacy for online and tech-based MBIs but more rigorous studies are needed.¹⁶⁰ Technology comes with its own set of challenges such as maintaining engagement and use. Supportive accountability and incentives are theorized ways to increase and sustain use of technology based interventions (mobile Apps, text messaging).^{165,166} However, even with these methods, the overall lower dose provided by technology only interventions, paired with engagement and use barriers known to be prevalent in this population, may not be enough to effectively promote behavior change. Hence, technology may be a low-cost, wide-reach option, but more research is needed to further tailor and test technology-based interventions for specific sub-populations.⁶⁴ This echoes the overall need for additional research and tailoring of MBIs for vulnerable populations to reduce disparities.²⁹

Summary

Tobacco use is a major public health problem which impacts current smokers and all of society due to tobacco smoke exposure and increased health expenditures.^{35,167} Novel advances are needed to reduce disparities, promote health equity, and to ultimately eliminate tobacco use in the U.S. Complex barriers exist for smoking cessation, which are often heightened in underserved populations of low SES female smokers.^{21,43} Addressing their additional cessation barriers (e.g., access, affordability, heightened stress, lack of coping skills, and poor mental health) through innovative approaches is a research priority.²⁹ However, the research is limited and inconclusive, especially among underserved populations. Theory-driven, innovative and targeted interventions, including adjunctive interventions intended to enhance broader intervention potency, are needed to combat disparities in tobacco use and health outcomes.¹⁰⁶

Theoretical Framework Guiding Current Proposal

Intersection of Social Cognitive Theory and Transactional Model of Stress and Coping

The theoretical framework guiding the impetus and methods for this study draws from a conceptual intersection between Social Cognitive Theory (SCT) and the Transactional Model of Stress and Coping (TMSC). Both the SCT and the TMSC have strengths and shortcomings. They are both peer-reviewed and effectively used in evidenced-based interventions to promote behavior change and increase well-being.¹⁶⁸⁻¹⁷² Each theory focuses on cognitions and behavioral outcomes. Further, both SCT and the TMSC include concepts relevant to the proposed MBI: self-efficacy, self-regulation, coping skills and adaptive coping. They both use risk evaluation and encourage the individual to weigh the controllability of the situation. Both models recognize individual differences and the ability of a person to modify cognitions and behavioral response. Both promote flexibility and malleability of cognitions with emphasis on emotion regulation. They differ in that the TMSC is more simplistic and does not account for many outside factors (e.g., environmental factors, reciprocal determinism). Further, the TMSC may rely too heavily on positive reappraisal and optimism.¹⁶⁸ Yet, SCT could be critiqued as being too broad; however, researchers often combat this by utilizing select sub-components such as self-efficacy.^{168,173} The conceptual model utilizes both SCT and the TMSC to build a framework for the pilot MBI with potential expansion to include an MBI as an adjunct or prelude to a larger CBT smoking cessation randomized control trial (RCT).

Social Cognitive Theory

Social Cognitive Theory (Figure 2-1) is an expanded version of Social Learning Theory and emphasizes the interplay and symbiotic relationship between individuals and the environment, highlighting the capacity for individuals to model behavior, learn and

adapt.^{168,172,174} The five main concepts are the psychological determinants of behavior (self-efficacy), observational learning, environmental determinants of behavior (reciprocal determinism, incentive motivation, facilitation), self-regulation, and moral disengagement.^{168,172} Self-efficacy is described as the degree to which a person believes in their capacity to influence or change aspects that impact their life.^{168,174} Self-efficacy is often conceptualized as a coping resource to support behavior change. Social outcome expectancies are understood as social norms, for instance the norms around protecting a child from secondhand smoke. Observational learning is a process of attention, retention, production and motivation in which an individual learns or adopts a behavior based on other sources (e.g., peers and mass media). Reciprocal determinism is the concept that the environment shapes the individual, but the individual can also influence and shape the environment.¹⁷⁴ Incentive motivation can occur through reward or punishment.¹⁶⁸ Facilitation can occur through environmental change or the addition of resources to increase empowerment and support.¹⁶⁸ Self-regulation is achieved through self-monitoring, goal-setting, feedback, self-reward, self-instruction, and utilizing social support in order to navigate short-term negative outcomes to achieve long-term positive outcomes.¹⁷⁴ Moral disengagement uses processes of thinking about harmful behavior (e.g., dehumanization or justification) to disengage and make suffering or immoral actions more acceptable.¹⁶⁸

There are many applications of SCT. Behavioral interventions, such as smoking cessation interventions, often use SCT as a guiding framework.¹⁶⁸ Due to the breadth of the theory, interventions often focus on a particular concept or two. Developing self-regulation and self-efficacy are often treatment goals when designing smoking cessation interventions.¹⁶⁸ For example, a smoking cessation intervention using the six sub-concepts under self-regulation showed the odds of quitting doubled within one year of telephone counseling using these

strategies compared to a self-help booklet control group.¹⁷⁵ The proposed study uses the concepts of self-efficacy and self-regulation as coping skills. Mindfulness practices were used to increase more effective self-regulation and urge management. Increased attention on emotion and reactivity build awareness and lead to a less reactive and potentially more skillful response to stressors, urges and triggers to smoke. Over time, it is theorized that through practicing mindfulness and emotion regulation, smoking cessation self-efficacy may increase.

Transactional Model of Stress and Coping

The transactional model of stress and coping (TMSC) (Figure 2-2) is a framework explaining the stress response: the impact of an external stressor is mediated by the individual's perception of the stressor, through primary appraisal (potential harms) and secondary appraisal (ability to manage or alter the emotion or situation), in tandem with the psychosocial resources available such as self-efficacy, coping skills and social support.^{168,169,176,177} TMSC encourages individuals to reappraise, regulate emotions, build problem management skills and increase coping strategies such as meaning-based coping (revising goals, positive reappraisal, spiritual beliefs).¹⁶⁸ This process can lead to increased emotional and functional well-being and impact health behaviors.^{168,169,177}

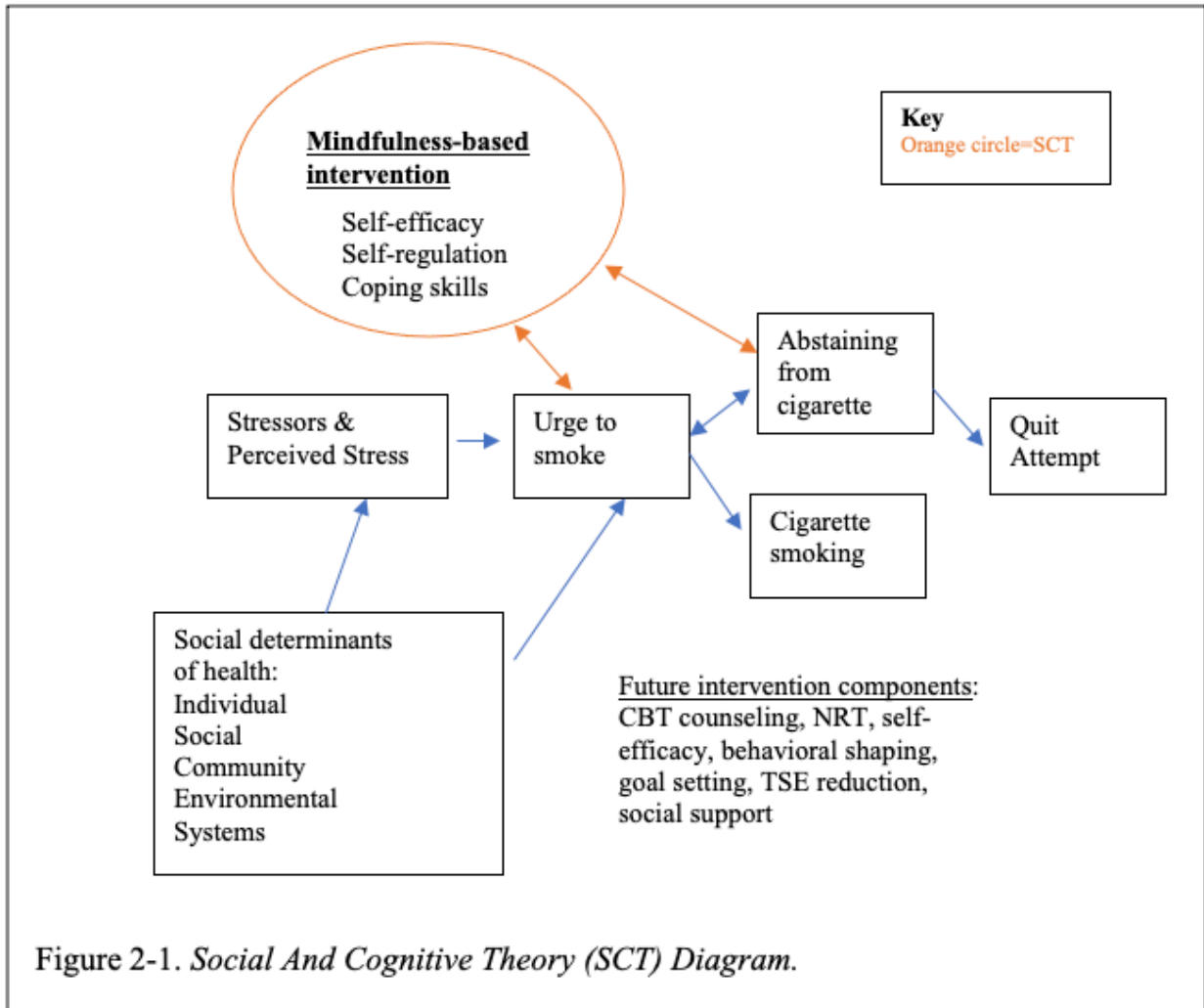
TMSC is often used when developing interventions for vulnerable populations undergoing a major life event (e.g., cancer diagnosis) or those experiencing elevated chronic stress.¹⁶⁸ As discussed in the determinants section, stress is related to smoking urge, smoking behavior, cessation and relapse. The TMSC is a useful model to better understand and potentially change the stress response that results in smoking. Higher mindfulness is associated with increased stress management and coping skills through reappraisal and reducing catastrophizing.¹⁷⁸ This could occur in the proposed MBI by encouraging individuals to notice

stressors and smoking urges as they arise. Following the act of noticing, a reappraisal of cognitions and behavioral response occurs, allowing space in which urges and stress reactivity may dissipate naturally or the individual may choose a different reaction or coping skill.¹⁷¹ Continued reappraisal and skill building around urge and stress management may potentially build smoking cessation self-efficacy and support to quit.¹⁷¹

Conceptual Framework

The conceptual model (Figure 2-3) for the proposed MBI incorporates the TMSC as the main theory guiding the MBI. Conceptually, the MBI is described as a mindfulness-based pre-quit intervention (targeting stress response and urge management), which could be a prelude to a larger cognitive behavioral therapy smoking cessation intervention driven by Social Cognitive Theory. However, an MBI (if efficacious) could potentially be used as an adjunct or replacement for cognitive behavioral therapy as well. For this framework, the proposed MBI is diagramed as a prelude using both theories to guide outcomes that includes a larger randomized controlled trial (future line of research). Integrating two theories to drive a conceptual model or framework has potential utility particularly given the multidetermined nature of nicotine dependence and smoking cessation. For instance, in a smoking cessation intervention a counselor may use the TMSC to frame strategies that guide the participant towards stress response reappraisal, emotion regulation and meaning-based coping to respond in a more adaptive manner instead of smoking. The TMSC also fits within a larger Social Cognitive Theory framework, in which both highlight the need to build self-efficacy, social support and coping skills. The overarching Social Cognitive Theory approach used in future larger trials would expand the intervention to include observational learning and self-regulation, for example setting goals to reduce cigarette consumption each week.

Overall, the framework is designed to illustrate how an MBI might increase stress management skills to aid in urge management, boost cessation self-efficacy, and eventually lead to a quit attempt and sustained abstinence in a low SES population of female smokers with elevated distress and challenges to quitting smoking. The MBI is understood through the TMSC, as mindfulness has shown to aid in positive reappraisal.¹⁷⁹ For example, mindfulness practices can encourage an individual to recognize a stressor, to make an effort to decenter (from the stressor) and then reappraise the stressor to facilitate cognitive restructuring.¹⁷⁹ The sequential order of the MBI followed by the cognitive behavioral therapy trial (based on SCT) would allow for integration of the MBI practices and skills for stress and urge management to be included in a larger framework of a randomized controlled trial. Behavioral shaping, in which small goals (built around mindfulness-based stress response and reappraisal) could increase coping skills and self-efficacy and then be added into larger cognitive behavioral therapy defined cessation goals.¹⁸⁰ The future full-scale randomized controlled trial would potentially include evidence-based methods used in previous large smoking cessation intervention studies such as, cognitive behavioral therapy telephone-based counseling focused on smoking cessation through self-efficacy, education, social support, self-regulation, and goal setting, as well as provider advice and NRT.¹⁸¹ Mindfulness would become an on-going tool for stress reduction and urge coping used in the larger trial. Although the MBI draws heavily from the TMSC, the two concepts of Social Cognitive Theory, self-regulation and self-efficacy, are also central for facilitating the study outcomes (stress reduction, increased urge management and smoking cessation self-efficacy). The theory-driven conceptual framework provides an innovative next research step to further reduce smoking in a low SES female population by adding an adjunct treatment targeting known cessation barriers to a current evidence-based intervention model.



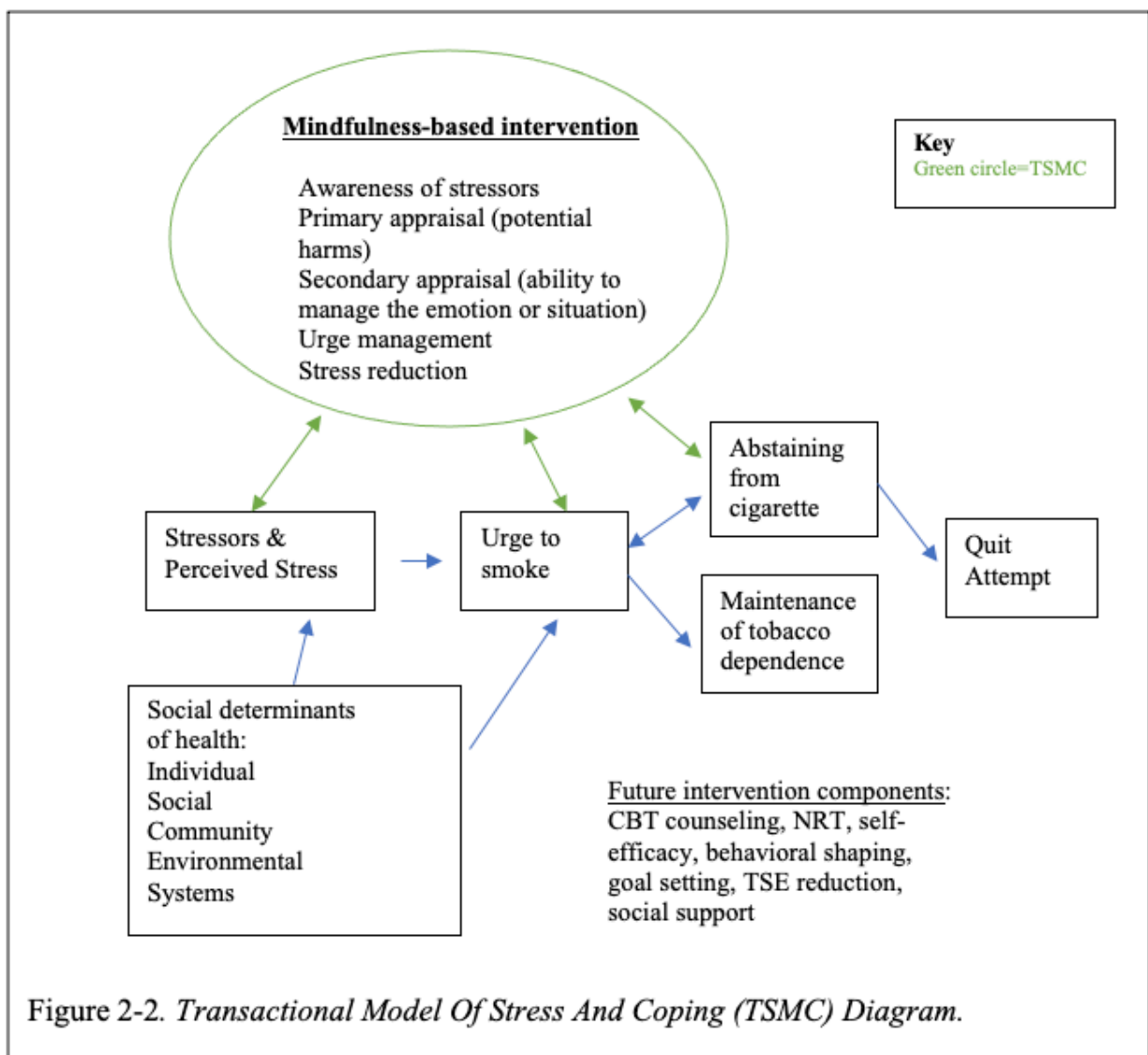


Figure 2-2. Transactional Model Of Stress And Coping (TSMC) Diagram.

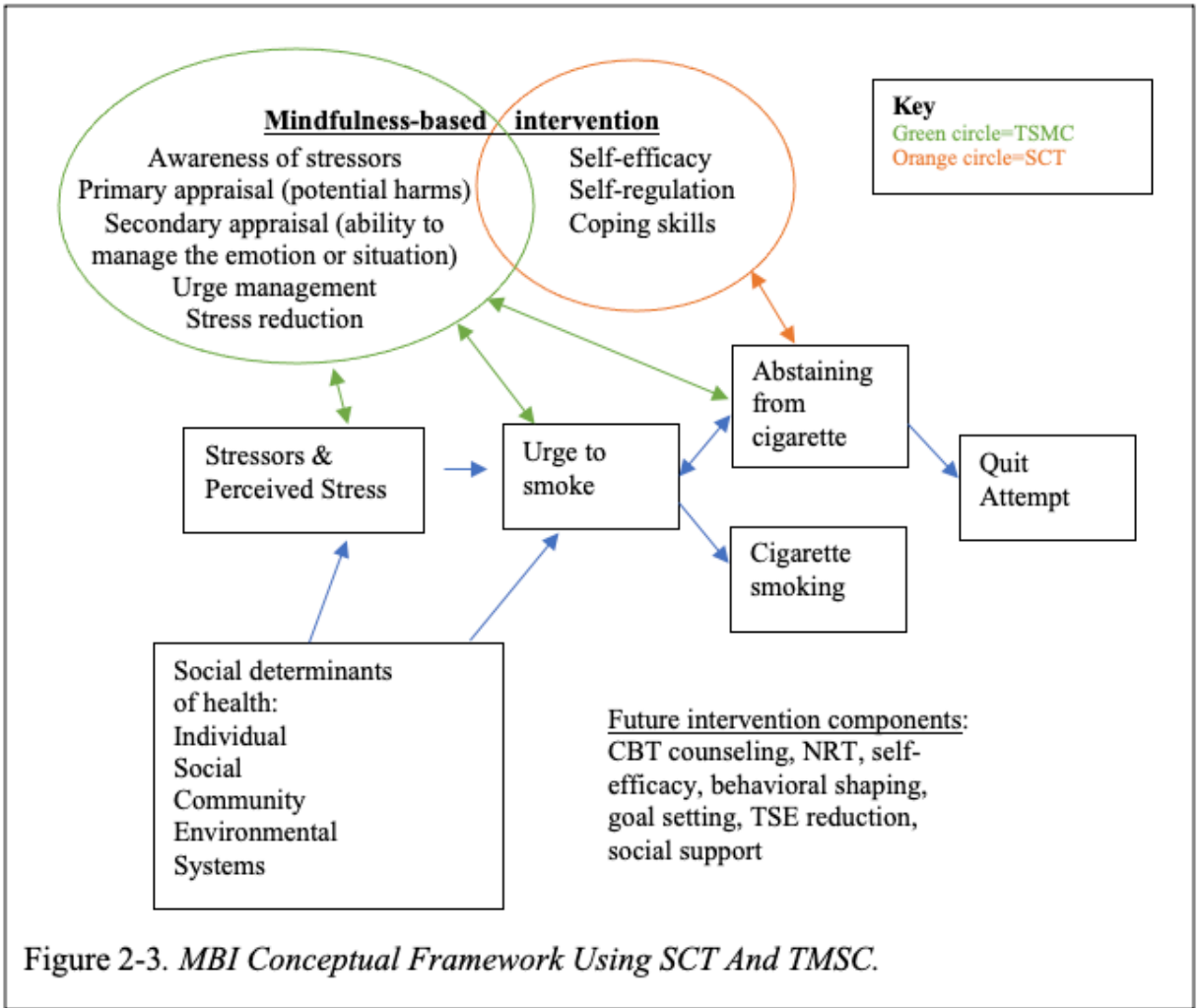


Figure 2-3. MBI Conceptual Framework Using SCT And TSMC.

CHAPTER 3

METHODS

Formative Research To Better Understand Mindfulness *Acceptability Among Low SES Women And Tailor the MBI*

Prior to the mindfulness-based intervention (MBI), we conducted formative research to understand the acceptability and feasibility of mindfulness practices in the target population as a first step to designing a tailored intervention for the 4-week MBI study. The formative research assessed overall mindfulness knowledge, attitudes and subjective norms, as well as specific feedback around content, language used, and pros/cons to different mindfulness practices. Additionally, participants were led through a sample mindfulness meditation and then asked to provide feedback. They were given examples of mindfulness practices and sample text messages targeting stress management and smoking urge management. The interviews also queried participants about modes of treatment delivery, such as preferences for text messages versus a mobile health App, to guide the design of the present study.

After IRB approval, twelve individual in-depth phone interviews occurred between April and June 2019. Participants were recruited from a previous study which recruited Women, Infant and Children (WIC) clinics to participate in a randomized trial on smoking cessation.¹⁸¹ Eligibility criteria required women to have no to little experience with mindfulness, e.g., self-report not practicing mindfulness in the last month. Participants were not told beforehand that mindfulness would be discussed. Participants were recruited by study flyers that invited respondents to enroll in a discussion about stress management and self-care topics for moms who smoke cigarettes. All participants provided verbal consent over the phone before the study began. Participants received \$25 for participating in the 1-hour phone interview.

Brief Assessment at Baseline Appointment

At the in-person baseline appointment, a lab-based assessment using a cue exposure paradigm was included due to concern about recruitment and retention of participants to complete the full study. Further, the cue reactivity assessment facilitated a manipulation check and simultaneously an analogue of mindfulness scenario for the MBI group as part of their treatment orientation. Cue exposure procedures assessed cue reactivity (urge, negative affect) in real time and served as an analog to smokers' routine urge experience, that often leads to smoking a cigarette. The assessment examined the post smoking cue exposure effects of a brief, single mindfulness session on cue reactivity (negative affect, urge) compared to control.

Priming procedures occurred when the participant first arrived at the HBRC lab, after consent. This 5-minute "priming" procedure standardizes the timing of the last nicotine dose and allowed participants to familiarize themselves, or habituate, to the test environment. After approximately 40-45 minutes, three 5-minute cue exposure trials occurred using a specific instruction set, visual imagery, and smoking paraphernalia (e.g., a box of cigarettes) with assessments of smoking urge and negative affect after each trial. Cue trial 1, which included a recorded instruction set lead the participant through a serious of steps to induce urge, e.g., pick up the cigarette, smell the cigarette, was the same for both groups. After cue trial 1, participants were informed of their treatment group. During the second cue trial, the MBI group listened to a 5-minute mindfulness recording on focused breathing and surfing the urge. The control group listened to a 5-minute informational recording about child safety. The third cue trial was the same as cue trial 1. The MBI debriefing that followed the assessment explained to participants that the trials represented situations that increase stress, negative affect and potentially urges to smoke and these are times when mindfulness could be a useful tool for managing negative moods and urges to smoke.

Mindfulness-Based Intervention (MBI) Design Overview

The MBI was a randomized, two group ($N = 40$), repeated measures, time series design to assess mindfulness-based training effects on key factors associated with the maintenance of tobacco smoking known to undermine motivation to quit and success with cessations compared to control. Participants were assessed at baseline, daily during the intervention, and at end of treatment. Self-report assessments included perceived stress, mindfulness and smoking urge (primary outcomes), as well as, exploratory outcomes of smoking cessation self-efficacy, number of cigarettes per day and negative affect. At baseline, participants were randomized into two groups. The intervention was delivered via daily text messages and audio recordings, the intervention is described in greater detail below.

Participants

The study recruited English-speaking, who reported being mindfulness naïve, low-income biological females, age ≥ 18 years old, who smoked ≥ 1 cigarette daily and had at least one child ≤ 11 years old. Income was determined by using the Pennsylvania Women, Infant and Children (WIC) cut-off levels, i.e., gross household income that is less than 185 percent of the U.S. Poverty Income Guidelines. Having a child as an inclusion criterion was necessary for the rationale behind the parenting skills training attention control in the control group.

Exclusion criteria included: individuals not owning a smartphone, active psychosis, cognitive impairment, and non-nicotine substance dependence (factors that could interfere with study procedures). Exclusion at baseline included a CO breath test of less than 3 ppm to ensure participants were current smokers at time of study initiation. Research shows the standard CO cutoff of 8 ppm leads to a very high misclassification of smokers as abstainers, and that a CO cutoff of 3 ppm most accurately distinguished smokers from nonsmokers.¹⁸² The 3 ppm cutoff

was accurate for both genders and racial minorities.¹⁸² Especially when trying to distinguish light smokers from abstainers, the literature suggests using a 2-3 ppm as a CO cutoff level.¹⁸³ The study's eligibility criteria included daily smoking, with a minimum of one cigarette per day, so a 3 ppm cutoff level was used to validate the participant was truly a daily smoker. Exclusion criteria were informed by the scientific intent to recruit a fairly homogenous sample. Eligibility information was not used for any purpose other than to screen and exclude ineligible individuals. Ineligibles were offered relevant community resource information.

Recruitment and Retention

After IRB approval, the study utilized recruitment strategies consistent with successful procedures used in previous studies with similar vulnerable populations.^{181,184,185} The research team actively built new community partnerships and continued to interact with existing partners, to enhance recruitment methods. Recruitment fliers were placed in Temple University Dental clinics, around Temple University Campus and in the surrounding community libraries, community centers, a nearby grocery store, and other community nonprofit organizations. Active recruitment involved handing out informational sheets to interested persons and conducting in-person eligibility screens and baseline scheduling. This occurred at the sites where fliers are placed (above). Using IRB approved methods used in other studies within the Temple University Health Behavior Research Center (HBRC), research staff approached women and asked if they were interested in learning about the study. If interested, staff would describe the study and then administer the eligibility screen using a tablet-based survey. Women who met all inclusion criteria were asked to participate. If a person was interested but did not have time for the in-person screen, they could fill out their name and phone number, and the staff would follow up with a phone call to complete the eligibility screen. Retention efforts included two supportive

accountability phone calls and two supportive accountability text messages during the month-long intervention. Incentives were provided after each study session (i.e., in-person baseline, end of treatment phone call) and throughout the 31 days to encourage adherence.

Procedures

MBI Screening

Interested participants who responded to study announcements were screened over the telephone or in-person via tablet survey by trained research staff to determine eligibility. Eligible participants were scheduled for the in-person baseline meeting. Referrals to smoking cessation services were provided to those who were ineligible.

Baseline assessment and treatment orientation

Participants attended a one-hour, in-person baseline meeting at the Temple HBRC laboratory to complete informed consent, baseline assessments, randomization and group specific treatment orientation. Upon arrival, participants were consented. CO level was measured, and participants took a priming dose of nicotine from their own cigarette as a cue reactivity preparatory procedure. Next, participants completed self-report assessments on an iPad. Items assessed at baseline included mindfulness, perceived stress, smoking urge, smoking cessation self-efficacy, non-program variables and demographics (described in greater detail in the measures section). General study orientation took approximately 5 minutes, during which both groups received instructions to self-monitor each night by responding to a text survey reporting their smoking urge, stress, and number of cigarettes smoked. Participants were informed they would receive study-related texts for approximately 4 weeks and two check-in phone calls. The cue reactivity assessment occurred next. Participants were randomized after cue trial 1. The study utilized the randomization feature in REDCap software to generate our allotment table. After the cue trials, the participants were debriefed. The MBI group received an

overview of mindfulness in relation to stress, urge and smoking. The control group received an overview of parenting skills, child safety and child well-being tips. To conclude, participants set a date/time for the EOT follow-up phone call and received payment.

MBI group four-week intervention procedures

The 4-week intervention was administered over 31 days to standardize the number of assessments and assessment dates. Baseline visits occurred on a Monday, Tuesday or Wednesday. Because of this, EOT (after 31 days) would occur on a Wednesday, Thursday or Friday (ensuring staff was on-campus and available to administer the EOT phone call). Each morning the MBI group received a text message reminder to meditate. This text included a 5-minute meditation audio recording centered around present moment awareness focusing on the breath and allowing thoughts to come and go. The daily texts were sent automatically (via MightyText™ text-based platform) at uniform, scheduled times. Additional texts throughout the day suggested informal practices, such as mindful walking and ways to apply mindfulness specific practices (e.g., urge surfing¹⁷) to their smoking urge (see Appendix A for examples of MBI text messages). Based on the preliminary qualitative research around cessation and mindfulness text message preferences with a similar population of smokers, brief audio recordings, images, short statements and informal language were used based on population preference, and to address potential low literacy and high chaos in the participant population. Reviews of text-based interventions suggest varying the time and number of messages.¹⁸⁶ The amount of the text messages varied, from 4-6 messages per day. The times of day the text messages were sent varied from day to day but were standardized across all participants. The first text was always a recording and the last text was always the daily 5-item (~2 minutes to complete) self-monitoring assessment (Table 3-1 below). The study coordinator contacted

participants by telephone on days 2 and 16 to encourage adherence and problem solve any technical mHealth-related or protocol specific questions (the researcher does not provide guidance with mindfulness).

Table 3-1.		
<i>Daily Diary Survey.</i>		
<i>Instructions: “Hi (insert name)! Please respond to each of the questions below based on TODAY. Thanks for being a part of (Study name)!”</i>		
Group	Question	Response
MBI	Did you listen to the clip, view the text, or use mindfulness today? (adherence)	Yes/No
Control	Did you view or listen to the text today? (adherence)	Yes/No
MBI/Control	How many cigarettes did you smoke?	#
MBI/Control	On a scale of 1-10 (1 as the lowest and 10 as the highest) ... <ul style="list-style-type: none"> • How strong was your strongest urge to smoke? • How high was your level of stress? • How much did you feel you could handle or deal with today’s stress? 	10-point Likert Scale

Control group: four-week attention equivalent intervention procedures

The control group received text messages on parenting skills, practices and well-being tips for their children, such as effective discipline (e.g., time-out) or child safety (see Appendix B for examples of Control text messages). Text messages were carefully selected to ensure the content would not induce a stress reduction in controls. Non-reactive topics such as changing the smoke detector batteries were used. The daily texts were also automatically sent via MightyText™ text-based platform and varied in time and frequency. The control group also received the nightly self-monitoring assessment each evening as well (Table 3-1). This enabled between-groups comparisons of outcomes over time (4-weeks). Two brief supportive accountability phone calls occurred to boost adherence on days 2 and 16. A pilot study, Steps to

Quit, found reminders and supportive accountability to be effective tools to prompt daily diary completion during a two-week App-based study (unpublished study results, HBRC lab). The control group text messages and daily self-monitoring survey were included to anticipate and help control for potential observer and attention/monitoring effects that could bias outcomes. They were also included to aid in recruitment and retention efforts.

Four-week follow-up phone assessment

At the end of the 4-week intervention, the end-of-treatment (EOT) assessment occurred via phone. Baseline questionnaires were re-administered. Surveys on the acceptability and use of the mindfulness intervention (MBI group) and openness to trying mindfulness (control) were administered. Payment was provided by gift card. Additional cessation resources (e.g., Quitlines) were provided.

Compensation

Participants received \$100 at baseline, \$60 over the course of the 31 days for daily diary responses, and \$70 for the EOT phone assessment, totaling \$230 if all timepoints were successfully completed. Participants received an electronic gift card as payment. Gift cards were texted, emailed or mailed after the completion of the entire BSL interview, EOT assessment or after meeting the weekly adherence bonus incentive.

Covid-19 Pandemic Amendment to Methods

The protocol methods were amended due to the new local Covid-19 pandemic regulations, such as social distancing advisories and closing of non-essential business. The goal was to modify the methods to protect the safety of participants and research staff, while maintaining the integrity of the study design. A reportable new information (RNI) document outlining these changes was sent to the Temple University IRB for approval on March 12, 2020.

The IRB approved the RNI on March 23, 2020. The primary change impacted the baseline meeting, which was changed from in-person to remote via video platforms. All the measures remained the same except the CO breath test could not be administered remotely.

Measures

Figure 3-1 (below) diagrams the study and assessment schedule. All measures were chosen based on reliability, validity, use in published research, and were administered with methods to reduce literacy barriers and burden. Self-report data was collected with REDCap (Research Electronic Data Capture). Figure 3-2 lists when measures were collected.

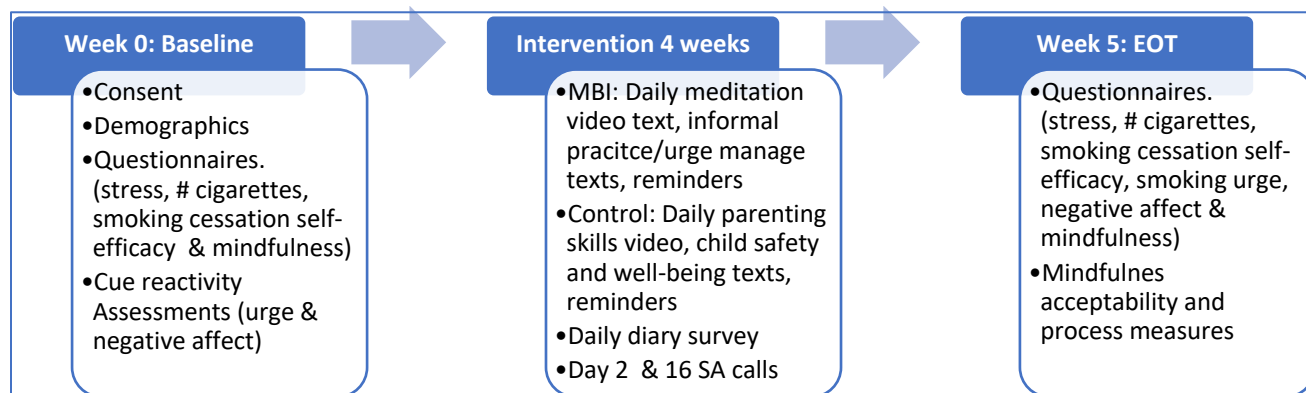


Figure 3-1. *Sequence Of Assessment And Treatment Procedures.*

Acceptability and feasibility were assessed using the following criteria and measures. Adherence to mindfulness practice was assessed every evening during the intervention via text message with one item: “Did you listen to the clip or use mindfulness today?” Acceptable adherence was defined as ≥ 4 days/week reported practice as research shows that as adherence and engagement increases so does the likelihood of quitting smoking.^{187,188} Attrition <35% at EOT was one criterion for acceptability and feasibility, as attrition is often high in low-income smoking populations.¹⁸¹

	Screening	Baseline	4-week Intervention	End of Treatment
ENROLLMENT:				
Eligibility screen	X			
Informed consent		X		
<i>CO verification</i>		X		
Allocation		X		
INTERVENTIONS:				
<i>Cue trials</i>		X		
<i>MBI group 4-week intervention</i>			X	
<i>Control group 4-week intervention</i>			X	
ASSESSMENTS:				
<i>Demographics</i>	X	X		
Outcomes		X		X
<i>Stress (PPS)</i>		X		X
<i>Mindfulness (CAMS-R & FFMQ)</i>		X		X
<i>Smoking Urge (QSU)</i>		X		X
<i>Smoking cessation self-efficacy</i>		X		X
<i>5-item Daily Diary</i>			X	
<i>Acceptability and feasibility</i>				X
Other Variables		X		
<i>Chronic conditions</i>		X		
<i>Smoking Behavior (TLFB)</i>		X		X
<i>Urge management coping skills</i>		X		X
<i>Intention to quit</i>		X		X
<i>Other smokers in home</i>		X		
<i>Attitudes and use of NRT, e-cigs and MJ</i>		X		
<i>Depressive symptoms (CESD)</i>		X		X
<i>Mobile phone and technology use</i>		X		
<i>Nicotine dependence (FTDN)</i>		X		X
<i>Process measures</i>				X

Figure 3-2. Spirit Chart Of Study Measures.

Perceived stress was assessed at BSL and EOT with the 10-item Perceived Stress Scale [PSS].¹⁸⁹ A 5-point Likert Scale is used for responses. Items were summed, with a higher score indicting greater perceived stress. The measure is validated and reliable ($\alpha=.0.86$ to 0.93)¹²⁸ and has been used in previous tobacco research with low SES female smokers.¹⁹⁰ In addition to using the PSS, we assessed daily stress level every evening (31 days as below?) during the intervention via text message using a 10-point Likert scale with one item: “How high was your level of stress?” (1= little to no stress to 10 =very high stress).

Smoking urge was assessed at BSL and EOT with the 10-item Questionnaire of Smoking Urges [QSU]^{191,192} Items were summed, with a higher score indicting greater smoking urge. A 7-point Likert Scale was used for responses. The measure is validated and reliable.¹⁹³ The QSU has been used in previous tobacco research with low SES female smokers¹⁹⁴ and within mindfulness for smoking urge management research.¹⁷ In addition to the QSU, daily smoking urge level was assessed every evening during the intervention (31 days) via text message on a 10-point Likert scale with one item: “How strong was your strongest urge to smoke?” (1= little to no smoking urge to 10 = very strong smoking urge).

Strength of smoking urge was assessed pre-post cue exposure procedures by a single item on a 10-point Likert scale (0 = no urge at all to 9 = very strong urge). Single measures of urge are shown to be as reliable as longer measures of craving/urge¹⁹⁵ and have been used in previous cue reactivity trials.¹⁹⁶

Negative affect was assessed pre-post cue exposure procedures using the 10-item Negative Affect subscale from the Positive and Negative Affect Scale (PANAS) with a higher score indicating greeter negative affect.^{197,198}

Smoking cessation self-efficacy was assessed at BSL and EOT with the 12-item measure of self-efficacy for smoking cessation maintenance which assesses self-efficacy for smoking avoidance in a variety of situations and stress levels.¹⁹⁹ Items were summed, with a higher score indicating greater smoking self-efficacy. Item correlations with total self-efficacy scores ranged from .58 to .76.¹⁹⁹ The measure is validated and reliable²⁰⁰ and has been used in previous tobacco research with low SES female smokers.¹⁸¹

Mindfulness was assessed at BSL and EOT with the 39-item Five Facet Mindfulness Questionnaire (FFMQ).¹²⁵ Each facet has 8 items, except nonreactivity. A 5-point Likert Scale was used. Items were summed, with a higher score indicating greater levels of mindfulness. The measure is validated and reliable ($\alpha=.0.86$ to 0.93)¹²⁸ and has been used in previous tobacco research with low SES female smokers.¹⁹⁰

Demographics assessed at baseline included: age; race; ethnicity; education; income-level; relationship status; and number of children.

Nicotine dependence was assessed with the 6-item Fagerström Test of Nicotine Dependence (FTND).²⁰¹

Depressive symptoms were assessed with the Center for Epidemiological Studies Depression Short Form²⁰² which is validated and reliable in smoking studies.^{170,181}

Smoking behavior was assessed with timeline follow back (TLFB) interview of daily smoking over the last week.^{203,204} The test-retest reliability of the TLFB across 24 weeks is $r=0.84$ ²⁰⁴ and this method has been used in previous tobacco research with low SES female smokers.¹⁸¹

Tobacco urge management coping skills was assessed using a 12-item measure internally developed in the HBRC lab by Drs. Collins and Lepore, based off O'Connell et al. findings.^{205,206}

Intention to quit was assessed with 1 item asking if the participant plans to quit smoking in the next 3 months.

Application and use of mindfulness. The Applied Mindfulness Process Scale (AMPS) is a 16-item scale with 5-point Likert response scale. Items were summed, with a higher score indicating a higher frequency of using mindfulness practices when facing challenges in daily life. The measure is validated and reliable ($\alpha = 0.91$ to 0.94).²⁰⁷ A one item question at EOT asked about the overall usefulness of the MBI (1=not useful and 5=very useful).

Number of other smokers in home was assessed by asking how many other cigarette smokers currently live in their house.

Attitudes and use of NRT, electronic cigarettes and cannabis was assessed.

Chronic conditions were assessed with two yes or no questions. The first question asked if the participant had ever been diagnosed with any physical chronic conditions (e.g., diabetes). The second question asked if the participant had ever been diagnosed with any mental health conditions (e.g., attention deficit disorder).

Technology proficiency and use was assessed with questions around phone and technology use, such as “how often in the last week did you use an App on your mobile phone?”

Exploratory process measures were assessed in both conditions at EOT using a series of 5-point Likert-type questions to ascertain perceptions of the text messages sent as part of the interventions, including length, frequency, helpfulness and interest in the content. Open-ended questions were also included to assess perceived usefulness of the material. The 5-item diary tracked daily engagement and usage over the 4-week intervention. Lab created measures are listed in Appendix C. Both groups received the same set of process questions. Research coordinators were blind to participant condition when administering the EOT process questions.

Data Analysis Plan

Quantitative data analysis was conducted using IBM SPSS statistics v. 26.²⁰⁸ Intent to treat analysis was used. Descriptive statistics were generated for all variables, including demographic information and behavioral measures. Descriptive statistics such as means, standard deviations, and correlations were generated for all continuous variables. Frequencies, odds ratios, 95% confidence intervals, and medians were generated for all categorical variables. The sample size and data analyses were modeled off a similar, two group, two-week ecological momentary assessment comparing brief daily mindfulness to control.¹⁵ The study analyzed 34 participants and found reductions in cigarette craving and cigarette use in the mindful group compared to control.¹⁵ We included an estimation for 20% attrition (~6 participants) based on a previous randomized controlled trial that recruited from a similar population of low SES maternal smokers in Philadelphia.¹⁸¹

Aim 1 qualitative analyses of interview data followed the Krueger method.²⁰⁹ Data was recorded, transcribed and reviewed for a thematic framework to create categories for indexing data and charting of quotes. Data was coded and verified by different research assistants for inter-coder reliability. Data analysis assessed internal consistency, frequency, context, intensity and specificity of comments and overall themes. Themes that emerged were used to develop and refine MBI content and study design. Interviews were transcribed and NVivo software was used to code and explore themes.²¹⁰ SPSS was used to analyze quantitative demographic and survey data.²⁰⁸

Aim 2 used repeated measures analysis of variance (RMANOVA) to assess the cue reactivity trial data outcomes, smoking urge and negative affect, over time (cue trials 1-3) between groups. Repeated measures analysis was used because of the simple study design,

equally spaced timepoints, and all participants having the same number of trial data (3 measurements).²¹¹ An RMANOVA for smoking urge (assessed at three timepoints: after cue trial 1, after cue trial 2, after cue trial 3) was used to assess if smoking urge differed between groups during the cue trials. RMANOVA for negative affect (assessed at three timepoints: after cue trial 1, after cue trial 2, after cue trial 3) was used to assess if negative affect differed between groups during the cue trials.

Aim 3a was assessed with attrition rate (<35% is acceptable) and daily MBI adherence (≥ 4 days/week). Aim 3b used linear mixed models (LMM) as they allow for different numbers of observations between subjects. The two continuous outcomes collected daily over 31 days (perceived stress and smoking urge strength) were analyzed in separate models. Day (within-subject) was entered as a continuous variable and included as a repeated measure. The main effect of condition (between-subject; two levels: MBI vs Control), and the condition \times day interaction was tested for the dependent outcome variable, smoking urge and stress level, in four different models.

The four linear mixed models were run to test which model fit the data the best. The assumptions were tested before running the models.²¹² To select the best model, Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) was used. A lower AIC and BIC score generally indicates a better fit.²¹³ Models were run with random intercepts and random slopes which is in line with current theory which allows for the slope and intercept to vary for each participant.^{15,214} Restricted maximum likelihood (REML) method was used to fit the models to the data and estimate the parameters. REML was used because of the small sample size.²¹⁵ An advantage of REML was that it does not delete cases if any data points are missing.²¹⁵ Model 1 was the simplest model which only included the interaction term (condition by time).

Model 2 included the interaction term as well as higher-order time parameters to test a nonlinear trend over the 31-day time period. Model 3 included the interaction term as well as the baseline variable of each outcome variable, smoking urge and stress level. Model 4 included the interaction term, baseline variable and the higher-order time parameters.

Aim 4a used Zero-order correlations to explore the relationship between mindfulness (CAMS-R), the five facets of mindfulness (FFMQ) and the outcome variables stress, smoking urge and smoking cessation self-efficacy at baseline and EOT. Further, an analysis of covariance (ANCOVA) was used to explore if there is a significant change from baseline to EOT between groups for mindfulness, the five facets of mindfulness and the outcome variables, controlling for baseline levels of each variable. Aim 4b used one-way ANCOVAs to compare group difference in negative affect, depressive symptoms, intention to quit and cigarettes per day at end of treatment (EOT) controlling for baseline values of each variable. Additional analyses reported process question means, frequencies and open-ended responses per group.

CHAPTER 4

RESULTS

Formative Research (Aim 1)

The sample ($N = 12$) were all women with children, self-reported being mindfulness naïve, had less than a college degree, were mostly (75%) African American, with an average age of 31 years old, and on average smoked 7 cigarettes/day. During the interview, all women reported experiencing daily stress, 82% reported feeling anxious or sad and 92% reported a link between smoking cigarettes and these feelings. Only 33% of women reported practicing any self-care techniques.

Results suggested interest in mindfulness and its potential utility in their lives for managing stress. On a 1-10 Likert Scale (unlikely/not useful to very likely/useful) participants rated using mindfulness daily $M = 8.77$, $SD = 1.47$; using mindfulness for managing stress $M = 8.36$, $SD = 2.11$; and using mindfulness for managing smoking urges $M = 5.59$, $SD = 2.87$. The sample agreed unanimously that mindfulness would not conflict with their own religion or religion in general. Interviews generated themes related to stress and coping skills, mindfulness acceptability, mindfulness for smoking urge, and study design. Within the themes, sub-themes were categorized as positive, negative or suggestions. These classifications are most useful for understanding and applying the comments for future tailoring of interventions. Many of the negative sub-themes could be described as barriers.

When discussing stress and coping skills, many women highlighted the need for tools to create a mini-break or moment to take a breather when experiencing stress. Many women acknowledged that they normally reach for a cigarette when stressed and use that as their moment to take a break or recharge. In regard to mindfulness, the women responded positively to

the sample meditation, stating they felt “relaxed.” However, many participants were quick to respond that they do not have time or a quiet enough house to meditate on their own. When discussing mindfulness and smoking urge, the participants stated it sounded complicated and that they would not remember to do it when they had an urge. In regard to study design, majority of the participants preferred a text-based study (e.g., because I can have the text messages for reference any time during the day) over an App (e.g., because my phone does not have enough space for another App) or an in-person visit or phone call (e.g., because I do not usually have time to participate in group meetings or calls).

The results led to specific adaptations and tailored content in the current MBI. Short, 5-minute meditation videos were used as a moment to take a break. Additional meditation videos that mothers could do with their children were included in the MBI content. We also added informal mindfulness practices, such as paying attention while washing the dishes or rocking your baby to sleep. Simple texts and visuals, as well as reminder text messages, were included in the current MBI content. Additional suggestions which were included in the current MBI study design were to include motivational messages, incentives and reminders. Further, the study design was kept simple as it employed only text-messages and brief check-in calls. Overall, the study provided a formative analysis of mindfulness acceptability and barriers in a high-risk underrepresented group of female smokers.

Overview: Mindfulness-Based Intervention (MBI)

Data collection occurred between December 2019 and June 2020. Of those contacted ($N = 167$), 40 participants were consented and enrolled in the study. The Consort diagram, Figure 4-1, displays the participant numbers from recruitment through end of treatment. Interestingly, mindfulness/meditation practice (39.4%) was the most common reason for ineligibility.

CONSORT 201

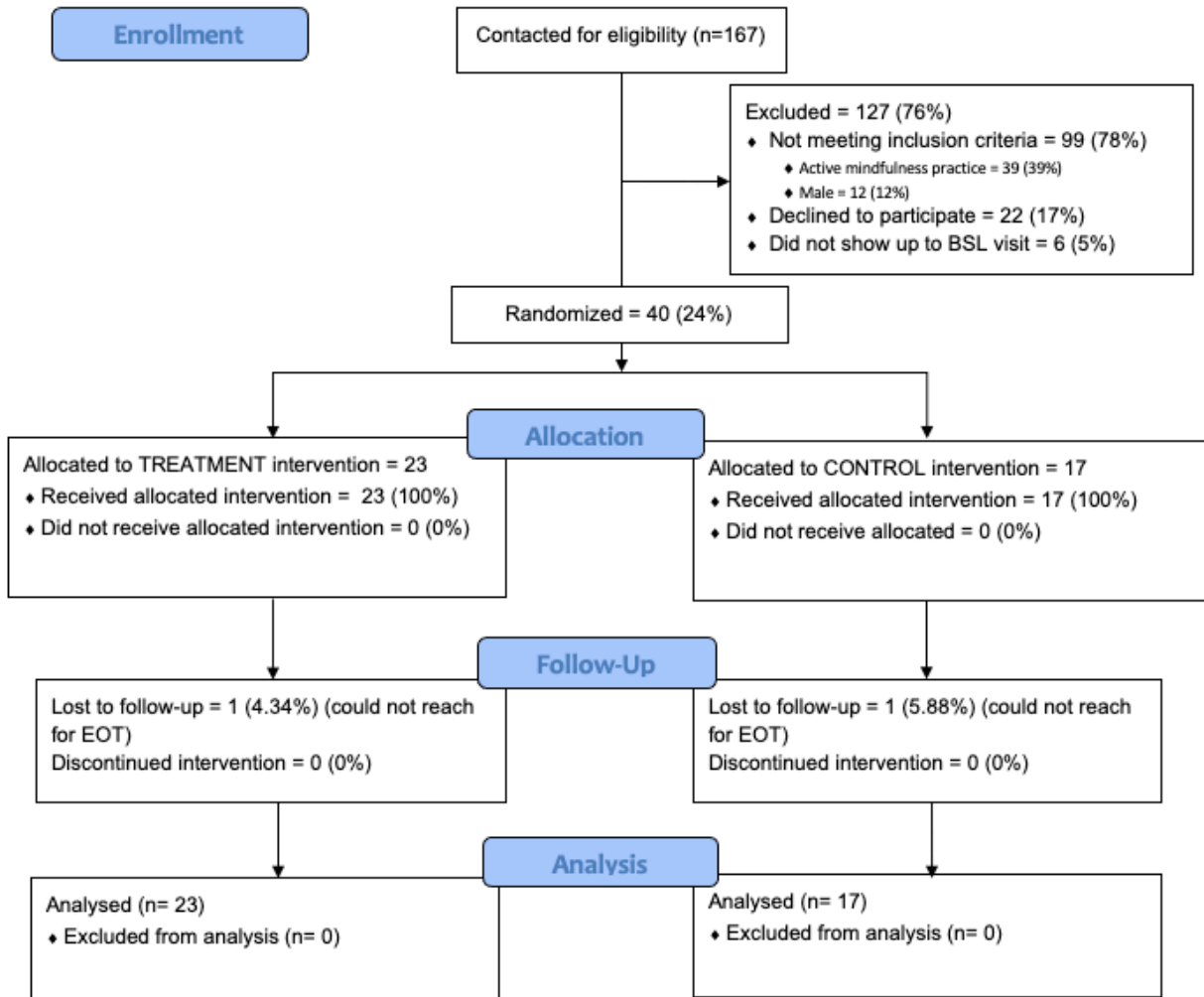


Figure 4-1. *Consort Flow Diagram.*

Demographics and Sample Characteristics

Purposeful sampling was successful in reaching the target population. Participants reported smoking 10 (SD = 6.13) cigarettes per day which is considered moderate to heavy smoking for this population. The mean age of the sample was 36.2 (SD = 8.85) years old. The majority of the sample was African American (88%) and 45% of the sample had some college or a vocational degree. Of the sample, 35% were employed full-time and 20% were employed part-time. There was an average of 4.60 (SD = 1.72) people in participants' households including themselves. Majority of the women were in a relationship (55%). At baseline, there were no differences between groups on the outcome variables and key demographics. Table 4-1 below shows expanded baseline participant demographics and key variables by group (MBI vs Control).

The sample reported a very high nicotine dependence with an average Fagerstrom Test for Nicotine Dependence (FTND) score of 7.12 (SD = 1.73). Participants (abstinent at the baseline session) reported baseline urge in the moderate range (M= 37.1 (SD = 15.0). Participants reported an average of 2.15 (SD = 2.19) lifetime quit attempts and 17.5% of participants stated they intended to quit in the next thirty days, 57.5% were thinking of quitting in the next six months and 25% were not thinking of quitting. Smoking cessation self-efficacy was reported as a low-to-moderate confidence in abstinence, with an average score of 22.9 (SD = 7.55). Participants reported high level of perceived stress (M= 29.1, SD = 4.97). The average mindfulness CAMS-R score was 33.4 (SD = 7.23), a score consistent with other mindfulness naïve samples (general population), i.e., mindfulness skills have not yet been fully developed in the current sample.²¹⁶

Table 4-1.

Baseline Characteristic By Condition.

Baseline Characteristic	MBI ⁷ (N = 23)	CONTROL (N = 17)	Significance Value (p)
Parent age	37.8 ± 8.8	34.0 ± 8.6	p = 0.192
Education			p = 0.327
Some High School or Less	9%	18%	
High school graduate or GED	52%	29%	
Vocational school or some college	39%	53%	
Cigarettes smoked per day	9.70 ± 6.70	10.4 ± 5.2	p = 0.698
Employment			p = 0.343
Not employed	50%	31%	
Part-time	14%	31%	
Full-time	36%	38%	
FTND ¹	7.09 ± 1.649	7.18 ± 1.98	p = 0.874
PANAS ²	29.0 ± 9.41	27.18 ± 9.11	p = 0.716
Mindfulness (CAMS-R ³)	34.5 ± 5.07	31.9 ± 9.37	p = 0.267
FFMQ ⁴ Observe	19.2 ± 4.81	20.9 ± 5.96	p = 0.306
FFMQ ⁴ Describe	28.7 ± 5.71	29.6 ± 5.22	p = 0.649
FFMQ ⁴ Awareness	34.2 ± 3.27	33.5 ± 3.27	p = 0.531
FFMQ ⁴ Nonjudge	32.3 ± 4.79	30.3 ± 4.29	p = 0.191
FFMQ ⁴ Nonreactivity	14.57 ± 2.59	16.0 ± 2.50	p = 0.092
Smoking urge (QSU ⁵)	35.0 ± 13.7	39.9 ± 16.7	p = 0.320
Perceived Stress Scale (PSS ⁶)	29.0 ± 3.01	29.4 ± 6.90	p = 0.807

Note. Mean + Standard Deviation values are derived from Independent Samples T-Tests conducted on continuous variables and percentage values are derived from Pearson's Chi Square test conducted on categorical variables.

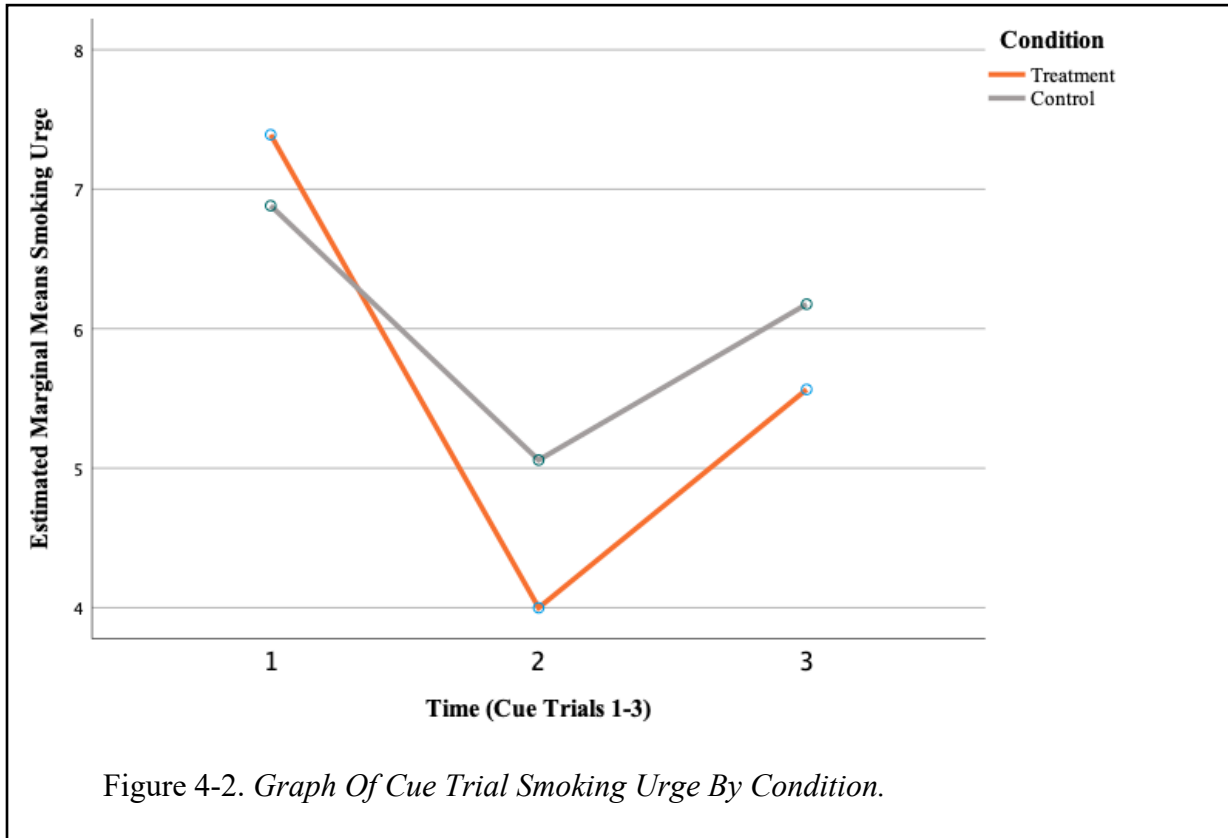
1. FTND = Fagerstrom Test for Nicotine Dependence
2. PANAS = Positive and Negative Affect Scale
3. CAMS-R = Cognitive and Affective Mindfulness Scale-Revised
4. Five Facet Mindfulness Questionnaire
5. Questionnaire of Smoking Urges
6. Perceived Stress Scale
7. MBI = mindfulness-based intervention

Several additional variables were collected at baseline to aid in describing and understanding the sample. These variables included depressive symptoms (CESD), health literacy, chronic conditions, physical activity, digital literacy, App and phone use. The sample reported an average of 3-4 days of depressive symptoms per week and 77% met the cut off used to indicate significant distress or a positive screen for depression. Approximately 30% of the participants were taking prescribed medicine, 23% had a chronic mental condition and 35% had a chronic physical condition. Majority (82%) were confident completing medical forms on their own (health literacy). Approximately half of the sample (52%) exercised at least once a week. The participants had a very high digital literacy score ($M = 49.2$, $SD = 8.90$). All participants reported receiving multiple texts per day and 82% reported using an App at least once a day. However, 40% of participants had never used a parenting App, 43% had never used a stress reduction App and 73% had never used an App to help quit smoking. Additional baseline data, such as electronic cigarette and cannabis use (Figure 4-2), was also collected to explore a wider range of descriptive data as potential controlling variables. Further, this data was collected to better understand the target population and for future secondary analysis exploring potential associations between candidate moderators. The additional baseline characteristics can be found in Appendix D.

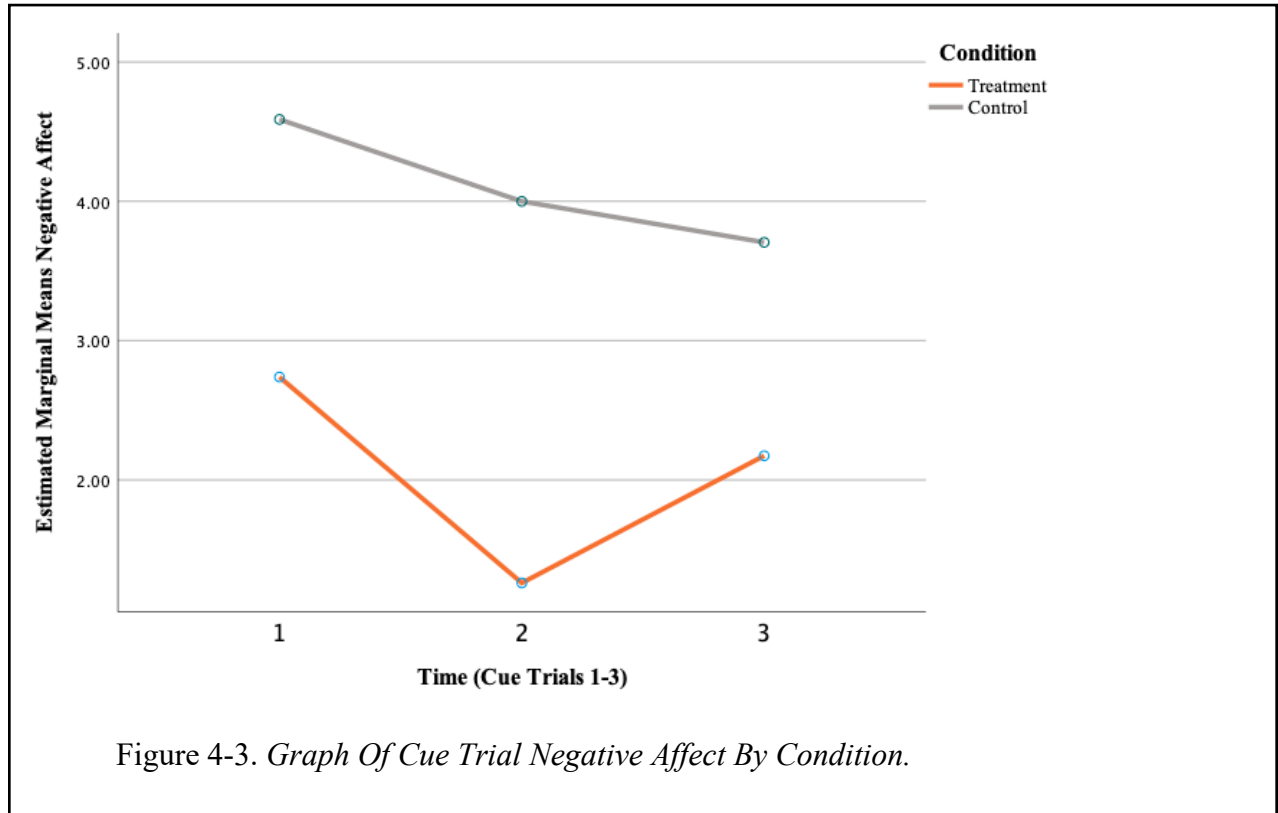
Baseline Assessment Using Cue Exposure Paradigm (Aim 2)

The RMANOVA for smoking urge showed that independent of condition, the time effect was statically significant over the three trials indicating that urge decreased over time for both groups [$F(1,38)=14.72$, $p < 0.001$]. The Greenhouse-Geisser epsilon value was between 0.75 - 1 so the Huynh-Feldt adjustment data was used with the univariate tests.²¹⁷ The results were not significant for condition by time, showing that the control and treatment groups did not

significantly differ in smoking urge over time. Figure 4-2 below depicts the smoking urge means for each group over the three time points assessed during the in-lab cue trial portion of the study.

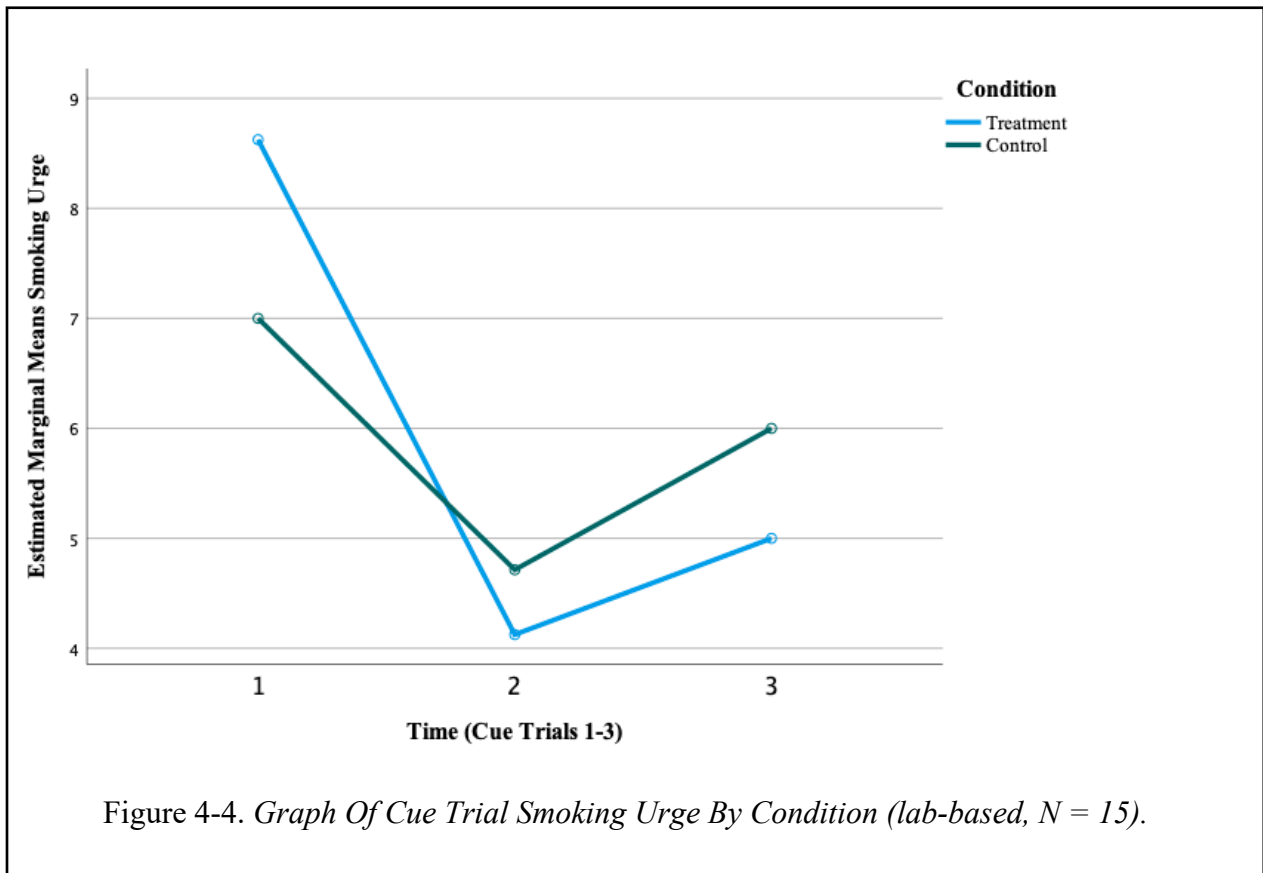


The RMANOVA for negative affect showed that independent of condition, time was statically significant over the three trials, so negative affect decreased over time for both groups [F(1,38)=4.30, $p = 0.045$]. The Greenhouse-Geisser epsilon value was between 0.75 - 1 so the Huynh-Feldt adjustment data was used with the univariate tests. However, the results were not significant for condition by time, showing that the control and treatment groups did not significantly differ in negative affect over time. Figure 4-3 below depicts the negative affect means for each group over the three time points assessed during the in-lab cue trial portion of the study.

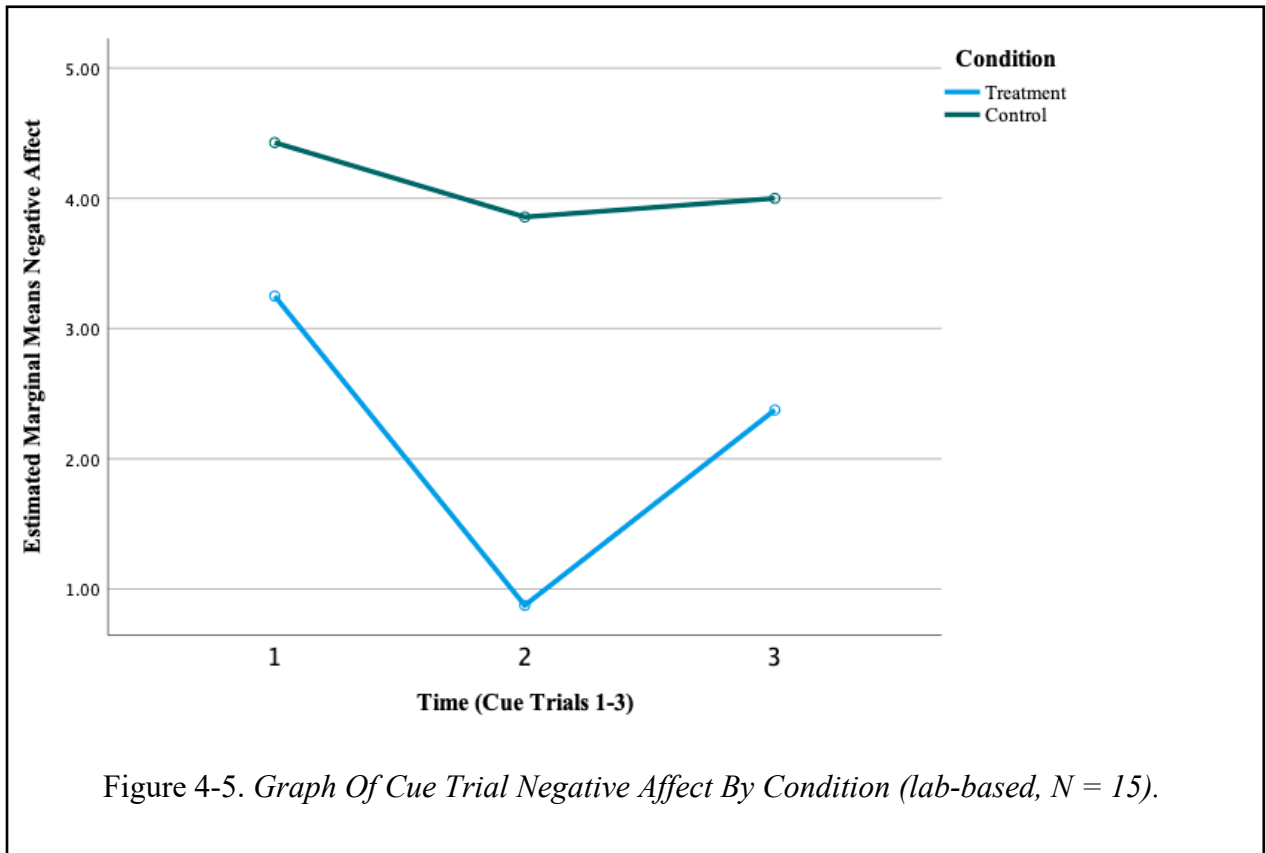


The Pearson Chi-Square test was used to assess group differences in smoking outcome after the cue trials. Half of the participants decided to smoke a cigarette when given the option at the end of the cue trials. There was no statistically significant association between condition and smoking outcome after the cue trials, $\chi(2) = 2.45, p = 0.293$. A timer was set up to record the number of seconds from being told you could now smoke to the time of first puff of the cigarette (if the participant decided to smoke). Of those who did smoke at the end of the cue trial, the average time to smoke in the control group was 2.67 seconds and the average time to smoke in the treatment group was 4.69 seconds. However, independent sample T-tests showed no significant difference between the number of seconds to smoke ($p = 1.60$). Results of the cue reactivity assessments suggest that the hypothesis for aim 2 was not supported. Data showed no significant group differences over time (3 cue trials) for smoking urge or negative affect.

Secondary analysis of the cue exposure trials was run using the data from participants who participated in the baseline assessment in-person at the Temple University lab ($N = 15$). The RMANOVA for smoking urge showed that independent of condition, the time effect was statically significant over the three trials indicating that urge decreased over time for both groups [$F(1,2)=7.06, p = 0.004$]. The Greenhouse-Geisser epsilon value was between 0.75 - 1 so the Huynh-Feldt adjustment data was used with the univariate tests.²¹⁷ The results were not significant for condition by time, showing that the control and treatment groups did not significantly differ in smoking urge over time. Figure 4-4 below depicts smoking urge means for each group over three time points during the cue reactivity assessment.



The RMANOVA for negative affect showed that time was not statically significant over the three trials independent of condition. Further, the results were not significant for condition by time, showing that the control and treatment groups did not significantly differ in negative affect over time. Figure 4.5 below depicts the negative affect means for each group over the three time points assessed during the in-lab cue trial portion of the study.



The Pearson Chi-Square test was used to assess group differences in smoking outcome after the cue trials. Over half of the participants decided to smoke a cigarette when given the option at the end of the cue trials. There was no statistically significant association between condition and smoking outcome after the cue trials, $\chi(1) = 0.026$ $p = 0.872$. Of those who did smoke at the end of the cue trial, the average time to smoke in the control group was 2.25

seconds and the average time to smoke in the treatment group was 4.80 seconds. However, independent samples T-tests showed no significant difference between the number of seconds to smoke ($p = 0.452$). Similar to the entire sample, the in-person sub-set of data showed no significant group differences over time (3 cue trials) for smoking urge or negative affect.

MBI Feasibility and Efficacy (Aim 3)

The MBI group attrition rate was 4%, suggesting acceptability of the intervention (attrition <35%). The average response rate to the daily diary was 87% of all days or approximately 6 out of 7 days a week during the intervention, thereby meeting another criterion of acceptability (>4 days/week). The MBI group completed the daily survey an average of 27.2 days ($SD = 7.34$). The Applied Mindfulness Process Scale (AMPS) showed the MBI group reported using mindfulness practices when experiencing a negative or stressful event an average of sometimes per day ($M = 40.7$, $SD = 8.55$) with 60 being the highest score. Further, the MBI group reported using mindfulness specifically for smoking urges sometimes/often per day ($M=2.72$, $SD = 0.985$) with 4 being the highest score. The MBI group reported high levels (97%) of satisfaction with the tailored MBI indicating the content was very useful.

Preliminary examination of modeling smoking urge at EOT suggested that assumptions of linear mixed models (LMM) were met. For example, the homogeneity of variance assumption of the four LMMs was met in that the variance appeared to be smaller at lower values of smoking urge. The normality assumption was met as residuals appeared to be approximately normally distributed. The linearity assumption was met based on the deviation from linearity statistic, $p = 0.655$. Preliminary examination of modeling perceived stress at EOT suggested that assumptions of linear mixed models (LMM) were met. For example, the homogeneity of variance assumption was met as the variance appeared to be smaller at lower values of perceived

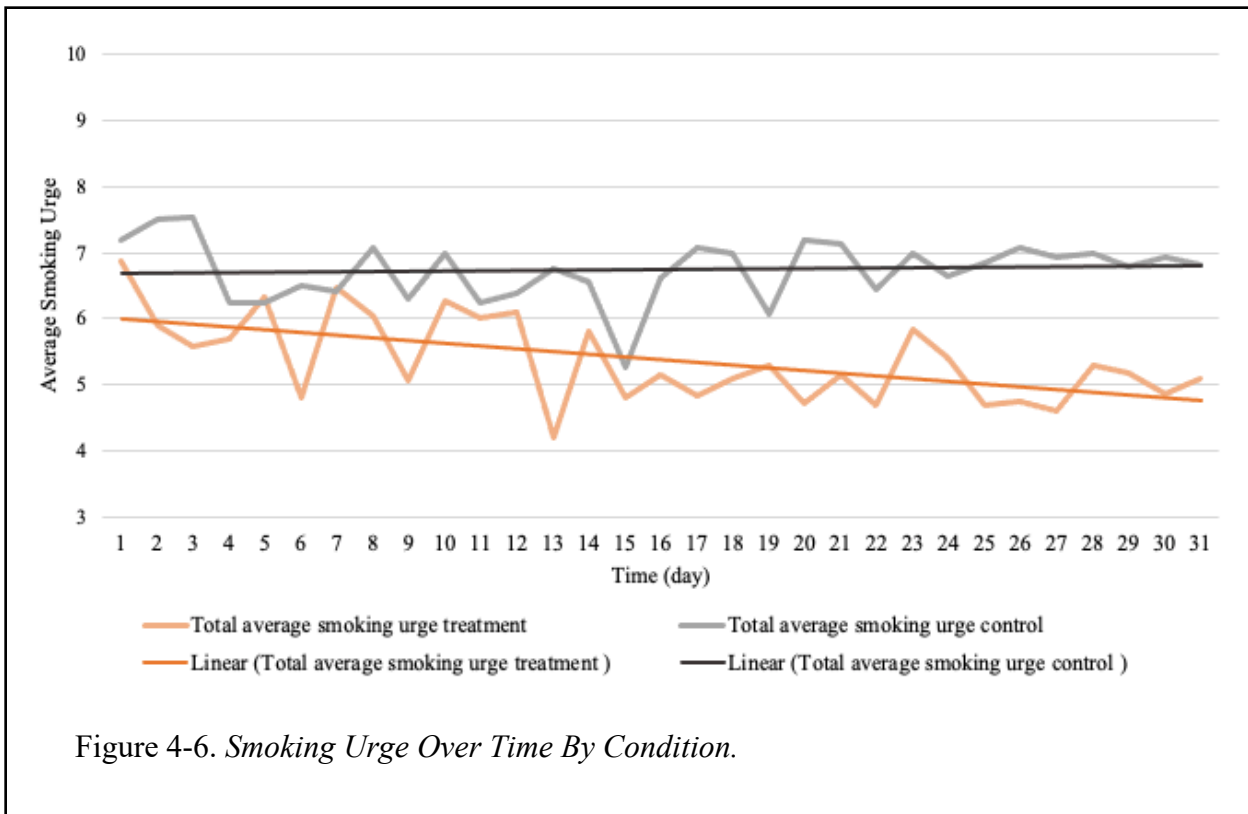
stress level. The normality assumption was met as residuals appeared to be approximately normally distributed. The linearity assumption was met based on the deviation from the linearity statistic ($p = 0.816$).

Smoking urge: Analysis of model fit across the four-smoking urge LMM models suggested that Model 1 achieved the best fit based on lower AIC and BIC values compared to the other models. Table 4-2 below displays the AIC and BIC values for each model.

Table 4-2.		
<i>Linear Mixed Models Model Fit Criteria for Smoking Urge.</i>		
Model Description	AIC ¹	BIC ²
Model 1: Time by Condition interaction	5136	5300
Model 2: Time by Condition interaction with quadratic time	5182	5346
Model 3: Time by Condition interaction with BSL urge	5152	5316
Model 4: Time by Condition interaction with BSL urge & quadratic time	5197	5361
<i>Note.</i>		
1. AIC = Akaike Information Criterion		
2. BIC = Bayesian Information Criterion		

Model 1 is also the most parsimonious model, which is preferred when selecting a model.²¹⁸

Model 1 showed a significant effect of time, [$F(1, 545) = 6.20, PE = -0.001, SE = 0.012, p = .013$] suggesting that smoking urge decreased over time for both groups. There was also a significant effect of condition [$F(1, 5405) = 7.58, PE = -0.791, SE = 0.288, p = .006$] suggesting that there was a significant difference in urge between groups at EOT. Further, Model 1 showed a significant time by condition effect [$F(1, 545) = 5.38, PE = -0.038, SE = 0.016, p = 0.021$] indicating that smoking urge declined significantly more over time in the MBI group compared to the control group. Figure 4-6 below shows a visual representation of average smoking urge as reported in the daily diary over time (31 days) by condition.



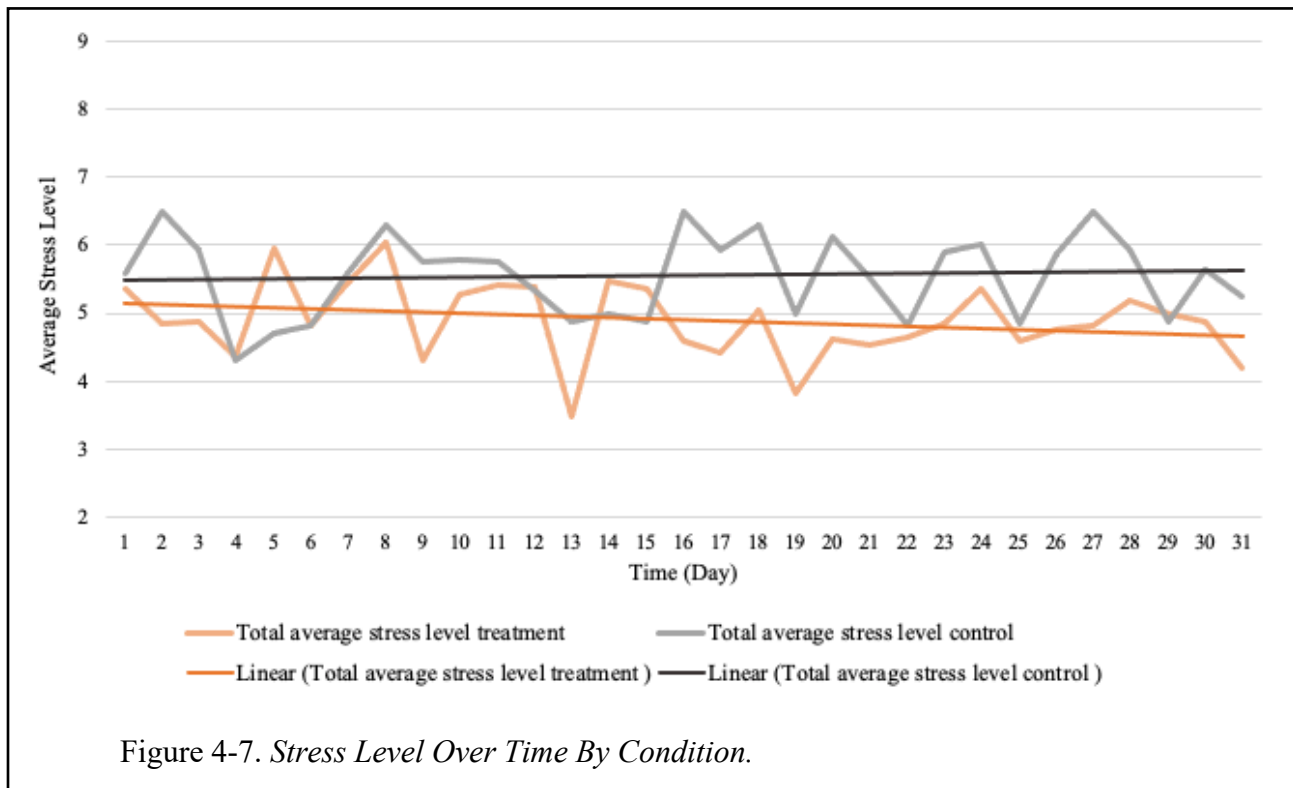
Stress Level. Analysis of model fit across the four LMM models of stress suggested that Model 1 achieved the best fit based on lower AIC and BIC values compared to the other models. Table 4-3 below displays the AIC and BIC values for each model. Model 1 had the best fit due to it having the lowest AIC and BIC. However, Model 1 as well as Models 2 through 4 showed no significant effect on time by condition. Model 1 had a non-significant effect of time, $F(1, 0) = 0$, $PE = .005$, $SE = 1109.440$, $p = 1.00$, condition, $F(1, 417) = 1.30$, $PE = -.404$, $SE = 354$, $p = 0.254$ or time by condition, $F(1, 542) = 1.01$, $PE = -0.020$, $SE = 0.020$, $p = 0.315$. Figure 4-7 below shows a visual representation of average stress level as reported in the daily diary over time (31 days) by condition.

Table 4-3.

Linear Mixed Models Model Fit Criteria for Stress Level.

Model Description	AIC ¹	BIC ²
Model 1: Time by Condition interaction	5451	5616
Model 2: Time by Condition interaction with quadratic time	5502	5666
Model 3: Time by Condition interaction with BSL urge	5461	5626
Model 4: Time by Condition interaction with BSL urge & quadratic time	5512	5676

Note.
 1. AIC = Akaike Information Criterion
 2. BIC = Bayesian Information Criterion



The model that fit the data the best, Model 1, was the most parsimonious. Model 1 included a random intercept and slope and the interaction term (time by condition). Results of the LMM suggest that the hypothesis for Aim 3b was partially supported. There was not a greater reduction in subjective stress in the MBI group compared to control over time (31 days). Yet, the data showed there was a greater reduction in smoking urges in the MBI group compared to the control group over time (31 days).

Exploratory Data (Aim 4)

Table 4-4 below displays the correlations exploring relationships between baseline mindfulness (total and 5 facets) scores with baseline stress, urge, smoking cessation self-efficacy (SCSE) and smoking rate (Aim 4a). Zero-order correlations showed higher levels of overall mindfulness (CAMS-R) and the observing facet (e.g., sensory awareness) were significantly correlated with greater perceived stress at baseline. In contrast, higher levels of awareness (e.g., the ability to be self-aware and act with awareness) and nonjudging (e.g., empathy towards oneself and others) were significantly correlated with lower perceived stress levels at baseline.

Baseline mindfulness characteristics were not predictive of change in stress, smoking urge or SCSE as a result of treatment: there were no significant relationships between baseline mindfulness or any of the five mindfulness facets and end of treatment perceived stress, smoking urge or SCSE. ANCOVAs suggested that there were no significant changes within or between groups for the five facets of mindfulness (FFMQ) or overall mindfulness scores (CAMS-R) from baseline to EOT. Therefore, no further examination was conducted to explore change in mindfulness characteristics to change in outcomes of interest. Results suggest that the hypothesis for aim 4a was not supported. In the sample, data showed that mindfulness remained stable across time.

Exploring additional outcome variables (Aim 4b). There were no significant differences between groups for negative affect, intention to quit or depressive symptoms. However, there was a significant difference between groups in reported mean cigarettes per day [$F(1,35) = 6.99$, $p = 0.012$] at EOT with the MBI reporting significantly fewer (Mean = 5.50, SD = 2.77) compared to control (Mean = 8.14, SD = 3.23). Figure 4-8 below shows between group differences in mean cigarettes per day at baseline (not significant) and EOT.

Table 4-4.

Zero-Order Correlations for Smoking Urge, Stress Level, Self-efficacy, and the 5 Mindfulness Facets.

	BSL CAMS-R ⁵	BSL FFMQ ⁶ Observe	BSL FFMQ ⁶ Describe	BSL FFMQ ⁶ Aware	BSL FFMQ ⁶ Nonjudge	BSL FFMQ ⁶ Nonreact
BSL Stress Level (PSS ²)	0.515**	0.385*	-0.215	-0.448**	-0.317*	0.026
BSL Smoking Urge (QSU ³)	0.125	0.113	0.122	0.019	0.131	-0.087
BSL Self-Efficacy (SCSE ⁴)	0.071	-0.023	0.010	-0.109	0.172	0.191
BSL Cigarettes per day	0.078	0.104	0.169	0.024	-0.229	0.137

Note.

*** Correlation is significant at the 0.01 level (2-tailed).*

** Correlation is significant at the 0.05 level (2-tailed).*

1. BSL = Baseline

2. PSS = Perceived Stress Scale

3. QSU = Questionnaire of Smoking Urges

4. SCSE = Smoking Cessation Self-Efficacy Measure

5. CAMS-R = Cognitive and Affective Mindfulness Scale-Revised

6. Five Facet Mindfulness Questionnaire

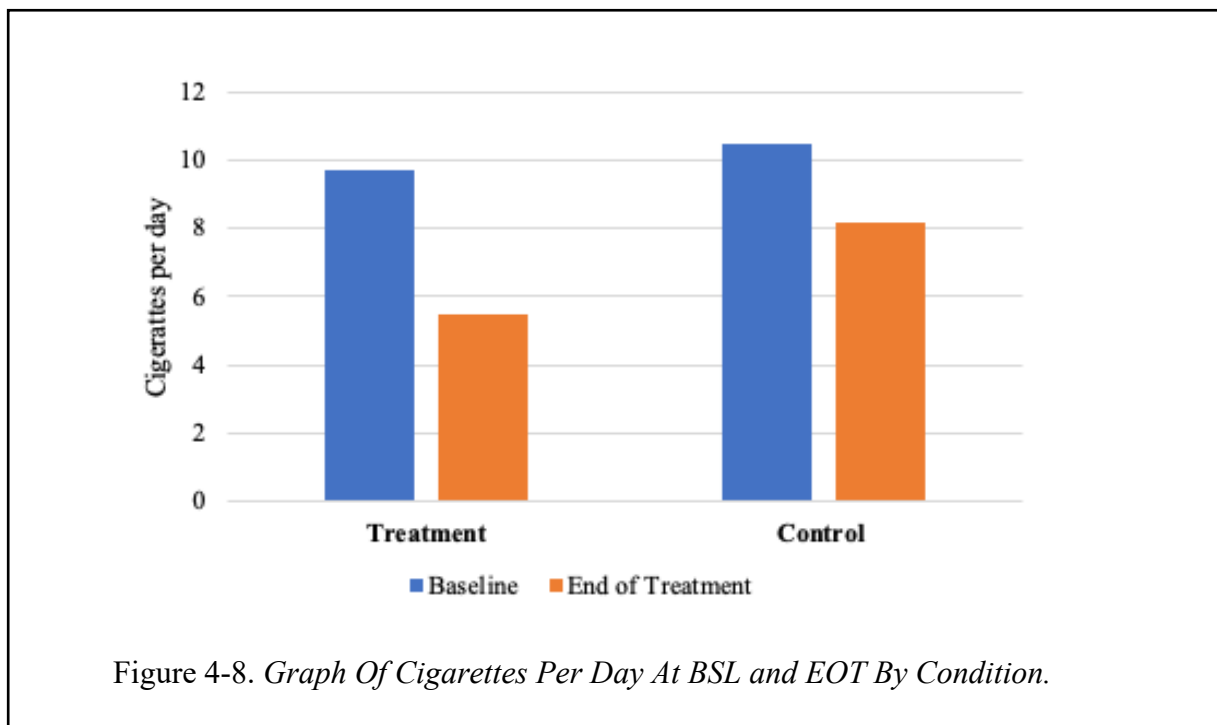


Figure 4-8. *Graph Of Cigarettes Per Day At BSL and EOT By Condition.*

To further explore the change in cigarette consumption between groups, the 31-day diary data was analyzed. our linear mixed models were run to test which model fit the data the best for the outcome cigarettes per day. Preliminary examination of modeling suggested that all assumptions of linear mixed models (LMM) were met. Table 4-5 below displays the AIC and BIC values for each model. Model 3 was selected for the best fit due to it having the lowest AIC and BIC. Model 3 includes baseline cigarettes per day. Model 3 showed a non-significant effect of time, $F(1, 594) = 2.072, PE = 0.017, SE = 0.019, p = 0.151$ and a non-significant effect of condition, $F(1, 783) = 0.401, PE = -0.372, SE = 0.587, p = 0.527$. Model 3 showed a significant effect of baseline cigarettes, $F(1, 896) = 39.023, PE = 0.153, SE = 0.032, p < 0.001$, and a non-significant effect of condition and baseline cigarettes per day $F(1, 896) = 1.038, PE = -0.56, SE = 0.040, p = .164$. Model 3 showed a significant effect for time by condition, $F(1, 595) = 7.747, PE = -0.069, SE = 0.025, p = 0.006$, indicating a significantly greater decline in cigarettes per day over time in the treatment group compared to the control group. Figure 4-9 below shows a visual representation of average cigarettes per day as reported in the daily diary over time (31 days) by condition.

Table 4-5.		
<i>Linear Mixed Models Model Fit Criteria for Smoking Urge.</i>		
Model Description	AIC ¹	BIC ²
Model 1: Time by Condition interaction	5845	6009
Model 2: Time by Condition interaction with quadratic time	5887	6051
Model 3: Time by Condition interaction with BSL urge	5820	5984
Model 4: Time by Condition interaction with BSL urge & quadratic time	5862	6026
<i>Note.</i>		
1. AIC = Akaike Information Criterion		
2. BIC = Bayesian Information Criterion		

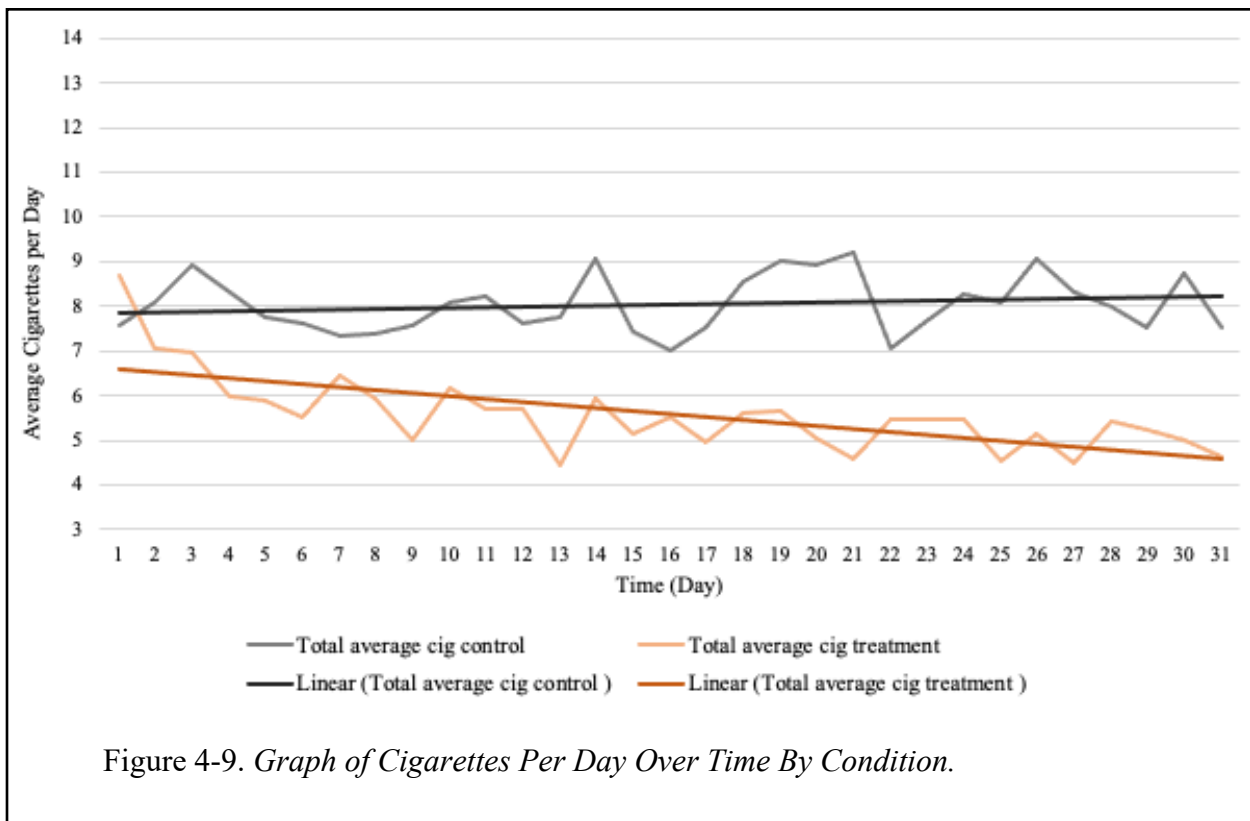


Figure 4-9. Graph of Cigarettes Per Day Over Time By Condition.

The data reflect there was not a significant difference between groups for negative affect, depressive symptoms or intention to quit in the MBI group compared to the control group. There was a significant difference between groups at end of treatment for cigarette consumption, when controlling for baseline cigarettes per day. Further, linear mixed models were run to assess change in cigarette consumption over time by group using the daily diary data. Model 3 was selected for best fit, as it included a random intercept and slope, the interaction term (time by condition) as well as baseline cigarettes per day. This model showed there was a greater reduction in cigarettes per day in the MBI group compared to the control group over time.

Exploring process measures within MBI group. None of the participants reported barriers (e.g., phone issues) to receiving the texts. Overall, the participants indicated the text messages were helpful, clear to understand and appealing: 86% of participants stated that the number of

texts received was the “right amount” and 14% stated not enough texts were sent; 96% of participants reported learning new information about mindfulness; 96% of participants reported learning new information about stress management; and 82% of participants reported learning new information about parenting. Appendix E displays participant responses for the remaining process measures.

The MBI group was asked to share anything they would change about the texts, with 55% of participants stating they would not change anything. Of the MBI participants, 14 % suggested more messages throughout the day, 9% of participants suggested more visuals and shorter texts, and 9% stated the first message of the day was too early. One participant shared “some of them were more boring than others, and I would make some of them a little more lively.” When asked what they did not like about the text messages, similar feedback was received as when asked what they would change, e.g., more visuals needed, shorter messages because a few were too long. Further, 9% of participants stated they did not like some of the pictures included in the text messages and 5% of participants shared that the messages did not feel unique enough. The MBI group was then asked to share anything they liked about the texts. Overall, participants expressed they liked the visuals and videos, and that the text messages were motivational, inspirational and helpful reminders to be mindful throughout their day. Appendix E displays each participant’s unique response to the question “What did you like about the text messages?”

Exploring process measures within control group. The control group was asked how often they viewed study related texts in a week and 94% of participants reported viewing the texts at least once a day. In the control group, 81% of participants stated that the number of texts sent was the right amount, 12% of participants stated too many texts were sent and 6% of participants stated not enough texts were sent. One of the participants reported barriers (e.g.,

phone issues) to receiving some of the texts. In the control group, 94% of participants reported learning new information about parenting, 69% of participants reported learning new information about mindfulness, and 81% of participants reported learning new information about stress management. Overall, the participants indicated the text messages were helpful, clear to understand, and informative. Appendix E displays participant responses for the remaining process measures.

The control group was asked to share anything they would change about the texts, with nine participants stating they would not change anything. Of the control participants, 13% wished the text messages were more about smoking, 6% of participants suggested more visuals and 6% of participants stated there were too many texts each day. One participant said the first message of the day was too early and another participant said the text messages should come earlier in the day. When asked what they did not like about the text messages, similar feedback was received as when asked what they would change, e.g., nothing to change/did not like, first message too early or wished it was more about quitting smoking. One participant stated they did not like some of the pictures and preferred the text only messages and another participant shared that bike safety section did not apply to her family. The control group was then asked to share anything they liked about the texts. Overall participants expressed that the text messages were informative and helpful. Appendix E displays each participant's unique response to the question "What did you like about the text messages?" Additionally, the control group at the end of treatment was asked about openness to trying mindfulness with 87% of the control group participants reporting an interest in trying or learning mindfulness practices and 70% reported they would likely use mindfulness daily for 5 or more minutes. Additionally, 84% of the control

group reported mindfulness practices would be useful to manage their daily stress and stressors. Further, 71% reported that mindfulness practices would be useful to manage their daily smoking urges and behavior.

Overall, both groups rated the intervention as acceptable. The MBI group rated several process measures higher than the control group. For example, Pearson Chi-Square tests showed a significant difference between groups for two key questions. The MBI group rated the text messages significantly more helpful for managing stress compared to control ($p = 0.046$). And the MBI group reported learning about mindfulness through the text messages significantly more compared to the control group ($p = 0.026$). Both groups offered positive feedback and suggestions when asked what they liked about the text messages. The messages were well received and viewed as helpful, inspirational and motivational.

CHAPTER 5

DISCUSSION

The results suggest the MBI is both acceptable and feasible within the target population. Findings from the mixed methods formative analysis showed participants' favorable attitude towards mindfulness, with specific preferences that were used to guide the tailoring of content and delivery of the current MBI. There was no evidence of efficacy with the one-session MBI on cue reactivity which may suggest that mindfulness naïve smokers are more likely to realize the benefits of mindfulness following more in-depth mindfulness training and repeated practice. However, the 4-week tailored MBI showed feasibility as well as potential efficacy with a significant reduction in smoking urge and cigarettes per day over time in the treatment group compared to control. There were no differential effects of the five facets of mindfulness on urge, stress, and cessation self-efficacy which may require additional exploration within this population. Overall, the results suggest that mindfulness practices tailored for low SES women with children to aid in smoking behavior change are both feasible and efficacious in mitigating some important factors related to smoking maintenance. Thus, further investigation is warranted.

The null results of the single session mindfulness mediation test was consistent with evidence reported in a similar cue reactivity study assessing mindfulness vs control which found no significant group difference for negative affect and smoking urge.¹⁵ Although there was not a statistically significant difference between groups over time for negative affect or smoking urge, both groups showed a decline in reactivity over the trials. Potential explanations of this null effect include the following: In general, women may be more reactive to negative affect and urge inducing procedures in a behavioral laboratory and are more likely to smoke at the end of the trial.²¹⁹ Therefore, perhaps alternative, in vivo procedures for testing the potential effects of single session mindfulness would be more appropriate. However, the most plausible explanation

without further experiments relates to the modification in cue exposure procedures that were necessary in response to the Covid-19 pandemic. Following pandemic-related work closures and social distancing regulations, this study modified lab procedures to be delivered via video conferencing. These procedures had not been pilot tested, and it was unknown if the modified procedures would be as reliable as those conducted in a more-controlled laboratory free of distractions from one's household. Many participants had children at home and struggled to find a quiet place or a permissible location to light a cigarette as instructed in the original audio recorded procedures. Moreover, there was no way to standardize or minimize the number of environment cues associated with smoking during the post exposure mindfulness session (cues that can sustain or increase smoking urge and promote smoking).²²⁰ Further, the control group may have benefited from the distraction as they listened to parenting tips and thus their smoking urge was also reduced. Distraction is a coping skill often used to aid in urge management and smoking cessation.²²¹ Most importantly, mindfulness is a skill that may take many sessions to build and experience benefits. Thus, a brief 5-minute guided mindfulness recording may not be sufficient to facilitate urge and mood management among smokers who are mindfulness naïve. However, it is promising that even a short-term intervention (4-week) can be sufficient to promote changes in smoking behavior.

The effects of the 4-week MBI in which smoking urge decreased significantly more over time in the MBI group than controls is consistent with a similar study that used a two-week, ecological momentary assessment design comparing an MBI to a control group.¹⁵ Several other studies have reported mindfulness practices mitigating smokers' reactivity to smoking cues and smoking urges.^{144,145} The current study sent daily text messages reminding participants to apply mindfulness when they had a smoking urge. This continuous influx of reminders through the text

messages may be part of the reason a reduction in urge over time was observed in the MBI group. Future research should explore adding in a daily component to interventions targeting smoking urge.

There was not a significant difference in stress level over time between groups. This finding is in line with previous research reporting insufficient evidence for mindfulness reducing stress as an outcome.²²² A more robust measure of stress may be needed as a one item question was used daily to measure stress in an effort to limit participant burden. Additionally, the MBI group may have reported a high level of stress, but perhaps gained new stress management and coping skills that were not captured by the daily survey. This in turn may partially explain why smoking urges decreased significantly more over time for the MBI group.

Two large scale factors to consider that occurred over the study timeline are the Covid-19 pandemic and Black Lives Matter. Pandemics are a known source of distress and may impact physical and psychological health. During previous pandemics, research shows an increase in worry, anger, depression, and emotional trouble.²²³ Evidence is beginning to show that African American and low-income communities are disproportionately impacted by the COVID-19 pandemic.²²⁴ Parental stress levels, especially among minority populations, are impacted by pandemic worry, economic hardship, elevated anxiety, lack of childcare or social support and systematic inequalities (e.g., healthcare access, over-crowded housing).²²⁵ Further, mental health in the target population is known to deteriorate by experiencing police killings of unarmed African Americans, as racism and trauma can be felt vicariously.²²⁶ During 2020, as recruitment and study administration occurred, the Black Lives Matter movement was at a peak with the killings of Ahmaud Arbery, Breonna Taylor and George Floyd. Research shows that protests, even non-violent, and riots have adverse effects on mental health outcomes and increase negative

behaviors such as substance use.²²⁷ More research is needed to investigate the role of the pandemic and unlawful killings of African Americans by police officers, especially within diverse populations, on social and behavioral outcomes such as stress and smoking behavior.

Results from the Aim 4a assessment of the 5 facets of mindfulness contributes to the on-going discussion around how to define and measure mindfulness. Researchers do not always agree on what elements should be included in the definition. For example, is mindfulness concentration or awareness, and are attitudes (how one approaches life), insight, acceptance or compassion essential components of mindfulness?²²⁸ Further, is mindfulness a practice, a mental state or both? Measurement of mindfulness is just as convoluted. A study exploring the validity of mindful measures compared mindfulness training to computerized attention training and found no support for discriminant validity as mindfulness measure scores (FFMQ, MAAS) responded to both groups; however, the study did find a significant difference between groups with a breathing counting measure.²²⁹ Yet, there is sound research in certain populations supporting the use of the current mindfulness measures. Still, some researchers call for the dismissal of mindfulness measures in research as they lack validity, do not always correspond with behavioral outcomes, often cannot distinguish experienced meditators compared to naïve meditators and even have shown illogical outcomes, such as binge-drinkers and drug users reporting higher mindfulness compared to healthy controls.²³⁰ Focusing on constructs related to mindfulness, such as body awareness or emotion regulation, may be more useful; for example it could be compared to the measurement of intelligence, in which researchers capture various cognitive capacities to “measure” overall intelligence.²³¹

The confusion around mindfulness definitions and measures is heightened in underserved communities, as there is even less research validating measures. In the current study, higher

baseline mindfulness (CAMS-R) was significantly related to higher baseline stress levels (PSS). Further, higher levels of the observe facet were significantly related to higher stress levels (PSS). However, higher levels of the awareness and non-judge facets were related to lower levels of stress (PSS). Observation is one of many factors that make up the concept of mindfulness. It may be that observing, without the key elements such as non-judging or compassion, is related to higher perceived stress. For example, knowing you are behind on rent may increase your stress level. Knowing you are behind on rent but being aware and nonjudgmental of the situation may provide a buffer to perceived stress level. The target population often lives in a stressful, “paycheck to paycheck” style life. This in turn could seem on a scale as a “present moment awareness” but may not actually include the beneficial skills of mindfulness practice. More research is needed on which concepts are relevant to the construct of mindfulness and how to measure them. Further, the definition and measurement of mindfulness may need to be tailored for varying populations.

There are other factors to consider when discussing mindfulness and outcome measures. The Covid-19 pandemic and social unrest have the potential to increase mind wandering which is associated with less present moment focus, worrying, and poor performance on everyday tasks.²³² Thus, the pandemic could be influencing the lack of change in mindfulness scores over time. The strength of the intervention is another factor that could influence the lack of observable change in mindfulness. The current intervention was half the length of the gold standard 8-week MBSR programs. MBSR also includes a group component and meets for approximately 2-3 hours a week with 45 minutes of home practice daily.¹⁶ And finally, there may not be a direct, observable link between measured mindfulness (FFMQ and CAMS-R) and smoking behaviors in this population, yet a significant change in the MBI groups smoking behaviors (reduced smoking

urge and cigarettes per day) occurred after 4-weeks of mindfulness practice. Hence, more research is needed on the facets of mindfulness and smoking behaviors in this population, as other studies have found a link between mindfulness training, smoking urge and self-efficacy.²³³

Additionally, we explored process questions about the overall study design and content. The findings are consistent with previous qualitative outcomes with a similar population discussing mindfulness-based interventions.²³⁴ Both groups felt that 4-6 text messages daily was an acceptable number of messages. Participants reported text messages should be short, concise, include visuals and include motivational messages. Majority of participants reported the utility of the daily reminders, which is in line with previous research on supportive accountability.¹⁶⁵ The reminder calls were also acceptable, yet participants rated the reminder texts as more useful. Future research should take into account the feedback provided by participants when designing e-health interventions for similar populations.

We also explored additional outcomes deemed important to theory and smoking behavior change. Cigarettes per day was significantly lower at EOT compared to the control group. The analysis included baseline cigarettes per day. Other studies have also found a reduction in cigarettes per day after a brief mindfulness session compared to control.^{15,17} The reduction in cigarette consumption is promising, especially as negative health behaviors, such as smoking cigarettes, have risen during the Covid-19 pandemic.²³⁵ Participants were not enrolled in a smoking cessation trial, as they were recruited for a stress reduction study. Due to funding and timeline, cessation was not the outcome, and this was made clear at recruitment and consent. Mindfulness may have the potential to aid in smoking behavior change, as a pre-quit component or as a standalone treatment, among populations not intending to quit or actively seeking cessation treatment. More research is needed to assess if mindfulness alone could aid in smoking

cessation, as that was not the target outcome of this study. Messages were designed to target stress and smoking urge but did not include specific cessation advice or setting a quit day. Future research should investigate mindfulness interventions with more intensive designs and messaging specifically targeting smoking cessation in the target population.

There was not a significant difference between groups at EOT for smoking cessation self-efficacy or intention to quit. This could be because the focus of the study was not specifically on quitting smoking, e.g., the participants were not coached on making a quit plan. There was not a significant difference between groups at EOT for negative affect and depression scores. Several factors could account for this. Both groups received positive reinforcement throughout the intervention. The Covid-19 pandemic may have impacted negative affect and depression scores as research shows mental health issues are worsened during the pandemic.^{236,237} The MBI may not have focused enough on emotion regulation and coping skills to impact negative affect and depression scores. A longer, more intensive intervention may be needed to impact affect measures in this population.

Limitations

The study had several limitations. As this was a study to test feasibility and potential efficacy, the sample size was small. The study targeted a specific population of urban, low-income mothers who smoke cigarettes, so results may not be generalizable to the general population. The study did not include bioverification and relied on self-report measures for cigarette consumption. Self-report measures are known to include bias, such as recall and expectancy bias; however, a control group was added to mitigate the bias and allow for assessment of group differences over time. Additional self-report and biological measures of autonomic nervous system reactivity to assess response to mindfulness, such as emotion

regulation, body awareness, breathing measures, were not included in the study. More research is needed to validate mindfulness measures in the target population. Also, there may have been group differences in reactivity to repeated measurement of key outcome variables given the number of reminders in the MBI group to practice mindfulness for stress and urge management (compared to parenting skills in the control group). However, if there was differential reactivity to the outcome measures, that would not explain why there was not a group difference in perceived stress, but differences in urge and cigarettes smoked per day. A long-term follow-up timepoint, such as 12 months, was not included due to funding and time constraints. And finally, the Covid-19 pandemic provided a unique challenge in recruitment, study administration and potentially impacted study outcomes such as stress level, mindfulness and negative affect.

Contribution To The Literature And Public Health Implications

The study had several strengths. The study achieved high adherence and low attrition. The study was grounded in theory and included modified content that was deemed acceptable and useful in this population. This research adds to the literature on tailored, individual, mobile MBIs. An issue with the current mindfulness literature with underserved populations is it being underpowered or poor quality. This intervention was randomized, powered on its main outcome, aim 3b, and included an attention control group used to compare outcomes. The control group is also useful to reduce the bias around demand characteristics. The research staff were blinded to participant study condition when administering end of treatment measures. Daily data collection over the four weeks allowed for more robust analysis beyond pre-post assessment. The non-significant findings should encourage further investigation of mindfulness measurement in underserved populations and enhanced study design with more potent factors, such as smoking

cessation quit tips or creating a quit plan. Further, the significant findings, such as a decline in smoking urge and number of cigarettes per day in the MBI group, are promising and should spur continued research on mindfulness practices for smoking behavior change.

The results of the study have significant public health implications. Cigarette smoking-related illnesses account for over \$300 billion in healthcare costs every year.²³⁸ The MBI is low cost and has a wide-reach due to it being a text-based intervention. Because of this, it could be added to current standard of care cessation treatment programs as an adjunctive or pre-quit program. Targeting mothers who smoke cigarettes has an impact on children's health. If a mother reduces or quits smoking, the secondhand smoke exposure experienced by her child is reduced or eliminated. Children who are exposed to secondhand smoke are at risk for many adverse health outcomes such as sudden infant death syndrome (SIDS) and respiratory infections, and low SES children are more likely to be exposed to secondhand smoke.²³⁹ Thus it is a priority to focus on parental smoking cessation in low SES populations.

The study population is often difficult to reach and not as responsive to conventional treatments compared to the general population.⁷⁷ The sample was not intending to quit smoking through this study, as it was advertised as a stress reduction study. Consistent with previous research, the sample reported low use and trust in the effectiveness of NRT.²⁴⁰ The sample averaged 2.15 (SD = 2.19) lifetime quit attempts, with research showing it may take an average of 30 or more attempts to successfully quit smoking cigarettes.²⁴¹ Therefore, the low attrition, high rates of adherence and acceptability scores, and the open-ended responses praising the study content and design should be considered a success within the population. Additional research should continue to tailor interventions for the target population to help ensure interventions are well received, which in turn may enhance effectiveness. An additional research direction would

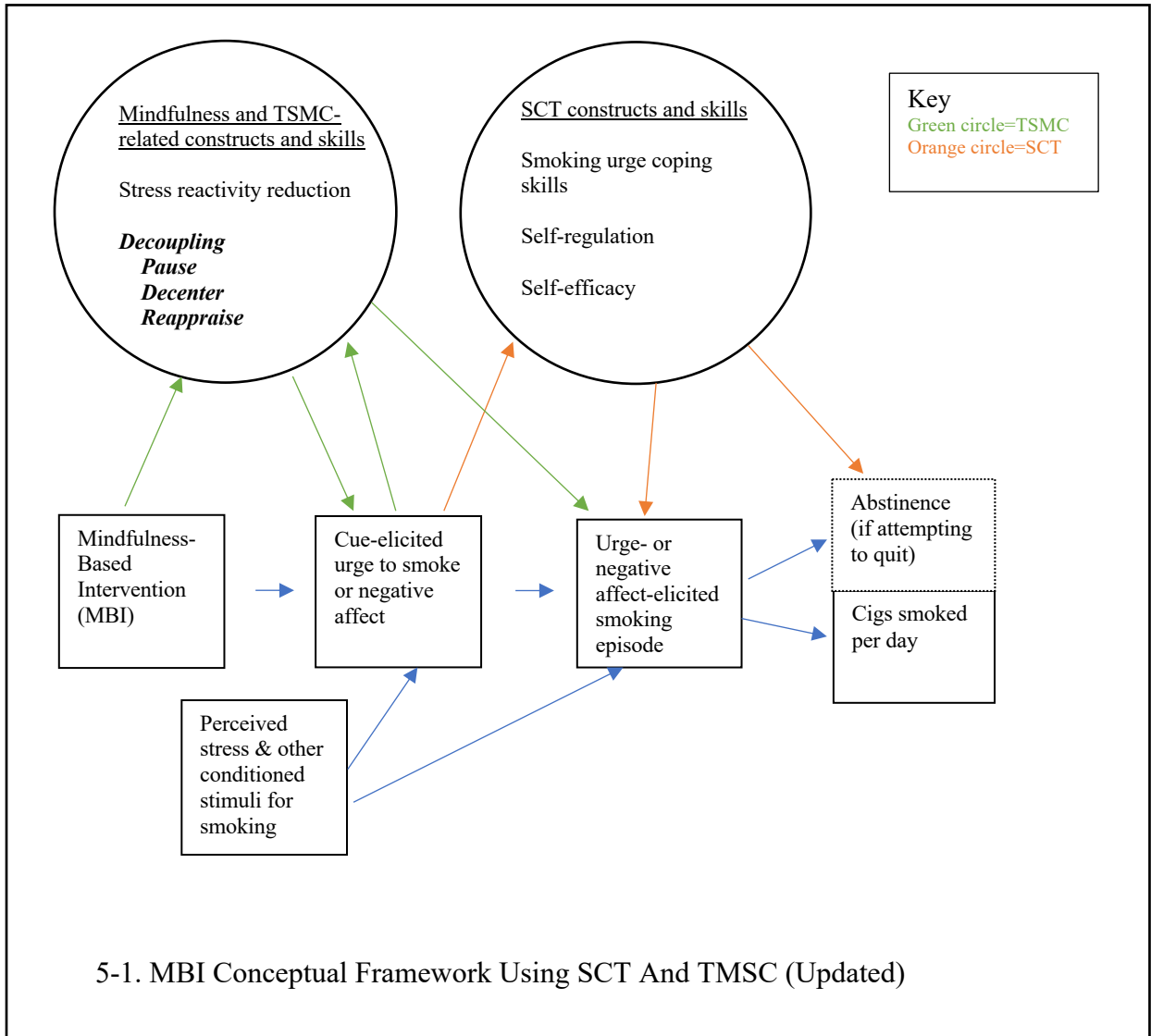
be to increase the potency of the intervention, e.g., add in quit tips, short videos, extend the length of the intervention. A future study should include additional self-report mindfulness measures but also should explore adding in physiological or biological validation to further test the mechanisms of mindfulness.

This research also impacts public health theory, as the MBI was designed with a conceptual framework that drew from social cognitive theory (SCT) and the transactional model of stress and coping (TSMC). The framework hypothesized that an MBI would increase stress and urge management skills and eventually could be used to aid in smoking cessation in a low SES population of female smokers. It was originally thought that skill building would increase smoking cessation self-efficacy as it has in previous research.¹⁷¹ However, there may not have been enough support and emphasis on smoking cessation to observe a change in smoking cessation self-efficacy. A reduction in stress level, as hypothesized through the TSMC, was not also observed in the MBI group compared to the control group.

The concept of decoupling or decentering should be added to the framework, as shown in Figure 5-1. Mindfulness decoupling in relation to smoking behavior is described as “individuals may learn to notice affective states and urges to smoke, and just allow them to arise and pass without habitually or impulsively acting on them.”²⁴² Mindfulness may aid in decoupling the relationship between a cue to smoke and smoking behavior (urge or cigarette consumption) but more research is needed to measure and assess this mechanism. It may be that when a smoker is presented with a cue to smoke (stressful event, positive or negative affect, etc.), mindfulness practice allows a person to pause, “decenter” from the event and reappraisal the situation. The transactional model of stress and coping emphasizes this reappraisal as an important step. Yet the TSMC focuses on stress and stressors triggering events. Perceived stress did not change over

time, but smoking urge and cigarette consumption decreased for the MBI group. The addictive loop often includes cues to smoke that are not just from stress, some are due to positive affect or habit.²⁴³ Mindfulness may encourage a person to “pause” and decenter from any cue event before acting out of habit.²⁴³ Mindfulness practices encourage a person towards this action through the use of present moment awareness with nonjudgmental and compassionate attitudes. A measure should be included in future research to capture emotion regulation, such as the Cognitive Emotion Regulation Questionnaire (CERQ).²⁴⁴ A new measure could be developed to capture these potentially key ingredients of mindfulness such as pausing, decentering and reappraisal specifically in scenarios related to smoking. Cue paradigm assessments post intervention could also assess the “pause and reappraise” by measuring how quickly a person smokes after being exposed to a cue, hypothesizing that those in the MBI group would take longer to smoke during an end of treatment cue exposure experiment.

As discussed in the above sections, the Covid-19 pandemic may have impacted the outcome of perceived stress. The self-regulation element of the SCT was shown to be successful with self-monitoring and incentives increasing adherence and retention rates. The TMSC could explain the reduction in smoking urge over time for the MBI group. Mindfulness practices may have helped participants to recognize a stressor, decenter (from the stressor) and then reappraise to aid in smoking urge management.¹⁷⁹ This processing could have also accounted for the reduction in cigarettes per day in the MBI group over time. The framework used to design the study was supported by the outcomes, with the exception of self-efficacy and stress reduction due to environmental factors. Efficacy for the intervention was shown by a decrease in smoking urge and cigarette consumption over time. Future research should investigate if the MBI could be used as a component of a larger smoking cessation intervention or as a standalone treatment.



Conclusion

A 4-week, tailored mindfulness intervention delivered by text messages was found acceptable, feasible, and efficacious within a population of low SES women with children. Smoking urge significantly decreased over time in the MBI group compared to control. More research is needed on mindfulness, stress, and affect in this population particularly during this unique time in history, as some of the outcomes may be impacted due to the Black Lives Matter movement and the Covid-19 pandemic. There were significant findings beyond the priming outcome of decreased smoking urge, as exploratory analysis showed a significant decrease in cigarettes per day for the MBI group compared to control. As discussed, there are many future public health implications. The research contributed to theory, as the MBI may have helped participants to recognize a stressor, decenter (from the stressor) and then reappraise to aid in smoking urge management and reduce cigarettes per day over time. Low SES mothers who smoke cigarettes have greater stressors and less success at quitting compared to the general population, and yet the research in this population is limited. Mindfulness practices should continue to be funded and studied to aid in a reduction of smoking urge and ultimately smoking cessation in a vulnerable population.

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APPENDICES

APPENDIX A

MBI TEXT MESSAGE EXAMPLES

Text Message Audio/Video Links

- Good morning! Check out this video: 3-minute mindful breathing space (relieve stress) <https://youtu.be/SEfs5TJZ6Nk> -MOMS team
- Good morning! If your kids are curious about what mom is doing when she sits and meditates watch this video with them: KIDS MEDITATION – Cooling out breath https://youtu.be/5bcZJIaO_8g -MOMS team

Text Messages, Text-only

- Be mindful of your triggers. Notice what triggers an urge to smoke. Take a pause next time you feel an urge and check-in how does your mind and body feel?
- Give yourself one minute to focus on your breath. Really notice what it feels like to breathe, right here, right now.
- Change takes time. It's a process not an immediate outcome. That's why they call it mindfulness practice. You are doing great! –MOMS team

APPENDIX B

CONTROL TEXT MESSAGE EXAMPLES

Text Message Audio/Video Links

- Good morning! Check out this video on positive communication: <https://youtu.be/mEqaNDwaKfk> -MOMS Team
- Good morning! Check out this video on child safety: <https://www.feedfond.com/child-safety/> -MOMS Team

Text Message, Text-only

- Take time to listen to your child:
 - When your child is upset, active listening can go a long way in helping your child know that you hear him and understand what he is trying to say.
 - Active listening can also be helpful in calming a situation and preventing a tantrum before it starts!
- Child safety is important! Make sure you check the batteries to your smoke detector twice a year.
- Protecting your child is important, good job!

APPENDIX C

LAB CREATED MEASURES

Attitudes and Use of Nicotine Replacement Therapy

TIMEPOINT	BSL
DESCRIPTION	Self-report of utilization of NRT, how it was acquired, how long it was used, how helpful and harmful they believe it is
REFERENCES CITED	Lab created

The following questions are **OPTIONAL**. You do not have to answer any of the questions.

If you choose to skip a question(s), it will not impact your participation in the study.

- **NRT_now.** Are you currently using nicotine replacement therapy, such as the patch or gum?
 - 1 = Yes
 - 0 = No

- **NRT_ever.** Have you ever used nicotine replacement therapy, such as the patch or gum?
 - 1 = Yes
 - 0 = No

- **NRT_how.** If yes, How did you get the product(s)?
 - 5 = Multiple sources
 - 4 = Prescription from health care provider
 - 3 = PA State Quitline
 - 2 = Friends or family
 - 1 = Self OTC

- **NRT_helpful.** Whether you've used it or not, how helpful do you believe nicotine replacement therapy (the patch, gum) would be in helping you quit smoking?
 - 4 = Very helpful
 - 3 = Somewhat helpful
 - 2 = A little helpful
 - 1 = Not at all helpful
 - 0 = Don't know

- **NRT_harmful.** How harmful do you believe nicotine replacement therapy (the patch, gum) is for your health?
 - 4 = Very harmful
 - 3 = Somewhat harmful
 - 2 = A little harmful
 - 1 = Not at all harmful
 - 0 = Don't know

E-cigarette Use and Beliefs

TIMEPOINT	BSL
DESCRIPTION	Self-report of utilization of e-cigs and beliefs about how helpful, harmful, and effective they are
REFERENCES CITED	Lab created

The next few questions are about electronic cigarettes and vaping.

- **Ecig_7days** From 0 to 7 days, how many days out of the last 7 did you smoke e-cigs or vape indoors or in a car?
 - 0 1 2 3 4 5 6 7
- **Ecig_oftn** How often do you or anyone vape inside your home or car when your children are present?
 - 1=Never, 2=Rarely, 3=Sometimes, 4=Often
- **Ecig_safe** How safe do you think e-cigarettes are?
 - 1 = Very safe
 - 2 = Somewhat safe
 - 3 = Somewhat unsafe
 - 4 = Very unsafe
 - 0 = Don't know
- **Ecig_harmu** How harmful do you believe e-cigarettes are for your health?
 - 1 = Very harmful
 - 2 = Somewhat harmful
 - 3 = A little harmful
 - 4 = Not at all harmful
 - 0 = Don't know

- **Ecig_harmch** How harmful do you believe e-cigarette vapor is to your child's health?
 - 1 = Very harmful
 - 2 = Somewhat harmful
 - 3 = A little harmful
 - 4 = Not at all harmful
 - 0 = Don't know

- **Ecig_ben** Have you heard of any benefits of e-cigarettes? (You can type "Don't know" or "No benefits" if that is still their answer after probing.)
 - We created a yes/no variable for able to name benefits or not
 - People that said "Don't know" or "No benefits" were combined and labeled 0 (Can't name benefits)

All others labeled 1 (Can name benefits) 1's were broken down into 6 categories:

- 1 = helps you quit, reduces cravings
 - 2 = less harmful to smoker (decreases cancer risk, water vapor better than smoke, live longer)
 - 3 = better flavor/taste/smell
 - 4 = miscellaneous (no 2nd hand smoke, 'better' than cigarettes, control nicotine level)
-
- **Ecig_risk** Have you heard of any risks of e-cigarettes? (You can type "Don't know" or "No risks" if that is still their answer after probing.)
 - We created a yes/no variable for able to name risks or not
 - People that said "Don't know" or "No risks" were combined and labeled 0 (Can't name benefits)
 - 1 = they explode, catch fire
 - 2 = bad for your health, toxic
 - 3 = miscellaneous risks (makes urges worse, liquid unsafe for kids - can OD, or said they've heard of risks but did not list any)

 - **Ecig_help** Whether you've used them or not, how helpful do you believe e-cigarettes would be in helping you quit smoking?
 - 1 = Very helpful
 - 2 = Somewhat helpful
 - 3 = A little helpful
 - 4 = Not at all helpful
 - 0 = Don't know

- **Ecig_home** Do you ever keep electronic nicotine devices like e-cigs or hookah sticks in your home? (IF YES: PROBE; IF NO: SELECT NOT APPLICABLE)
 - 1 = Yes
 - 0 = No

- **Ecig_storg** If there is the nicotine liquid or other e-cig and hookah products in your home, how are they stored? (Probe, keeping in mind we want to know how accessible it is to children in the home. Follow up with questions, such as "It can be difficult to keep children out of everything. Do you think your child could get it if they wanted to?" "Is that somewhere where your child can reach?" "Is that locked?")

Select all that apply:

 - Not applicable (777)
 - Children not allowed in room where it is stored (2)
 - Up high where children can't reach (3)
 - Kept somewhere locked (4)
 - No precautions/accessible (5)
 - Other: If "Other" specify: _____

History of Smart Phone and Social Website Use

TIMEPOINT	ELG, BSL
DESCRIPTION	Self-report of utilization of text messaging, mobile apps, and social media websites.
REFERENCES CITED	Lab created

Txt_freq (*ask only in ELG*) In the past week, how often did you receive text messages on your phone?

- 5 = Multiple times an hour
- 4 = Multiple times a day
- 3 = At least once a day
- 2 = At least once a week
- 1 = Never (no phone/cannot receive text messages)

App_

use In the past 3 months, how often did you use any mobile apps on your phone?

- 5 = At least once a day
- 4 = At least once a week
- 3 = At least once a month⁴
- 2 = Less than once a month
- 1 = Never use

Soweb_use In the past 3 months, how often did use social media websites like Facebook, Linked In, Pinterest, etc?

- 5 = At least once a day
- 4 = At least once a week
- 3 = At least once a month
- 2 = Less than once a month
- 1 = Never use

App_parent In the past 3 months, how often have you used mobile apps to help you with parenting?

- 5 = At least once a day
- 4 = At least once a week
- 3 = At least once a month
- 2 = Less than once a month
- 1 = Never use

App_stress In the past 3 months, how often have you used mobile apps to help you with stress management?

- 5 = At least once a day
- 4 = At least once a week
- 3 = At least once a month
- 2 = Less than once a month
- 1 = Never use

App_smkg In the past 3 months, how often have you used mobile apps to help you with cut down or quit smoking?

- 5 = At least once a day
- 4 = At least once a week
- 3 = At least once a month
- 2 = Less than once a month
- 1 = Never use

Intrnt_use How do you regularly access the internet?

- 4 = Use my home computer
- 3 = Use my mobile phone
- 2 = Other (public library)
- 1 = I don't access the internet

Marijuana Use and Beliefs

TIMEPOINT	BSL
DESCRIPTION	Self-report of marijuana use & beliefs about its harmfulness
REFERENCES CITED	Lab created

I just wanted to remind you again that all of your answers to these questions are completely confidential and we will not share them with anyone outside of the study.

MJ_7days. From 0 to 7, how many days out of the last 7 did you smoke marijuana? (Even if they say 0, proceed to next question.)

0 1 2 3 4 5 6 7

MJ_child. How often do you or anyone smoke marijuana inside your home or car when your children are present?

- 1=Never, 2=Rarely, 3=Sometimes, 4=Often

MJ_safe. How safe do you think marijuana is?

- 0. Very safe
- 1. Somewhat safe
- 2. Somewhat unsafe
- 3. Very unsafe
- 4. Don't know

MJ_harmu. How harmful do you believe marijuana is for your health?

- 0. Very harmful
- 1. Somewhat harmful
- 2. A little harmful
- 3. Not at all harmful
- 4. Don't know

MJ_harmch. How harmful do you believe marijuana smoke is to your child's health?

- 0. Very harmful
- 1. Somewhat harmful
- 2. A little harmful
- 3. Not at all harmful
- 4. Don't know

MJ_storage. If there is marijuana in your home, how is it stored? _____
(Describe location keeping in mind we want to know if it is accessible to children in the home. If unclear, follow up with question, such as “Is that a place that your children have access to?”

Select all that apply:

- Not applicable (777)
- Not specified (2)
- Up high where children can't reach (3)
- Kept somewhere locked (4)
- Purse (5)
- In car (6)

Openness to Trying Mindfulness

TIMEPOINT	EOT (<i>control group only</i>)
DESCRIPTION	Attitudes regarding any barriers and openness to trying mindfulness.
REFERENCES CITED	Lab created

Ctrl_openmindfulness - Would you be interested in trying or learning mindfulness practices?

- Yes – 1
- No – 2

Ctrl_mndfl_likely - On a scale of 1-10 (10 very likely/interested), how likely would you be to use or practice mindfulness, just for say 5 min. every day?

- 1 2 3 4 5 6 7 8 9 10

Ctrl_mndfl_stress - On a scale of 1-10 (10 being very useful), how useful could mindfulness be for managing stress?

- 1 2 3 4 5 6 7 8 9 10

Ctrl_mndfl_smkg - On a scale of 1-10 (10 being very useful), how useful could mindfulness be for managing smoking urge?

- 1 2 3 4 5 6 7 8 9 10

Ctrl_barriers_mndfl -What (if anything) might get in the way of you doing these mindful practices, even if you decided that you were interested?

- (open ended text entry)

Process Measures

TIMEPOINT	EOT
DESCRIPTION	Items used to assess participant satisfaction of study text message intervention.
REFERENCES CITED	Lab created

PM1. How often did you read/view your texts during a typical week during the program?

More than 5 times every day 1-5 times every day Once a day
 5-7 days/week 2-4 time/week Once a week Never

PM2. How much did the text messages help you manage stress?

Not at all only a little some a lot very much

PM3. How much did the text messages help you prepare to quit smoking?

Not at all only a little some a lot very much

PM4. How helpful were the tips sent by text message?

Not at all only a little some a lot very much

PM5. What would you change about the text messages?

- What did you like about the text messages? Why?
- What did you not like about the text messages? Why?
- The text messages were clear and easy to understand?
 Not at all only a little some a lot very much
- The audio clips were clear and easy to understand?
 Not at all only a little some a lot very much
- I enjoyed listening to the audio clips?
 Not at all only a little some a lot very much
- The visuals (pictures, memes) in text messages were visually appealing?
- Were the reminder texts to complete the daily diary useful?
 Not at all only a little some a lot very much
- Did you feel the text messages were unique and specifically for you?
 Not at all only a little some a lot very much
- Did the short phone calls encourage you to view and use the text messages more?
 Not at all only a little some a lot very much

APPENDIX D

ADDITIONAL BASELINE DATA

Electronic cigarettes, nicotine replacement therapy (NRT), and marijuana use and beliefs were assessed at baseline. Majority of participants (95%) reported not using an electronic cigarette device in the last 7 days. However, 63% of participants viewed electronic cigarettes as somewhat to very safe. When asked if electronic cigarettes could be a helpful tool to quit smoking, 23% of participants indicated they could be somewhat to very helpful. Approximately half (55%) of participants reported trying NRT in their lifetime with majority of those who used NRT obtaining it from a healthcare provider. When asked about the helpfulness of NRT, 30% of participants believed NRT is somewhat or very helpful. More than half (60%) of the sample used marijuana in the last 7 days and 20% of participants report sometimes or often using marijuana around their children. When asked if marijuana is safe, 35% of participants reported it is somewhat to very safe. When asked about marijuana expectancies, 78% of participants reported that marijuana is somewhat or very helpful in reducing stress, 60% of participants reported that marijuana is somewhat or very much useful for helping people get along, and 68% of participants reported that marijuana somewhat or very much helps you sleep. Below is a table reporting perceived harmfulness of electronic cigarettes, NRT and marijuana.

<i>Perceived Harmfulness of Electronic Cigarettes, NRT, and Marijuana.</i>					
Likert Scale Rating	NRT ¹ : how harmful?	E-cigs ² : how harmful?	MJ ³ : how harmful?	E-cigs ² : how harmful to kids?	MJ ³ : how harmful l to kids?
Not at all Harmful	20	50.5	7.5	65	40
A little harmful	15	22.5	22.5	15	37.5
Somewhat harmful	22.5	5	25	0	0
Very harmful	12.5	0	30	2.5	12.5
Do not know	30	22	15	17.5	10
<i>Note.</i> 1. NRT = Nicotine replacement therapy; 2. E-cigs = electronic cigarettes; 3. MJ = Marijuana					

APPENDIX E

ADDITIONAL PROCESS MEASURE DATA

<i>Process Measures: MBI Group.</i>					
Process Question	Not a lot %	A little %	Somewhat %	A lot %	Very much %
How helpful were the tips sent by text message?	0	9.1	18.2	31.8	40.9
How much did the texts help you manage stress?	4.5	22.7	13.6	36.4	22.7
How much did the texts help you prepare to quit smoking?	4.5	13.6	22.7	36.4	22.7
Were the texts clear and easy to understand?	0	4.5	0	27.3	68.2
Were the audio clips clear and easy to understand?	0	0	4.5	22.7	72.7
Did you enjoy listening to the audio clips	0	14.3	14.3	28.6	42.9
Were the visuals appealing?	0	19	14.3	33.3	33.3
Were the reminder texts (daily diary) useful?	0	15	0	30	55
Did you feel the text messages were unique for you?	0	27.3	27.3	18.2	27.3
Did the short calls encourage you to view the texts?	9.1	13.6	22.7	31.8	22.7

<i>MBI Group Process Measure: What did you like about the text messages?</i>
<i>Gave a different perspective, a different way to view your situation.</i>
<i>Inspirational.</i>
<i>Liked that texts were consistent, she felt like they always came at the perfect time when she was feeling stressed.</i>
<i>Loved videos and exercises that she could keep using. She loved one quote specifically she wrote it down and looks at it every day. She told a lot of people that the study helped her quit smoking.</i>
<i>Meditation.</i>
<i>She liked that the texts were constant reminders to take time for herself. She loved the reminders (texts and calls) to keep filling out survey. She felt encouraged and 'seen.'</i>
<i>She liked that they teach you how to be mindful, and the breathing exercises were the best part. The helped her to be more present.</i>
<i>She liked the breathing videos - she loved the STOP sign the quick reminders were very helpful. She liked the things that would reminder her to be mindful and things she could put into action in the moment - like "stop to breath."</i>
<i>She liked the reminders to take a moment to breath.</i>
<i>She liked the reminders and she looked forward to reading the messages each day.</i>
<i>She liked the videos a lot they really helped her lessen her smoking on certain days. She liked that she could save the links and go back to them. She loved the "You got this!" texts. She felt like they always brought her to the moment and made her more hopeful.</i>
<i>She liked the ones that were quick and It would make her more mindful - "take a moment to take a breath" or "notice your surroundings."</i>
<i>Texts inspired to do better and stop smoking, and liked the videos where kids could meditate too.</i>
<i>Texts were helpful. She really liked the deep breathing and meditation videos.</i>
<i>That they were random and throughout the day and they would sometimes come right when she was having a smoking urge.</i>
<i>The videos because she is a visual learner.</i>
<i>The videos were helpful and nice, and she liked tips set about kids and managing stress.</i>
<i>The visuals, like the videos and pictures.</i>
<i>There wasn't a lot of reading, they were straightforward.</i>
<i>They got her to reflect on herself and situation.</i>
<i>They were thoughtful, and she looked forward to them each day.</i>
<i>They were very motivational and served as reminders throughout the day. She liked the pictures they were a quick reminder.</i>

<i>Process Measures: Control Group.</i>					
Process Question	Not a lot %	A little %	Somewhat %	A lot %	Very much %
How helpful were the tips sent by text message?	0	6.3	12.5	31.3	50
How much did the texts help you manage stress?	18.8	18.8	43.8	18.8	0
How much did the texts help you prepare to quit smoking?	25	31.3	18.8	18.8	6.3
Were the texts clear and easy to understand?	0	0	0	37.5	62.5
Were the audio clips clear and easy to understand?	0	0	0	18.8	81.3
Did you enjoy listening to the audio clips	0	12.5	31.3	18.8	37.5
Were the visuals appealing?	0	12.5	6.3	31.3	50
Were the reminder texts (daily diary) useful?	6.7	6.7	13.3	26.7	46.7
Did you feel the text messages were unique for you?	6.3	12.5	37.5	31.3	12.5
Did the short calls encourage you to view the texts?	0	18.8	18.8	31.3	31.3

<i>Control Group Process Measure: What did you like about the text messages?</i>
<i>A lot of great parenting tips.</i>
<i>She liked that they had helpful affirmations and gave a lot of knowledge that she never knew about keeping her kids safe. She modified a lot of things in her life.</i>
<i>Clear and straightforward.</i>
<i>Helpful for any parent. Very relevant to keeping children safe. Good reminders to keep kids safe.</i>
<i>She liked the parenting tips.</i>
<i>Helpful tips to become more safety conscious.</i>
<i>She liked that they were interactive because they kept it interesting.</i>
<i>Poison control, bike helmets, fire drills smoke detector, and carbon monoxide were topics that really stuck with her. She liked the encouraging messages like the "great job!" messages. She felt really supported like she had another family supported her. She repeated at end how she loved feeling so supported by "the MOMs Team."</i>
<i>She liked that they gave you information about smoking and how it affects the kids.</i>
<i>The texts were unique/variety of topics.</i>
<i>They were user friendly links.</i>
<i>They were very informative.</i>
<i>Tips that they gave and the motivational texts.</i>
<i>Visuals and audio were engaging.</i>