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LOMA LINDA UNIVERSITY
School of Behavioral Health
in conjunction with the
Faculty of Graduate Studies

Mediators of the Relationship between Mindfulness and E-cigarette Use

by

Denise Dao Tran

A Dissertation submitted in partial satisfaction of
the requirements for the degree
Doctor of Philosophy in Psychology

June 2020

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Each person whose signature appears below certifies that this dissertation in his/her opinion is adequate, in scope and quality, as a dissertation for the degree Doctor of Philosophy.

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ABBREVIATIONS

<i>M_{age}</i>	Mean Age
SD	Standard Deviation
LED	Light Emitting Diode
APV	Advanced Personal Vaporizer
USB	Universal Serial Bus
NRT	Nicotine Replacement Therapy
CDC	Centers for Disease Control and Prevention
MBT	Mindfulness-Based Therapy
MBSR	Mindfulness-Based Stress Reduction
MBCT	Mindfulness-Based Cognitive Therapy
ACT	Acceptance and Commitment Therapy
IBMT	Integrative Body-Mind Training
DERS	Difficulties with Emotion Regulation Scale
ACC	Amino Acid of Protein Anterior Cingulate Cortex and the
mPFC	Medial Prefrontal Cortex
PFC	Prefrontal Cortex
DT	Distress Tolerance
MAAS	Mindful Attention Awareness Scale
PANAS	Positive and Negative Affect Schedule
NA	Negative Affect
DTS	Distress Tolerance Scale
PSS	Perceived Stress Scale

SPSS	Statistical Package for Social Sciences
BC CI	Bias-Corrected Confidence Interval
OR	Odds Ratio
FDA	Food and Drug Administration
USDHHS	United States Department of Health and Human Services

ABSTRACT OF THE DISSERTATION

Mediators of the Relationship between Mindfulness and E-cigarette Use

by

Denise Dao Tran

Doctor of Philosophy, Graduate Program in Clinical Psychology

Loma Linda University, June 2020

Dr. Holly E. R. Morrell, Chairperson

E-cigarettes have increased in popularity and production over the years. Although many individuals believe that e-cigarettes are safe for use, there is increasing evidence that e-cigarette use is associated with negative health consequences. Mindfulness is negatively associated with substance use including traditional cigarette smoking. Although there is limited research on the relationship between mindfulness and e-cigarette use, research on the relationship between mindfulness and traditional cigarette smoking may serve as a guide for e-cigarette use research. The objective of the present study is to test whether mindfulness is a protective factor against e-cigarette use through its effect on variables that are related to conventional cigarette smoking, such as negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress. Eight hundred sixty-seven participants were recruited via online forums and local businesses in Southern California ($M_{age} = 29.2$, $SD = 10.9$; 62.9% male). Multiple mediation analyses revealed that mindfulness was not significantly associated with either lifetime or current e-cigarette use and that negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress did not mediate this relationship. However, mindfulness was significantly associated with all of the proposed mediators. Findings suggest that e-

cigarette users and traditional cigarette smokers may be using for different reasons. Given that e-cigarette use is on the rise, particularly among middle and high school aged youth, future research should continue to prioritize prevention efforts by examining potential predictors of use.

CHAPTER ONE

INTRODUCTION

E-cigarettes

Electronic cigarettes, or e-cigarettes, are devices that deliver nicotine in a vaporized form. These battery-powered devices were first manufactured and marketed in China in 2004 (Dawkins, Turner, Roberts, & Soar, 2013; Dockrell, Morrison, Bauld, & McNeill, 2013) and were later introduced to the U.S. market in 2007. Products, including the device itself, chargers, accessories, and flavors, are typically offered through the Internet, but can also be found in smoke shops and in mall kiosks throughout the nation. Research indicates that 54.4% of companies operate exclusively online, and 70.2% use multiple social network services to advertise their products (Mackey, Miner, & Cuomo, 2015). Manufacturers frequently offer a variety of new liquid flavors ranging from fruit (i.e., watermelon, coconut), herbs/spices (i.e., cinnamon, green tea), dessert (i.e., hazelnut, vanilla), and tobacco.

Manufacturers of e-cigarettes offer a variety of designs where they can either be recharged or discarded after just one use. Product designs vary depending on the manufacturer, but most e-cigarettes contain a battery, a cartridge, an atomizer, and an airflow sensor. Cartridges, often referred to as tanks via advertisements, are available in a variety of nicotine concentrations, and are replaced after use. In addition, the cartridge contains the individual's choice of liquid, which is often called e-liquid. When the user inhales, an airflow sensor activates the battery. This causes the atomizer to heat and vaporize the liquid nicotine located inside the cartridge. This vaporized form of nicotine is then inhaled, and in some designs, a light bulb at the end of the device is lit to simulate

the end of a traditional cigarette during use. E-cigarette products can also be used to deliver marijuana and illicit substances (U.S. Department of Health and Human Services, 2016).

Over the years, e-cigarette companies have released various “generations” or modified versions of e-cigarettes. First generation e-cigarettes, or “cig-a-likes,” are similar in size and appearance to traditional cigarettes with the addition of an LED light at the end of the device that lights up during usage. Most first generation e-cigarettes are disposable, which means that users can dispose of them once the non-reusable battery discharges. However, some versions come with rechargeable batteries and replaceable cartridges. Second generation e-cigarettes are larger than their first generation counterparts and are typically designed to resemble pens or laser pointers. They are often referred to as “mid-size electronic cigarettes” and contain a battery that typically lasts longer than those featured in first generation e-cigarettes.

Third generation e-cigarettes, often referred to as “advanced personal vaporizers (APVs),” are typically more difficult to identify because they vary in design. Some may resemble a bulky smartphone or radio, while others may take on the form of a screwdriver. Third generation e-cigarettes are typically larger than first- and second-generation e-cigarettes and contain a “mod,” which is considered the power source of the device. There are two types of mods: mechanical mods and regulated mods. Mechanical mods are considered simple devices because they do not contain any electrical circuitry. Regulated mods are complex in which their design allows users to control and modify the device’s voltage, and frequently offer additional features such as reverse battery polarity protection. Lastly, fourth generation e-cigarettes are the most recent devices to enter the

market with newer, more advanced features including automatic temperature control and adjustable dual airflow slots. More recently, pod systems, which are designed to resemble flash drives or sleek pens that can be charged with a USB port, have been introduced into the e-cigarette market and quickly rose in popularity among youth. Typically, individuals can use them more discreetly than other forms of e-cigarettes, not only because of their resemblance to pens and flash drives, but also because they often do not emit smoke or clouds when users exhale.

Since their introduction to the U.S. in 2007, the marketing, production, and popularity of e-cigarettes have increased exponentially. According to the most recent data available from the U.S. Department of Health and Human Services (2016), the prevalence of past 30-day use of e-cigarettes was 5.7% among adults aged 25 years and older, 13.6% among young adults aged 18 years through 24 years, 16.0% among high school students, and 5.3% among middle school students. Reports indicate that the sales of e-cigarettes doubled from 2012 to 2013 (Giovenco, Hammond, Corey, Ambrose, & Delnevo, 2015), and by early 2014, there were 466 brands on the market, each with their own websites, advertisements, unique liquid flavors, and product designs (Zhu et al., 2014). Furthermore, the e-cigarette market in the U.S. is expected to reach \$6 billion by 2019 (Research and Markets, 2015) and to surpass the market of traditional cigarettes by 2023 (McArtle, 2014). Unsupported claims related to health benefits and smoking cessation made by various manufacturing companies have been noted. In 2011, 59 e-cigarette websites were evaluated where 95% displayed health-related claims (i.e., “The realistic experience of smoking without the serious health issues associated with tobacco cigarettes”) and 64% included smoking-cessation related claims (i.e., “Have helped 85%

of people to stop smoking;” Grana & Ling, 2014). Similarly, Klein et al. (2016) found that among 78 manufacturing and 32 retailer websites, half of them made modified risk claims and secondhand smoke-related claims that were unsupported by empirical evidence.

The debate over whether or not e-cigarettes are safe to use has also become a controversial topic. Medical providers report that there has been an increase in e-cigarette-related questions over time (Brown-Johnson et al., 2016). Among these 512 medical providers, 34% reported that their patients asked them about the specific side effects and relative harm, 27% were asked about general safety, 19% were asked about effectiveness for smoking cessation, and 18% were asked about the relative harm of e-cigarettes compared to combustible tobacco. Nearly half of the providers discussed e-cigarettes as a harm reduction alternative for their patients (48%). In terms of their overall perceptions of e-cigarettes, 47% of the providers reported a negative attitude, 33% provided neutral responses, and 20% reported positive attitudes toward e-cigarettes (Brown-Johnson et al., 2016). In another study examining the overall attitudes of medical providers toward e-cigarettes, Lazuras, Muzi, Grano, and Lucidi (2016) reported that, although there is limited empirical evidence, 60% of medical providers reported favorable beliefs toward e-cigarettes regarding their safety and effectiveness as quitting aids. These results suggest that more intensive efforts are needed to increase and improve knowledge about e-cigarettes, which may help guide health professionals as they provide more empirically supported treatment and medical advice to their patients.

It is also important to note that in addition to health professionals, the general adult population also reports favorable beliefs toward e-cigarettes. For example, 23% of

college students in a U.S. sample reported beliefs that e-cigarettes were less harmful than conventional cigarettes (Sutfin et al., 2013). Similarly, in a sample of 1, 434 adult participants with a history of both e-cigarette use and traditional cigarette use, researchers performed two sets of paired *t*-tests comparing expectancies for e-cigarettes versus traditional cigarettes and e-cigarettes versus nicotine replacement therapy (NRT). Relative to conventional cigarettes, participants believed that e-cigarettes had fewer negative health-related consequences, were less addicting, and tasted better (Harrell et al., 2015). In comparison to NRT, participants believed that e-cigarettes were associated with fewer risks, more affordable, more satisfying, and more effective at reducing cravings during abstinence from conventional cigarettes (Harrell et al., 2015). Overall, these results suggest that individuals may be misinformed about the short-term health and smoking cessation effects of e-cigarettes.

Although e-cigarettes have not been shown to be completely safe for consumption, there is evidence to suggest that e-cigarettes may be less harmful to use than traditional cigarettes. The aerosols released by e-cigarette use typically contain fewer toxic chemicals than the 7,000 chemicals found in traditional cigarettes (Patnode et al., 2015). Even so, there is increasing evidence to suggest that e-cigarette use may be associated with negative health consequences. For example, the FDA recently reported that various chemical substances and ultrafine toxic particles were identified in e-cigarette emissions, aerosols, e-liquids, and cartridges and that these substances and particles are known to be carcinogenic and can lead to cardiac as well as respiratory distress (Brandon et al., 2015; Wender et al., 2013). Formaldehyde and acetaldehyde, which are toxic chemicals, have been specifically identified in e-cigarette aerosols

(Goniewicz, Knysak, et al., 2014; Uchiyama, Ohta, Inaba, & Kunugita, 2013). Moreover, exposure to e-cigarette aerosols can lead to the release of cytokines and proinflammatory mediators, upper respiratory tract irritation, dry cough, allergic airway inflammation, changes in bronchial gene expression, and lung cancer (Polosa, 2015). It is also important to note that propylene glycol and glycerin are two of the most commonly found nicotine solvents in e-cigarettes, which are associated with respiratory irritation (Goniewicz, Knysak, et al., 2014). E-cigarette use has also been associated with negative cardiovascular effects. For example, mild e-cigarette inhalation has been associated with chest pain, high blood pressure, and tachycardia, as well as more serious cardiac-related consequences including hypotension, respiratory paralysis, atrial fibrillation, dyspnea, and bradycardia (Lippi, Favalaro, Meschi, Mattiuzzi, Borghi, Cervellin, 2014; Middlekauff, Park, Moheimani, 2014). Additionally, heavy metals including tin, nickel, and lead have been identified in e-liquids and e-cigarette aerosols, and are associated with negative effects on the nervous and respiratory systems (Uchiyama, Ohta, Inaba, & Kunugita, 2013).

The short-term effects of e-cigarette use have also recently been examined. Researchers found that five minutes of e-cigarette use may lead to immediate harmful physiological consequences including respiratory impedance and flow respiratory resistance (Vardavas et al., 2012), which are similar harmful effects observed after prolonged conventional cigarette use. Additionally, results from an international survey given in ten different languages indicate that more than half (57.9%) of e-cigarette users experienced at least one harmful health effect after using an e-cigarette, including sore or dry mouth and throat (Farsalinos et al., 2014). Furthermore, in some brands, the amount

of toxins released during use of e-cigarettes is higher than the amount released by conventional cigarettes (Williams et al., 2013), suggesting that e-cigarettes may have harmful secondhand smoke effects. However, more research is needed regarding the secondhand effects of e-cigarette use. Recent results also suggest that the form of nicotine typically available in e-cigarettes is just as addictive as the form found in traditional cigarettes (American Chemical Society, 2015). Together, all of these previous findings suggest that e-cigarettes may contain chemicals, toxins, and the form of nicotine that is typically associated with harmful health effects, some of which are similar to the effects associated with conventional cigarette use.

Many e-cigarette manufacturing companies advertise their products as safe and effective smoking cessation aids. In fact, many adults report using e-cigarettes as a means to quit traditional cigarettes (Caraballo, Shafer, Patel, Davis, & McAfee, 2016). Thus far, studies that examine the effectiveness of e-cigarettes as cessation aids have produced mixed results. Evidence from two randomized controlled trials suggests that e-cigarettes can help individuals quit smoking traditional cigarettes compared to placebos (Hartmann-Boyce et al., 2016). However, these studies have been known to include several limitations including small sample sizes, wide margins of error around their estimates, and small number of trials (CDC, 2018). In contrast, several longitudinal studies have indicated that e-cigarettes are not effective smoking cessation tools (Grana, Popova, & Ling, 2014; Adkison et al., 2013; Vickerman et al., 2013). As such, e-cigarettes are currently not approved by any regulatory organization for the purposes of smoking cessation (Loakeimidis, Vlachopoulos, & Tousoulis, 2016). A 2014 report by the World Health Organization (WHO) stated that there is insufficient evidence to market e-

cigarettes as an effective smoking cessation aid and recommended the continued use of existing cessation aids instead (WHO, 2014).

There is also increasing evidence that e-cigarette use may lead to dual use of both e-cigarettes and conventional cigarettes. For example, among a sample of South Korean adolescents aged 13 to 18 years, 8.0% reported having ever used both e-cigarettes and conventional cigarettes simultaneously, while 3.6% reported current dual use (Lee, Grana, & Glantz, 2013). In study of high school students in the U.S., 12% had reported dual use of both products (Wills et al., 2015a). Similarly, in another study with a sample of adolescents as well as young adults, 37.5% of the study's participants who reported e-cigarette use at baseline eventually began smoking conventional cigarettes as well (Primack et al., 2015). In adult samples, dual use of e-cigarettes and traditional cigarettes was reported by 8% of participants (Kalkhoran, Grana, Neilands, & Ling, 2015) and is prevalent in many states (CDC, 2010). Several epidemiological studies indicate that many adults who use e-cigarettes initially plan to use them to quit or reduce their traditional cigarette smoking, but usually use them in a dual use capacity instead (Etter & Bullen, 2011; Kralikova, Novak, West, Kmetova, & Hajek, 2013). It is also important to note that e-cigarette use rates are higher in current smokers than in nonsmokers and former smokers (Tomar, Alpert, & Connolly, 2010) and that one-third of current smokers report also using e-cigarettes (King, Patel, Nguyen, & Dube, 2015; McMillen et al., 2015). These empirical findings suggest that there may be an association between e-cigarette use and conventional cigarette smoking and raise concerns of whether nicotine use is becoming renormalized (Fairchild, Bayer, & Colgrove, 2014). Given the evidence suggesting that e-cigarette use is on the rise and that e-cigarettes may contain toxic and

carcinogenic substances, it is important to identify variables that are associated with e-cigarette use for the prevention and reduction of e-cigarette use.

Mindfulness

Mindfulness is often referred to as the awareness that results from purposefully attending to the present moment and accepting the full experience from moment to moment as it unfolds without a preference or attachment to any particular outcome (Kabat-Zinn, 2003). Mindfulness can also be conceptualized as a set of skills that are often learned with repeated practice that includes the ability to (1) attend to internal as well as external experiences (including emotions, thoughts, and physiological responses) during events as they happen, (2) label or describe the events in the present moment, (3) be fully aware of present events, and (4) nonjudgmentally accept these events (Baer et al., 2006). Generally, mindfulness is believed to enhance and promote clarity, acceptance, and objectivity in an individual's day-to-day life, which is often referred to as de-centering. Individuals who are de-centered are able to change their relationship with everyday experiences so that they are more open and less resistant to the experiences and are able to accept cognitions and emotions as transient perceptual events that do not always need to be reacted to (Baer et al., 2006).

The main tenets of mindfulness are historically rooted in Eastern traditions, including Buddhism, where "mindfulness" means "to see with discernment" (Marlatt, 2002; Ong, 2016). Mindfulness involves the implementation of a less automatic state of mind, improves awareness of internal processes, and decreases reactive patterns of behaving, processing, and thinking (Chapman et al., 2013). A central theme in many Buddhist teachings includes the notion that fixating on something always leads to

suffering. It is believed that in order to discontinue or resolve the suffering, the individual must disrupt this fixation (i.e., rumination) through mindfulness-based practices such as meditation. Although there are many ways to meditate, in the context of mindfulness, meditation is an activity that cultivates attention and awareness directed at the present moment while also promoting compassion in the form of gentleness directed toward the self and others in the form of connection and peace (Ong, 2016). It is important to note that mindfulness meditation is not just simply a relaxation strategy (Ong, 2016).

Although relaxation can be a result of mindful meditation, the intervention emphasizes being mindful of the present moment without attempting to resist or eliminate any negative experiences along the way (Ong, 2016). Furthermore, mindfulness-based meditation does not involve being in a trance-like state or clearing the mind of all thoughts. Rather, mindfulness-based meditation helps the individual be aware of and work with any present thoughts, emotions, or physiological experiences (Ong, 2016).

There are several ways to enhance mindfulness. In fact, mindfulness-based therapies (MBTs) are taught in Western societies and can be practiced by nearly anyone (Ong, 2016). Kabat-Zinn (1990) developed an eight-week program called mindfulness-based stress reduction (MBSR), which was originally designed to teach participants how to practice mindfulness in order to reduce stress due to medical-related conditions. After the success of MBSR, several other MBTs were designed in order to target more specific conditions. For example, mindfulness-based cognitive therapy (MBCT) was designed to address relapse prevention among those with a history of recurrent major depression (Segal, Williams, & Teasdale, 2002). There is a large body of literature to suggest that

both MBSR and MBCT are beneficial for improving health and have sustainable long-term effects (Kabat-Zinn, Lipworth, Burney, & Sellers, 1987; Segal et al., 2010).

There is also increasing evidence that mindfulness is a key theoretical construct for physical as well as mental health promotion and disease prevention. In fact, mindfulness may be associated with increased psychological well-being and reductions in several mental health problems including aggression, depression, anxiety, and severe reactions to physiological sensations (Ostafin et al., 2006). Similarly, a review conducted in 2009 indicated that mindfulness is associated with a wide array of benefits in a variety health-related areas including psychological, emotional, and behavioral health (Greeson, 2009). There is also a growing body of evidence to suggest that mindfulness-based meditations can also reduce cognitive biases and improve overall mental states (Hafenbrack, Kinias, & Barsade, 2014; Lueke & Gibson, 2014). Furthermore, mindfulness-based interventions appear to have positive and protective effects on several health and behavioral domains in both clinical and nonclinical youth samples (Black, Milan, & Sussman, 2009) and adults (Brown, Ryan, & Creswell, 2007; Grossman, Niemann, Schmidt, & Walach, 2004). These results suggest that mindfulness and mindfulness-based interventions may play an important role in health-related outcomes.

Mindfulness and E-cigarettes

It appears that little is known regarding the relationship between mindfulness and e-cigarette use. Results from recent studies suggest that mindfulness in students from 4th through 6th grade is associated with improvements in several areas of executive functioning, including behavioral impulse control and emotional regulation (Pentz, Riggs, & Warren, 2016), which is associated with a lower risk of having ever used an e-cigarette

(Pentz, Shin, Riggs, Unger, Collison, & Chou, 2015). These empirical findings suggest that mindfulness may be a protective factor for e-cigarette use by, for example, increasing an individual's ability to emotionally regulate, but more research is needed to test these possible associations. Given that research on mindfulness and e-cigarette use is relatively new, information regarding the effects of mindfulness on traditional cigarette smoking may be useful to consider given that e-cigarettes were designed to emulate the properties of traditional ones.

Mindfulness and Traditional Cigarettes

Several researchers have noted the benefits of mind-body practices, such as yoga and MBTs, for preventing as well as treating substance abuse and addictive behaviors (Dakwar and Levin, 2009; Kissen and Kissen-Kohn, 2009; Lohman, 1999). Theoretical papers and systematic reviews have identified multiple overlapping mechanisms that may explain how these mindfulness-based practices may prevent or decrease substance use, including tobacco use. These researchers propose that mindfulness-based interventions lead to (1) reductions in stress and the overt behavioral and neuroendocrine components related to the stress (Khanna and Greeson, 2013); (2) improvements in affect through reductions in depression and anxiety and increased psychological well-being (Carim-Todd et al., 2013); (3) enhanced state of consciousness, which may help decrease the need to turn to substance (i.e., nicotine) use during times of distress (Lohman, 1999); (4) increased self-awareness and self-regulation skills, which may lead to an increased ability to intervene and prevent maladaptive behaviors such as smoking (Chiesa and Serretti, 2014); and (5) improved self-esteem and knowledge about the relationship between an individual's internal and external experiences (Kissen and Kissen-Kohn, 2009). In

summary, extant research suggests that MBTs may be useful in the prevention or reduction of substance use, including smoking, through their effect on several psychological domains including stress, emotional dysregulation, and affect.

Mindfulness-based practices may help individuals increase their tolerance for negative affect and distress similar to treatments such as Acceptance and Commitment Therapy (ACT) that emphasize the acceptance of an individual's immediate and current experience or state. Yoga, a form of mind-body practice, incorporates strategies for relaxation and mindfulness exercises designed to decrease stress and tension and increase mind-body awareness, emotion regulation skills, and attention (Butzer et al. 2016). In fact, a common element of yoga includes mindfulness techniques that emphasize adopting a non-judgmental and non-reactive state of awareness to the here-and-now (Carim-Todd et al. 2013). These are the same mechanisms that researchers believe may explain how mindfulness may serve as a protective factor against substance use (Chiesa and Serretti 2014; Khanna and Greeson, 2013).

Several studies have specifically examined the beneficial effects of mind-body practices on cigarette smoking. For example, in a sample of 211 adolescents, participants were randomly assigned to either a 32-session yoga intervention or a control condition that consisted of regular physical education classes (Butzer, LoRusso, Shin, & Khalsa, 2017). Follow-up surveys were completed at six months and one year post-intervention. Results indicate that adolescents assigned to the control condition were more willing to initiate cigarette use after the intervention than adolescents who practiced yoga (Butzer, LoRusso, Shin, & Khalsa, 2017). These findings suggest that mind-body practices that enhance mindfulness may have important implications for the prevention of tobacco use.

State mindfulness refers to being mindful during a specific situation whereas trait mindfulness is often referred to as a dispositional form of mindfulness where an individual is able to display mindful behavior across time and contexts (Brown & Ryan, 2003). Research suggests that frequent practice of engaging in a state of mindfulness may help an individual develop trait mindfulness over time (Carmody & Baer, 2008). Recent studies have highlighted the potentially beneficial effects of trait mindfulness on the reduction of cigarette smoking prevalence rates through its effects on affect and stress. Among a youth sample, greater levels of trait mindfulness were negatively associated with cigarette smoking through the effects of decreased negative affect and perceived stress (Black et al., 2012a). Black et al. (2012b) also found that adolescents who reported more intentions to smoke cigarettes were more likely to actually initiate smoking if they also reported low levels of trait mindfulness compared to adolescents who reported high levels of trait mindfulness. These findings suggest that mindfulness-based interventions or greater levels of dispositional mindfulness may be useful in the prevention as well as reduction of tobacco use.

Studies examining the effects of mindfulness on cigarette smoking and smoking outcomes have also been conducted with adult samples. Davis et al. (2007) found that 10 out of 18 participants were able to maintain six weeks of smoking abstinence after receiving mindfulness training. In another study, college-aged smokers reported smoking significantly fewer cigarettes after receiving mindfulness training on non-judgmental acceptance of thoughts, cravings, and sensations without attempting to change them compared to students who did not receive the training even though there were no group differences on measures of cravings (Bowen & Marlatt, 2009). Similarly, in a 2011 study,

participants who received mindfulness training reported significantly greater decreases in the number of cigarettes smoked and were able to maintain this reduction in frequency 17 weeks later compared to participants who received standard smoking cessation treatment (Brewer et al., 2011). These findings highlight the benefits of mindfulness and suggest that mindfulness not only reduces the frequency of traditional cigarettes smoked but may also help individuals abstain from smoking traditional cigarettes altogether.

Given that mindfulness and mindfulness-based practices appear to help reduce or prevent traditional cigarette use, it is possible that mindfulness may have similar effects on e-cigarette use. If results indicate that mindfulness may potentially reduce and/or prevent e-cigarette use, it may be important for prevention and intervention programs to include mindfulness-based practices and to provide psychoeducation on the potential benefits of mindfulness skill building techniques. In fact, previous research suggests that trait mindfulness is typically higher among individuals who regularly practice mindfulness strategies (Brown & Ryan, 2003). However, it is also possible that e-cigarette users present differently than traditional cigarette smokers and that mindfulness has different effects on e-cigarette use. Therefore, evidence that mindfulness may have similar, mitigating effects for e-cigarette users is needed before implementing mindfulness-based components into prevention and cessation programs. Although there is very little research on the relationship between mindfulness and e-cigarette use, there are several studies that highlight the effect of mindfulness on traditional cigarettes and the variables that may explain this relationship, which include negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress. It may be particularly

helpful to examine these variables and explore whether or not they have similar effects on mindfulness and e-cigarette use.

Negative Affect and Mindfulness

Several researchers have noted the benefits of mind-body practices, such as yoga and MBTs, for preventing as well as treating substance abuse and addictive behaviors (Dakwar and Levin, 2009; Kissen and Kissen-Kohn, 2009; Lohman, 1999). Theoretical papers and systematic reviews have identified multiple overlapping mechanisms that may explain how these mindfulness-based practices may prevent or decrease substance use, including tobacco use. These researchers propose that mindfulness-based interventions lead to (1) reductions in stress and the overt behavioral and neuroendocrine components related to the stress (Khanna and Greeson, 2013); (2) improvements in affect through reductions in depression and anxiety and increased psychological well-being (Carim-Todd et al., 2013); (3) enhanced state of consciousness, which may help decrease the need to turn to substance (i.e., nicotine) use during times of distress (Lohman, 1999); (4) increased self-awareness and self-regulation skills, which may lead to an increased ability to intervene and prevent maladaptive behaviors such as smoking (Chiesa and Serretti, 2014); and (5) improved self-esteem and knowledge about the relationship between an individual's internal and external experiences (Kissen and Kissen-Kohn, 2009). In summary, extant research suggests that MBTs may be useful in the prevention or reduction of substance use, including smoking, through their effect on several psychological domains including stress, emotional dysregulation, and affect.

Negative Affect and Traditional Cigarette Use

Negative affective states appear to also have a significant relationship with substance use, including traditional cigarette use. According to the Affective Model of Drug Motivation, substance use is often the result of an individual's attempt to avoid or decrease negative affect, who has over time adopted the belief that substance use will indeed alleviate the negative affect (Baker et al., 2004). In support of this possible explanation, smoking rates appear to remain high in those who attempt to regulate their negative affective states (Cohen, McCarthy, Brown, & Myers, 2002). Previous studies indicate that smokers report that their smoking behaviors can be attributed to a strong desire to relieve anxiety (Schneider & Houston, 1970) and that they smoke more during and after distressing and anxiety-provoking situations (Rose, Ananda, & Jarvik, 1983). In fact, smokers frequently report that (1) smoking will help them cope with negative emotions; (2) smoking is primarily done in order to decrease feelings of negative affect; and (3) smoking is often triggered by events that evoke negative affect (Brandon & Baker, 1991; Piper et al., 2004)

Generally, smokers report significantly higher levels of negative affect than nonsmokers (Kassel, Stroud, & Paronis, 2003). In addition, negative affect is one of the strongest predictors of smoking relapse (Kenford et al., 2002). Smokers who typically smoke to reduce their negative affect are at increased risk for smoking relapse compared to smokers who typically do not smoke in response to their affectivity (Shiffman et al., 2007). Empirical work also suggests that an individual's success at smoking abstinence may depend on a smoker's ability to regulate and tolerate negative affect (Abrantes et al., 2008; Brown et al., 2008).

There is also evidence to suggest that mindfulness is negatively associated with cigarette smoking via reductions in negative affect. Black, Milam, Sussman, and Johnson (2012a) collected cross-sectional as well as longitudinal data that indicate that mindfulness may indirectly reduce smoking behaviors in adolescents by reducing feelings of negative affect. Therefore, it is possible that negative affect may play an important role in the initiation and frequency of e-cigarette use as well, particularly if individuals believe that e-cigarettes are a safer alternative to traditional cigarettes that may also help with reducing negative affect. Understanding the potentially beneficial role that mindfulness may play in regards to negative affect and e-cigarettes use may be important for the prevention and intervention of e-cigarette use.

Difficulties with Emotion Regulation

Although the mechanisms by which mindfulness promotes physical and mental well-being are not yet completely understood, previous research indicates that mindfulness enhances cognitive control (Tang et al., 2012), which is a construct closely related to emotion regulation (Teper & Inzlicht, 2013). Emotion regulation is characterized as the process by which individuals influence or control which emotions they experience during an event or situation, when they occur, and how they ultimately internally experience and outwardly express these emotions (Gross, 2014). On the other hand, emotional dysregulation is characterized as an impulsive form of emotional self-regulation (Wills et al., 2006, 2015b). Gratz and Roemer (2004) conceptualize difficulties with emotion regulation as involving struggles in six specific domains: (1) the level of clarity the individual has about his or her current emotional state; (2) the ability to attend

to and acknowledge the individual's emotions; (3) the ability to exert behavioral control when experiencing negative or unpleasant emotions; (4) the ability to experience these negative or uncomfortable emotional states without exhibiting intense secondary emotional responses; (5) the ability to engage in goal-directed behaviors during negative emotional states; and (6) access to effective coping strategies for emotion regulation during negative emotional states.

Previous studies suggest that emotion regulation is an important skill that facilitates normal and healthy emotional development (Saarni, 1999) and that difficulties with emotion regulation are associated with negative outcomes in several domains, including physical and mental health as well as social, academic, and cognitive functioning (Sroufe, 2005). Moreover, emotion dysregulation is often referred to as a transdiagnostic process that underlies many features of psychopathology (Bradley, 2003; Kring & Sloan, 2010). In fact, adaptive emotion regulation appears to help individuals maintain control over their affective states particularly during negative experiences, whereas emotion dysregulation may lengthen the negative emotional experience and lead to psychopathology over time (Aldao et al., 2009; Gross, 1999). Dvorak et al. (2015) found a significant association between alcohol use and mood instability in a sample of college students. Likewise, Wills et al. (2006) reported that emotion dysregulation and problematic substance use are significantly and positively associated among adolescents. Furthermore, children who struggle with obtaining adaptive emotion regulation skills are at increased risk for internalizing and externalizing behavioral problems (Kring & Sloan, 2010).

Emotion Regulation and Mindfulness

There is evidence that mindfulness may play a key role in increasing an individual's ability to self-regulate his or her affective states. After controlling for symptoms of depression, anxiety, and stress, Erisman, Salter-Pednault, and Roemer (in preparation) found that self-reported level of mindfulness was negatively and significantly associated with scores on the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004), which is a measure of emotion regulation skills. In another study, similar results were reported where self-reported mindfulness and use of adaptive emotion regulation strategies were positively and significantly correlated (Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007). In another study, trait mindfulness and difficulties with emotion regulation were negatively correlated and these difficulties predicted 46% of the variance in mindfulness (Goodall, Trejnowska, & Darling, 2012).

Previous research suggests that mindfulness-based interventions appear to increase adaptive emotion regulatory skills at both the cognitive level (Jermann et al., 2009) and neural level (Goldin & Gross, 2010; Modinos, Ormel, & Aleman, 2010). For example, several studies suggest that mindfulness is positively associated with adaptive emotional regulation strategies that include emotional acceptance, awareness, and rejection of negative thoughts (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Brown & Ryan, 2003; Frewen, Evans, Maraj, Dozois, & Partridge, 2008), and negatively associated with maladaptive forms of emotion regulation, such as passivity, impulsivity, thought suppression, and rumination (Baer et al., 2006; Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007; McKee, Zvolensky, Solomon, Bernstein, & Leen-Feldner,

2007). On a more neurological level, the practice of mindfulness meditation is associated with improvements in emotion regulation evidenced by neuroimaging methods (Tang & Posner, 2014) of the anterior cingulate cortex (ACC) and the medial prefrontal cortex (mPFC), which are both areas associated with cognitive control and emotion regulation (Bush et al., 2000; Posner, Rothbart, Sheese, & Tang, 2007; Rudebeck et al., 2008). Together, these findings suggest that mindfulness may be utilized in interventions designed for increasing adaptive emotion regulation skills.

Several researchers have also examined the specific mechanisms by which mindfulness increases emotion regulation skills. Findings suggest that the nonjudgmental acceptance and moment-to-moment awareness heightened by mindfulness are imperative in promoting emotional self-control because they enhance sensitivity to affective cues and improve response to early affective cues that signal the individual to exert control and regulate the emerging emotions (Teper, Segal, & Inzlicht, 2013). In addition, emotion regulation does not always occur purposefully and consciously, but can also operate on more implicit and unconscious levels. These more implicit processes may help individuals decide whether or not it is the time to practice emotion regulation, select effective emotion regulation strategies based on the current context, and then enact these strategies (Koole, Webb, & Sheeran, 2015; Tang et al., 2015).

Emotion Regulation and Traditional Cigarette Use

Given that negative affective states and traditional cigarette use are related (Abrantes et al., 2008; Brown et al., 2008; Kassel, Stroud, & Paronis, 2003; Shiffman, et al., 2007; Windle & Windle, 2001), there is also evidence to suggest that emotion

regulation and substance use, particularly smoking, are also related. Several preliminary studies have found that emotional dysregulation significantly increases an adolescent's risk for substance use (Kassel et al., 2000; Simons, Carey, & Gaher, 2004). In two studies examining the effect of emotional dysregulation on smoking behavior among regular smokers, more engagement in a maladaptive form of emotion regulation (i.e., experiential avoidance) during stressful experiences was associated with higher levels of smoking (Pirkle & Richter, 2006) and increased risk for early relapse during quit attempts (Gifford et al., 2004). Likewise, difficulties with emotion regulation are associated with recent smoking behavior (Adams, Tull, & Gratz, 2012; Johnson, Farris, Schmidt, & Zvolensky, 2012). These findings indicate that difficulties with emotion regulation may influence initiation and exacerbation of smoking behaviors.

Previous studies may help provide some explanation for the mechanisms by which difficulties with emotion regulation affect smoking behaviors. Some studies suggest that initial failures to emotionally regulate may lead to impulsive smoking behaviors, which then lead to additional aversive emotional states (Baumeister and Heatherton, 1996; Bechara, 2005). Over time, this repeated failure to adaptively self-regulate results in recurring compulsive smoking, particularly during times where aversive emotional states are experienced (Baumeister and Heatherton, 1996; Bechara, 2005). Researchers also theorize that an inability to detect, understand, assess, differentiate, and regulate negative emotional states would then further heighten or lead to additional negative emotional states (Paulus, Bakhshaie et al., 2016). Consequently, the resulting emotional dysregulation may lead to the use of smoking as a way to regulate the aversive emotional state (Leventhal & Zvolensky, 2015). In addition, evidence from

several neuroimaging studies suggests that individuals with nicotine dependence exhibit abnormal brain functions in several areas of the prefrontal cortex (PFC; i.e., both dorsal and ventral lateral PFC and dorsal medial PFC) and basal ganglia (Galvan et al., 2011; Goldstein and Volkow, 2011; Sutherland et al., 2012), which are neural regions involved in emotion regulation (McRae et al., 2010; Mocaiber et al., 2011; Moratti et al., 2011).

ACT is an example of a type of intervention that utilizes strategies such as mindfulness and acceptance to decrease maladaptive forms of emotion regulation, including experiential avoidance, and increase cognitive flexibility. In a study comparing the effects of adaptive versus maladaptive forms of emotion regulation on smoking behaviors among daily cigarette smokers, researchers found that participants who were taught how to engage in more adaptive, ACT-based forms of emotion regulation strategies reported a reduction in their smoking frequency and cravings compared to participants who engaged in emotional suppression, which is considered to be a maladaptive form of emotion regulation (Beadman, Das, Freeman, Scragg, West, & Kamboj, 2015). Given that difficulties with emotion regulation may increase smoking behaviors or deter efforts to decrease smoking frequency, it may be possible that difficulties with emotion regulation may have similar effects on e-cigarette use. It may be useful to examine the effect of emotion dysregulation on e-cigarette use and whether or not mindfulness may have an inverse relationship with e-cigarette use through the effect of decreased difficulty with emotion regulation.

Distress Tolerance

Distress tolerance (DT) may also play a key role in smoking behaviors. Distress tolerance is conceptualized as the ability to endure negative or aversive emotional states (Simons & Gaher, 2005). It can also be defined as the ability to engage in goal-directed behavior while withstanding the experience of psychological and emotional distress (Daughters et al., 2008). Distress tolerance is also considered a meta-emotion that involves subjective evaluation of negative stimuli while relating this evaluation to four distinct components: (1) tolerability of aversive emotional experiences; (2) appraisal; (3) level of attention dedicated to the negative stimuli or experience; and (4) emotion regulation (Simons & Gaher, 2005). Previous research suggests that distress tolerance is positively associated with measures of positive affect and negatively associated with measures of emotion dysregulation (Simons & Gaher, 2005).

Distress tolerance may play a key role in negative outcomes in several areas of functioning, including psychopathology and maladaptive behaviors (Kashdan et al., 2006; Leyro et al., 2010). For instance, low levels of DT may be associated with both internalizing and externalizing behaviors in adolescents (Cummings et al., 2013; Daughters, Gorka, Magidson, MacPherson, & Seitz-Brown, 2013). Furthermore, measures of distress tolerance have demonstrated significant associations with problematic substance use, including alcohol (Simons & Gaher, 2005), marijuana (Buckner, Keough, & Schmidt, 2007), and cocaine (O'Cleirigh, Ironson, & Smits, 2007).

Distress Tolerance and Mindfulness

Given that low levels of distress tolerance appear to be associated with negative outcomes, studies have been conducted on factors that may increase an individual's ability to withstand unpleasant stimuli and sensations, such as studies on the effects of mindfulness. For example, several studies have specifically examined the association between individual differences in mindfulness and persistence with challenging laboratory tasks. In a study with both clinically-anxious and non-anxious adults, greater levels of mindful awareness and attention predicted persistence with the difficult laboratory task that all participants were instructed to complete (Arch & Craske, 2010). Likewise, persistence in a challenging activity involving anagrams was predicted by level of mindfulness among a sample of college students (Evans, Baer, & Segerstrom, 2009). Similarly, during a computer task, researchers found that higher levels of trait mindfulness were associated with behavioral persistence in the presence of performance-related distress (Feldman, Dunn, Stemke, Bell, & Greeson, 2014).

Other studies have specifically examined the relation between mindfulness and measures of distress tolerance where the data suggest that mindfulness can improve distress tolerance. Among participants with borderline personality disorder, those who engaged in eight minutes of a mindful self-focusing activity experienced significant increases in persistence on a behavioral distress tolerance activity compared to participants who engaged in a ruminative self-focusing task (Sauer & Baer, 2012). In another study, participants who were randomly assigned to 15 minutes of mindfulness training reported significantly lower levels of distress after placing their hands into iced water than participants who only listened to gentle music (Liu, Wang, Chang, Chen, &

Si, 2013). Moreover, in a group of smokers, mindfulness accounted for one-third of the variance in distress tolerance, and higher levels of mindfulness skills (i.e., being aware of the present and nonjudgmentally accepting the current experience) was significantly associated with higher levels of distress tolerance (Luberto, McLeish, Robertson, Avallone, Kraemer, & Jeffries, 2014). Together, these findings suggest that mindfulness may play a major role in increasing distress tolerance in both clinical and non-clinical populations.

Distress Tolerance and Traditional Cigarette Use

More research is suggesting that distress tolerance plays a key role in traditional cigarette smoking. For example, extant studies suggest that distress tolerance is associated with smoking cessation outcomes. Individuals with an inability to withstand negative affective states tend to exhibit poorer smoking outcomes, including smoking relapse and early attrition from smoking cessation programs, than those who are more able to tolerate negative emotional states (Brandon et al., 2004; Brown et al., 2002; Daughters et al., 2005; MacPherson, Stipelman, Duplinsky, Brown, & Lejuez, 2008). In another study, smokers who were never able to abstain from smoking for more than 24 hours reported significantly lower levels of distress tolerance during a task than smokers who reported being able to previously abstain from smoking for at least three months (Brown, Lejuez, Kahler, & Strong, 2002). Also, in a prospective study examining the relationship between distress tolerance and time to relapse from smoking abstinence, more persistence on distressing tasks was associated with a greater number of hours before smoking relapsed occurred (Cameron, Reed, & Ninnemann, 2013).

In addition to affecting smoking cessation outcomes, distress tolerance also appears to affect smoking behaviors in general. For example, lower levels of distress tolerance are significantly associated with higher levels of nicotine dependency and a greater number of years as a regular smoker (Brandon et al., 2003; Leyro, Bernstein, Vujanovic, McLeish, & Zvolensky, 2011). Also, adolescents with low levels of distress tolerance may be at increased risk for either smoking initiation or increased smoking frequency for those who have already initiated smoking, and researchers suggest that it may be helpful to assess for distress tolerance for the purposes of predicting smoking intentions and risk for smoking initiation (Shadur, Ninnemann, Lim, Lejuez, & MacPherson, 2017).

Several studies may shed light on the mechanisms by which distress tolerance affects cigarette smoking frequency and cessation. Individuals with an inability to tolerate unpleasant affective states tend to perceive the experience of negative affect as intense, intolerable, and aversive and may engage in maladaptive behaviors (i.e., substance use) to manage or avoid these unpleasant internal experiences (Simons & Gaher, 2005). Thus, individuals with low distress tolerance may be at particular risk for behaviors that they perceive as a means to reduce negative affect. Cigarette smoking is an example of a behavior that is often thought to reduce negative affect (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004; Kassel, Stroud, & Paronis, 2003; Perkins & Karelitz, 2015). Given that mindfulness-based practices appear to increase distress tolerance (Liu, Wang, Chang, Chen and Si, 2013; Sauer and Baer, 2012) and decrease negative affect (Ding et al., 2014; Holzel et al., 2011; Robins et al., 2012), it is possible that engaging in mindfulness rather than cigarette smoking may have the same, if not more beneficial,

effects so that individuals do not have to resort to smoking as a means to cope with negative mood states.

Mindfulness interventions appear to enhance distress tolerance, and preliminary data suggest that increasing distress tolerance using mindfulness-based techniques may be an effective approach to reducing smoking initiation or frequency (Abrantes et al., 2008; Bowen & Marlatt, 2009). For example, previous research indicates that mindfulness accounts for a significant amount of variance in distress tolerance, and smokers who are able to practice mindfulness techniques (i.e., attend to the present moment, accept the event nonjudgmentally) during unpleasant experiences may be more likely to withstand such events without having to resort to smoking in an attempt to alleviate the distress that resulted from the experience (Luberto, McLeish, Robertson, Avallone, Kraemer, & Jeffries, 2014). Instead of smoking, mindfulness is thought to increase an individual's ability to endure aversive affective experiences without attempting to reduce the discomfort through the use of substances (Eifert & Heffner, 2003). These findings all suggest that mindfulness may help decrease smoking behaviors, particularly smoking behaviors triggered by low levels of distress tolerance. Given that traditional cigarette use is related to both mindfulness and distress tolerance, it is possible that mindfulness and distress tolerance may also be related to e-cigarette use as well. Individuals with low levels of distress tolerance who believe that e-cigarettes are a safer alternative to traditional cigarettes may turn to e-cigarette use as a means to escape or reduce their aversive mood state, whereas mindfulness may be a useful preventative strategy for these individuals to increase their level of distress tolerance. However, research is needed to test these possibilities.

Perceived Stress

Stress is often referred to as a negative cognitive and emotional state that results from an individual's perceived difficulty with managing life events (Taylor, 2006) or when the demands of the current context exceed the individual's available resources (Lazarus, 1993). The experience of stress itself is considered subjective as its manifestation differs from individual to individual, with the types of appraisals made and physiological differences all contributing to each individual's unique experience of stress (Taylor, 2006). Previous findings suggest that in general, adults have the ability to utilize both internal and external resources to cope with new and emerging stressors, which over time will ultimately reduce perceived stress (O'Connor et al., 2011). However, those who experience chronic elevated levels of stress are at increased risk for negative life and health outcomes, including cardiovascular disease (Goble & Le Grande, 2008), accelerated aging (Simon et al., 2006), and unhealthy eating and obesity (Dallman et al., 2003). Moreover, researchers found that a one standard deviation increase in reported level of perceived stress was associated with a 19% increase in risk for mortality in a sample of Taiwanese adults aged 53 years and above (Vasunilashorn, Gleib, Weinstein, & Goldman, 2013).

Perceived Stress and Mindfulness

The literature suggests that an individual's level of perceived stress is associated with smoking behaviors, and that mindfulness-based practices may reduce the perceived stress. For example, several researchers found that individuals who participate in MBSR are more likely to endorse significant reductions in reported level of stress in both clinical

(Carmody, Crawford, & Churchill, 2006; Galantino, Baime, Maguire, Szapary, & Farrar, 2005) and nonclinical populations (Chang et al., 2004). Furthermore, in healthy, nonclinical populations, participation in MBSR has been associated with more adaptive responding during times of stress (Davidson et al., 2003) and reduced anxiety (Shapiro, Schwartz, & Bonner, 1998). In addition to practicing mindfulness-based strategies, there is also evidence that trait mindfulness is associated with lower levels of perceived stress in both adolescent (Black et al., 2012a) and adult samples (Brown & Ryan, 2003).

Perceived Stress and Traditional Cigarette Use

There are also several studies that have examined the relationship between perceived stress and smoking behaviors in both adolescent and adult samples. For example, in a sample of adolescent smokers attending a primary care clinic, 72% reported stress reduction as their primary reason for transitioning from experimental smoking to regular smoking, and perceived stress was lowest in participants who had never smoked or were only experimentally smoking (Siqueira et al., 2000). These findings suggest that there is a dose-response relationship between perceived stress and smoking frequency. Likewise, in a sample of 6,410 Australian adolescents, reported level of stress was associated with both current smoking status and smoking initiation (Byrne et al., 1995). In adult samples, perceived stress has been associated with significantly increased odds for smoking (Gallo et al., 2014; Webb & Carey, 2008), and traditional cigarettes were used to relieve stress and contributed to persistent smoking (Slopen et al., 2013). Perceived stress has also been implicated in smoking cessation outcomes. Higher levels of perceived stress are associated with lower odds of cessation success (al'Absi et al.,

2005) and lower levels of confidence to abstain from smoking (Ng & Jeffery, 2003). Overall, these findings suggest that greater perceived stress is associated with more smoking behaviors.

Mindfulness may be a protective factor that can play a key role in smoking prevention by its mitigating effect on perceptions of stress. For example, findings suggest that trait mindfulness has significant inverse associations with stress and negative affect and positive associations with emotional well-being and regulation (Brown & Ryan, 2003). Results from another study indicate that perceived stress significantly mediates the relationship between trait mindfulness and past 30-day smoking frequency (Black, Milam, Sussman, & Johnson, 2012a). More specifically, trait mindfulness had a significant indirect and negative association on past 30-day smoking frequency through the effect of decreased perceived stress, and these effects continued to remain significant during a 13-month follow-up session (Black, Milam, Sussman, & Johnson, 2012a). These findings suggest that although perceived stress may be associated with increased smoking behaviors, mindfulness may reduce or prevent smoking by reducing perceptions of stress. Individuals with high levels of perceived stress who believe that e-cigarettes are a safer alternative to traditional cigarettes may be at risk for e-cigarette use to reduce their perceived level of stress. Increasing mindfulness may be a useful preventative strategy for potential at-risk individuals. However, research is needed to test these possible relationships.

Aims of Current Study

The overarching goals of the current study are to (1) determine whether trait mindfulness is significantly associated with e-cigarette use after controlling for the effects of covariates, and (2) determine whether negative affect, difficulties with emotion regulation, distress tolerance, and perceptions of stress are significant mediators of the relationship between trait mindfulness and e-cigarette use. Previous studies indicate that positive e-cigarette expectancies (Doran & Brikmanis, 2016) and experience with traditional cigarette smoking (Chivers, Hand, Priest, & Higgins, 2016) predicted e-cigarette use. Therefore, possible covariates will include perceptions of benefits associated with e-cigarette use and previous smoking experience with traditional cigarettes. We hypothesize that as the level of trait mindfulness increases, the level of e-cigarette use will decrease after controlling for the effects of covariates. We also hypothesize that as the level of trait mindfulness increases, e-cigarette use will decrease via the effects of decreased negative affect, emotion dysregulation, and perceived stress, and increased distress tolerance.

CHAPTER TWO

METHODS

Participants

Eight hundred sixty-seven respondents were recruited via online forums, social media sites (i.e., Facebook, Yelp), and local businesses in Southern California. Participants were between the ages of 18 and 78 years ($M = 29.2$, $SD = 10.9$). Thirty-two percent identified as female, 62.9% identified as male, and the remaining participants did not disclose their sex. The majority of the sample identified as Caucasian (71.7%), followed by Asian (12.7%), Latino (6.3%), Other (5.3%), Black/African American (1.2%), American Indian/Alaska Native (1.0%), and Hawaiian/Pacific Islander (0.2%). Participants included both individuals with a history of e-cigarette use (59.40%) and those without. Participants who reported being under the age of 18 years were excluded from the current study, and therefore the final sample consisted of 837 participants. Complete demographic information is presented in Table 1.

Table 1. Demographic Information and Measured Characteristics of Sample.

Characteristic	<i>N</i> (%)	<i>M</i> (<i>SD</i>)
Age		29.20 (10.87)
Sex		
Female	274 (32.70%)	
Male	465 (55.60%)	
Race		
American Indian/Alaska Native	8 (1.00%)	
Asian/Asian American	106 (12.70%)	
Black/African American	10 (1.20%)	
Latino	52 (6.33%)	
Native Hawaiian/Pacific Islander	2 (.20%)	
White	600 (71.70%)	
Other	44 (5.30%)	
Ethnicity		
Hispanic or Latino	50 (6.00%)	
Not Hispanic or Latino	689 (82.30%)	
Previous Cigarette Smoking Experience	593 (70.8%)	
Perceptions of Benefits of E-cigarette Use		22.98 (5.83)
Trait Mindfulness		3.96 (.86)
Negative Affect		20.41 (8.33)
Difficulties with Emotion Regulation		40.23 (12.79)
Distress Tolerance		3.43 (.92)
Perceived Stress		23.32 (6.45)
Lifetime E-cigarette Use	497 (59.40%)	
Current E-cigarette Use	357 (42.70%)	

Procedure

Study participants were recruited from online forums (i.e., Reddit, Facebook, Yelp, Craigslist) and advertisements distributed throughout the Southern California region (i.e., local businesses such as drycleaning businesses and mechanic shops). Advertisements included information about the study and a link to the online survey. During the recruitment and informed consent process, participants were instructed to visit the online page where a 10 to 15 minutes survey will be provided. Prior to taking the online survey, participants were required to provide written informed consent for their participation in the study. Details regarding the study's purpose, procedures, risks and benefits of participation, and confidentiality assurances were provided. Items from the survey addressed multiple topics including demographic information, intentions to use e-cigarettes, perceptions of e-cigarettes, negative affect, and distress tolerance. Participants were entered into a raffle for the chance to win Amazon gift cards of various amounts (i.e., \$5.00, \$10.00, \$45.00). This study was approved by the Loma Linda University Institutional Review Board.

Materials

Demographic information

Participants were asked to indicate their age, sex, highest level of education attained, and ethnic/racial group. See appendix for a list of all survey items.

Trait Mindfulness

Trait mindfulness was measured using the Mindful Attention Awareness Scale, trait version (MAAS; Brown & Ryan, 2003), which is a 15-item scale with response options ranging from 1 (*almost always*) to 6 (*almost never*). Items include “I rush through activities without being really attentive to them” and “I do jobs or tasks automatically without being aware of what I’m doing.” An average score of the 15 items was computed, with a higher score indicating higher levels of trait mindfulness. The MAAS has demonstrated good to excellent psychometric properties with internal consistencies ranging from .80 to .90 (Brown & Ryan, 2003; Carlson & Brown, 2005). For the current study, this scale has a Cronbach’s alpha of .88.

Negative Affect

Negative affect was measured using the ten items that comprise the Negative Affect subscale of the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegan, 1988). Previous research indicates that the Negative Affect subscale is a reliable and valid standalone measure of negative affect (Watson, Clark, & Tellegan, 1988). Each item is rated on a five-point Likert scale (1 = *Very slightly or not at all* to 5 = *Extremely*), where participants were instructed to indicate to what extent they have felt a variety of feelings and emotions (i.e., distressed, upset, scared) during the past week. Responses on all ten items were summed, with higher scores indicating higher levels of negative affect. The PANAS-NA has demonstrated strong psychometric properties ($\alpha = .90$, Leyro, Bernstein, Vujanovic, McLeish, & Zvolensky, 2011). For the current study, this scale also demonstrated excellent reliability ($\alpha = .90$).

Difficulties with Emotion Regulation

The Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) contains 36 items and was designed to measure emotional dysregulation. However, in order to limit response burden, the DERS-18 (Victor & Klonsky, 2016), which was adapted from the original DERS but with 18 items, was used to measure emotional dysregulation. The DERS-18 has been validated among five different samples that vary in sample type (i.e., college samples, community adult samples, clinical and nonclinical samples) and age (Victor & Klonsky, 2016). The DERS contains six subscales: (1) nonacceptance of emotional responses (NONACCEPTANCE); (2) difficulties engaging in goal-directed behavior (GOALS); (3) impulsive control difficulties (IMPULSE); (4) lack of emotional awareness (AWARENESS); (5) limited access to emotion regulation strategies (STRATEGIES); and (6) lack of emotional clarity (CLARITY). The DERS-18 contains the strongest items with the highest factor loadings from each of these six subscales (Victor & Klonsky, 2016). Items are rated on a five-point Likert scale (1 = *Almost never* to 5 = *Almost always*). Scores were summed, with higher total scores corresponding to greater difficulties with emotion regulation. Participants were instructed to indicate how often the provided statements apply to them. Example items include “I have no idea how I am feeling” and “When I’m upset, I have difficulty focusing on other things.” The DERS-18 has demonstrated good to excellent internal consistencies ($\alpha = .87$ to $.98$; Victor & Klonsky, 2016), with each individual subscale also demonstrating acceptable to excellent internal consistencies ($\alpha = .77$ to $.97$; Victor & Klonsky, 2016). In this study, the DERS-18 demonstrated excellent reliability ($\alpha = .90$).

Distress Tolerance

The Distress Tolerance Scale (DTS; Simons & Gaher, 2005) was used to measure perceived ability to tolerate distress. The DTS is composed of 15 items and has four subscales: (1) an individual's ability to tolerate negative emotional states (tolerance), (2) perception of the emotional event as acceptable (appraisal), (3) level of attention absorbed by the emotional event and its interference with overall functioning (absorption), and (4) ability to manage or regulate affect (regulation). Example items include "Feeling distressed or upset is unbearable to me" and "My feelings of distress are so intense that they completely take over." Responses are based on a five-point Likert scale (1 = *Strongly agree* to 5 = *Strongly disagree*), with higher mean scores of the four subscales corresponding to greater levels of distress tolerance. The DTS has shown acceptable to good internal consistencies ranging from .72 to .82 (Simons & Gaher, 2005). For the current study, the DTS demonstrated excellent reliability ($\alpha = .90$).

Perceived Stress

The Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermeistein, 1983), which is a ten-item measure, was designed to measure the degree to which experiences in an individual's life are perceived as stressful. Items were created to measure how uncontrollable, unpredictable, and overloaded respondents perceive their lives to be. Participants were instructed to indicate how often they feel a certain way (0 = *Never* to 4 = *Very often*), with higher scores reflecting overall greater levels of perceived stress. Example items include "In the last month, how often have you been upset because of something that happened unexpectedly?" and "In the last month, how often have you felt

nervous and ‘stressed’?” The PSS has demonstrated good psychometric properties, with internal consistencies ranging from .84 to .86 (Cohen, Kamarck, & Mermeistein, 1983). In this study, the PSS also demonstrated good psychometric properties with a Cronbach’s alpha of .87.

E-cigarette Use

A history of e-cigarette use and frequency of e-cigarette use was measured using three questions. The first two questions addressed lifetime (Have you ever tried an electronic cigarette, even one puff?) as well as past 30-day use (In the last 30 days, have you tried an e-cigarette, even one puff?), where respondents were instructed to provide a response of either “yes” or “no.” Frequency of current e-cigarette use was measured by asking respondents to indicate the number of days they have used an e-cigarette in the past 30 days.

Validity Check

Two items were added for the purposes of checking for the validity of each participant’s responses: “Have you ever used derbisol in your lifetime?” and “In the last 30 days, have you used derbisol?” Derbisol is a fictitious substance and was used in the survey to identify participants who were providing invalid responses (e.g., participants who may be selecting “yes” without reading the question, participants who were “faking bad”). Participants were instructed to respond either “yes” or “no” to these items.

Reasons for E-cigarette Use

For respondents who indicated that they have used an e-cigarette before, they were instructed to indicate their primary reason for using e-cigarettes (Rutten et al., 2015). Examples of responses that were selected include, “a way to reduce the health risks of smoking,” “stress/relax/nerves,” “because I find the flavors appealing,” and “to try to quit smoking cigarettes.”

Statistical Analyses

Analyses were performed using logistic multiple mediation with bootstrapping in order to test whether mindfulness is associated with e-cigarette use, and whether negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress mediate this possible relationship. Analyses were conducted in SPSS version 20 using the Indirect macro (Preacher & Hayes, 2008). Multiple mediation with bootstrapping is typically performed when more than one hypothesized mediator is being tested (Preacher & Hayes, 2008). Furthermore, bootstrapping is superior to more traditional mediation methods (i.e., Baron and Kenny’s causal steps strategy and Sobel’s t) in terms of both power and Type I error (Hayes, 2009). Multiple mediation with bootstrapping provides estimates of the total indirect (mediation) effect of all the possible mediators combined, in addition to the specific indirect effects of each individual mediator. This allows for pairwise comparisons of the strengths of each mediator (Preacher & Hayes, 2008).

The bootstrapping procedure involves drawing thousands of samples with replacement from the original sample, calculating estimates of the indirect effects (i.e., ab) for each newly drawn sample, and finally creating a sample distribution for these

indirect effects. The mean of the sampling distribution is the indirect effect and the standard deviation of the sampling distribution is the reported standard error. A confidence interval is then calculated from these estimates and a significance test is conducted. An effect is considered statistically significant at $\alpha = .05$ if its 95% bias-corrected confidence interval (BC CI) does not cross zero (Preacher & Hayes, 2008). For the current study, 5,000 random bootstrap samples were drawn, after which estimates of effects, standard errors, and 95% BC CIs were calculated. BC CIs are considered to be most accurate (Preacher & Hayes, 2008).

Prior to running the analyses, data were checked for outliers and violations of assumptions of linear and logistic regression. No outliers or violations of assumptions of linear regression were detected. Power analyses were performed with G*Power (Faul, Erdfelder, Buchner, & Lang, 2009) and indicated that, with a sample size of 837 participants, we had 99.99% power to detect a clinically significant effect of $OR = 2.0$ at $\alpha = 0.05$ (Ferguson, 2009).

CHAPTER THREE

RESULTS

Validity Check

Two items were created for the purposes of verifying the validity of each participant's responses. Out of the 837 respondents, six (0.7%) indicated that they had used derbisol within their lifetime and five (0.6%) indicated use within the past 30 days. Given that such a small percentage of our sample indicated the use of a fictitious substance, it appears reasonable to infer that the majority of participants are providing valid responses.

Lifetime E-cigarette Use

A multiple mediation analysis was used to assess whether trait mindfulness significantly predicted the odds of having ever used an e-cigarette and whether negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress mediated this relationship controlling for the effects of previous traditional cigarette smoking experience and perceived benefits associated with e-cigarette use (see Figure 1). Correlations between all proposed variables were also assessed (see Table 2).

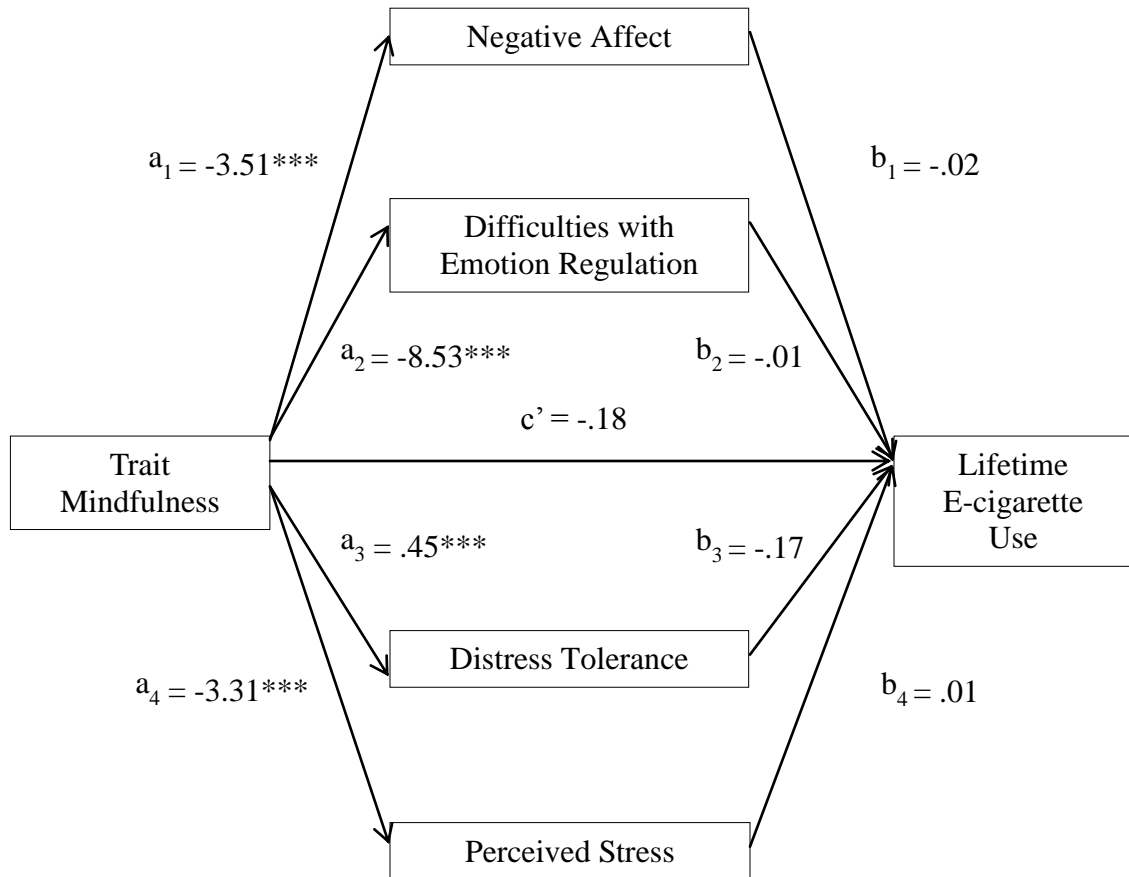


Figure 1. Results of multiple mediation analysis with negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress as mediators of the relationship between trait mindfulness and lifetime e-cigarette use. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2. Correlations, Means, and Standard Deviations for Variables of Interest.

Variable	1	2	3	4	5	6	7	8
1. TM	1.00	-	-	-	-	-	-	-
2. NA	-.42**	1.00	-	-	-	-	-	-
3. DER	-.59**	.53**	1.00	-	-	-	-	-
4. DT	.45**	-.49**	-.73**	1.00	-	-	-	-
5. PS	-.41**	.68**	.56**	-.53**	1.00	-	-	-
6. PBEU	.03	.05	.00	.02	.05	1.00	-	-
7. PCSE	-.02	-.01	.05	-.05	-.05	-.32**	1.00	-
8. LEU	-.04	-.02	.00	-.02	-.02	-.58**	.57**	1.00
9. CEU	-.03	.04	.11	-.11	.10	-.60**	.10**	NA
Mean (SD)	3.96 (.86)	20.41 (8.33)	40.23 (12.79)	3.43 (.92)	23.32 (6.45)	22.98 (8.83)	-	-

Note. TM = trait mindfulness, NA = negative affect, DERS = difficulty with emotion regulation, DT = distress tolerance, PS = perceived stress, PBEU = perceptions of benefits of e-cigarette use, PCSE = previous cigarette smoking experience, LEU = lifetime e-cigarette use, CEU = current e-cigarette use. NA = the correlation between LEU and CEU is not available due to an error in calculating the correlation in SPSS. This error may be due to not having enough variability in participants' responses to these items (i.e., participants mostly answered "yes" to these questions).

* $p < .05$. ** $p < .01$.

The portion of our hypothesis stating that as the level of trait mindfulness increased, lifetime e-cigarette use would decrease was not supported (see Table 3). After controlling for the effects of previous cigarette smoking experience, perceived benefits of e-cigarette use, negative affect, perceived stress, difficulties with emotion regulation, and distress tolerance, trait mindfulness was not significantly associated with having ever used an e-cigarette ($p > .05$). Previous cigarette smoking experience was significantly associated with having ever used an e-cigarette ($OR = 12.17, p < .001$). The odds of having ever used an e-cigarette were 1117.15% greater for individuals with previous cigarette smoking experience relative to those with no previous smoking experience. Perceptions of benefits associated with e-cigarette use was also significantly associated with having ever used an e-cigarette, such that for every one-unit increase in perceived benefits of e-cigarette use, the odds of having ever used an e-cigarette decreased by 20.98% ($OR = .79, p < .001$).

We also hypothesized that negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress would mediate the relationship between trait mindfulness and lifetime e-cigarette use. This hypothesis was not supported (see Table 3). After controlling for the effects of previous cigarette smoking experience and perceived benefits of e-cigarette use, negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress did not significantly mediate the effect of trait mindfulness on having ever used an e-cigarette ($ps > .05$). However, individual paths in the model indicated that trait mindfulness was significantly associated with negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress ($ps < .001$). A one-unit increase in trait mindfulness was associated with a decrease of 3.51

units in negative affect ($b = -3.51, t = -6.40, p < .001$). A one-unit increase in trait mindfulness was associated with a decrease of 8.53 units in difficulties with emotion regulation ($a = -8.53, t = -11.67, p < .001$). Additionally, a one-unit increase in trait mindfulness was associated with an increase of .45 units in distress tolerance ($a = .45, t = 7.77, p < .001$). Finally, a one-unit increase in trait mindfulness was associated with 3.31-unit decrease in perceived stress ($a = -3.31, t = -7.67, p < .001$). Individual paths in the model indicated that negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress were not significantly associated with having ever used an e-cigarette ($ps > .05$).

Table 3. Results of Multiple Mediation Analysis Testing Negative Affect, Difficulties with Emotion Regulation, Distress Tolerance, and Perceived Stress as Mediators of the Relationship Between Trait Mindfulness and Lifetime E-cigarette Use.

Mediated Effect	<i>ab</i>	SE	95% BC CI
Negative Affect	.08	.11	[-.13, .31]
Difficulties with Emotion Regulation	.13	.20	[-.25, .54]
Distress Tolerance	-.08	.14	[-.38, .19]
Perceived Stress	-.02	.11	[-.25, .21]
Total Indirect Effect	.10	.16	[-.21, .44]

Note. 95% BC CI = bias-corrected bootstrap confidence interval, SE = standard error, and *ab* = mediation effect.

Current E-cigarette Use

A multiple mediation analysis was used to assess whether trait mindfulness significantly predicted the odds of currently using an e-cigarette and whether negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress mediated this relationship controlling for the effects of previous traditional cigarette smoking experience and perceived benefits associated with e-cigarette use (see Figure 2). Our hypothesis that trait mindfulness would significantly predict current e-cigarette use was not supported. After controlling for the effects of previous cigarette smoking experience, perceived benefits of e-cigarette use, negative affect, perceived stress, difficulties with emotion regulation, and distress tolerance, trait mindfulness was not significantly associated with current e-cigarette use ($p > .05$). Previous cigarette smoking experience was also not significantly associated with current e-cigarette use ($OR = 1.31$, $p > .05$). However, perceptions of benefits associated with e-cigarette use was significantly associated with current e-cigarette use ($OR = .6405$, $p < .001$). For every one-unit increase in perceived benefits of e-cigarette use, the odds of current e-cigarette use decreased by 35.95%.

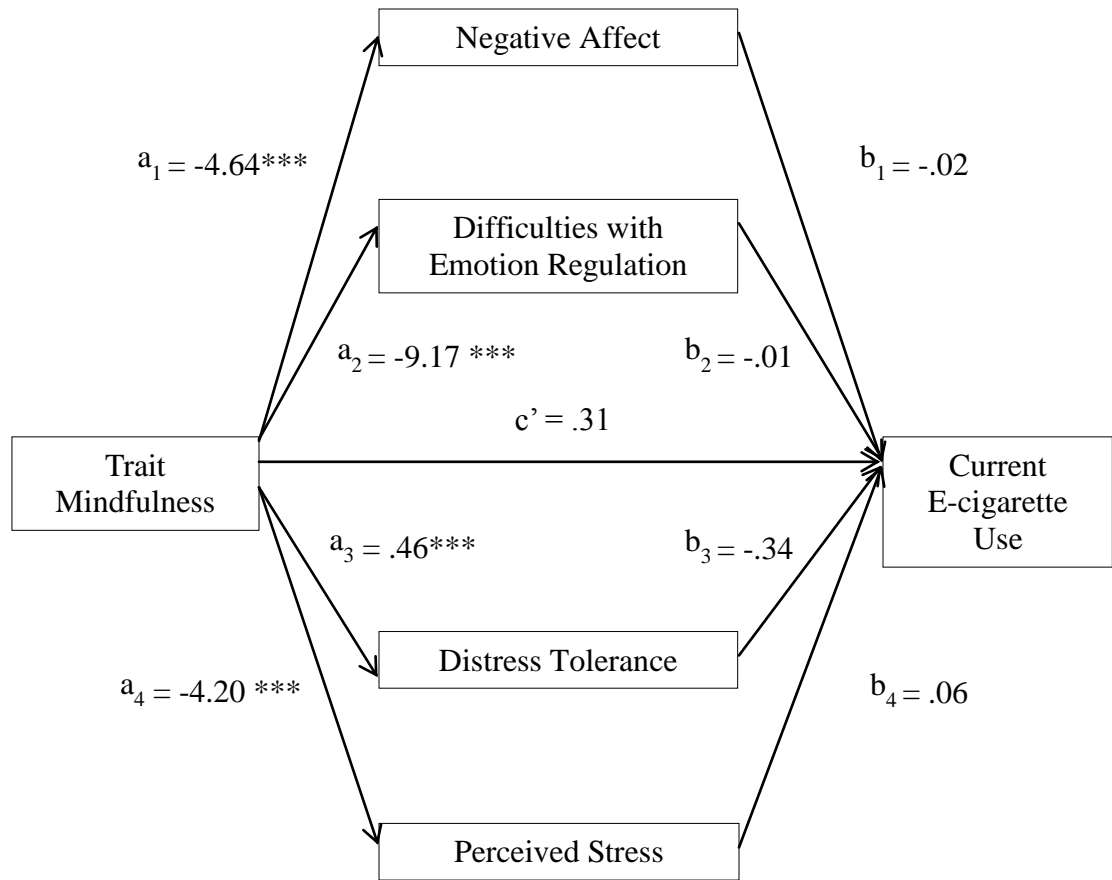


Figure 2. Results of multiple mediation analysis with negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress as mediators of the relationship between trait mindfulness and current e-cigarette use. * $p < .05$. ** $p < .01$. *** $p < .001$.

The portion of our hypothesis stating that negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress would mediate the relationship between trait mindfulness and current e-cigarette use was also not supported (see Table 4).

Table 4. Results of Multiple Mediation Analysis Testing Negative Affect, Difficulties with Emotion Regulation, Distress Tolerance, and Perceived Stress as Mediators of the Relationship Between Trait Mindfulness and Current E-cigarette Use.

Mediated Effect	<i>ab</i>	SE	95% BC CI
Negative Affect	.10	.20	[-.29, .52]
Difficulties with Emotion Regulation	.10	.27	[-.45, .64]
Distress Tolerance	-.15	.20	[-.57, .23]
Perceived Stress	-.27	.23	[-.74, .19]
Total Indirect Effect	-.23	.24	[-.74, .23]

Note. 95% BC CI = bias-corrected bootstrap confidence interval, and *ab* = mediation effect.

After controlling for the effects of previous cigarette smoking experience and perceived benefits of e-cigarette use, negative affect, difficulties with emotion regulation,

distress tolerance, and perceived stress did not significantly mediate the effect of trait mindfulness on current e-cigarette use ($ps > .05$). However, individual paths in the model indicated that trait mindfulness was significantly associated with negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress ($ps > .001$). A one-unit increase in trait mindfulness was associated with a 4.64-unit decrease in negative affect ($a = -4.64, t = -6.79, p < .001$). A one-unit increase in trait mindfulness was associated with a decrease of 9.17 units in difficulties with emotion regulation ($a = -9.17, t = -9.42, p < .001$). Further, a one-unit increase in trait mindfulness was associated with an increase of .46 units of distress tolerance ($a = .46, t = 6.04, p < .001$). Lastly, a one-unit increase in trait mindfulness was associated with a 4.20-unit decrease in perceived stress ($b = -4.20, t = -7.54, p < .001$). Individual paths in the model indicated that negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress were not significantly associated with current e-cigarette use ($ps > .05$).

CHAPTER FOUR

DISCUSSION

To our knowledge, this study is the first to examine mood and stress-related variables related to traditional cigarette smoking to determine whether these variables mediate the relationship between mindfulness and both lifetime and current e-cigarette use among adults. Contrary to our predictions, trait mindfulness was not significantly associated with either lifetime or current e-cigarette use. Additionally, our proposed mediators, negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress, did not significantly mediate the relationship between trait mindfulness and either lifetime or current e-cigarette use.

Although there is considerable research indicating that trait mindfulness and the proposed mediators are all related to traditional cigarette smoking (Brewer et al., 2011; Shiffman et al., 2007; Adams, Tull, & Gratz, 2012; Leyro, Bernstein, Vujanovic, McLeish, & Zvolensky, 2011; Gallo et al., 2014), these variables were not significantly associated with e-cigarette use in our sample. It is possible that traditional cigarette smokers and e-cigarette users present quite differently. More specifically, traditional cigarette smokers and e-cigarette users may be using for different reasons, which may provide some explanation for our null findings. Many traditional cigarette smokers, including pregnant smokers, adolescent smokers, and smokers of varying ethnicities and cultural backgrounds, report smoking because they believe that smoking will help regulate their mood and/or reduce their stress (Berlin et al., 2003; Borderías, Duarte, Escario, & Molina, 2015; de Wilde et al., 2016; da Motta et al., 2010). In a 2015 study

examining reasons why more than 25,000 adolescent smokers smoke cigarettes, 53.69% reported smoking for tension reduction/relaxation purposes, and these findings were consistent across different ages and gender (Borderías, Duarte, Escario, & Molina, 2015).

While traditional cigarette smokers report stress reduction or mood regulation as a primary reason for smoking, recent studies suggest that e-cigarette users are smoking for different reasons than smokers use conventional cigarettes. In a 2016 study, more than 13,000 U.S. adults reported currently using an e-cigarette for more than one reason (Patel et al, 2016). In this sample, 84.5% reported using an e-cigarette for smoking cessation or health-related purposes, 71.5% reported “consideration of others,” 56.7% reported convenience, 45.2% reported being curious, and 34.4% reported for the flavorings (Patel et al, 2016). In another 2016 study, 20,675 middle and high school students in the U.S. were surveyed, and those who indicated they were lifetime or current e-cigarette users were instructed to select the reason for their use (Tsai et al., 2016). Among these adolescents, the most commonly reported reason for using e-cigarettes were “friend or family member used them” (39.0%); available flavors including mint, candy, fruit or chocolate (31.0%); and beliefs that e-cigarettes were less harmful than other tobacco products (17.1%). However, in these studies, researchers did not specifically include “stress or tension reduction” or “to manage mood” as an option when measuring reasons for e-cigarette use among their samples.

In 2009, the FDA banned all flavored traditional cigarettes other than menthol from being sold in the U.S. The FDA deemed this ban as a pivotal step in tobacco regulation, as flavored cigarettes have attracted youth and young adults to smoke (USDHHS, 2012). Data from the FDA’s Population Assessment of Tobacco and Health

indicate that almost 80% of adolescents ages 12 to 17 and about 75% of young adults ages 18 to 25 who currently use a tobacco product reported that their first experience using tobacco was with a flavored tobacco product (Villanti et al., 2017). In November of 2018, the FDA announced that it would ban menthol in traditional cigarettes as well as restrict the sales of flavored e-cigarettes to youth in response to the rising number of high school students using e-cigarettes (NBCNews, 2018). However, the sales of flavored e-cigarettes to adults have not been banned. Given that flavored traditional cigarettes have been banned for all age groups altogether, it stands to reason that the majority of traditional cigarette smokers are not necessarily smoking because of the appeal of flavored cigarettes. In contrast, many e-cigarettes users have reported using e-cigarettes based on the fact that they find the flavors of e-cigarettes attractive (Patel et al, 2016; Tsai et al., 2016). If the majority of traditional cigarette smokers are smoking for stress-reduction purposes while e-cigarette users are smoking for other reasons (i.e., appeal of flavors), it is possible that these two subpopulations have different behavioral and/or psychological mechanisms that explain why they use their respective tobacco products. For example, if e-cigarette users are not using e-cigarettes for stress reduction and/or mood regulation, it is possible that variables related to affect and stress (i.e., difficulties with emotion regulation, negative affect) would not have significant relationships with e-cigarette use.

In our sample, participants who reported having ever used an e-cigarette in their lifetime were instructed to select a reason for using e-cigarettes. The majority of participants reported trying an e-cigarette for the following reasons: to quit smoking conventional cigarettes ($n = 131$; 15.7%), out of curiosity ($n = 92$; 11.0%), to reduce the

health risks of smoking conventional cigarettes ($n = 84$; 10%), because the flavors are appealing ($n = 43$; 5.1%), as a way to cut down on the number of traditional cigarettes they smoke ($n = 30$; 3.6%), and to reduce stress/relax/calm nerves ($n = 25$; 3.0%). Unlike traditional cigarette smokers, the majority of the current study's participants were not necessarily using e-cigarettes to manage their stress, but rather as a means to quit smoking traditional cigarettes, out of curiosity, or to reduce the health risks associated with smoking cigarettes. Given that only 3% of our sample reported using e-cigarettes to reduce stress, this may provide some explanation for our null findings where we hypothesized that mood and stress-related variables would be play a significant role in the relationship between mindfulness and e-cigarette use.

We also examined covariates, which were previous cigarette smoking experience and perceptions of benefits associated with e-cigarette use, to determine whether these covariates were significantly associated with either lifetime or current e-cigarette use. Our findings indicate that previous cigarette smoking experience was significantly associated with having ever used an e-cigarette (*lifetime use*; $OR = 12.17, p < .001$). The odds of having ever used an e-cigarette were 1117.15% greater for individuals with previous cigarette smoking experience relative to those with no previous smoking experience. These findings are consistent with previous studies indicating that previous cigarette smoking behaviors significantly predicted subsequent e-cigarette use (Anand et al, 2015; Giovenco, Lewis, & Delnevo, 2014; Hanewinkel & Isensee, 2015).

Perceptions of benefits associated with e-cigarette use were also significantly associated with having ever used an e-cigarette. For every one-unit increase in perceived benefits of e-cigarette use, the odds of having ever used an e-cigarette decreased by

20.98% ($OR = .79, p < .001$). One possible explanation for this counterintuitive finding is the presence of statistical suppression. Suppression occurs when the effect of one predictor is suppressed after other predictor variables have been added into the model (Kline, 2016). In addition to suppressing the effect of the predictor, adding other predictors into the analysis can also change the sign of the effect of the predictor variable in question (Kline, 2016). One way that suppression generally occurs is when the absolute value of a predictor's beta weight or regression coefficient (the slope of a line in regression) is greater than that of its bivariate correlation with the dependent variable (Kline, 2016). When there is suppression, the estimated magnitude and/or direction of the relationship between a predictor and a dependent variable while controlling for other predictor variables is unexpected (Kline, 2016). In the current study, the beta weight for perceptions of benefits of e-cigarette use is .79, whereas the absolute value of its bivariate correlation is .57. Therefore, it is possible that suppression may play a role as to why our findings regarding the relationship between perceptions of benefits with e-cigarette use and lifetime e-cigarette use are counterintuitive. More specifically, it appears that the effect of perceptions of e-cigarettes is being suppressed and that the sign of the effect this predictor has on lifetime e-cigarette use is now in the opposite direction of what would typically be expected.

Previous cigarette smoking experience was not significantly associated with *current* e-cigarette use. Examining proximal versus distal predictors may provide one possible explanation for this finding. Proximal predictors are typically related to current behaviors or are variables that are causally nearer to the outcome variable (i.e., the proximal predictor was measured at a time that was near the time when the outcome

variable occurred). Distal predictors tend to be related to traits, long-term factors, or past behaviors. It is possible that as a distal predictor, previous cigarette smoking experience does not have significant influence on current e-cigarette use because current use is too far removed in time or in the causal chain from previous cigarette experience. This explanation may especially be applicable to participants whose previous cigarette smoking experience occurred too far in the past. Variables that are closer in time or in the causal chain of possible events leading up to current use, such as current social status, current e-cigarette use by significant others, or current occupation, may be possible variables to examine for future research. Another alternative is to examine participants whose previous cigarette smoking occurred at a more recent time.

Perceptions of benefits associated with e-cigarette use were significantly associated with current e-cigarette use ($OR = .6405, p < .001$). For every one-unit increase in perceived benefits of e-cigarette use, the odds of current e-cigarette use decreased by 35.95%. Current literature suggests that as perceptions of harm associated with e-cigarettes use increases, the odds of susceptibility to e-cigarette use among youth decreases (Kowitt, Osma, Ranney, Heck, & Goldstein, 2018). Contrary to our hypotheses, however, perceived benefits associated with e-cigarette use was associated with decreased odds of currently using an e-cigarette in our sample. These counterintuitive findings may also be due to suppression. As previously stated, suppression can occur when the absolute value of a predictor's beta weight is greater than that of its bivariate correlation with the dependent variable (Kline, 2016). This can then result in a sign change or suppression of the effect that the predictor variable has on the dependent variable. In the current study, the beta weight for perceptions of benefits of e-

cigarette use is .64, whereas the absolute value of its bivariate correlation with current e-cigarette use is .60. As a result, it appears that the sign of the effect of perceptions of benefits associated with e-cigarette use has been changed so that the magnitudes of the beta weights are different. Therefore, it is possible that suppression may play a role as to why our results indicate that increased perceptions of benefits associated with e-cigarette use is associated with decreased odds of current e-cigarette use.

Trait mindfulness was significantly associated with all proposed mediators, which were negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress. First, higher levels of trait mindfulness were associated with a significant decrease in negative affect, which is consistent with current research (Ding, Tang, Tang, & Posner, 2014; Holzel et al., 2011; Montero-Marín et al., 2015; Robins et al., 2012; Vinci et al., 2014). Second, an increase in trait mindfulness was associated with a significant decrease in difficulties with emotion regulation, which is consistent with findings from previous studies (Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007; Goodall, Trejnowska, & Darling, 2012). Third, an increase in trait mindfulness was associated with a significant increase in an individual's reported ability to tolerance distress, which is also consistent with the current literature (Liu, Wang, Chang, Chen, & Si, 2013; Luberto, McLeish, Robertson, Avallone, Kraemer, & Jeffries, 2014). Finally, also consistent with current research, an increase in trait mindfulness was significantly associated with a decrease in perceived stress (Carmody, Crawford, & Churchill, 2006; Chang et al., 2004; Galantino, Baime, Maguire, Szapary, & Farrar, 2005).

Individual paths in both models indicated that negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress were not significantly

associated with either lifetime or current e-cigarette use. As previously mentioned, it is possible that e-cigarette users are using e-cigarettes for reasons other than stress-reduction or mood regulation, which may set them apart from traditional cigarette smokers who frequently report smoking to relax or manage their stress (Berlin et al., 2003; Borderías, Duarte, Escario, & Molina, 2015; de Wilde et al., 2016; da Motta et al., 2010).

Contrary to our predictions, trait mindfulness did not have significant associations with either lifetime or current e-cigarette use. These findings are in contrast to the results of two studies indicating that increased levels of mindfulness in middle school aged students was associated with increased emotional regulation skills (Pentz, Riggs, & Warren, 2016), which was associated with a lower risk for lifetime e-cigarette use (Pentz, Shin, Riggs, Unger, Collison, & Chou, 2015). It is possible that these relationships are significant among adolescents but not among adults. It is also possible that these relations may have differed had the current study examined the relationship between e-cigarette use and the individual facets of mindfulness, but we did not measure the latter. Previous research has identified five facets that encompass mindfulness: observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience. Given that smoking behaviors have been linked to emotional reactivity (Engelmann, Gewirtz, & Cuthbert, 2011), it is possible that testing individuals facets (i.e., non-reactivity to inner experience) rather than mindfulness as an entire entity may have yielded different results.

Although the direct effect of mindfulness and the mediating effects of negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress were

not significant, it is important to emphasize noteworthy effect sizes. Post-hoc power analyses indicated that with trait mindfulness as the predictor, the study had an 82.30% and 99.75% chance of detecting a significant effect for lifetime and current e-cigarette use, respectively. Our results indicate that for every one-unit increase in trait mindfulness, the odds of having ever used an e-cigarette increased by 16.43% while the odds of current e-cigarette use increased by 36.57%. Post-hoc power analyses indicated that with distress tolerance as the predictor, the study had an 80.47% and 99.93% chance of detecting a significant effect for lifetime and current e-cigarette use, respectively. Results indicate that for every one-unit increase in distress tolerance, the odds of having ever used an e-cigarette increased by 15.97% and the odds of current e-cigarette use increased by 28.79%. Effect sizes provide a more accurate illustration of the magnitude of an effect (Ferguson, 2009). Thus, these effect sizes may indicate that, despite the lack of statistical significance, trait mindfulness and distress tolerance should still be considered as potentially important factors related to both lifetime and current e-cigarette use.

Limitations

Several limitations should be considered regarding the current study's findings. Analyses were conducted with self-reported data, and thus the reliability and validity of our findings may be affected by response bias and social desirability. This may especially be true for sensitive items related to health-risk behaviors and/or emotional difficulty. To counter this concern, steps were taken to ensure that participants' responses remain anonymous and their identities remain confidential, which may have improved

participants' candor. Further, possible suppression makes it difficult to discern the actual effects that perceived benefits associated with e-cigarette use had on both lifetime and current e-cigarette use in the current sample. Another limitation of the study is the use of cross-sectional data, which means that causal inferences cannot be made.

Another limitation affecting our ability to infer causal inferences is the use of a convenience sample. With the use of a convenience sample, a particular type of individual may be more likely to respond to the study's survey than others, which in turn may influence the types of responses that are provided. For example, the current study was advertised on online social forums, such as Reddit.com, some of which were forums specifically for e-cigarette users. As a result, our sample consisted of greater percentages of lifetime (59.40%) and current (42.70%) e-cigarettes users than typically reported in the general adult population (i.e., 2.8% reported current use in 2017; Wang et al., 2018).

Lack of biological measures (e.g., carbon monoxide levels) to confirm smoking status was another limitation of this study. However, previous research indicates that self-reported smoking is an acceptable proxy for measured values (Patrick, Cheadle, Thompson, Diehr, Koepsell, & Kinne, 1994). In addition, given the rapid rise in e-cigarette use among adolescents (CDC, 2018), it may have been more beneficial, particularly for prevention efforts, to recruit adolescents rather than adult participants.

Summary and Recommendations

To date, there is inconclusive evidence about the effectiveness of e-cigarettes as tools for smoking cessation (Carpenter et al., 2017; Halpern et al., 2018). Furthermore, although e-cigarettes may contain fewer toxic chemicals than traditional cigarettes, recent

studies suggest that they may still have harmful health effects, including increased cancer risk (American Chemical Society, 2018; Franzen et al., 2018). Until more definitive conclusions can be made regarding the long-term benefits and/or consequences of e-cigarette use, it is important to examine correlates of the use of these electronic devices. Based on our findings, it appears that negative affect, difficulties with emotion regulation, distress tolerance, and perceived stress, which have been shown to significantly affect traditional cigarette smoking behaviors, may not have similar relationships with e-cigarette use. In a study examining whether other known predictors of cigarette smoking (i.e., beliefs about cigarette addiction, perceptions of the risks and benefits of cigarette smoking, and exposure to anti-tobacco information) also predicted e-cigarette use among adolescents, results indicated non-significant relationships (Tran, 2016). Therefore, other known correlates or predictors of traditional cigarette smoking may not significantly relate to e-cigarette use. Instead, future research may benefit more from focusing on other variables when examining predictors of e-cigarette use. For example, it may be more beneficial to examine the mechanisms behind why e-cigarette flavors are so appealing to middle and high school students and why many individuals who use e-cigarettes to quit smoking traditional cigarettes end up utilizing both tobacco products simultaneously.

It is also possible that age and gender may moderate the relationship between mindfulness and e-cigarette use, especially if adolescents and adults are demonstrating different reasons for using e-cigarettes. It may be beneficial for future research to explore reasons for use among adolescents, as well as potential moderators of the relationship between mindfulness and e-cigarette use, including age and gender.

Recent numbers indicate that e-cigarette use among youth has been on an upward trend for the past few years. In fact, e-cigarette use rates increased by 78% among high school students in one year since 2017 (Cullen, Ambrose, Gentzke, Apelberg, Jamal, & King, 2018). According to a 2018 report from the CDC, the number of middle and high school students in the U.S. who have used an e-cigarette in the past 30 days continued to rise by 1.5 million students from 2017 to 2018. CDC Director, Robert R. Redfield, M.D., released in a statement that “the skyrocketing growth of young people’s e-cigarette use over the past year threatens to erase progress made in reducing youth tobacco use.” In addition, public health representatives and other experts, including the American Academy of Pediatrics, have disclosed their concerns regarding the addictiveness of e-cigarettes and the potential of e-cigarettes for being a gateway product for the future use of other tobacco products, such as traditional cigarettes. The FDA Commissioner, Scott Gottlieb, has noted that the rapid increase in adolescent e-cigarette use can be partially attributed to the attractiveness of flavored nicotine pods sold by Juul, a popular manufacturer of e-cigarette products, and other manufacturing companies.

In early 2018, Juul, attempted to implement mindfulness as part of an anti-vaping curriculum in school districts in response to the rising popularity of e-cigarettes among middle and high school students, as they were deemed to be the most widely used tobacco product among youth in 2015 (Singh et al., 2016). In fact, in a recent advisory report issued by the U.S. Surgeon General, he declared youth vaping an “epidemic” in response to the recent surge in e-cigarette use among adolescents (FDA, 2019). Juul made claims that mindfulness could be utilized as a prevention tool despite the lack of evidence to support these claims. Results of our study indicate that there continues to be a

lack of supporting evidence that mindfulness could be used as a prevention technique for e-cigarette use.

The life-threatening effects of tobacco use have been a concern at the heart of public health agencies for decades, resulting in many efforts to restrict its sales and advertisements. With the introduction of e-cigarettes, researchers and public health officials now debate over whether to prioritize their potential to reduce the harm caused by traditional cigarette use or their potential as a gateway to nicotine use and addiction among youth (Fairchild, Lee, Bayer, & Curran, 2018). Given that current knowledge regarding the effectiveness of e-cigarettes as a cessation aid is still inconclusive (Carpenter et al., 2017; Halpern et al., 2018) while there is a clear upward trend in adolescent e-cigarette use (Cullen, Ambrose, Gentzke, Apelberg, Jamal, & King, 2018) that can potentially lead to dual use of both e-cigarettes and traditional cigarettes (Hanewinkel, & Isensee, 2015; Lee, Grana, & Glantz, 2014), future research should continue to prioritize identifying prevention strategies to help counter further increases in e-cigarette use, particularly among youth.

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APPENDICES

Demographic Information

Instructions: Please answer the following questions as accurately as you can.

1. What is your age?
2. What is your sex? Male Female
3. What was the highest level of education that you have completed?
 Grade School
 Middle School/Junior High
 High School or Equivalent/GED
 Some College/Trade school
 Associate's Degree
 Bachelor's Degree
 Master's Degree
 Doctoral Degree or Equivalent
4. What best describes your ethnicity?
 Hispanic or Latino Not Hispanic or Latino
5. What best describes your race?
 American Indian/Alaska Native
 Asian or Asian American
 Black or African American
 Native Hawaiian or Other Pacific Islander
 White
 Other
 Mixed Race

Smoking History

6. Have you ever tried smoking a cigarette, even one puff? Yes No
Note: If no please go to #10.
7. Have you ever smoked 100 whole cigarettes in your lifetime? Yes No
8. In the last 30 days, have you smoked cigarettes every day, some days, or not at all?
9. How many cigarettes have you smoked in the last 30 days?
10. Have you ever tried an electronic cigarette (e-cigarette or vape), even one puff?
Yes No
11. In the last 30 days, have you tried an e-cigarette, even one puff? Yes No
12. In the last 30 days, how many days did you use an e-cigarette?

Validity Check

13. Have you ever used derbisol in your lifetime? Yes No
14. In the last 30 days, have you used derbisol? Yes No

Reasons for E-cigarette Use

15. What was the main reason you used e-cigarettes?
 "A way to reduce the health risks of smoking"
 "To try to quit smoking cigarettes"
 "As a way of cutting down the number of cigarettes that I smoke"
 "Because I find the flavors appealing"
 "Not as strong/less nicotine/lighter/no tar"
 "Habit/addicted"
 "Out of curiosity"
 "Stress/relax/nerves"
 "That's what I've always smoked/what I like"
 "Cost/cheaper than cigarettes"
 "Because I can use them in places where I can't smoke cigarettes (e.g., indoors)"
 "Because they are less harmful to use around family/friends/children than cigarettes."
 "I can use them to control my weight."

Intentions to Use E-cigarettes

Instructions: Please read the statements below and then tell us how much you agree or disagree with each statement using the following rating scale.

- [1] Definitely not
[2] Probably not
[3] Probably yes
[4] Definitely yes

16. Do you think you will try an e-cigarette soon?
17. Do you think you will try an e-cigarette anytime during the next year?
18. If one of your best friends were to offer you an e-cigarette, would you use it?

Negative Affect

Instructions: This scale consists of a number of words that describe different feelings and emotions. Read each item and then list the number from the scale below next to each word. Indicate the extent you have felt this way over the past week.

- [1] Very slightly or Not at All
- [2] A Little
- [3] Moderately
- [4] Quite a Bit
- [5] Extremely

- 19. Distressed
- 20. Upset
- 21. Guilty
- 22. Scared
- 23. Hostile
- 24. Irritable
- 25. Ashamed
- 26. Nervous
- 27. Jittery
- 28. Afraid

Trait Mindfulness

Instructions: Below is a collection of statements about your everyday experience. Using the 1-6 scale below, please indicate how frequently or infrequently you currently have each experience. Please answer according to what *really reflects* your experience rather than what you think your experience should be. Please treat each item separately from every other item.

- [1] Almost Always
- [2] Very Frequently
- [3] Somewhat Frequently
- [4] Somewhat Infrequently
- [5] Very Infrequently
- [6] Almost Never

- 29. I could be experiencing some emotion and not be conscious of it until some time later.
- 30. I break or spill things because of careless, not paying attention, or thinking of something else.
- 31. I find it difficult to stay focused on what's happening in the present.
- 32. I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.

33. I tend not to notice feelings of physical tension or discomfort until they really grab my attention.
34. I forget a person's name almost as soon as I've been told it for the first time.
35. It seems I am "running on automatic" without much awareness of what I'm doing.
36. I rush through activities without being really attentive to them.
37. I get so focused on the goal I want to achieve that I lose touch with what I'm doing right now to get there.
38. I do jobs or tasks automatically without being aware of what I'm doing.
39. I find myself listening to someone with one ear, doing something else at the same time.
40. I drive places on 'automatic pilot' and then wonder why I went there.
41. I find myself preoccupied with the future or the past.
42. I find myself doing things without paying attention.
43. I snack without being aware that I'm eating.

Perceived Stress

Instructions: The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate by circling how often you felt or thought a certain way.

- [0] Never
- [1] Almost Never
- [2] Sometimes
- [3] Fairly Often
- [4] Very Often

44. In the last month, how often have you been upset because of something that happened unexpectedly?
45. In the last month, how often have you felt that you were unable to control the important things in your life?
46. In the last month, how often have you felt nervous and "stressed"?
47. In the last month, how often have you felt confident about your ability to handle your personal problems?
48. In the last month, how often have you felt that things were going your way?
49. In the last month, how often have you found that you could not cope with all the things that you had to do?
50. In the last month, how often have you been able to control irritations in your life?
51. In the last month, how often have you felt that you were on top of things?
52. In the last month, how often have you been angered because of things that were outside of your control?
53. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

Difficulties with Emotion Regulation

Instructions: Please indicate how often the following statements apply to you by writing the appropriate number from the scale below (1-5).

[1] Almost never (0-10%) [2] Sometimes (11-35%) [3] About half the time (36-65%)

[4] Most of the time (66-90%) [5] Almost always (91-100%)

- 54. I pay attention to how I feel.
- 55. I have no idea how I am feeling.
- 56. I have difficulty making sense out of my feelings.
- 57. I am attentive to my feelings.
- 58. I am confused about how I feel.
- 59. When I'm upset, I acknowledge my emotions.
- 60. When I'm upset, I become embarrassed for feeling that way.
- 61. When I'm upset, I have difficulty getting work done.
- 62. When I'm upset, I become out of control.
- 63. When I'm upset, I believe that I will remain that way for a long time.
- 64. When I'm upset, I believe that I'll end up feeling very depressed.
- 65. When I'm upset, I have difficulty focusing on other things.
- 66. When I'm upset I feel ashamed with myself for feeling that way.
- 67. When I'm upset, I feel guilty for feeling that way.
- 68. When I'm upset, I have difficulty concentrating.
- 69. When I'm upset, I have difficulty controlling my behaviors.
- 70. When I'm upset, I believe that wallowing in it is all I can do.
- 71. When I'm upset, I lose control over my behaviors.

Distress Tolerance

Instructions: Please read the statements below and then tell us how much you agree or disagree with each statement using the following rating scale.

- [1] Strongly agree
- [2] Mildly agree
- [3] Agree and disagree equally
- [4] Mildly disagree
- [5] Strongly disagree

- 72. Feeling distress or upset is unbearable to me.
- 73. When I feel distressed or upset, all I can think about is how bad I feel.
- 74. I can't handle feeling distressed or upset.
- 75. My feelings of distress are so intense that they completely take over.
- 76. There's nothing worse than feeling distressed or upset.
- 77. I can tolerate being distressed or upset as well as most people.

78. My feelings of distress or being upset are not acceptable.
79. I'll do anything to avoid feeling distressed or upset.
80. Other people seem to be able to tolerate feeling distressed or upset better than I can.
81. Being distressed or upset is always a major ordeal for me.
82. I am ashamed of myself when I feel distressed or upset.
83. My feelings of distress or being upset scare me.
84. I'll do anything to stop feeling distressed or upset.
85. When I feel distressed or upset, I must do something about it immediately.
86. When I feel distressed or upset, I cannot help but concentrate on how bad the distress actually feels.

Perceptions of Benefits of E-cigarettes

Instructions: Please read the statements below and then tell us how much you agree or disagree with each statement using the following rating scale.

- [1] Strongly disagree
- [2] Somewhat Disagree
- [3] Undecided
- [4] Somewhat agree
- [5] Strongly agree

87. E-cigarettes are less harmful than traditional cigarettes.
88. E-cigarettes can help people quit smoking.
89. E-cigarettes are less addictive than traditional cigarettes.
90. E-cigarettes are more socially acceptable than traditional cigarettes.
91. E-cigarettes help in the management of stress.
92. E-cigarettes can help with weight control.
93. The available e-cigarette flavors are appealing to me.