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Aaron L. Bergman
Pacific University

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Feasibility and Acceptability of Mindfulness-Based Relapse Prevention and Adjunct Mobile Technology in Rural Communities

Abstract

While problematic substance use transcends geographic regions, rural communities appear to be especially impacted. More prevalent problematic substance use and associated problems in these areas are exacerbated by lack of consistent access to evidence-based practices. Mindfulness-Based Relapse Prevention (MBRP) combines standard cognitive-behavioral relapse prevention with formal and informal mindfulness training, and may be a novel and effective treatment approach for substance use disorders (SUD) in these isolated areas. The current study explored feasibility and acceptability, and potential differences in variance accounted for by group randomization on substance use and secondary outcomes, between MBRP and treatment as usual (TAU) in a rural treatment setting, as well as the impact of a specially designed mobile application on treatment engagement and enactment. No differences were observed in variance of substance use or secondary outcome by groups; however, participants in TAU vs. MBRP were more likely to drop out of treatment against medical advice. The mobile application did not appear to impact treatment engagement or enactment. Implications and limitations are discussed.

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FEASIBILITY AND ACCEPTABILITY OF MINDFULNESS-BASED RELAPSE
PREVENTION AND ADJUNCT MOBILE TECHNOLOGY IN RURAL COMMUNITIES

A DISSERTATION SUBMITTED TO THE FACULTY
OF
PACIFIC UNIVERSITY SCHOOL OF GRADUATE PSYCHOLOGY
HILLSBORO, OREGON

BY
AARON LESLIE BERGMAN, MA, MS

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FOR
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To the people of Linn County, we see you.

To my beloved girlfriend TJH, thank you for being a protagonist in the story of my adventure. Together, we can do anything.

Finally, to my family: thank you for your unwavering belief in me, despite my best efforts.

ABSTRACT

While problematic substance use transcends geographic regions, rural communities appear to be especially impacted. More prevalent problematic substance use and associated problems in these areas are exacerbated by lack of consistent access to evidence-based practices. Mindfulness-Based Relapse Prevention (MBRP) combines standard cognitive-behavioral relapse prevention with formal and informal mindfulness training, and may be a novel and effective treatment approach for substance use disorders (SUD) in these isolated areas. The current study explored feasibility and acceptability, and potential differences in variance accounted for by group randomization on substance use and secondary outcomes, between MBRP and treatment as usual (TAU) in a rural treatment setting, as well as the impact of a specially designed mobile application on treatment engagement and enactment. No differences were observed in variance of substance use or secondary outcome by groups; however, participants in TAU vs. MBRP were more likely to drop out of treatment against medical advice. The mobile application did not appear to impact treatment engagement or enactment. Implications and limitations are discussed.

Table of Contents

Acknowledgements..... 2

Abstract.....3

Table of Contents.....4

Chapter 1: Manuscript Prepared for Publication.....6

 Introduction.....7

 Method.....25

 Results.....32

 Discussion.....36

Chapter 2: Literature Review.....60

 Rural Substance Abuse.....61

 Associated Peripheral Problems.....63

 Potential Contributing Factors.....64

 Barriers to Care.....65

 Proposed Solutions.....69

 Research with Rural Populations.....71

 Mindfulness and Substance Use Disorders.....72

 Peripheral Factors.....74

 Mindfulness-Based Relapse Prevention.....75

 MBRP for Rural Communities.....76

 Smartphone Apps and Behavior Change.....78

 References.....80

Chapter 3: Initially Proposed Methodology.....91

Chapter 4: Response to Reviews of Initially Proposed Methodology.....100

Chapter 1:

Manuscript Prepared for Publication

Introduction

Problematic Substance Use: Disproportionate Impact on Rural Communities

Problematic substance use continues to negatively impact and burden the people and resources of the United States. In 2013, an estimated 24.6 million Americans self-identified as current illicit drug users, and more than half of the U.S. population reported drinking alcohol, with one quarter binge drinking and 10% driving under the influence of alcohol. Engagement in treatment, however, lags far behind the problem. Of the 24.6 million Americans who self-identified as needing substance use treatment (itself a minority of overall substance users), an estimated 20.2 million of them denied having received any in the past year (Adams, Knopf, & Park, 2014).

This disparity phenomenon appears to be disproportionately greater in rural communities, defined as geographic areas more than 10 miles away from the centroid of a population center of 40,000 people or greater (Oregon Office of Rural Health, retrieved from <http://www.ohsu.edu/xd/outreach/oregon-rural-health/data/rural-definitions/>). More than half of rural drug users meet diagnostic criteria for drug dependence and have never received any form of treatment services (Oser et al., 2011), with similar trends among people who struggle with problematic alcohol use (Dawson et al., 2005). While rural opioid users appear to experience higher rates of overdose, the ongoing expansion of the opioid epidemic may be closing the disparity between rural and urban impact (Dunn, et. al., 2016).

Early research demonstrated an increasing but overall lower instance of substance use disorders (SUD) in rural areas (Gfroerer, Larson, & Colliver, 2007; Diala, Muntaner, & Walrath, 2004), as well as protective factors against problematic use in these communities, (Schoeneberger, Leukefeld, Hiller, & Godlaski, 2006; Leukefeld et al., 2002). More recent and

larger studies suggest rural youth tend to use more substances than urban counterparts, with findings consistent across developed nations (Coomber et al., 2011). However, other recent studies appear to challenge this trend by identifying lower drug access and strong religious beliefs as buffers against rural youth prescription opioid use, offsetting the risks imposed by criminal activity, lower perceived substance use risk, and high emergency department utilization among this population (Monnat & Rigg, 2016).

Use of methamphetamine and cocaine has also seen an exponential increase in rural communities (Booth et al., 2010), with rates of rural cocaine use estimated to be at least three times that in urban areas, representing a specific and pressing threat to public health in these areas (Falck et al., 2007), even beyond that of methamphetamine use (Garrity et al., 2007). However, methamphetamine use is still highly problematic, with an estimated annual cost of \$23.4 billion, 70% of which is related to health burden and mortality associated with addiction (Dobkin & Nicosia, 2009).

Additional Impact of Peripheral Factors on Rural SUD

Beyond the direct public health harms attributable to SUD, studies suggest that rural communities also appear to experience increased secondary consequences. Criminal behavior, previously only associated with urban drug abuse, is becoming evident in rural communities as well, possibly due to the rapid increase in methamphetamine use and availability (Herz & Murray, 2003). Rural areas report higher instances of driving under the influence, possibly related to rural-specific factors such as increased time spent on the road, greater distance between alcohol consuming locations, and lack of public transportation (Webster et al., 2009). This is taxing on rural drug courts, as they were developed and implemented without

consideration of rural-specific factors, which may dampen their effectiveness in combatting SUD from a justice approach (Bouffard & Smith, 2005).

Rural-Specific Factors Perpetuating Impact

Several community characteristics common to rural areas may explain differences in patterns of use between rural and urban communities. Economic crises in farming and coal mining industries have exerted a devastating impact on rural community resilience (Schoeneberger, Leukefeld, Hiller, & Godlaski, 2006). Managing the chronic pain associated with these professions, as well as in logging (Leukefeld, Walker, Havens, Leedham, & Tolbert, 2007) and high impact seasonal agriculture work, has been associated with binge substance use and overprescribing of prescription opioids in rural areas (Hall, Leukefeld, & Havens, 2013). Overprescribing of prescription pain management drugs such as oxycodone by overextended physicians has also likely contributed to increased intravenous opioid use in rural communities (Young & Havens, 2012).

Other contributing factors may include a general cultural acceptability of substance use in these communities (Leukefeld, Walker, Havens, Leedham, & Tolbert, 2007), with oxycodone often serving as social capital in low-income, rural areas where it can be valued as currency (Draus & Carlson, 2009). Indeed, relatively small social circles and few opportunities of acquaintance diversification can create a “vortex” that perpetuates SUD in small towns with newly abundant drug supplies (Draus & Carlson, 2009). Finally, internet-enhanced distribution networks now connect urban distributors with rural markets (Dew, Elifson, & Dozier, 2007). These factors, in addition to simple boredom (Willging, Quintero, & Lillioth, 2014), create an environment highly conducive to the development and maintenance of SUD in rural areas. While

data suggest these factors are contributive, the largest perpetuating factors of rural SUD appear to be rural-specific barriers to SUD treatment (Sexton, Carlson, Leukefeld, & Booth, 2008).

Rural-Specific Barriers to SUD Treatment

Sexton, Carlson, Leukefeld, and Booth (2008) identified specific, economic, organizational, social, psychological, and geographical barriers to accessing addiction and mental health treatment in rural areas. Economic barriers include cost of treatment, but also opportunity cost of dedicating time to treatment versus time spent working or looking for work, and appears to continue to perpetuate the rural/urban care gap even after implementation of the Affordable Care Act (Chavez, Kelleher, Matson, Wickizer, & Chisolm, 2018); organizational barriers include limits on providers' abilities to coordinate care across healthcare systems for interrelated or complex presenting problems; social barriers include an inherent distrust in the effectiveness of addiction treatment, as well as a sense of stigma and fear of community response; psychological barriers include un-, or under-treated psychological comorbidities and life stressors; and geographic barriers are related to the distance clients often have to travel to receive services (Sexton, Carlson, Leukefeld, & Booth, 2008). These findings have been corroborated by other researchers, in addition to concerns regarding treatment confidentiality in these communities (Browne et al., 2016a; Young, Grant, & Tyler, 2015).

The extent to which geographic barriers impact accessibility to treatment is not completely clear. Client and patient characteristics such as health status, functional impairment, travel cost, and work/family obligations differentially impact the extent to which simple geographical distance represented a barrier to accessing addiction treatment (Buzza et al., 2011).

Individuals engaging in problematic drug use in rural areas appear less likely to access services than urban users, perhaps due to disparities in availability, accessibility, and cultural

acceptability of the services (Metsch & McCoy, 1999), and have expressed a need for increased treatment options (Falck et al., 2007). This disparity limits research in these communities, and treatment providers in rural areas are less equipped to provide detoxification services, intensive outpatient care, opioid replacement treatment, and transitional housing services (Oser, Harp, O'Connell, Martin, & Leukefeld, 2012), and appear to use generally antiquated treatment and infrastructure technologies (Browne et al., 2016b). It is estimated that only 10.7% of rural hospitals are equipped to provide detoxification services, compared to 26.5% of urban facilities (Dew et al., 2007), and follow up with any available substance use treatment from primary care referrals is lower in rural areas (Chan et al., 2016). Rural areas have fewer Emergency Medical Technicians trained in the administration of the powerful opioid overdose reversal drug, naloxone (Faul et al., 2015), which is a life-threatening liability for rural opioid users, who also have less access to the needle exchange programs and virus testing services available to urban users (Day, Conroy, Lowe, Page, & Dolan, 2006). Though access to naloxone has increased, there are puzzling trends in some rural areas where access to this effective, available, and affordable tool seems to be intentionally slowed, such to the extent that some have suggested this comes from a punitive attitude towards people struggling with SUD (Dombrowski, Crawford, Khan, & Tyler, 2016).

Lack of updated facilities, geographic isolation from providers, and limited interagency cooperation may exacerbate these limitations (Pullen & Oser, 2014), with a notable lack of treatment resources for comorbid substance use and mental health disorders (Hoolahan, Kelly, Stain, & Killen, 2006). Over 60% of rural counties do not have a physician with a Drug Enforcement Agency waiver to prescribe buprenorphine to people struggling with opioid use (Andrilla, Coulthard, & Larson, 2017), and even those who do still may be unintentionally

overrepresenting the number of patients actually receiving this treatment (Andrilla, Coulthard, & Patterson, 2018).

Other barriers to service include limited availability of community health and mental health resources (Merwin, Snyder, & Katz, 2006), outdated treatment technology, economic costs, and community stigma (Browne et al., 2016). Even within a community with high need for mental health and addictions treatment, rural areas generally have fewer office-based resources, higher overall prescription rates, and more services delivered by low-cost providers, relative to non-rural areas (Ziller, Anderson, & Coburn, 2010). Generally, rural treatment agencies appear less likely than urban agencies to conduct research (Jameson & Blank, 2007) and employ evidence-based practices, possibly due to limited contact with academic institutions (Dotson et al., 2014). This leaves peer-support programs such as 12-step meetings as the primary treatment modality (Cellucci & Vik, 2001), though even access to peer-support is more limited in rural areas (Young, Grant, & Tyler, 2015). Other research has found that rural treatment facilities had reduced access to qualified counselors, were more likely to depend on public funds, less likely to prescribe buprenorphine, had fewer wraparound treatments, and had fewer options for specialty care, all of which are likely attributable to lack of available physicians in these areas (Edmond, Aletraris, & Roman, 2015).

Factors that impact the providers of mental health and SUD treatment services indirectly represent additional barriers to care in rural areas. Mental health workers practicing in rural areas have identified more sources of burnout than urban providers, and report feeling underprepared and undertrained to manage professional boundaries while treating substance use and mental health disorders in small communities (Young, Grant, & Tyler, 2015; Hastings & Cohn, 2013; Bradley, Werth, Hastings, & Pierce, 2012). Providers in these areas are challenged to operate

within a context of limited economic resources, shared and conspicuous community values, generally lower health and wellness status, and limited availability and accessibility of healthcare resources, all of which impact confidentiality, boundaries, dual relationships, and allocation of financial resources when practicing in these communities (Nelson, Pomerantz, Howard, & Bushy, 2007). While there have been improvements in professional training for SUD treatment in rural areas, discrimination, sociopolitical agendas, and lack of attention to the needs of these communities may still interfere with proliferation of trained professionals in these areas (Elder, 2007), which may have contributed to the increase in recruitment of specialist providers already serving these communities to take a more active role in SUD treatment outreach efforts (Berends, 2010).

While these barriers clearly exert a significant impact on the community at large, ethnic minority populations living in rural areas are most severely impacted. Rural minorities experience more barriers to service and are especially underserved in rural areas for both mental health and SUD treatment services (Gamm, 2004). It has been suggested that this alienation from available treatment represents a risk factor that outweighs previously identified resilience factors in the rural African American communities (Brown & Van Hook, 2006). Some of the most alienated areas, however, are American Indian reservations, where access to treatment is generally the most difficult and problematic tobacco, alcohol, marijuana, and oxycodone use represent major community health crises (Dennis & Momper, 2012).

Proposed Solutions for Overcoming Barriers and Improving Rural SUD Treatment

The unique needs of rural communities regarding access to mental health, SUD, and healthcare services have not gone unnoticed, and various strategies have been explored as means for enhancing access. Convenient case management services appear to be an important

component in rural addictions treatment (Kopelman, Huber, Kopelman, Sarrazin, & Hall, 2006); however, implementation of these services does not appear to enhance substance abuse treatment outcomes, possibly due to the complex and extensive case management needs of this population (Hall et al., 2008).

Non-traditional venues and providers, such as nurses (Wilson & Usher, 2015), clergy (Sexton, Carlson, Siegal, Leukefeld, & Booth, 2006), peers (Boyd et al., 2005), outpatient medical centers (Cucciare et al., 2018), primary care providers (Chan et al., 2016), and educational settings (Brown, Guo, Singer, Downes, & Brinales, 2007), have also been explored as avenues for initiating mental health and SUD treatment services, though successful implementation has been limited (Hall & Gjesfjeld, 2013; Brown et al., 2007; Boyd et al., 2005). While peer support programs, such as 12-step models, may be more accessible, and effective for some (Gossop, Stewart, & Marsden, 2008), many of the ideological and practical components of the program may not fit with all stages of recovery (Day, Wilkes, & Copello, 2003) and may alienate some individuals seeking recovery services (White et al., 2013).

Alongside these efforts, there is a growing appreciation for the potential of technology to increase access to services for rural residents (Jameson & Blank, 2007) and treatment providers (Meyer, 2006). With increased inter-agency communication and coordination, telehealth services have been proposed as novel ways to increase addictions treatment engagement for rural adolescents (Miller, 2005), and the rural community at large (Paulson, Casile, & Jones, 2015). While the potential for technology and telehealth-facilitated addictions treatment is clear, early implementation was unsuccessful (Meyer, 2006). Nevertheless, after continued development and research in this area (Borders & Booth, 2007) recent efforts appear to have overcome these early challenges making telehealth treatment delivery a promising new technology in addictions

treatment (Zhou, Crawford, Serhal, Kurdyak, & Stockaliagm, 2016), especially when adopted along with other harm-reduction and public policy approaches (Moody, Satterwhite, & Bickel, 2017). Additionally, a comprehensive technology initiative, which included a mobile app, appeared to facilitate provider care integration providing SUD treatment in a highly rural and underserved setting (Mehrotra et al., 2018). The role of mobile technology in helping to combat the rural opioid epidemic specifically is promising and requires further study (Winstanley, Stroup-Menge, & Snyder, 2018), along with innovative and evidence-based practices for treating SUD.

Mindfulness and the Treatment of SUD

Mindfulness, or the process of bringing awareness to ones senses to “move beyond the well-worn grooves of our highly conditioned and largely habitual and unexamined thought processes and emotional reactivity” (viii; Segal, Williams, & Teasdale, 2012), appears to serve a central function in the interruption of the development, maintenance, and relapse of addictive behaviors (Witkiewitz, Marlatt, & Walker, 2005), and should be measured, along with psychological flexibility, as a candidate mechanism or secondary outcome. While some early reports questioned the applicability of mindfulness training to SUD treatment (Alterman, Koppenhaver, Mulholland, Ladden, & Baime, 2004; Appel & Kim-Appel, 2009), a quickly growing body of literature suggests that a promising approach for treating SUD is mindfulness training (Black, 2014).

Individuals presenting for SUD treatment appear to exhibit lower dispositional mindfulness than normative samples (Shorey, Brasfield, Anderson, & Stuart, 2014), with this deficit exacerbated among poly- versus single-substance users (Dakwar, Mariani, & Levin, 2011). Specific facets of mindfulness deficits appear to be predictive of problematic substance

use (Levin, Dalrymple, & Zimmerman, 2014) and craving (Witkiewitz, Bowen, Douglas, & Hsu, 2013), suggesting that mindfulness training and interventions that increase present-moment awareness have may disrupt the automaticity of reaction to substance-related emotional and affective triggers (Breslin, Zack, & McMMain, 2002), and lead to more effective coping responses in high-risk situations (Witkiewitz et al., 2005). This process may restructure neurobiological connections between overlearned conditioned internal and external drug cues and behaviors, as well as a restructuring of reward processing to attend to a broadening of response to include non-drug related positive stimulus response (McConnell & Froeliger, 2015), possibly by enhancing connectivity between the anterior cingulate and medial prefrontal cortices (Tang, Tang, & Posner, 2016).

A meta-analysis found that deficits in trait mindfulness were associated with alcohol use and problematic substance use behaviors (Karyadi, VanderVeen, & Cyders, 2014), though many of these studies' participants consisted of college student samples. Interventions using formal mindfulness training to increase mindfulness, or Mindfulness-Based Interventions (MBIs), have been demonstrated to significantly reduce use and misuse of alcohol, cocaine, amphetamines, marijuana, cigarettes, and opioids to a significantly greater extent than waitlist controls, active controls, and other specific control comparisons (Chiesa & Serretti, 2014). Other reviews present evidence that mindfulness training targets the larger, biopsychosocial domains of problematic substance use and pathology which lead to neurological reward system restructuring, increased emotion regulation, identification and clarification of personal values and spirituality, and self-awareness (Shonin & Gordon, 2016).

With this promising meta-analytic and review-level evidence, MBIs for SUD need to be sensitive and ecologically valid when applied to special populations in order to demonstrate

measurable impact (Amaro, 2014). Fortunately, MBIs for SUD seem to be adaptable and acceptable to special populations including youth inpatient settings (Himmelstein, Saul, & Garcia-Romeu, 2015), detoxification units (O'Connell, 2009), jail inmates (Bowen et al., 2006), and low-income, highly marginalized populations (Vallejo & Amaro, 2009). MBIs for treatment of SUD appear to have a particularly critical role for reaching individuals for whom traditional 12-step approaches are not a good fit (Bayles, 2014), while at the same time being congruent with this treatment modality (Dermatis & Egelko, 2014). In addition to the promising role of MBIs in the treatment of SUD, they appear to have a positive impact on co-occurring and associated peripheral factors, which often exacerbate negative substance use-related consequences, representing a potentially critical component of treating co-occurring disorders (Shorey, Elmquist, Anderson, & Stuart, 2015).

Mindfulness and Secondary Outcomes

There is growing evidence that MBIs for problematic substance use also have a positive impact on psychiatric and trauma symptoms (Garland, Roberts-Lewis, Tronnier, Graves, & Kelley, 2016), as well as physiological and psychological indices of stress (Brewer et al., 2009). Comorbid SUD and both depression, and post-traumatic stress disorder (PTSD) seem to be characterized by lower trait mindfulness (Shorey et al., 2014), and comorbid SUD and PTSD can be successfully treated with MBIs and related treatment approaches (Foster & Kelly, 2012), which suggests that trauma may serve a maintenance function for substance use, and possible mechanism of action in treatment that should be measured in MBI research. The role of these peripheral factors merits further study as secondary outcomes in MBI research.

In addition to measures of SUD severity, studies of MBIs for SUD have found positive effects on depressive symptoms (Shorey, Gawrysiak, Anderson, & Stuart, 2015), major

depressive disorder (Brewer, Bowen, Smith, Marlatt, & Potenza, 2010), legal and medical problems (Witkiewitz et al., 2014), and binge eating (Courbasson, Nishikawa, & Shapira, 2011), and trait mindfulness may be protective against the development of PTSD (Thompson, Arnkoff, & Glass, 2011), providing further evidence for the significance of trauma and PTSD in the development and maintenance of SUD. Other evidence suggests that deficits in mindfulness may be implicated in other problematic conditions for individuals seeking SUD treatment and also experiencing borderline features and suicidal ideation (Shorey et al., 2016), low self-control and parent-child conflict (Tarantino, Lamis, Ballard, Masuda, & Dvorak, 2015), and compulsive sexual behaviors (Shorey, Elmquist, Gawrysiak, Anderson, & Stuart, 2016).

Possible explanations for positive outcomes for co-occurring disorders point to similar mechanistic processes between SUD and other mental health conditions. MBIs may provide dually-diagnosed individuals increased ability to decrease avoidance, increase tolerance of aversive experiences and emotional states, unlearn maladaptive reactions, and weaken the associations between these experiences and substance-related behaviors and mental health problems (Brewer et al., 2010). This has particular significance in rural areas, as they generally have less available treatment for both dual diagnosis (Hoolahan, Kelly, Stain, & Killen, 2006) and PTSD (Hassija & Gray, 2011). MBIs also appear to attenuate the relationship between depression and craving (Witkiewitz & Bowen, 2010), negative affect and craving (Garland, Roberts-Lewis, Kelley, Tronnier, & Hanley, 2014), psychological inflexibility (Luoma, Drake, Kohlenberg, & Hayes, 2011), and PTSD symptoms and substance use (Bowen, De Boer, & Bergman, 2016) suggesting that they may target the underlying bidirectional relationships maintaining comorbidities.

Taken together, evidence supports the use of MBIs in the treatment of SUD and related problems. One of the most robustly examined MBIs for addiction is Mindfulness-Based Relapse Prevention (MBRP; Bowen, Chawla, & Marlatt, 2010).

Mindfulness-Based Relapse Prevention

MBRP combines standard, cognitive-behavioral relapse prevention with formal meditation training and practice in an 8-week group therapy format with weekly, two-hour sessions (Bowen, Chawla, & Marlatt, 2010). Therapists facilitate mindfulness practices and discussions of clients' observations, relevant experiences and related skills as they relate to cravings, stressors and high-risk situations, with weekly instructions for home practice and exercises.

The specific targets and practices in MBRP are hypothesized to impact the reward, conditioned learning, motivation, stress, interoception, and executive control neural systems that appear to perpetuate substance use behavior (Witkiewitz, Lustyk, & Bowen, 2013). Specific practices to increase present-moment awareness and sustain contact with discomfort, and to reduce reactivity to substance cues, are thought to increase self-regulation and non-reactivity, and enhance attentional control by targeting the use-related associations in these brain regions (Witkiewitz, Lustyk, & Bowen, 2013). A recent review of MBRP (Penberthy et al., 2015) concludes that existing studies demonstrate initial efficacy for clinical applications of MBRP in the prevention of relapse with a variety of substances. MBRP has been successfully implemented with a wide variety of populations and settings, and may be more effective in treating substance use and related outcomes than treatment as usual and cognitive-behavioral relapse prevention (Bowen et al., 2014). MBRP appears widely acceptable, as it has demonstrated improvements in drug and alcohol outcomes with low-income, ethnically diverse women (Amaro, Spear, Vallejo,

Conron, & Black, 2014), and may even be more efficacious than treatment as usual with ethnic minority populations (Witkiewitz, Greenfield, & Bowen, 2013). MBRP has also demonstrated a positive impact on medical and legal problems in a residential treatment population, in addition to favorable substance use outcomes (Witkiewitz et al., 2014), and appears particularly helpful for participants with low distress tolerance (Hsu, Collins, & Marlatt, 2013).

MBRP: A Promising New Approach to Treating SUD in Rural Communities

Due to its demonstrated effectiveness in treating addictive behaviors with traditionally underserved and treatment-resistant populations, MBRP may be a promising approach to addressing the disparities in and barriers to substance abuse treatment in rural communities. MBRP does not require extensive client-provider contact, intensive follow-up, or systems-level resources. Rather, it assists clients in discovering and drawing upon their own inner resources to respond effectively to craving (Bowen, Chawla, & Marlatt, 2010). These features suggest that MBRP may have the potential to overcome some of the economic, organizational, social, psychological, and geographical barriers of access to rural SUD treatment (Sexton, Carlson, Leukefeld, & Booth, 2008). Given that MBRP and related MBIs have also shown salutary effects on associated mental health problems in SUD populations (Garland et al., 2016; Brewer et al., 2009; Foster & Kelly, 2012), possibly due to the related processes that maintain addictive behaviors and mental health problems (Brewer et al., 2010), MBRP may also be a vital response to the problematic lack of dual diagnosis treatment in rural communities (Hoolahan et al., 2006), as integrated SUD and mental health treatments in these areas appear to have the most successful implementation (Clark et al., 2004). MBRP is an evidence-based practice with features that may address barriers to care in rural areas, such as its limited need for provider contact and sustained follow-up, as well as the cultivation of clients' individual, inner resources to manage their

recovery (Bowen, Chawla, & Marlatt, 2010). Data do not suggest differential gender effects (Bowen et al., 2014), and support its efficacy with low-income women of color (Amaro et al., 2014), which may be of particular significance in rural areas where this demographic appears especially isolated from treatment resources (Gamm, 2004). This lends support for the study of the feasibility and acceptability of MBRP in rural areas, as a potentially effective and novel treatment approach sensitive to rural-specific barriers.

An integral part of MBRP, similar to the other MBIs, is between-session mindfulness practice. Other studies of MBRP have identified between-session practice as a mechanism of positive treatment gains (Bowen & Kurz, 2012), as well as the challenges associated with between-session practice engagement in diverse populations (Amaro et al., 2014). Sustaining mindfulness practice after the conclusion of the 8-week group appears to be a challenging, but a potentially critical, component of maintaining treatment gains (Grow, Collins, Harrop, & Marlatt, 2015). Strategies for overcoming barriers to treatment engagement and enactment, or the extent to which clients participate in treatment and apply learned skills in their daily life, are critical to attend to in rural settings, given the prevalence of existing barriers and lack of related support (Sexton et al., 2008).

Telehealth (Miller, 2005) and technology (Paulson et al., 2015) may facilitate engagement in both addictions treatment and research (Jameson & Blank, 2007) within rural communities, as well as provide a systems-level method to connect providers with struggling substance users in rural or isolated areas (Fifield & Oliver, 2016). Some evidence suggests computerized delivery of comorbid depression and substance abuse treatment was equally effective in urban and rural areas (Kay-Lambkin, Baker, Kelly, & Lewin, 2012). This suggests

that mobile-assisted technology, such as smartphone apps, may be a novel and effective supplement to implementation of MBRP in rural communities.

Smartphone Apps to Augment Treatment

Results from research on effectiveness of mobile apps in behavior change processes are mixed. A variety of behavior change apps have been developed and reviewed positively by users for art therapy (Mattson, 2015), smoking cessation (Iacoviello, et al., 2017), reducing alcohol use (McTavish, Chih, Shah, & Gustafson, 2012; Barrio, Ortega, López, & Gual, 2017), college-specific alcohol use (Pocuca et al., 2016; Hides et al., 2018), prolonged exposure for PTSD (Kuhn et al., 2015), and college sexual behavior (Richman, Webb, Brinkley, & Martin, 2014). However, these apps have been deemed unlikely to actually impact behavior (Pocuca et al., 2016). Other studies suggest use of apps support diabetes management (Fukuoka, Gay, Joiner, & Vittinghoff, 2015), prenatal maternal wellness in a rural community (Bush, Barlow, Echols, Wilkerson, & Bellevin, 2017), prevention of non-suicidal self-injury (Franklin et al., 2016), physical fitness (Higgins, 2016), and vegetable consumption (Mummah, King, Gardner, & Sutton, 2016), though problems persist such as low widespread adoption of the mobile platforms (Helander, Kaipainen, Korhonen, & Wansink, 2014), and poor sustainment of treatment gains (Fukuoka et al., 2015; Franklin et al., 2016).

Further studies suggest that limited beta-testing may be cause for lack of success in implementing mobile apps for behavior change (Campbell, Hester, Lenberg, & Delaney, 2016). The National Institutes of Health concluded in a recent review that behavior change apps generally lacked evidence of collaborations between users and professionals, suffered from poor user interface and usability, limited the usable customizability, and overlooked strategies for maintaining new behaviors (McMillan, Hickey, Patel, & Mitchell, 2016). Other studies have

pointed to lack of adherence to medical guidelines and recommendations (Abroms, Padmanabhan, Thaweethai, & Phillips, 2011), involvement of healthcare professionals (Rosser & Eccleston, 2011), evidence-based practices (Abroms, Westmaas, Bontemps-Jones, Ramani, & Mellerson, 2013), and formal study and evaluation (Eng & Lee, 2013) as problematic limitations of currently available apps for behavior change, specifically those related to SUD (Penzenstadler, Chatton, Van Singer, & Khazaal, 2016). In spite of these limitations, there still appears to be strong interest among patients in the incorporation of mobile technology into SUD treatment (Ashford, Lynch, & Curtis, 2018; Sharpe et al., 2018; Ashford et al., 2018), and there is support for using apps to facilitate mindfulness practice in a medical setting (Rosen, Paniagua, Kazanis, Jones, & Potter, 2018; Smith et al., 2018).

Use of mobile technology and apps to enhance access and engagement in treatment represents an important area for continued study (Kratzke & Cox, 2012), with identified limitations of design and implementation suggesting areas of focus for future app and trial design. For example, existing literature offers strategies to avoid pitfalls in continued research of mobile-assisted behavior change, largely through extensive beta-testing (Campbell et al., 2016), and careful attention to facilitating maintenance of treatment gains following the intervention (Fukuoka et al., 2015; Franklin et al., 2016), and recruiting a sufficiently large sample size (Payne, Lister, West, & Bernhardt, 2015).

With rural populations in particular, mobile apps may be an important technology to transmit evidence-based practices from academic and medical centers into more isolated rural areas (Jameson & Blank, 2007; Meyer, 2006). A mobile app developed specifically to support MBRP may improve treatment engagement and enactment, lower the need for provider contact, and enhance feasibility and acceptability of the intervention, improving its effectiveness in

populations with difficulty accessing care, and traditionally lower levels of involvement and improvement.

The purpose of the current study is threefold: 1) assess feasibility and acceptability of MBRP in a rural population; 2) compare substance use and secondary outcomes between participants randomized to MBRP and treatment as usual (TAU); and 3) develop a mobile app to facilitate delivery of MBRP and study the impact of this app in rural addictions treatment settings by comparing engagement and enactment between app-enhanced MBRP and standard MBRP.

AIM 1: Assess feasibility and acceptability of MBRP in a rural population.

H1a: Treatment feasibility will be evinced by MBRP participant retention rate of $\geq 65\%$.

H1b: Treatment acceptability will be evinced by positive appraisal of the intervention, based on the course satisfaction survey, with participants rating the importance of the intervention, and likelihood of continuing formal and informal mindfulness practice at least 8/10 on a Likert-type scale (Bowen et al., 2009).

AIM 2: Compare substance use and secondary outcomes of MBRP compared to TAU.

H2a: Randomization to MBRP will predict superior substance use outcomes compared to those randomized to TAU, specifically lower severity of dependence and craving, and fewer negative consequences of substance use at post-course.

H2b: Randomization to MBRP will predict significantly greater increases in secondary outcomes compared to those randomized to TAU, specifically greater mindfulness, psychological flexibility, and decreases in trauma symptoms at post-course.

AIM 3: Assess group differences in treatment engagement and enactment between MBRP participants assigned to use a specially designed and manual adherent mobile application (MBRP-Mobile), compared to participants in standard MBRP.

H3a: Participants assigned to MBRP-Mobile versus standard MBRP will demonstrate higher engagement as measured by session attendance.

H3b: Participants assigned to MBRP-Mobile versus standard MBRP will demonstrate higher enactment as measured by home mindfulness practice during the follow-up period.

Method

Participants

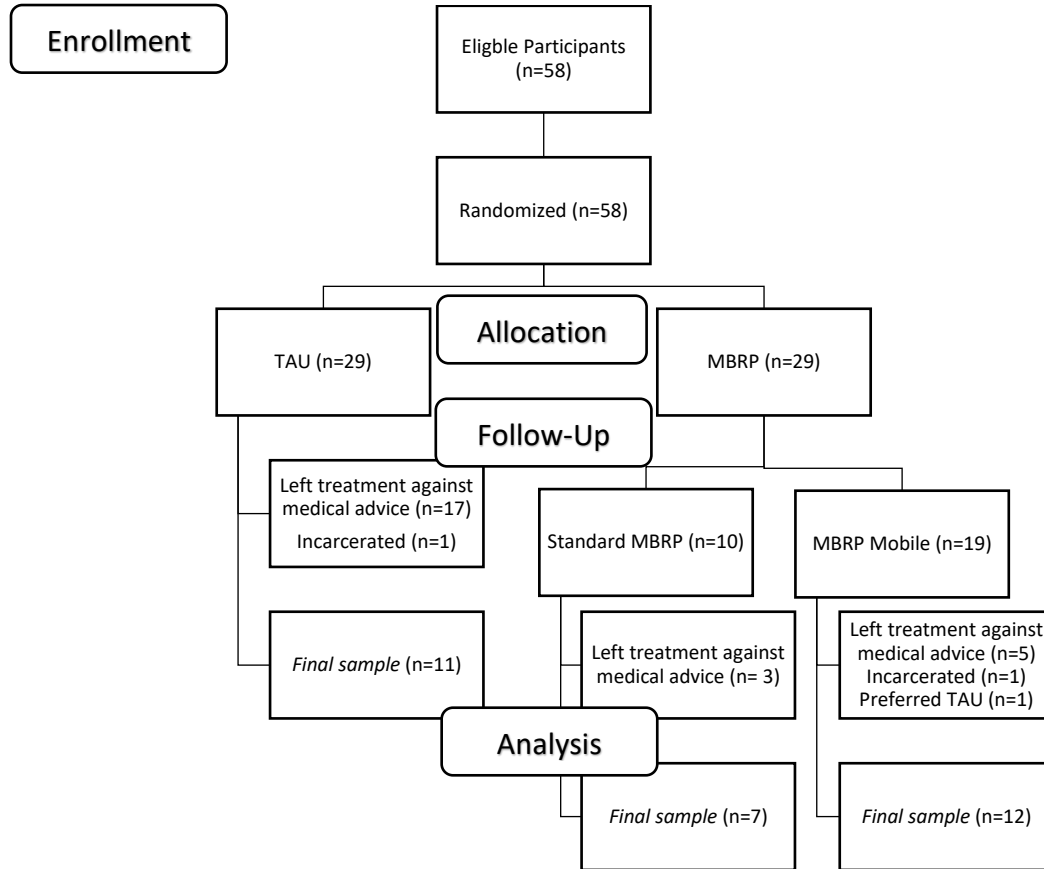
Based on an a priori power calculation using G*Power for a medium effect size on outcomes between MBRP and TAU, we sought to recruit at least 36 participants, with 18 randomized to MBRP and 18 to TAU. While multiple measures increased the likelihood of a Type-I Error, alpha inflation in an initial efficacy study such as this is of less concern (Field, 2009) and so alpha was set at .05. Participants were recruited from current clients receiving SUD treatment through a public treatment agency in the rural Pacific Northwest through direct referrals from agency staff. Potential participants were screening for exclusionary criteria (under 18, active psychotic features, risk of medical withdrawal as determined by agency staff, current active suicidal ideation, expected to complete treatment in less than eight weeks) before being invited to participate. Eligible participants were informed that they were a good fit for the study, given a personal identification number, and informed of the assessment procedure. All assessments were conducted via paper-and-pencil measures in small group sessions with research personnel. A total of 58 eligible participants were recruited for this study.

Participants were fairly well balanced across gender with 29 (42%) males, 18 females (40.6%), and 1 transgender male (1.4%). The sample overwhelmingly identified as Caucasian/white (91.4%), with 3 identifying as multiracial (4.3%), 1 as American Indian/Alaskan Native (1.4%), and 1 as Native Hawaiian or other Pacific Islander (1.4%), with a mean age of 36 (SD=12) and approximately 81% living below the federal poverty level.

Participants were randomized into MBRP and TAU using a 1:1 ratio (n = 28 MBRP and n = 29 TAU) using an online randomization tool. Based on their personal schedules and existing treatment plans, participants attended either a morning group or an evening group at one of two clinic locations (A and B), so those randomized to the MBRP condition who attended a morning group at Location A, or evening group at Location B were selected into MBRP with the addition of the specially designed mobile application, MBRP-Mobile (n = 19), with the rest receiving standard MBRP (n=10) in an evening group at Location A. While these group sizes limit power, the primary purpose of this study was to explore preliminary feasibility and acceptability of MBRP, and the use of mobile apps in a rural SUD treatment setting. There was no cost to participants for the MBRP course or the MBRP-Mobile app, and gift card incentives for completion of assessments (up to \$60 per subject) were provided to support participant retention.

Figure 1.

Consort diagram



Feasibility & Acceptability Measures

Treatment feasibility was assessed by session attendance.

Treatment acceptability was measured by the post course satisfaction survey which has been used in previous MBRP studies (Bowen et al., 2014).

Substance Use Outcome Measures

Severity of dependence was measured by the Severity of Dependence Scale (SDS) which has demonstrated good reliability in previous studies (Gossop et al., 1995). Reliability in the current study was good to excellent (Cronbach’s alpha pre = .82, post = .90).

Negative consequences of substance use were measured using the Short Inventory of Problems (SIP), an adapted alcohol problem severity index that can be used for all alcohol and drug-related consequences and has demonstrated good reliability (Feinn, Tennen, & Kranzler, 2003). Reliability in the current study was excellent (Cronbach's alpha pre = .94, post = .98).

Craving was assessed using the Penn Alcohol Craving Scale (PACS; Flannery, Volpicelli, & Pettinati, 1999), which has demonstrated excellent reliability and was modified to assess craving for all substances as has been done in previous MBRP studies (Bowen et al., 2014). Reliability in the current study was excellent (Cronbach's alpha pre = .94, post = .94).

Secondary Outcome Measures

Mindfulness was measured by the Five Facet Mindfulness Questionnaire (FFMQ), which assesses several composite domains of mindfulness and has demonstrated good (Baer et al., 2008) to acceptable (Christopher, Neuser, Michael, & Baitmangalkar, 2012) reliability. Reliability in the current study was good (Cronbach's alpha pre = .84, post = .86).

Psychological flexibility was measured by the Acceptance and Action Questionnaire – Substance Abuse, which has demonstrated good reliability (AAQ-SA; Luoma et al., 2011). Reliability in the current study was excellent (Cronbach's alpha pre = .90, post = .93).

Trauma symptoms were measured by the civilian version of the PTSD Checklists (PCL-C; Conybeare, Behar, Solomon, Newman, & Borkovec, 2012) which measures experience of trauma response and has demonstrated good to excellent reliability. Reliability in the current study was good to excellent (Cronbach's alpha pre = .93, post = .87).

Engagement & Enactment Measures

Treatment engagement was measured by session attendance.

Treatment enactment was measured by the Meditation Practice Questionnaire (MedPQ; Bowen, et al., 2009).

Mindfulness-Based Relapse Prevention

MBRP was delivered per outlined clinical protocol (Bowen, Chawla & Marlatt, 2010), with no deviations or adaptations from standard delivery. The MBRP group had 10 participants at outset and was delivered in eight weekly, two-hour group sessions by one facilitator, with participants' TAU group facilitator shadowing the sessions but not participating in intervention delivery. The first two sessions of MBRP target awareness of "automatic pilot" and consequences of reactive "automatic" impulses or behaviors. Specifically, the first session includes experiential discernment between acting with, versus reacting without, awareness, and explores the relevance to substance use and relapse. Session two focuses on recognizing relapse triggers and introduces mindfulness training as a strategy for experiencing these triggers without automatically reacting. Sessions 3-6 help participants develop a repertoire of alternative responses to stressful and high-risk situations, and provide support for practicing these skills in daily life. Specifically, session three introduces practices of pausing and bringing gentle, approach-based awareness to internal experience as a strategy for returning to the present moment, especially in high-risk situations. In session four, participants practice staying present in challenging situations, or those which have been previously associated with substance use, and subsequent reactive, "automatic pilot" behavior. Session five introduces acceptance as an important step for releasing attempts to control situations or experiences that participants cannot control, while taking skillful and meaningful action where possible. Session six uses various mindfulness practices to help clients create distance between thought content and direct, in-the-moment experience, and exploring the role that fusion with thoughts has to relapse using a

behavior chain analysis. The final two sessions focus on cultivating self-care and maintaining social support. Session seven introduces the importance of expanding awareness into the broader picture of participants' lives, outside of addiction, and increasing various nourishing activities and skillful behaviors. Finally, session eight summarizes the journey of the course, reviews content, and provides support for continued practice and community engagement (Bowen, Chawla & Marlatt, 2010).

MBRP-Mobile

The MBRP Mobile groups were administered in a morning and afternoon session to a total of 19 different participants, with their TAU group facilitator shadowing but not participating in intervention delivery. The morning group was facilitated by two intervention therapists, and the evening group facilitated by one. The group was delivered per outlined MBRP clinical protocol (Bowen, Chawla & Marlatt, 2010), with no deviations or adaptations from standard delivery, except that these groups were asked to access the "MBRP Mobile" app from Google and Apple app stores at the beginning of the fourth session. This app contains audio practices, digital access to homework assignments and practice tracking and feedback. Part of this introduction involved orienting participants to the app and providing instructions and guidelines for use.

Throughout the course of MBRP-Mobile, participants were instructed to access audio recordings of various formal and informal mindfulness practices. These recordings were contained within the app in a centralized location to facilitate convenience of use. The audio files, when selected, played directly through participants' own Smartphones and related devices.

In standard MBRP, group summaries and reminder handouts were provided at the conclusion of each session. With MBRP-Mobile, participants were able to access these handouts digitally, through their own devices using the app.

MBRP-Mobile also contained a graphical representation of summary of practice, as measured by time spent listening to formal audio files, and mood and craving measured by slider bar prompts before each practice. Using line graph and color coding, this feature allowed participants to view a personalized, graphical representation of a summary of their practice, moods, and cravings as a means for exploring interactions between practice and internal states in an accessible and convenient way.

Several features of the app were developed to facilitate participant safety and privacy. The app included an “S.O.S.” button on the home screen which allowed users to upload identified photos and emergency contacts, such as those of a loved one or sponsor. Graphically, the icon for MBRP-Mobile contained no reference or cues to it being a treatment-service product, and users were provided with information and suggestions for maintaining privacy while using the app when it was introduced.

Treatment as Usual (TAU)

Treatment as usual condition consisted of regularly scheduled activities as a part of regular intensive outpatient treatment at the agency. Treatment was informed by the Matrix model of directive, supportive behavior modification and consists of relapse prevention groups, psychoeducation groups, social support groups, and individual therapy (Obert et al., 2000).

MBRP Intervention Therapist Training

Masters-level intervention therapists completed a five-day residential MBRP training that is the established standard for MBRP clinical practitioners. This training program includes

didactic instruction, role-play, and experiential practice. All intervention therapists were supervised by a licensed psychologist and co-developer of the intervention. To assure adherence to the manual, intervention therapists also co-facilitated each morning session, so that each afternoon session reflected the same content.

Statistical Analysis

To assess feasibility and acceptability of MBRP in a rural community, session attendance was collected and participants were asked to complete a course satisfaction survey, which asked respondents to rate, on a Likert-type scale of one to ten, how important the program had been to them, how likely they were to continue with formal meditation practice, and how likely they were to continue with informal meditation practice.

To assess impact of group randomization on substance use and secondary outcomes between participants in TAU and either MBRP condition, a series of linear regressions were conducted to explore variance accounted for by group designation, when controlling for baseline values of the dependent variables. To explore differences in treatment engagement and enactment between MBRP and MBRP-Mobile conditions, t-tests were used to compare session attendance and minutes of mindfulness practice between MBRP and MBRP Mobile groups. Statistical assumptions and tests of normality were conducted with the Kolmogorov-Smirnov test. A zero-order correlation matrix was used to screen for consistent patterns of multicollinearity and potential covariates to include in the analysis (see Table 2).

Results

Of participants randomized to either MBRP condition, 19/29 (65.5%) were retained throughout the full eight weeks of the intervention. Participants also rated the intervention as highly important to them ($M = 8.15/10$, $SD = 2.03$), and indicated that they were highly likely to

continue with formal ($M = 8.4/10$, $SD = 2.50$) and informal ($M = 9.25/10$, $SD = 1.41$) mindfulness practice, supporting H1a and H1b by establishing that MBRP is a feasible and acceptable treatment for rural communities. No differences were observed between groups on substance use outcomes (see Table 3). For severity of dependence, as measured by the Severity of Dependence Scale (SDS), there were no significant differences between either MBRP group and TAU ($\beta = -.24$, $p = .24$), refuting H2a that randomization to MBRP would predict significantly better SUD outcomes than TAU. No main effects were observed. For negative consequences of substance use, as measured by the Short Inventory of Problems (SIP), there were no significant differences between either MBRP group and TAU ($\beta = -.11$, $p = .65$), refuting H2a. No main effects were observed. For craving, as measured by the Penn Alcohol Craving Scale (PACS) adjusted for all substance craving, no significant differences were observed between MBRP and TAU ($\beta = -.32$, $p = .08$), refuting H2a. No main effects were observed.

In examining secondary outcomes, no significant differences were observed either. For mindfulness, as measured by the Five Facet Mindfulness Questionnaire (FFMQ), no significant differences were found between either MBRP group and TAU ($\beta = .17$, $p = .41$) refuting H2b that participants in MBRP conditions would demonstrate significantly better change in secondary outcomes than TAU. Baseline mindfulness did appear to predict post-course mindfulness ($\beta = .54$, $p = .01$). For psychological flexibility, as measured by the Acceptance and Action Questionnaire for Substance Abuse, (AAQ-SA), no significant differences were observed between MBRP and TAU ($\beta = -.18$, $p = .14$) refuting H2b. Baseline psychological flexibility did appear to predict post-course psychological flexibility ($\beta = .80$, $p < .001$). For trauma symptoms, as measured by the PTSD-Checklist (PCL), no significant differences were found between either

MBRP group and TAU ($\beta = -.12, p = .49$), refuting H2b. Baseline trauma symptoms did appear to predict post-course trauma symptoms ($\beta = .64, p = .001$).

Table 1.
Descriptive Statistics

	TAU M (SD)	MBRP M (SD)	MBRP-Mobile M (SD)	Total Sample M (SD)
SDS				
Baseline	9.2 (4.0)	7.1 (5.2)	10.3 (5.0)	9.2 (4.6),
Post-Course	4.6 (4.9)	2.9 (3.5)	2.7 (3.4)	3.5 (4.1)
SIP				
Baseline	12.7 (3.9)	9.7 (6.5)	14.2 (0.9)	12.7 (4.1)
Post-Course	6.1 (6.7)	3.9 (6.6)	5.5 (6.9)	5.3 (4.1)
PACS				
Baseline	18.6 (7.8)	18.8 (10.1)	21.1 (9.0)	19.5 (8.6)
Post-Course	12.3 (9.7)	7.1(6.5)	7.3 (6.2)	9.0 (7.8)
FFMQ				
Baseline	76.2 (11.5)	81.7 (11.8)	75.6 (9.8)	77.0 (11.2)
Post-Course	82.1 (13.3)	85.3 (12.0)	81.8 (9.9)	82.7 (11.3)
AAQ				
Baseline	93.8 (17.7)	93.1 (13.5)	85.3 (13.0)	90.9 (15.9)
Post-Course	99.4 (17.3)	100.1 (16.1)	94.2 (15.9)	97.5 (16.1)
PCL				
Baseline	46.6 (14.4)	41.6 (14.6)	47.3 (17.3)	45.9 (15.2)
Post-Course	41.9 (9.1)	34.4 (8.0)	35.6 (12.9)	37.3 (10.8)

Note. SDS = Severity of Dependence Scale, SIP = Short Inventory of Problems, PACS = Penn Alcohol Craving Scale, FFMQ = Five Facet Mindfulness Questionnaire, AAQ = Acceptance and Action Questionnaire, PCL = PTSD Checklist, TAU = treatment as usual, MBRP = Mindfulness-Based Relapse Prevention, MBRP-Mobile = Mindfulness-Based Relapse Prevention with Mobile App.

Table 2.
Correlation Matrix

	SDS	SIP	PACS	FFMQ	AAQ	PCL
SDS	1					
SIP	.385*	1				
PACS	.540*	.205	1			
FFMQ	-.130	-.249	-.174	1		
AAQ	-.126	-.124	-.235	.507**	1	
PCL	.382*	.219	.319*	-.400**	-.520**	1

Note. * Correlation significant at the .05 level, ** Correlation significant at the .01 level, SDS = Severity of Dependence Scale, SIP = Short Inventory of Problems, PACS = Penn Alcohol Craving Scale, FFMQ = Five Facet Mindfulness Questionnaire, AAQ = Acceptance and Action Questionnaire, PCL = PTSD Checklist.

To further explore secondary outcomes, analyses were repeated on each of the individual five facets of mindfulness measured by the FFMQ. Because of the repeated analysis within the same measure, a Bonferroni correction was applied, which set our alpha at .01. While controlling for baseline, group randomization did not account for significant variance in the Acting with Awareness ($\beta = -.25, p = .17$), Nonreactivity ($\beta = -.05, p = .81$), Non-judging ($\beta = -.34, p = .02$) Observing ($\beta = .01, p = .95$), or Describing ($\beta = -.12, p = .50$) facets of mindfulness.

When comparing treatment engagement and enactment between MBRP and MBRP-Mobile groups, no significant differences were found between number of sessions attended ($t(23) = .64, p = .53$), with participants in standard MBRP attending a mean of 5.5 (SD=2.95) sessions and participants in MBRP-Mobile attending a mean of 6.2(SD=2.46) sessions. No significant differences were found, either, between self-reported minutes of mindfulness practiced daily ($t(17) = .27, p = .79$), with participants in standard MBRP practicing a mean of 12.78 (SD=10.64) minutes and participants in MBRP-Mobile practicing a mean of 14.00 (SD=8.76) minutes, refuting H3a and H3b, that the app would improve engagement in and enactment of MBRP.

Table 3.

Regressions for Group Effect (MBRP vs TAU) and Effect Sizes

	<i>B</i>	<i>SEB</i>	β	<i>p</i>	<i>d</i>	<i>d*</i>	<i>d†</i>
SDS	-.97	.80	-.24	.24	.17	-1.20	-1.38
SIP	-.77	1.65	-.11	.65	.17	-1.21	-9.53
PACS	-2.58	1.42	-.32	.08	.66	-1.56	.14
FFMQ	-1.97	2.36	-.17	.41	.04	.66	.97
AAQ	-3.06	2.01	-.18	.14	.02	1.46	1.61
PCL	-1.33	1.87	-.12	.49	.34	-1.01	-.59

Note. SDS = Severity of Dependence Scale, SIP = Short Inventory of Problems, PACS = Penn Alcohol Craving Scale, FFMQ = Five Facet Mindfulness Questionnaire, AAQ = Acceptance and Action Questionnaire, PCL = PTSD Checklist, *B* = unstandardized regression coefficient, *SEB* = standard error of the coefficient, β = standardized regression coefficient, *p* = significance, *d* = Cohen's *d* for between group effect size, *d** = Cohen's *d* for MBRP pre-post effect sizes, *d†* = Cohen's *d* for TAU pre-post effect sizes.

When comparing patterns of missing data, participants randomized to TAU were more likely to have dropped out of treatment at post-course ($\chi^2 = 7.8, p = .02$). Gender identity, racial identity, and sexual orientation did not impact the likelihood of participants having missing data at post course, nor did age of first traumatic experience, age of first alcohol use, age of first tobacco use, substance of choice, number of previous times in treatment, income, or clinic site location.

Discussion

The current study assessed feasibility and acceptability of MBRP in a rural population, compared substance use outcomes and secondary outcomes between TAU and MBRP groups for SUD treatment, and compared treatment engagement and enactment between MBRP and MBRP-Mobile groups. Based on findings from the current study, MBRP appears to be a feasible and acceptable intervention for SUD in rural communities, supporting Aim 1. Substance use findings included severity of dependence, consequences of use, and craving, and no differences in variance were found between treatment conditions, failing to reject the null hypothesis for Aim 2. This may be partially explained by the fact that post course assessment could only be done with participants still engaged in SUD treatment. Participant retained in treatment after the eight weeks of study likely had similar substance use patterns, regardless of group, as longer-term engagement in SUD treatment is associated with positive outcomes (Coker, Stefanovics, & Rosenheck, 2016; Brunette, Drake, Woods, & Hartnett, 2001). Interestingly, participants in TAU were more likely to drop out of treatment early, suggesting that the MBRP had better retention and is more likely to retain SUD clients in treatment.

Also contrary to hypotheses, there were no significant differences in variance accounted for by group randomization in the secondary outcomes, which included mindfulness,

psychological flexibility, and trauma, also failing to support the hypotheses for Aim 2. Some of these effects may be due to inherent limitations of self-report measures. Challenges with the self-reporting of mindfulness are well known (Brown, Warren, & Ryan, 2004; Christopher, Charoensuk, Gilbert, Neary, & Pearce, 2009), and may have limited the ability to accurately reflect group differences. It is also possible that, paradoxically, participants in the MBRP conditions actually increased awareness of their tendency to be un-mindful and were actually describing their own mindfulness in a more accurate, but deflated manner than the participants in TAU, as challenges persist in parsing out differences in measuring actual mindfulness, rather than the outcomes of mindfulness practice (Brown & Ryan, 2004). With psychological flexibility and trauma symptoms, participants in TAU were receiving treatment from Masters-level mental health counselors, thus TAU may have had similar peripheral impact on these factors as well, similar to the MBRP conditions. Between group effect sizes for substance use and secondary outcomes were generally smaller than observed in previous MBRP studies (Bowen et al., 2014), however the medium effect size for craving is consistent with previous research and with proposed mechanisms of MBRP treatment (Witkiewitz, Bowen, Douglas, & Hsu, 2013). Also, participants in MBRP demonstrated medium to large effect sizes across all variables pre- to post-intervention in the hypothesized directions, also consistent with previous studies for both substance outcomes (Bowen et al., 2014; Li, Howard, Garland, McGovern, & Lazar, 2017) and co-occurring disorders (Zemestani & Ottaviani, 2016), though the comparable effect sizes in the TAU condition in the current study is not consistent. Given how attrition impacted our final sample size (N=30), these effect sizes suggest that it is possible that statistically significant findings may be observed with larger samples.

The absence of significant differences in treatment engagement and enactment between MBRP and MBRP-Mobile conditions for AIM 3 may be due to several technical difficulties and limitations. There are factors that may have limited actual use of the app, including its large file size (199.6 MB; similar to highly sophisticated, interactive, and frequently updated news apps such as CNN and Politico), lack of high-speed data in the geographic area, or general low app usage among participants, although all participants owned a smartphone. In general, to better understand how these factors may have limited app use, more research is needed on overall smartphone use and behavior in rural areas, especially areas without high-speed data.

Despite null findings on differences between TAU and MBRP conditions on substance use and secondary outcomes, this study contributes important information regarding treatment of problematic substance use with rural populations. We found that MBRP is a feasible and acceptable intervention for rural communities. We also found that MBRP may be better at retaining participants in treatment than cognitive-behavioral TAU, perhaps due to the more experiential or novel nature of the intervention. Regardless, this contributes compelling support for the proliferation of MBRP into rural and other underserved communities.

These findings should be interpreted in context of several study limitations. The study population was predominantly Caucasian/white and, though this is reflective of the demographics of the study location, limits the extent to which findings can be applied to more diverse communities, though MBRP has demonstrated effectiveness in such communities (Amaro et al., 2014). There were some violations of statistical assumptions of parametric testing which may limit the extent to which results can be interpreted. While participants were randomized to TAU or one of the MBRP conditions, there was no random assignment to MBRP versus MBRP-Mobile, which may have limited our ability to detect group differences. In

addition, MBRP and MBRP-Mobile groups were facilitated by different intervention therapists with different levels of clinical experience, which may have had an impact on participants' group experience and outcomes.

Arguably the most significant limitation related to the technical aspects of the MBRP-Mobile role out and delivery. The MBRP-Mobile app was developed with the support of external coders. Due to unforeseen circumstances, several different coders had to be approached at different stages of app development, which significantly slowed development and forced the research team to forgo certain aspects of the app - aspects which may have improved its usability and appeal. This also delayed introduction of the app to participants, with the Apple version not becoming available until after the second session. This limitation was further exacerbated by the fact that the vast majority of participants did not own iPhones, and the Android version was not made available until session 4. This version lacked the visual aesthetic, ease of user interface, and general functionality of the Apple version, which likely discouraged participants from taking full advantage of it. Finally, also due to the multiple generations of coders recruited to develop the app, mobile analytics and participant usage information were impossible to obtain, which greatly limits the extent to which information about the app and how it was used can be discussed.

Despite these limitations, findings support that MBRP is a feasible and acceptable intervention for SUD treatment with rural populations, based on better treatment retention in the current study in MBRP versus TAU. This is of particular importance in areas where evidence-based practices are scarce (Oser, Harp, O'Connell, Martin, & Leukefeld, 2012), and communities continue to be negatively impacted by substance use epidemics (Oser et al., 2011). MBRP

represents a novel approach to SUD treatment and could be a powerful approach to engage and retain people in need of effective and evidence-based services.

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Chapter 2:

Literature review

Rural Substance Abuse

Problematic substance use continues to plague the United States. In 2013, an estimated 24.6 million Americans identified as current illicit drug users, and more than half of the U.S. population reported drinking alcohol, with one quarter binge drinking and 10% driving under the influence of alcohol. Engagement in treatment, however, lags far behind the problem. Of the 24.6 million Americans who self-identified as needing substance use treatment (itself a minority of overall substance users), an estimated 20.2 million of them denied having received any in the past year (Adams et al., 2014).

This disparity phenomenon appears to be disproportionately greater in rural communities, defined as geographic areas more than 10 miles away from the centroid of a population center of 40,000 people or greater (Oregon Office of Rural Health, retrieved from <http://www.ohsu.edu/xd/outreach/62regon-rural-health/data/rural-definitions/>). More than half of rural drug users meet diagnostic criteria for drug dependence, though have never received any form of treatment services (Oser et al., 2011), with similar trends among people who struggle with problematic alcohol use (Dawson et al., 2005). While rural opioid users appear to experience higher rates of overdose, the ongoing expansion of the opioid epidemic may be closing the disparity between rural and urban impact (Dunn, et. al., 2016).

This pattern appears to begin during formative years, as rural substance use begins at a younger age, and shows different patterns from urban youth (Adams et al., 2014). Rates of heavy drinking increase faster among rural youth (Martino, Ellickson, & McCaffrey, 2008), and higher rates of drinking are evident by middle school years (Warren, Smalley, & Barefoot, 2017), relative to their urban peers. While urban adolescents appear to use more ecstasy, rural adolescents tend to use more methamphetamine, a use disparity that evidently persists into adulthood (Gfroerer, Larson, & Colliver, 2007).

While early research demonstrated an increasing but overall lower instance of problematic substance use in rural areas (Gfroerer, Larson, & Colliver, 2007; Diala, Muntaner, & Walrath, 2004), as well as protective factors against problematic use in these communities, (Schoeneberger, Leukefeld, Hiller, & Godlaski, 2006; Leukefeld et al., 2002), more recent and larger studies suggest rural youth tend to use more substances than urban counterparts, with these findings consistent globally across developed nations (Coomber et al., 2011). However, recent studies appear to challenge this conclusion by identifying lower drug access and strong religious

beliefs as buffers against rural youth prescription opioid use, offsetting the risks imposed by criminal activity, lower perceived substance use risk, and high emergency department utilization among this population (Monnat & Rigg, 2016).

While problematic drug use in rural communities appears to transcend sex, race, age, and education, and includes varied substances and methods of administrations, there appear to be some patterns associated with demographics, drug category, use patterns and administration method. For example, evidence suggests low income rural White users generally tend to be most heavily substance involved (R. S. Falck, Siegal, Wang, Carlson, & Draus, 2005). Drugs traditionally associated with urban areas, such as heroin and prescribed narcotics, have emerged in rural communities (Hays, 2004), in addition to methamphetamine and cocaine (Booth, Leukefeld, Falck, Wang, & Carlson, 2006). While urban opioid users tended to favor oral ingestion, rural opioid users appear more inclined towards injection or insufflation (Young, Havens, & Leukefeld, 2010), and transition more quickly from time of first use to time of first injection (A. M. Young & Havens, 2012), all of which are associated with increased negative health consequences (Young, Havens, & Leukefeld, 2010). This trend can be observed nationally, with the majority of new rural opioid users being non-urban Whites who transition to opioid use from prescribed narcotics and a rapidly expanding illicit methadone trend in rural communities, again attributed to initial overprescribing of narcotics (M. T. Hall et al., 2013).

Older adults in poor health with complex medical problems in rural areas appear to be at highest risk for prescription misuse (Blalock et al., 2005). However, among rural opioid abusers, oxycodone was the most common first intravenous administration, injected as frequently as stimulants, other opioids, and heroin combined (A. M. Young & Havens, 2012).

Use of methamphetamine and cocaine has also seen an exponential increase in rural communities (Booth et al., 2010), with rates of rural cocaine use estimated to be at least three that in urban areas, and representing a specific and pressing threat to public health in these areas (Falck et al., 2007), even beyond that of methamphetamine use (Garrity et al., 2007). However, methamphetamine use is still highly problematic, with an estimated annual cost of \$23.4 billion, 70% of which is related to health burden and mortality associated with addiction (Dobkin & Nicosia, 2009).

Associated Peripheral Problems

Beyond the direct public health harms attributable to substance abuse, studies suggest that rural communities appear to experience increased secondary consequences. Criminal behavior, previously only associated with urban drug addiction, is becoming evident in rural communities as well, possibly due to the rapid increase in methamphetamine use and availability (Herz & Murray, 2003). Rural areas report higher instances of driving under the influence charges, possibly related to rural-specific factors such as increased time spent on the road, greater distance between alcohol consuming locations, and lack of public transportation (Webster et al., 2009). This is problematic and taxing on rural drug court systems, as they were developed and implemented without consideration of rural-specific community factors, which may dampen their effectiveness in combatting alcohol and drug abuse from a justice approach (Bouffard & Smith, 2005).

There is strong evidence to suggest that women experience a disproportionate number and severity of consequences of substance use in rural communities, as compared to men. Rural women who use alcohol and drugs experience more stressors and fewer positive, uplifting events, possibly due to traumatic victimization (Boyd, Baliko, Cox, & Tavakoli, 2007). Women

in rural areas are more prone to substance abuse while pregnant (Jumah, et. al., 2016), and women in rural jails demonstrate higher substance use, mental health, and HIV-related risk behaviors, relative to their female urban peers. Violence is a common experience in general for rural women, and appears to be predictive of (Boyd, 2000) and exacerbated by addiction problems (Boyd, 2003), particularly among African American women (Boyd, Berger, Baliko, & Tavakoli, 2009). While African American women tend to have lower rates of drug and alcohol use in these communities, they experience disproportionately high use-related health problems, possibly due to systemic limitations on access to health resources (Boyd, Phillips, & Dorsey, 2003). Women in rural communities demonstrate an elevated association between substance abuse, mental health problems, and intimate partner violence, which is concerning, given the increased likelihood of at least one firearm in these households (Hink, Toschlog, Waibel, & Bard, 2015).

Potential Contributing Factors

Several community characteristics common to rural areas have been put forth in attempt to explain differences in patterns of use between rural and urban communities. Economic crises in farming and coal mining industries have exerted a devastating impact on rural community resilience (Schoeneberger, Leukefeld, Hiller, & Godlaski, 2006). Managing the chronic pain associated with these professions, as well as logging (Leukefeld, Walker, Havens, Leedham, & Tolbert, 2007) and high impact seasonal agriculture work, have been associated with binge substance use and overprescribing of prescription narcotics in rural areas (M. T. Hall et al., 2013). Overprescribing of prescription pain management drugs such as oxycodone by overextended physicians has also likely contributed to intravenous opioid use in rural communities (A. M. Young & Havens, 2012).

Other contributing factors may include a general cultural acceptability of substance use in these communities (Leukefeld, Walker, Havens, Leedham, & Tolbert, 2007), with oxycodone often serving as social capital in low-income rural areas where it can be valued as currency (Draus & Carlson, 2009). Indeed, relatively small social circles and few opportunities of acquaintance diversification can create a “vortex” that perpetuates substance abuse in small towns with newly abundant drug supplies (Draus & Carlson, 2009). Finally, internet-enhanced distribution networks now connect urban distributors with rural markets (Dew et al., 2007). These factors, in addition to boredom (Willging, Quintero, & Lillioth, 2014), create an environment highly conducive to the development and maintenance of problematic substance use in rural areas. While data suggest these factors are contributive, the largest perpetuating factors of rural substance abuse appear to be rural-specific barriers to substance use treatment (Sexton, Carlson, Leukefeld, & Booth, 2008).

Barriers to Care

Sexton, Carlson, Leukefeld, and Booth (2008) identified specific, economic, organizational, social, psychological, and geographical barriers to accessing addiction and mental health treatment in rural areas, undoubtedly limiting the study of evidence-based practices in this population as well. Economic barriers include cost of treatment, but also opportunity cost of dedicating time to treatment versus time spent working or looking for work; organizational barriers include providers’ abilities to coordinate care across healthcare systems for interrelated or complex presenting problems; social barriers include an inherent distrust in the effectiveness of addiction treatment, as well as a sense of stigma and fear of community response; psychological barriers include un-, or under-treated psychological comorbidities and life stressors; and geographic barriers are related to the distance clients often have to travel to

receive services (Sexton, Carlson, Leukefeld, & Booth, 2008). These types of barriers have generally been identified and corroborated by other researchers as well, in addition to concerns regarding treatment confidentiality in these communities (Browne et al., 2016a) (L. B. Young et al., 2015). The extent to which geographic barriers impact accessibility to treatment is not completely clear. Client and patient characteristics such as health status, functional impairment, travel cost, and work/family obligations differentially impact the extent to which simple geographical distance represented a barrier to accessing addiction treatment (Buzza et al., 2011).

Problematic drug users in rural areas appear less likely to access services than urban users, perhaps due to disparities in availability, accessibility, and cultural acceptability of the services (Metsch & McCoy, 1999), and have expressed a need for increased treatment options (Russel S. Falck et al., 2007). This disparity serves to limit research in these communities and appears to be evident at all levels of care, as treatment providers in rural areas are less equipped to provide detoxification services, intensive outpatient care, opioid replacement treatment, and transitional housing services (Oser, Harp, O'Connell, Martin, & Leukefeld, 2012), and appear to use generally antiquated treatment and infrastructure technologies (Browne et al., 2016b). It is estimated that only 10.7% of rural hospitals are equipped to provide detoxification services, compared to 26.5% of urban facilities (Dew et al., 2007), and follow up with any available substance use treatment from primary care referrals is lower in rural areas (Chan, et. al., 2016). Rural areas have fewer Emergency Medical Technicians trained in the administration of the powerful opioid overdose reversal drug, naloxone (Faul et al., 2015), which is a life-threatening liability for rural opioid users, who also have less access to the needle exchange programs and virus testing services available to urban users (Day et al., 2006). Though access to naloxone has increased, there are puzzling trends in some rural areas where access to this effective, available,

and affordable tool seemed to be intentionally slowed, to the extent that some have suggested this comes from a punitive attitude towards people struggling with addiction (Dombrowski, Crawford, Khan, & Tyler, 2016).

Lack of updated facilities, geographic isolation from providers, and limited interagency cooperation may exacerbate these limitations (Pullen & Oser, 2014), with a notable lack of treatment resources for comorbid substance use and mental health disorders (Hoolahan, Kelly, Stain, & Killen, 2006). Over 60% of rural counties do not have a physician with a Drug Enforcement Agency waiver to prescribe buprenorphine to people struggling with opioid addiction (Andrilla, Coulthard, & Larson, 2017), and even those who do still may be underrepresenting the number of patients actually receiving this powerful treatment (Andrilla, Coulthard, & Patterson, 2018).

Other barriers to service include limited availability of community health and mental health resources (Merwin et al., 2006), outdated treatment technology, economic costs, and community stigma (Browne et al., 2016), which may be more significant in smaller communities where individuals' actions may be perceived as more visible to the community at large. Even within a community with high need for mental health and addictions treatment, rural areas generally have fewer office-based resources, higher overall prescription rates, and more services delivered by low-cost providers, relative to non-rural areas (Ziller et al., 2010). Generally, rural treatment agencies appear less likely than urban agencies to research (Jameson & Blank, 2007) and employ evidence-based practices, possibly due to limited contact with academic institutions (Dotson et al., 2014). This leaves peer-support programs such as 12-Step as the primary treatment modality in these areas (Cellucci & Vik, 2001), though even access to peer-support is more limited in rural areas (Young, Grant, & Tyler, 2015). Other research has found that rural

treatment facilities had reduced access qualified counselors, were more likely to depend on public funds, less likely to prescribe buprenorphine, had fewer wraparound treatments, and had fewer options for specialty care, all of which are likely attributable to lack of available physicians in these areas (Edmond, Aletraris, & Roman, 2015)

Factors that impact the providers of mental health and addictions services indirectly represent another barrier to care in rural areas. Mental health workers practicing in rural areas have identified more sources of burnout than urban providers, and report feeling underprepared and undertrained to manage professional boundaries while treating substance use and mental health disorders in small communities (Young, Grant, & Tyler, 2015). This may be related to professional isolation, job dissatisfaction, and lack of emergency referral services (Hastings & Cohn, 2013). Rural treatment providers have also expressed frustration over feeling limited in their abilities to engage in social justice activities in their private lives, given the conspicuous role in the communities (Bradley, Werth, Hastings, & Pierce, 2012), which also limits political activity and challenges traditional notions of professional clinical boundaries (Hastings & Cohn, 2013). Providers in these areas are challenged to operate within a context of limited economic resources, shared and conspicuous community values, generally lower health and wellness status, and limited availability and accessibility of healthcare resources, all of which impact confidentiality, boundaries, dual relationships, and allocation of financial resources when practicing in these communities (Nelson et al., 2007).

While these barriers clearly exert a significant impact on the community at large, ethnic minority populations living in rural areas are most severely impacted. Rural minorities experience more barriers to service and are especially underserved in rural areas for both mental health and substance abuse treatment services (Gamm, 2004). It has been suggested that this

alienation from available treatment represents a risk factor that outweighs previously identified resilience factors in the rural African American communities (E. J. Brown & Van Hook, 2006). Some of the most alienated areas, however, are American Indian reservations, where access to treatment is generally the most difficult and tobacco, alcohol, marijuana, and oxycodone abuse represent major community health crises (Dennis & Momper, 2012).

Proposed Solutions

The unique needs of rural communities regarding access to mental health, addictions, and healthcare services have not gone unnoticed, and various strategies have been explored as means for enhancing access. Convenient case management services appear to be an important component in rural addictions treatment (Kopelman et al., 2006); however, implementation of these services did not appear to enhance substance abuse treatment outcomes, possibly due to the complex and extensive case management needs of this population (J. A. Hall et al., 2008).

While there have been improvements in professional training for addictions treatment in rural areas, discrimination, sociopolitical agendas, and lack of attention to the needs of these communities may still interfere with proliferation of trained professionals in these areas (Elder, 2007), which may have contributed to the increase in recruitment of specialist providers already serving these communities to take a more active role in addictions treatment outreach efforts (Berends, 2010). Non-traditional venues and providers, such as nurses (Wilson & Usher, 2015), clergy (Sexton et al., 2006), peers (Boyd et al., 2005), and educational settings (C. H. Brown et al., 2007), have also been explored as avenues for initiating mental health and addictions treatment services, though successful implementation has been limited (S. Hall & Gjesfjeld, 2013) (C. H. Brown et al., 2007) (Boyd et al., 2005). While peer support programs, such as 12-Step models, may be more accessible, and effective for some (Gossop, Stewart, & Marsden,

2008), many of the ideological and practical components of the program may not fit with all stages of recovery (Day, Wilkes, & Copello, 2003) and may alienate some individuals seeking recovery services (White et al., 2013).

Alongside these efforts, there is a growing appreciation for the potential of technology to increase access to services for rural residents (Jameson & Blank, 2007) and treatment providers (Meyer, 2006). With increased inter-agency communication and coordination, telehealth services have been proposed as novel ways to increase addictions treatment engagement for rural adolescents (A. S. Miller, 2005), and the rural community at large (Paulson et al., 2015). While the potential for technology and telehealth-facilitated addictions treatment is clear, early implementation was unsuccessful (Meyer, 2006). Nevertheless, after continued development and research in this area (Borders & Booth, 2007) recent efforts appear to have overcome these early challenges making telehealth treatment delivery a promising new technology in addictions treatment (Zhou, Crawford, Serhal, Kurdyak, & Stockaliagn, 2016). The role of mobile technology in helping to combat the rural opioid epidemic is also promising and requires further study (Winstanley, Stroup-Menge, & Snyder, 2018).

Research with Rural Populations

In spite of the evident need, addictions research in rural areas remains particularly challenging. Logistical complications of addictions research with rural communities include recruitment, maintaining participant confidentiality, and a culture resistant to the influence of university-affiliated “outsiders” (Dew et al., 2007). Shortage of personnel and lack of provider integration further compound difficulties (Jameson & Blank, 2007), and local providers may be skeptical of feasible implementation of evidence-based practices (S. T. Miller & Beech, 2009). These factors may adversely impact research findings, as addiction studies comparing rural and

urban trends may inadvertently recruit higher functioning samples in rural communities, given that mistrust of research makes it less likely for representative recruitment from these populations (Rigg & Monnat, 2015). Rural minorities are especially understudied by addictions and mental health researchers (Gamm, 2004), with African American men being the largest, understudied rural minority demographic (Emma J. Brown & Smith, 2006). Despite these challenges, it is possible to engage with rural communities during formative stages of research to establish bidirectional trust (Stewart, Wright, Sims, Tyner, & Montgomery, 2012), and study issues such as risk and protective factors for mental health and addiction, early intervention strategies, access to care, and the possible role of telehealth and related technologies to serve rural communities (Fraser et al., 2002). Given the compounded impact of high levels of addiction and low access to services, the introduction to and study of novel approaches, including technologically-facilitated methods founded in evidence-based practices, is an urgent and exciting area of research (Jameson & Blank, 2007).

Mindfulness and Substance Use Disorders

Mindfulness, or the process of bringing awareness to one's senses to “move beyond the well-worn grooves of our highly conditioned and largely habitual and unexamined thought processes and emotional reactivity” (viii; (Segal et al., 2012), appears to serve a central function in the interruption of the development, maintenance, and relapse of addictive behaviors (Witkiewitz et al., 2005). While some early reports contributed to ambivalence about the applicability of mindfulness training to addiction treatment (Alterman et al., 2004) (Appel &

Kim-Appel, 2009), a quickly growing body of literature suggests that a promising approach for treating substance use disorders (SUDs) is mindfulness training (Black, 2014).

Individuals presenting for SUD treatment appear to exhibit lower dispositional mindfulness than normative samples (Shorey et al., 2014), with this deficit exacerbated among poly-substance users compared to mono-substance users (Dakwar et al., 2011). Specific facets of mindfulness deficits appear to be predictive of SUDs (Levin et al., 2014) and craving (K. Witkiewitz et al., 2013). This suggests that mindfulness training and interventions that increase present-moment awareness have the potential to disrupt the automaticity of reaction to substance-related emotional and affective triggers (Breslin et al., 2002), and lead to more effective coping responses in high-risk situations (Witkiewitz et al., 2005). This process may restructure neurobiological connections between overlearned conditioned internal and external drug cues and behaviors, as well as a restructuring of reward processing to attend to a broadening of response to include non-drug related positive stimulus response (McConnell & Froeliger, 2015), possibly by enhancing connectivity between the anterior cingulate and medial prefrontal cortices (Tang et al., 2016).

A meta-analysis found that deficits in trait mindfulness were associated with alcohol use, problematic substance use behaviors (Karyadi et al., 2014), though many of these participants consisted of college students. Interventions using formal mindfulness training to increase mindfulness, or Mindfulness-Based Interventions (MBIs), have been demonstrated to significantly reduce use and misuse of alcohol, cocaine, amphetamines, marijuana, cigarettes, and opiates to a significantly greater extent than waitlist controls, active controls, and other specific control comparisons (Chiesa & Serretti, 2014). Other reviews present evidence that mindfulness training targets the larger, biopsychosocial domains of addiction and pathology

which lead to neurological reward system restructuring, increased emotion regulation, identification and clarification of personal values and spirituality, and self-awareness (Shonin & Gordon, 2016).

With this promising meta-analytic and review-level evidence, MBIs for addiction need to be sensitive and ecologically valid when applied to special populations in order to demonstrate measurable impact (Amaro, 2014). Fortunately, MBIs for addiction seem to be adaptable and acceptable to special populations including youth inpatient settings (Himmelstein et al., 2015), detoxification units (O'Connell, 2009), jail inmates (Bowen et al., 2006), and low-income, highly marginalized populations (Vallejo & Amaro, 2009). MBIs for treatment of SUDs appear to have a particularly critical role for reaching individuals for whom traditional 12-Step approaches are not a good fit (Bayles, 2014), while at the same time being completely convergent with this treatment modality (Dermatis & Egelko, 2014). In addition to the promising role of MBIs in the treatment of substance abuse, they appear to have a positive impact on co-occurring and associated peripheral conditions, which often exacerbate consequences of problematic substance abuse, representing a potentially critical component of treating co-occurring disorders (Shorey, Elmquist, et al., 2015).

Peripheral Factors

There is growing evidence that MBIs for addiction also have a positive impact on psychiatric and trauma symptoms (Garland et al., 2016), as well as physiological and psychological indices of stress (Brewer et al., 2009). Comorbid SUDs, depression, and post-traumatic stress disorder (PTSD) seem to be characterized by lower trait mindfulness (Shorey et al., 2014), and comorbid SUD and PTSD can be successfully treated with MBIs and related

treatment approaches (Foster & Kelly, 2012). The role of these peripheral factors merits further study as candidate mechanisms for outcomes in MBI research.

In addition to measures of addiction severity, studies of MBIs for SUDs have found positive effects on depressive symptoms (Shorey, Gawrysiak, et al., 2015), major depressive disorder (Brewer et al., 2010), legal and medical problems (Witkiewitz et al., 2014), and binge eating (Courbasson et al., 2011). Other evidence suggests that deficits in mindfulness may be implicated in other problematic conditions for individuals seeking substance abuse treatment and also experiencing borderline features and suicidal ideation (Shorey, Elmquist, Wolford-Clevenger, et al., 2016), low self-control and parent-child conflict (Tarantino et al., 2015), and compulsive sexual behaviors (Shorey, Elmquist, Gawrysiak, et al., 2016).

Possible explanations for these findings point to similar mechanistic processes between SUDs and other mental health disorders. MBIs may provide dually-diagnosed individuals ability to decrease avoidance, increase tolerance of aversive experiences and emotional states, unlearn maladaptive reactions, and weaken the associations between these experiences and substance-related behaviors and mental health problems (Brewer et al., 2010), suggesting that these processes may serve some type of mechanistic function in the maintenance of addictive behaviors. MBIs also appear to attenuate the relationship between depression and craving (Witkiewitz & Bowen, 2010), negative affect and craving (Garland et al., 2014), psychological inflexibility (Luoma et al., 2011), and PTSD symptoms and substance use (Bowen et al., 2016).

Taken together, evidence supports the use of MBIs in the treatment of addiction and related problems. One of the most robustly examined MBIs for addiction is Mindfulness-Based Relapse Prevention (MBRP; (Bowen et al.).

Mindfulness-Based Relapse Prevention

MBRP combines standard, cognitive-behavioral relapse prevention with formal meditation training and practice in an 8-week group therapy format with weekly, two-hour sessions (Bowen et al.). Therapists facilitate mindfulness practices and discussions of clients' observations, relevant experiences and related skills as they relate to cravings, stressors and high-risk situations, with weekly instructions for home practice and exercises.

The specific targets and practices in MBRP are hypothesized to impact the reward, conditioned learning, motivation, stress, interoception, and executive control neural systems that appear to perpetuate addictive behavior (Katie Witkiewitz, M. Lustyk, et al., 2013). Specific practices to increase present-moment awareness and sustain contact with discomfort, and to reduce reactivity to addictive cues, are thought to increase self-regulation and non-reactivity, and enhance attentional control by targeting the addiction-related associations in these brain regions (Witkiewitz, Lustyk, & Bowen, 2013). A recent review of MBRP (Penberthy et al., 2015) concludes that existing studies demonstrate initial efficacy for clinical applications of MBRP in the prevention of relapse with a variety of substances. MBRP appears widely acceptable, as it has demonstrated improvements in drug and alcohol outcomes with low-income, ethnically diverse women (Amaro et al., 2014), and may even be more efficacious than treatment as usual with ethnic minority populations (Katie Witkiewitz, Brenna L. Greenfield, et al., 2013). MBRP has also demonstrated a positive impact on medical and legal problems in a residential treatment population, in addition to substance use outcomes (Witkiewitz et al., 2014), and appears particularly helpful for participants with low distress tolerance (Hsu et al., 2013). MBRP has been successfully implemented with a wide variety of populations and settings, and may be more effective in treating substance use and related outcomes than treatment as usual and cognitive-behavioral relapse prevention (Sarah Bowen et al., 2014).

MBRP for Rural Communities

Due to its demonstrated effectiveness in treating addictive behaviors with traditionally underserved and treatment-resistant populations, MBRP may be a promising approach to addressing the disparities in and barriers to substance abuse treatment in rural communities. MBRP does not require extensive client-provider contact, follow-up, or systems-level resources. Rather, it assists clients in discovering and drawing upon their own inner resources to respond effectively to craving (Bowen et al.). These features suggest that MBRP may have the potential to overcome some of the economic, organizational, social, psychological, and geographical barriers that rural substance users face in accessing care (Sexton et al., 2008). Given that MBRP and related MBIs also exert salutary effects on associated mental health problems for substance users (Garland et al., 2016) (Brewer et al., 2009) (Foster & Kelly, 2012), possibly due to the related processes that maintain addictive behaviors and mental health problems (Brewer et al., 2010), MBRP may also be a vital response to the problematic lack of dual diagnosis treatment in rural communities (Hoolahan et al., 2006), as integrated addictions and mental health treatments in these areas appear to have the most successful implementation (Clark et al., 2004). MBRP is an evidence-based practice with features that may address barriers to care in rural areas, such as its limited need for provider contact and sustained follow-up, as well as the cultivation of clients' individual, inner resources to manage their recovery (Bowen, Chawla, & Marlatt, 2010). Data suggest this intervention is equally impactful between genders (S. Bowen et al., 2014), and specifically with low-income women of color (Amaro et al., 2014), which may be of particular significance in rural areas where this demographic appears especially isolated from treatment resources (Gamm, 2004). This lends support for the study of the feasibility and acceptability of

MBRP in rural areas, as a potentially effective and novel treatment approach that may overcome these barriers.

An integral part of MBRP, similar to the other MBIs, is between-session mindfulness practice. Other studies of MBRP have identified the potential of between-session practice as a mechanism of positive treatment gains (Bowen & Kurz, 2012), as well as the challenges associated with between-session practice engagement in diverse populations (Amaro et al., 2014). Sustaining mindfulness practice after the conclusion of the 8-week group also appears to be a challenging, but a potentially critical component of maintaining treatment gains (Grow et al., 2015). Strategies for overcoming barriers to treatment engagement and enactment, or the extent to which clients participate in treatment and apply learned skills in their daily life, are critical to attend to in rural settings, given the prevalence of existing barriers to treatment (Sexton et al., 2008).

A potential means of overcoming these barriers is through telehealth (A. S. Miller, 2005) and technology (Paulson et al., 2015), to facilitate engagement in both addictions treatment and research (Jameson & Blank, 2007) within rural communities, as well as provide a systems-level method to connect providers with struggling substance users in rural or isolated areas (Fifield & Oliver, 2016). Some evidence suggests computerized delivery of comorbid depression and substance abuse treatment was equally effective in urban and rural areas (Kay-Lambkin et al., 2012). This suggests that mobile-assisted technology, such as Smartphone Apps, may be a novel and effective supplement to implementation of MBRP in rural communities.

Smartphone Apps and Behavior Change

Results from research on effectiveness of mobile apps in behavior change processes are mixed. A variety of behavior change apps have been developed and reviewed positively by users

for art therapy (Mattson, 2015), smoking cessation (Iacoviello, et, at., 2017) alcohol use (McTavish, Chih, Shah, & Gustafson, 2012) ,College-specific alcohol use (Pocuca et al., 2016), prolonged exposure for PTSD (Kuhn et al., 2015), and college sexual behavior (Richman et al., 2014). However, these apps have been deemed unlikely to actually impact behavior (Pocuca et al., 2016).

Studies of other apps suggest they support diabetes management (Fukuoka et al., 2015), prevention of non-suicidal self-injury (Franklin et al., 2016), physical fitness (Higgins, 2016), and vegetable consumption (Mummah et al., 2016), though problems persist such as low widespread adoption of the mobile platforms (Helander et al., 2014), and poor sustainment of treatment gains (Fukuoka et al., 2015) (Franklin et al., 2016). Other studies suggest that limited beta-testing may be cause for lack of success in implementing mobile apps for behavior change (Campbell et al., 2016). The National Institute of Health concluded in a recent review that behavior change apps generally lacked evidence of collaborations between users and professionals, suffered from poor user interface and usability, limited the usable customizability, and overlooked strategies for maintaining new behaviors (McMillan et al., 2016). Other studies have pointed to lack of adherence to medical guidelines and recommendations (Abroms, Padmanabhan, Thaweethai, & Phillips, 2011), involvement of healthcare professionals (Rosser & Eccleston, 2011), evidence-based practices (Abroms, Westmaas, Bontemps-Jones, Ramani, & Mellerson, 2013), and formal study and evaluation (Eng & Lee, 2013) as problematic limitations of currently available apps for behavior change.

Despite this review, and mixed results from previous studies, use of mobile technology and apps to enhance access and engagement in treatment represents an important area for continued study (Kratzke & Cox, 2012), with identified limitations of design and implementation

suggesting areas of focus for future app and trial design. For example, existing literature offers strategies to avoid pitfalls in continued research of mobile-assisted behavior change, largely through extensive beta-testing (Campbell et al., 2016), and careful attention to facilitating maintenance of treatment gains following the intervention (Fukuoka et al., 2015) (Franklin et al., 2016), and recruiting a sufficiently large sample size (Payne, Lister, West, & Bernhardt, 2015).

With rural populations in particular, mobile apps may be an important technology to transmit evidence-based practices from academic and medical centers into more isolated rural areas (Jameson & Blank, 2007) (Meyer, 2006). A mobile app developed specifically to support MBRP may improve treatment engagement and enactment, as well as feasibility and acceptability of the intervention, improving its effectiveness with a population that has difficulty accessing care, and traditionally lower levels of involvement and improvement.

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Chapter 3:

Initially Proposed Methodology

Participants

An a priori power calculation using G*Power determined that, for a medium effect size on outcomes between MBRP and TAU, we will seek to recruit 36 participants with 18 randomized to MBRP and 18 to treatment as usual (TAU). While multiple measures increase the

likelihood of a Type-I Error, alpha inflation in an initial efficacy study such as this is of less concern and so alpha will be set at .05. Participants will be recruited from current patients receiving substance treatment through Linn County Department of Health Services Alcohol and Drug Treatment Program (ADTP; the public treatment provider in rural Linn County, Oregon). In collaboration with ADTP, we will recruit for the proposed study in three ways: 1) posting fliers on bulletin boards in community gathering spaces, 2) direct referrals from agency staff, and 3) having members of the research team attend and give brief presentations at clinic staffing/triage meetings. The fliers, presentations and emails will include basic information about the intervention, total length of involvement in the study, outcomes we will be assessing and how often we will assess them, and contact information for a member of the research team who will answer further questions, oversee participant recruitment and screen for eligibility.

Interested participants will undergo a brief screening for exclusionary criteria (under 18, active psychotic features, risk of medical withdrawal, current active suicidal ideation). Participants' primary residence will be within a rural zip code as designated by the Oregon Office of Rural Health and may be receiving treatment for alcohol, marijuana, opiate, powder or crack cocaine, methamphetamine, MDMA or ecstasy, benzodiazepine or other sedative hypnotic, hallucinogen, or inhalant use disorders. If immediate risk to self or other is detected from a potential participant, primary therapists or caseworkers will be notified immediately. Eligible participants will be informed that they are a good fit for the study, given a personal identification number and informed of the assessment procedure. All assessments will be conducted via paper-and-pencil measures in small group sessions with research personnel.

Stratifying for gender, age, and zip code of residence, we will randomly assign the pool of interested participants into the MBRP and TAU conditions in a 1:1 ratio ($n = 18$ MBRP and $n =$

18 TAU) using a permuted-block randomization procedure. Those randomized to the MBRP condition (n = 18) will be subsequently randomized into a standard MBRP group (n = 9) or an MBRP with the addition of the specially designed mobile application, MBRP-Mobile (n = 9) (see Figure 7 for participant flow). While these group sizes limit power, the primary purpose of this study is to explore preliminary feasibility and observed mean directions will be used to provide evidence to support future, fully powered trials. There will be no cost to participants for the MBRP course or the MBRP-Mobile app and gift card incentives for submission of data (up to \$80 per subject) will be provided to support participant retention.

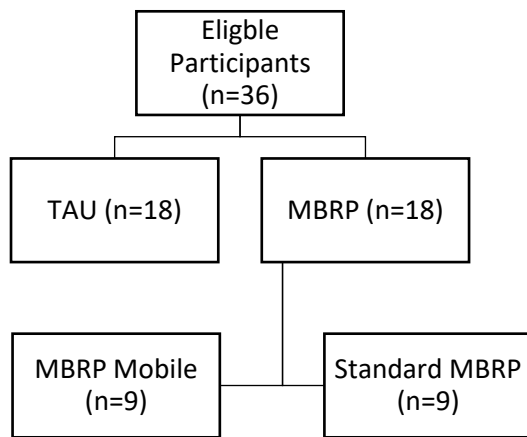


Figure 1. Participant Flow

The research team will have training and experience in the assessment and treatment of both active suicidality and psychosis. In the event that suicidality or psychosis becomes apparent in study participants, formal risk assessment will be conducted before participants are permitted to leave the study location. As appropriate, in the event of active psychosis or suicidal ideation, participants will be immediately referred to the Linn County Mental Health Program for mental health treatment and primary therapists or addictions counselors will be notified. Participants

who endorse significant drug and alcohol use that puts them at risk for withdrawal will be referred to medically supervised detoxification. In the event of imminent risk, research team members will contact the Linn County Health and Human Services Crisis line, which is able to triage, and coordinate response with local service providers and the Sheriff's Office. Based on level or risk, participants may then be referred for urgent appointments, emergency mental health services, or hospital commitment (voluntary or otherwise) at Samaritan Inpatient Mental Health, the nearest psychiatric hospital, or Bridgeway Detox for medical detoxification.

Engagement, Enactment, Outcome, and Candidate Mechanism Measures

- Treatment engagement will be assessed by session attendance, participant feedback (via the MBRP Post-course Satisfaction Survey (Bowen et al., 2010), and therapeutic alliance (via the Working Alliance Inventory (Horvath & Greenberg, 1989).
- Treatment enactment will be measured by the Meditation Practice Questionnaire (MedPQ), which data assesses participant practice of approaches learned in the intervention, and, has been used past MBRP studies (Sarah Bowen et al., 2014).
- Substance use will be assessed using the Timeline Followback (TLFB), which assesses the nature of daily substance use (Sobell, Brown, Leo, & Sobell, 1996).
- Craving will be assessed using the Penn Alcohol Craving Scale (PACS; (Flannery et al., 1999), modified to assess craving for all substances as has been done in previous MBRP studies (Sarah Bowen et al., 2014).
- Negative consequences of substance use will be measured using the Short Inventory of Problems (SIP), an adapted alcohol problem severity index that can be used for all alcohol and drug-related consequences (Feinn et al., 2003).

- Mindfulness will be measured by the Five Facet Mindfulness Questionnaire (FFMQ), which assesses several composite domains of mindfulness (Baer et al., 2008).
- Affect will be measured by the Positive and Negative Affect Scale (PANAS) (Watson, Clark, & Tellegen, 1988), which measures experienced positive and negative affective states.
- Psychological flexibility will be measured by the Acceptance and Action Questionnaire – Substance Abuse (AAQ-SA; (Luoma et al., 2011).
- Trauma symptoms will be measured by the civilian version of the PTSD Checklists (PCL-C; (Conybeare et al., 2012) which measures experience of trauma response.
- Severity of dependence will be measured by the Severity of Dependence Scale (Gossop et al., 1995).

MBRP Intervention Therapist Training

Intervention therapists will have undergone a five-day residential MBRP training that is the established standard for MBRP clinical practitioners. This training program includes didactic instruction, role-play, and experiential practice. Dissertation Chair (Bowen) will provide supervision to all intervention therapists throughout the course of the study.

Treatment as Usual (TAU)

Treatment as usual condition will consist of regularly scheduled activities as a part of regular intensive outpatient treatment at ADTP. Treatment is informed by the Matrix model of directive, supportive behavior modification and consists of relapse prevention groups, psychoeducation groups, social support groups, and individual therapy (Obert et al., 2000).

Mindfulness-Based Relapse Prevention (MBRP)

The first two sessions of MBRP target awareness of “automatic pilot” and consequences of reactive “automatic” impulses. Specifically, the first session includes experiential discernment between acting with versus without awareness, and explores the relationship between this process and substance relapse. Session two focuses on recognizing relapse triggers and introduces mindfulness training as a strategy for experiencing these triggers without automatically reacting. Sessions 3-6 help participants develop a repertoire of alternative responses to stressful situations and provide support for practicing these skills in daily life. Specifically, session three introduces practices of pausing and bringing gentle, approach-based awareness to internal experience as a strategy for returning to the present moment, especially in high-risk situations. In session four, participants practice staying present in challenging situations, or those which have been previously associated with substance use, and subsequent reactive, “automatic pilot” behavior. Session five introduces acceptance as an important step for releasing attempts to control situations or experiences that participants cannot control, while taking skillful and meaningful action where possible. Session six uses various mindfulness practices to help clients create distance between thought content and direct, in-the-moment experience, and exploring the role that fusion with thoughts has to relapse using a behavior chain analysis. The final two sessions focus on cultivating self-care and maintaining social support. Session seven introduces the importance of expanding awareness into the broader picture of participants’ lives, outside of addiction, and increasing various nourishing activities and skillful behaviors. Finally, session eight summarizes the journey of the course, reviews content, and provides support for continued practice and community engagement (Bowen et al.).

MBRP-Mobile

The MBRP Mobile group will be asked to access the “MBRP Mobile” app at the beginning of the first group, which contains audio practices, digital access to homework assignments, practice tracking and feedback, and access to a MBRP peer recovery social media network. Part of this first group content will be socializing participants to the app and providing instructions and guidelines for use. This socialization process will be based on a “Standards and Practices” document that covers app content, security, and suggestions for intended use. Participants will be able to customize the user interface experience with the app to personalize the extent to which they wish to access different features of the program.

Throughout the course of MBRP-Mobile, participants are instructed to access audio recordings of various formal and informal mindfulness practices. These recordings will be contained within the app in a centralized location to facilitate convenience of use. The audio files, when selected, will play directly through participants’ own Smartphones and related devices.

In standard MBRP, paper and pencil homework assignments are distributed at the conclusion of each session, with instructions to complete before the next week’s groups. With MBRP-Mobile, participants will be able to access these assignments digitally and complete them via Smartphone-facilitated interfacing. These assignments will be automatically saved for convenient review during the upcoming session.

MBRP-Mobile will also contain “MyMindr,” a graphical representation of summary of practice, as measured by time spent listening to formal audio files, and mood and craving measured by slider bar prompts before each practice. Using line graph and color coding, this feature will allow participants to view a personalized, graphical representation of a summary of

their practice, moods, and cravings as a means for exploring interactions between practice and internal states in an accessible and convenient way.

Finally, participants in the MBRP-Mobile condition will be able to access, through the app, a peer support social media network, “Community.” Through this function, users will be able to generate a profile to post messages to a Community Wall as a means for sharing resources, asking questions, and providing peer support through barriers to meditation practice. Participants will be able to report inappropriate content that will be flagged and reviewed by administrators for further action. The “Community” feature will also include a “Commit to Sit” function where users establish a date and time for a particular practice and invite other users to practice at the same time. Users will be able to view how many other participants practiced with them, and how many people are practicing at any given moment in general.

Several features of the app have been developed to facilitate participant safety and privacy. In addition to the flag and review system by app administrators, the app will include an “S.O.S.” button on the home screen in which users can upload personalized coping skills, resources, support networks, crisis service information, and, if selected, may use their device’s location services to provide information about local services and providers. Graphically, the icon for MBRP-Mobile will contain no reference or cues to it being a treatment-service product, and users will be provided with information and suggestions for maintaining privacy while using the app in the first session during review of the “Standards and Practices” document.

Data Analysis

Initial feasibility will be measured by acceptability of randomization, a minimum of 65% session attendance across participants, and a mean score of 7 on the 10 items in the Post course Satisfaction Survey . Indices of treatment engagement will be measured by session attendance,

participant feedback, and therapeutic alliance. Index of treatment enactment will be measured by continued mindfulness practice following the end of the course. S measured will include mindfulness, psychological flexibility, positive affect, craving, and trauma symptoms. Substance use outcomes will include delay until first relapse, number of substance use days, and number of heavy drinking days, as defined by four or more drinks per occasion for women and five or more drinks per occasion for men (Health & Services, 2004). All variables will be measured using pencil-and-paper measures delivered at pre- and post-course, and 2 months following post course. Data will be analyzed using analysis of covariance (ANCOVA) approach to compare mean residualized change scores (as has been done in other MBI studies; (Greeson et al., 2011) between groups between postcourse and compared again at 2 month follow-up. For all outcomes and candidate mechanisms, baseline levels will be included as covariates. A zero-order correlation matrix will inform which significantly correlated variables will be included as additional covariates before analyses.

To preliminarily examine how treatment engagement and enactment predict outcomes, a zero order correlation matrix will explore the presence of significant relationships between engagement/enactment variables related to random assignment to MBRP-Mobile (session attendance, participant feedback, therapeutic alliance) and participant practice (delay until first relapse, number of substance use days, and number of heavy substance use days) among participants in the MBRP and MBRP-Mobile conditions.

Chapter 4:

Response to Reviews of Initially Proposed Methodology

Response to Initial Reviews

Based on suggestions and discussion with the Dissertation Committee, several specific adjustments to the proposal and design will be implemented before moving forward with the study. Thank you for your valuable input.

Suggestions will be implemented regarding formatting, citations, detail regarding psychometrics, and terminology (e.g., “non-conventional versus nontraditional, and opiate versus opioid).

Significant design-related changes are outlined below, and include addition of a study Phase I specifically targeting engagement of community stakeholders to increase feasibility, adjusting the randomization block ratio, and shifting the data analytic strategy.

Introduction

More detailed discussion of how mindfulness training and an accompanying app can address barriers to rural addictions treatment (as identified by Sexton, Carlson, Leukefeld, & Booth, 2008) will be provided. Specifically, I will include discussion of how mindfulness training may help to overcome social barriers through increased self-compassion reducing help-seeking stigma and psychological barriers through salutary effects on comorbid mental health issues.

Method

A study Phase I will be added to support feasibility by engaging with community stakeholders and identify strategies for increasing acceptability and likelihood for study success before moving into the treatment phase of the study. Specific discussions surrounding language and

terminology, logistics, timing, and staffing of the intervention conditions among study personnel and agency staff will be planned, audio recorded with consent, and used to inform the treatment phase of the study. These discussions will also identify ways in which the research team can support community partners in implementing new clinical programs after the study concludes, possibly through workshops and ongoing consultation. A meeting with Dr. Brems will further inform this phase.

Reimbursement for study participants, including travel costs, will be largely informed by the results of study Phase I. Timing of the intervention will be set up so as to coordinate with times that the existing Linn County treatment transportation services have already brought clients to the agency / study location.

The randomization ratio will be changed from 1:1 (MBRP – TAU) to a 2:1 (MBRP – TAU) weighted for the MBRP condition to have equal group sizes across the three conditions (MBRP, MBRP-Mobile, and TAU).

Timeline Followback as a primary outcome measure may be replaced with specific items from the Addiction Severity Index and combined with the Severity of Dependence Scale to reduce participant burden and maintain consistency across measures and covariates between baseline, postcourse, and follow up measurement points.

Data will be analyzed using Multilevel Linear Modeling (MLM), rather than ANCOVA. This approach will be robust to likely missing data, non-normal distribution, heterogeneity of

variance, and nested variance within the repeated measures design. While MLM will not account for item response bias, minimizing variance associated with repeated measures may minimize the impact that this bias exerts on findings. Finally, using MLM in a longitudinal design with three measurement points as proposed will allow for the analysis of growth models over time, which will allow for more detailed discussion of the relationships between outcome and candidate mechanism variables. This analysis will be supervised by Dr. Christopher with consultation from Dr. Matthew Hunsigner.