THE IMPACT OF CHANGES IN SOCIAL SUPPORT ON SUBSTANCE USE

OUTCOMES AMONG TREATMENT SEEKING WOMEN

By

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ABSTRACT OF THE DISSERTATION

The Impact of Changes in Social Support on Substance Use Outcomes among Treatment

Seeking Women

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Social support is a complex construct that plays an important role in promoting and
sustaining abstinence among individuals with alcohol and substance use disorders. Social
support networks naturally or purposefully change during substance use treatment and
these changes may influence treatment outcomes. Increased recognition of the dynamic
nature of social factors that can impact treatment outcomes among women with substance
use disorders may allow for more tailored treatment interventions. This study focused on
characterizing and comparing the composition of women's social support networks at the
beginning and end of a 12-week substance use intervention. Predictors of abstinence at
treatment completion were examined with a novel focus on changes in social support that
occur over treatment. Finally, the comorbidity of depression and whether it moderates the
relationship between social support and substance use outcomes was explored.
Participants included 52 women, ages 18 and older, enrolled in an intensive outpatient
substance use treatment program. Given high attrition rates, multiple imputation was
performed to address missing data, thus maximizing the data available for analysis.
Within-subjects paired t-tests were used to assess changes in social support from baseline

to treatment completion. Regression analyses were used to analyze the relationship between social support (at baseline, treatment completion, and change) and substance use outcomes (abstinence and drinks per drinking days (DDD)) at treatment completion. The results showed that network size significantly increased, but the percent of high risk (HR) users remained stable over treatment. There was a significant decrease in the percent of women and an increase in the percent of friends from work, per network, between the two time points. While the frequency of contact with HR users in networks remained stable over time, the frequency of contact with low risk (LR) users was not correlated over time and there was no significant association between percent of, and frequency of contact with, LR users at either time. Rates of abstinence increased significantly, yet baseline percent days abstinent was the only significant predictor of abstinence at treatment completion in the models examined. None of the baseline, treatment completion, or change variables was a significant predictor of DDD. Depression severity did not moderate the relationship between social support and substance use outcomes. The lack of significant network effects may be due to high dropout rates and limited power. In conclusion, this study focused on an understudied population and sheds light on the structure of social support networks among women at the start and completion of a substance use treatment program, as well as on changes in network composition over time. Future studies may investigate the impact of changes in social support on substance use using larger samples and assess post-treatment time points to ascertain whether long-term interventions focusing on social support may be beneficial. This knowledge may offer insight into the social support factors that influence abstinence among high risk women with alcohol and drug use disorders.

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Social support is a multidimensional construct that can have a far-reaching impact on an individual's behavior, well-being, and overall functioning. This support comes from social networks that are comprised of a matrix of relationships that can have strong positive or negative influences on their members (S. Cohen, 2004). Positive social support generally refers to any relationship that promotes healthy behaviors among its members, whereas negative social support connotes encouragement or acceptance of harmful behaviors. Social support can be general and relate to one's overall well-being, or specific, and focus on the promotion or discouragement of a specific behavior, such as substance use. Examination of the role of social support in substance use may offer insight into the trajectory of these disorders and inform beneficial treatment approaches.

Social networks can be comprised of friends, partners, family members, and coworkers, and can differ in their size, structure, and function. The relationships that form the basis of the networks are highly variable in number, perceived importance, and quality across persons (Beattie & Longabaugh, 1997). Relationships can also differ in the frequency of contact between members, their length, intimacy, and the amount of support they provide (Sarason & Sarason, 2009). For some, social networks are highly fluid whereas for others they are fairly stable over time (House, 1987). Some individuals rely heavily on their networks for support and guidance and are easily influenced by the behaviors of their network members. Others function more independently and are less impacted by the behaviors of their social network members (Tracy, Munson, Peterson, & Floersch, 2010). Whereas the term *social networks* typically refers to a structural set of social relationships (House, 1987), *social support* relates to their functional or behavioral content (S. Cohen, 2004). Understanding the dimensions of this construct and their

unique influence on behavior can allow clinicians and researchers to adopt a more holistic perspective regarding an individual's behaviors and the presence and maintenance of psychopathology.

Membership in a social support network is generally viewed positively. Individuals who are part of a supportive social network typically feel cared for, loved, and valued and often endorse a sense of belongingness (Knowles & Gardner, 2008; Thoits, 2010). Additionally, they have people upon whom they can depend, trust, and communicate with openly (Suchman, McMahon, Slade, & Luthar, 2005). Although social support is not a panacea, general social support, which is support for overall well-being (Beattie & Longabaugh, 1999), is associated with a number of positive health related outcomes including recovery from illness, the ability to withstand life stressors, and even overall morbidity and mortality (Sarason & Sarason, 2009). Social support has also been shown to mitigate the development of physical and psychological disorders that result from stress, adversity, and life adjustment (S. Cohen, 2004). For example, high levels of social support may protect against depression (Cobb, 1976; Cruwys et al., 2013), moderate irritation and anxiety (Frese, 1999), and improve overall psychosocial functioning (Beattie et al., 1993). Furthermore, having a strong social support network is often considered a protective factor against the risk of suicide (Bryan & Rudd, 2005). The buffering model proposes that social support acts as a buffer against the harmful effects of stressors, suggesting that social support may be most important during stressful events (S. Cohen, 2004). Given that harmful alcohol and substance use are often a behavioral response to life stressors, social support may be critical for safeguarding against the use of substances to cope with stress. Seeking support from one's friends, partner, and family

in times of distress may be an alternate behavioral response, one with fewer negative consequences than substance use.

Conversely, individuals with fewer social relationships are at increased risk for negative health related outcomes (S. Cohen, 2003; Smith & Christakis, 2008), both psychological such as depression (Dobkin, Civita, Paraherakis, & Gill, 2002; Martínez-Hernáez, Carceller-Maicas, DiGiacomo, & Ariste, 2016) and physical such as irritable bowel syndrome (Koloski, Talley, & Boyce, 2001). Quantity and quality of social support have been linked consistently to morbidity and mortality (Uchino, Cacioppo, & Kiecolt-Glaser, 1996) and mortality is reportedly higher among socially isolated individuals (House, Landis, & Umberson, 1988). These findings highlight the powerful influence of a strong and supportive social network on one's physical and psychological well-being and the increased health risks for those with more limited networks.

Social support and Substance Use

The relationship between social support and substance use is one example of the complex and powerful influence that network members can have on both positive and negative behaviors. Substance use disorders, among the most prevalent psychological disorders, pose a significant public health concern. Alcohol and drug use disorders are chronic disorders with high rates of poor treatment retention and relapse (Leshner, 1997). In 2014, approximately 20 million individuals ages 18 or older in the United States met criteria for a substance use disorder (SUD) in the prior year (SAMHSA, 2015). Despite the presence of evidence-based treatments for these disorders, treatment gains are often transient and not maintained following treatment completion (Havassy, Hall, & Wasserman, 1991; McLellan, Lewis, O'Brien, & Kleber, 2000).

In the field of substance use, relapse is the norm, not the exception. Less than 50% of patients remain abstinent one to two years post-treatment (Nathan, 1986), which is only slightly better than rates seen in individuals with "spontaneous remission," defined as cessation from substance use without formal treatment (Walters, 2000). Once formal treatment ends, individuals return to their natural environments and are presented with the environmental triggers and social challenges to which they were susceptible prior to treatment, such as bars, alcohol at family and work related events, substance using friends or partners, and daily life stressors.

Research has highlighted the benefits of social support in recovery from alcohol and drug treatment (Beattie & Longabaugh, 1997, 1999; Havassy et al., 1991; Hunter-Reel, McCrady, & Hildebrandt, 2009; Zywiak et al., 2009). Individuals suffering from substance use disorders frequently exist within a complex network of social forces that exert a powerful influence on behavior. Broadly speaking, positive support for abstinence from alcohol and substance use, such as modeling and encouraging abstinence, may have beneficial effects on individuals' substance use behaviors. In contrast, negative support for abstinence, such as promoting substance use and providing substances, may be destructive. Social network members often intentionally or unintentionally enable substance use by providing alcohol or drugs, offering monetary support, a place to use, expressing disbelief in the individual's ability to recover or abstain, or using in the presence of the individual (Tracy et al., 2010). Understanding substance using individuals' unique social environments and the nature of their relationships may shed light on factors that influence abstinence among individuals with SUDs. This insight has

potential clinical relevance as it may identify important areas to target in treatment aimed

to reduce alcohol and substance use.

A substantial literature has dissected the construct of social support to understand

the unique benefits and characteristics of positive support for abstinence and the dangers

of negative support for abstinence. Given the numerous types of social support discussed

in the literature, Beattie and Longabaugh (1997) examined the unique influence of

different types of support on drinking behaviors and on overall well-being among alcohol

dependent individuals who recently completed outpatient alcohol treatment. They

distinguished between the roles of *functional support,* defined as the content or purpose

of interactions such as general emotional support or support for abstinence; *structural*

support, defined as objective qualities such as the size of one's network, frequency of

contact with network members, and the drinking status of network members; and the

quality of the relationships, which is subjective and is defined by the character of

relationships such as how much one values their friendships and is invested in their

relationships.

The results of Beattie and Longabaugh's study (1997) study reinforced the

complexity of social support and revealed that each dimension of social support did not

uniformly impact treatment outcomes. Firstly, alcohol related social support variables,

and not general support variables, were associated with post-treatment drinking

behaviors, quantified as the percentage of days abstinent (PDA). Specifically,

encouragement of abstinence from friends was most strongly associated with PDA,

followed by encouragement of abstinence from family members, and then from work

colleagues. Furthermore, the functional aspects of social support that were measured,

specifically support for abstinence, had a greater impact on the outcomes than either the structural or quality measures. Notably, non-alcohol specific support was significantly related to subjective well-being, but not to alcohol related behaviors. Therefore, as general social support had only marginal short-term benefits with regard to drinking behaviors (Beattie & Longabaugh, 1997, 1999), the most productive focus of treatment should be on identifying the benefits of and reinforcing contact with social network members that specifically promote abstinence. Furthermore, as highlighted by Beattie and Longabaugh's study (1997), both the nature of the support, and from whom the support comes, may be important influences of outcomes.

While substance specific social support is evidently an important determinant of substance use outcomes, the studies reviewed thus far did not address which individual components of social support account for the majority of the effect on substance use. Given the various indices that contribute to the nature of one's social support network, such as network size, frequency of contact with network members, and network members' alcohol and drug use status, there are multiple potential areas to target in treatment. As such, more recent research has attempted to unpack this construct further and identity specific aspects of social support that are most influential in terms of substance use and treatment outcomes. Longabaugh et al. (2010), for example, found that network members' drinking and opposition to the patient's drinking was most predictive of PDA during and following treatment. In contrast, other measures of support, such as amount of contact and support for the individual's participation in treatment were not predictive of outcome. Manuel et al. (2007) found that among women seeking treatment for alcohol use disorders, those with more drinkers in their social network had a higher

percentage of drinking days than those who had fewer drinkers in their network. Similarly, Zywiak et al. (2002) sought to identify which indices of the Important People and Activities Inventory (IPA) (Clifford & Longabaugh, 1991), a commonly used measure of alcohol-specific social support, were most predictive of alcohol treatment outcomes. They found that having a larger network, daily contact with network members, and more abstainers and recovering alcoholics than users in one's network predicted a greater percentage of days abstinent. Likewise, individuals were more likely to remain abstinent if their social group had few members who support substance use and if they had little exposure to drugs and drug paraphernalia (Havassy et al., 1991; Wasserman, Stewart, & Delucchi, 2001).

Other studies have highlighted the role of a life partner in influencing substance use, both negatively and positively. Women with partners whom they perceived as moderate to heavy drinkers consumed alcohol more frequently at baseline than women with abstaining or light drinking partners (Manuel, McCrady, Epstein, Cook, & Tonigan, 2007). However, significantly lower drug use relapse rates were found among those who had a partner compared to those who did not have a partner (Havassy et al., 1991). The authors did not specify, however, whether this partner was a substance user or an abstainer, which may significantly alter the support dynamic. Furthermore, in line with the discussion earlier regarding the benefits of substance-specific support versus general support, greater abstinence-specific support from partners predicted a decreased risk of relapse as compared to general partner support. Similarly, among individuals who completed alcohol and drug use treatment, those who had more abstinence-specific

support from their partner had a lower risk of relapse than those who lacked this support (Havassy et al., 1991).

Changes in Social Support over the Course of Treatment

Notably, in the research presented thus far social support was evaluated at intake (Beattie & Longabaugh, 1997; Dobkin et al., 2002) and substance use was evaluated at treatment completion, which does not account for changes in social support that likely occur during treatment and that may impact outcomes. Few studies have looked at changes in social networks from treatment initiation to treatment completion, which likely occur as people intentionally or unintentionally lose ties with those who supported their use and develop relationships with abstainers, sponsors, or peers in their treatment groups.

Changes in one's social support network may contribute to substance related behaviors and treatment outcomes and are therefore important to evaluate. Kelly et al. (2014), in an analysis of changes in social support networks from pre-treatment to 12-month post-treatment, found that the number of high risk friends significantly decreased and the number of low risk friends significantly increased, with the greatest changes occurring from baseline through the three month post-treatment follow-up. The number of high risk and low risk friends at follow-up were, in turn, strong predictors of substance use outcomes, with the number of high risk friends predicting significantly less PDA and number of low risk friends predicting significantly more PDA at 12-months post-treatment.

Although this study addressed an important and understudied aspect of social support, that is changes in networks apparently induced by substance use treatment

programs, it is important to note its limitations. Changes in social support networks that may have occurred during treatment (mean length of stay of 25 days) (Kelly, Stout, Greene, & Slaymaker, 2014) were not assessed at treatment completion; rather, the first follow-up assessment of social support was one month post-discharge from the program. The delayed assessment of social networks may overlook important changes in networks that occur during the treatment itself and that may be predictive of PDA outcomes. Additionally, if changes in social networks that occur during treatment are uniquely predictive of PDA outcomes, measurement at treatment completion could serve as an exit assessment to aid in risk prognosis for relapse among individuals who complete the treatment program. As such, the current study aimed to evaluate social support at baseline and at treatment completion and to quantify its relationship to substance use outcomes.

Furthermore, Kelly (2014) looked exclusively at changes in high risk and low risk friends and did not assess other constructs that have been shown to be important predictors of PDA, such as the amount of contact with the network member (Buckman, Bates, & Cisler, 2007; Buckman, Bates, & Morgenstern, 2008; Zywiak, Longabaugh, & Wirtz, 2002; Zywiak et al., 2009). Additionally, the authors did not report the nature of the changes in the support networks, such as whether high risk friends left the network while low risk friends joined, or if the drinking patterns of the existing network members changed and those who were formerly high risk drinkers were now classified as low risk drinkers.

Finally, this study focused on predominantly Caucasian (95%) young adults, 18-24 years of age, whose social networks may differ from those of adults and other racial groups and thus the generalizability of these results may be limited. For example, young

adult networks may be larger and change more rapidly and over a shorter period of time than adult networks (Cotterell, 2013). Young adults also face different social risks with regard to maintenance of use as well as relapse risk as they are in a stage of life where drinking, particularly binge drinking, and experimentation with different drugs is normative (Chung, 2013; Johnston, O'Malley, & Bachman, 1999). The current study, therefore, aimed to address the aforementioned gaps in the literature, such as changes in social support over the course of substance use treatment as well as unique social support characteristics that may influence substance use outcomes among adult women.

Examining natural changes in social support networks over the course of treatment provides information about which aspects of an individual's networks are most malleable or amenable to change and therefore potential treatment targets. Nargiso et al. (2014) looked at change in social support networks among incarcerated women with co-occurring major depressive and substance use disorders. Not surprisingly, they found that over the course of incarceration, women's social networks decreased in size and in the percentage of drinkers and substance users in their networks. This reduction in the size of their network resulted from breaking ties with family members, friends, and romantic partners. This is an important finding given that incarceration is common among substance using populations (Mumola & Karberg, 2006) and often can serve as a catalyst for treatment initiation and change in substance use behaviors. While network size subsequently increased in the months following prison release, the percentage of drinkers and drug users in the network did not (Nargiso, Kuo, Zlotnick, & Johnson, 2014). Recognizing and maintaining positive changes in social networks that may occur in prison can guide treatment and become a point of reference for patients who doubt the

benefits of or their ability to alter their social networks. This study, however, did not assess substance use behaviors and therefore the relationship between the changes identified in social support networks over time could not be linked to substance use behaviors. Furthermore, there was a marked overlap of substance use disorders with depression, with 68% of the participants in the study participating in depression treatment while in prison. One of the focuses in the depression treatment was learning skills to bolster social support networks, which thus may confound the relevance of network changes vis-à-vis substance use outcomes. As such, additional research is needed to determine ways in which changes in social networks over time may contribute to treatment outcomes.

Social Support, Substance Use and Depression

Whether depression may moderate the relationship between social support and substance use treatment outcomes is another area of considerable interest that has not been well studied. The reciprocal relationship between depression and social support, as well as the multiple factors that can contribute to this relationship, add to its complexity. Higher levels of social support, including larger networks and more interpersonal relationships, have been shown to protect against depression (Cobb, 1976), and lower levels of social support have been shown to precipitate depression (Cacioppo, Hughes, Waite, Hawkley, & Thisted, 2006; Kawachi & Berkman, 2001). Yet, this relationship is less clear among individuals with comorbid substance use disorders.

Depression and substance use disorders are highly comorbid. Among those seeking alcohol and drug use treatment, between 26% and 60% are diagnosed with comorbid depression (Marel et al., 2016). Conversely, 18% of individuals with a mood

disorder are diagnosed with a co-occurring substance use disorder (Teesson, Slade, & Mills, 2009), and there is a 40% lifetime prevalence of comorbid SUDs and depression (Grant et al., 2004). This comorbidity is noteworthy as it can result in a higher risk of suicide, other psychiatric conditions, and personal and social impairment (Davis, Uezato, Newell, & Frazier, 2008). Furthermore, there is an increased risk of alcohol relapse among individuals with depression and a history of an alcohol use disorder (Brewer, Bowen, Smith, Marlatt, & Potenza, 2010). There are several explanations for the frequent co-occurrence of these disorders. Firstly, the self-medication hypothesis proposes that individuals with depression use substances to alleviate their symptoms (Khantzian, 1997). Alternatively, withdrawal from drugs and alcohol may lead to feelings of depression (Goodwin, Fergusson, & Horwood, 2004).

Social support plays an important role in depression and the social network characteristics that are thought to predict depression are similar to those that can predict substance use. For example, in a study of individuals ages 16-88, lower frequency of contact with friends was related to higher odds of having a diagnosis of major depressive disorder (MDD) in the past year (Werner-Seidler, Afzali, Chapman, Sunderland, & Slade, 2017). Having no friends to rely on or to confide in increased the odds of having a diagnosis of MDD in the past year (Werner-Seidler et al., 2017). In contrast, having a larger social network is an important protective factor against depression (Ford, Clark, & Stansfeld, 2011) and having three or more friends to rely can decrease the odds of having an MDD diagnosis in the prior year (Werner-Seidler et al., 2017). Furthermore, age and sex may influence the impact of social support on MDD. Among a sub-sample of participants ages 16-34, frequency of contact with family members was not related to a

diagnosis of MDD in the past year, whereas among participants ages 35-54 daily contact with family members decreased the odds of a past year MDD diagnosis (Werner-Seidler et al., 2017). Similarly, the impact of social support on the risk for developing major depression has been shown to be significantly stronger in women as compared to men (Kendler, Myers, & Prescott, 2005).

Conversely, depression may negatively affect social networks as depressed individuals tend to weaken ties with their social networks over time due to the burden that their illness places on their network members (Blazer, 1983). A study of adults ages 65 years and older found that lower levels of social support were associated with the presence of MDD, both at baseline and at 30-month follow-up. Unexpectedly, however, at 30-month follow-up those who had improvements in social support network were 2.6 times more likely to have been depressed earlier than those whose social support did not improve. This may suggest that those who were significantly depressed sought treatment or changed their social support network in an effort to improve their health whereas those who were not depressed did not see as much of a need. The findings of this study, however, may not generalize to a younger population. Older adult networks are often smaller and less supportive than networks of younger individuals (Fung, Carstensen, & Lang, 2001). Furthermore, older adults may be more susceptible to the negative outcomes of having a weaker support network (Blazer, 1983). Not surprisingly, in this sample the depressed participants were more likely than the non-depressed participants to have alcohol related problems. This, however, was not a focus of the study and not expanded upon further.

Social support has a complex interplay with both depression and substance use disorders and the reciprocal influences have not been well elucidated. For example, those who lack friendships may become depressed and use alcohol and drugs to self-medicate, which can, in turn, further increase depressive symptoms (Martínez-Hernáez et al., 2016). Conversely, individuals who are depressed may develop weaker social support networks as they socially isolate or push others away (Barbour, 2003). As such, they may become more depressed, continue to withdraw, and turn to alcohol or substances. Finally, as individuals increase their substance use behaviors, there is a tendency to socially isolate (Havassy et al., 1991), which can also contribute to depressive symptoms.

Given the dynamic inter-relationship between depression, social support, and substance use, as well as the high comorbidity of substance use and depression (Davis et al., 2008; Nargiso et al., 2014), further exploration of this relationship may inform treatment. The combination of these disorders may negatively impact an individual seeking treatment for a substance use disorder, as suffering from depression can further diminish a substance using individual's motivation to engage in treatment, as well as hamper the individual's belief that s/he can overcome the disorder. One study that considered the interplay between social support, substance use, and depression found that among men receiving treatment for alcohol use, greater perceived social support, defined as emotional and instrumental aid from family and friends, was associated with a reduction in depressive symptoms (Booth et al., 1992). This study, however, did not look at the impact of depression on substance use outcomes, which is another important facet. Additionally, the study only included men, which limits generalizability, particularly given the 1.5-3 times higher rates of depression among females as compared to males

(APA, 2013). In a more recent study, Dobkin et al. (2002) found that individuals with low levels of social support had more depressive symptoms at both intake and six-month follow-up and higher severity of alcohol and drug use at six-month follow-up compared to those with high levels of social support.

In summary, social support is a complex construct that may influence behavioral change and play a role in promoting and sustaining abstinence among individuals with substance use disorders. Individuals are often part of social networks that can have a powerful and enduring influence on behaviors that can either promote the health and wellbeing of an individual or lead to harmful behaviors. The multiple subtypes of social support (e.g. functional and structural), the characteristics of social support networks (e.g. number of network members and frequency of contact with network members) and factors that may moderate its effects (e.g. depression) further add to its complexity and the need for additional research. Given the chronicity of substance use disorders, coupled with the persistent influences that trigger substance use behavior (McLellan et al., 2000), it is important to assume a multi-dimensional perspective to address substance use more effectively. Formal substance use treatment can serve as a catalyst for reduced substance use, more positive life outcomes, and an overall improvement in health, but may be insufficient by itself to sustain these gains over time (McLellan et al., 2000). For long-term successful outcomes, treatment must address those factors that persist even after treatment completion, such as one's social support network. Recognizing the role of social support in substance use outcomes may influence the development of clinical interventions and may improve treatment outcomes.

Study Rationale

Much of the prior research that examined the relationship between social support and treatment outcomes assessed social support as a baseline variable, collected at treatment initiation. Few studies, however, have also evaluated social support at treatment completion to capture the dynamic nature of social support networks, which may evolve over the course of treatment. Social support networks naturally or purposefully change during substance use treatment and these changes may influence alcohol and substance use treatment outcomes. The current study focused on identifying social network changes that occur from treatment entry to the completion of an intensive outpatient treatment program. As such, the present study aimed to capture a more dynamic view of social support networks, with a focus on changes over the course of treatment and the impact of these changes on substance use outcomes.

Historically, there has been a paucity of literature regarding alcohol and substance use among women and the majority of longitudinal studies have researched predominantly or exclusively male samples (e.g., Fillmore & Midanik, 1984; Schuckit, Smith, Anthenelli, & Irwin, 1993). Moreover, findings from studies using male samples have been generalized to women (Brett, Graham, & Smythe, 1995). Although in the past, alcohol and substance dependence were viewed primarily as a "men's disease," the gender gap in the prevalence of alcohol and substance use has been narrowing over the years, increasing the need to understand the nature of use among women (Grucza, Norberg, & Bierut, 2009; Keyes, Grant, & Hasin, 2008; Slade et al., 2016; White et al., 2015). Additionally, more recent studies exploring the relationship between social support and substance use were comprised predominantly of male samples (Buckman et

al., 2007; Kelly et al., 2014; Longabaugh, Wirtz, Zywiak, & O'Malley, 2010). These studies have identified network size (Zywiak et al., 2002), frequency of contact with network members (Buckman et al., 2007; Buckman et al., 2008; Peyser, Buckman, & Bates, 2016), and the number of users in the network (Longabaugh et al., 2010) as most predictive of substance use outcomes. Whether these same factors predict substance use outcomes in an exclusively female sample needs further examination.

Women who consume alcohol are physiologically more vulnerable than men to acute and chronic alcohol-related problems (Ceylan-Isik, McBride, & Ren, 2010; Fox & Sinha, 2009) and women may be more susceptible than men to drug cravings (Fox, Morgan, & Sinha, 2014; Hitschfeld et al., 2015; Kennedy, Epstein, Phillips, & Preston, 2013) and relapse (Rubonis et al., 1994). Additionally, there are high comorbidity rates among women with alcohol and substance use disorders for Axis I psychopathology, including depression, anxiety, and posttraumatic stress disorder (Goldstein, Dawson, Chou, & Grant, 2012). Finally, drug and alcohol use among women who are mothers can negatively impact their children's physical and psychological health (Conners et al., 2003; Finkelstein, 1994; Hawley, Halle, Drasin, & Thomas, 1995; Kerwin, 2005). As such, understanding factors that may contribute to substance use behaviors and treatment outcomes among this subgroup is particularly important. The current study, therefore, focused on exploring the relationship between social support and substance use in a high risk, underserved, and understudied population of women, most of whom were mothers of young children.

In order to design and implement effective treatment interventions for women with alcohol and substance use disorders, it may be valuable to understand the complex

social network dynamics that impact alcohol and substance use among women.
Therefore, the focus of this study was to characterize the nature of, and changes in, the
structure and function of social support networks among a female, substance-using
population. This addresses a significant public health need and provides a unique sample
for identifying factors that may impact substance use behavior and treatment outcomes.
Increased recognition of the complex array of social factors that influence treatment
outcomes for women with alcohol and substance use disorders may allow for more
tailored treatment interventions that are designed within the context of their social
support networks.

Hypotheses and Predictions

The aim of this study was to characterize the role of social support over the course
of substance use treatment and to examine its relationship to abstinence among women
with substance use disorders, with a specific focus on changes in social support during
treatment. This study was exploratory in nature and therefore aimed to highlight areas
that may provide novel information and that may have implications for future research
and clinical work.

Specific aim 1. To characterize the structure and function of social support
networks among women in treatment for substance use disorders. Specifically, to
describe the average number of network members in individuals' networks, the type of
relationship (parents, children, partners, ex-partners, coworkers, alcoholics anonymous
(AA)/ narcotics anonymous (NA) members, and friends), the duration of these
relationships, the amount of contact participants have with network members, and the
network members' alcohol and substance use statuses.

Rationale. Social support is one factor that may contribute to treatment outcomes among individuals with substance use disorders (Havassy et al., 1991; Longabaugh et al., 2010; Zywiak et al., 2002). The participants in this study are unique as they are all women who are enrolled in an intensive outpatient substance use treatment program. Additionally, many of them are mothers who have been mandated to seek treatment by child services or who have recently been released from jail. As such, the network composition of these women may differ from that previously shown in the literature, which generally has been based on primarily male samples. Understanding the unique nature of these participants' social support networks is an important consideration for devising a more holistic and targeted treatment approach for women with substance use disorders. Additionally, it may serve as a paradigm for other substance using populations as to the value of identifying unique social support factors that may influence treatment outcomes.

Hypotheses. Although the participants in this study had the option to list up to 12 members in their networks, it was expected that their networks would be relatively small given that at the point at which they initiated treatment they may have isolated themselves (Havassy et al., 1991). It was expected that participants would have average levels of contact (several times per week) with network members, consistent with prior literature (Buckman et al., 2007). Furthermore, given this study's focus on women, a majority of whom are mothers, young children were expected to comprise a portion of their social support networks. Family members, ex-spouses, and friends from NA/AA were expected to comprise the remainder of participant's networks.

Specific aim 2. To investigate changes in social support networks over the course

of 12 weeks of substance use treatment.

Rationale. The majority of the literature that has examined the impact of social support on treatment outcome has assessed social support at treatment entry and substance use at treatment completion (Beattie & Longabaugh, 1997; Dobkin et al., 2002; Havassy et al., 1991; Rice & Longabaugh, 1996). This model does not account for changes in social support that likely occur during treatment. Social networks and the support they provide naturally change over time (Sarason & Sarason, 2009) and may especially do so in the context of substance use treatment. These changes may reflect individuals' therapeutic gains and conscious decisions to shift the constituents of their social networks. Although Kelly and colleagues (2014) looked at changes in social support networks, they used a sample of young adults and evaluated social support at baseline and then again at one month following the completion of treatment. Identifying and characterizing changes in social support among women from treatment entry to treatment completion, therefore, can offer a more inclusive picture of mechanisms that operate during formal treatment and that can be extended following treatment.

Hypotheses. It was predicted that networks would change over the course of treatment such that participants would increase the number of non-users in their networks (Kelly et al., 2014; Litt, Kadden, Kabela-Cormier, & Petry, 2007) and/or increase their frequency of contact with these individuals. Similarly, consistent with prior literature (Kelly et al., 2014) it was also hypothesized that participants would decrease the number of heavy users in their networks and/or decrease their frequency of contact with these individuals. Given that network sizes have been shown to remain stable following substance use treatment despite changes in network composition (Kelly et al., 2014),

overall network size was expected to be stable over the course of treatment. As participants progress through treatment, they may develop relationships with AA/NA peers and counselors and become reacquainted with family members, while simultaneously breaking ties with former substance using peers. As such, it was hypothesized that post-treatment networks would include more non-users or AA/NA friends compared to pre-treatment networks (Humphreys & Noke, 1997). At treatment completion, social support networks also were expected to reflect more frequent contact with children with whom women may have had limited or restricted contact prior to treatment.

      Specific aim 3. To examine the influence of changes in social support variables (network size, frequency of contact with network members, and the percentage of high risk in the network) over the course of treatment on substance use treatment outcomes (abstinence and DDD).

      Rationale. Given the documented impact of social support on substance use (Beattie & Longabaugh, 1997, 1999; Buckman et al., 2007; Buckman et al., 2008; Zywiak et al., 2002), successful recovery from SUDs may be associated with or attributable in part to changes in social support networks.

      Hypotheses. Prior literature has shown that daily contact with network members (Buckman et al., 2007; Buckman et al., 2008; Zywiak et al., 2002) and having more abstainers and recovering alcoholics than users in one's network predicts greater PDA (Beattie & Longabaugh, 1997; McDonald, Griffin, Kolodziej, Fitzmaurice, & Weiss, 2011; Zywiak et al., 2002). It was hypothesized that the inclusion of more non-users and

fewer users in the network and an increase in frequency of contact with these members would be most predictive of substance use outcomes.

Specific aim 4. To measure changes in symptoms of depression (as measured by the BDI-II) from the start of the intervention (week 3) to study completion (week 12) and to explore whether depression impacts the relationship between social support and substance use outcomes.

Rationale. Having depression increases the likelihood of social isolation and substance use and reduces the likelihood of successful substance use treatment outcomes (Johnson et al., 2010). Additionally, social support may impact alcohol and substance use outcomes differently among those with different severities of depression. Those with mild depression may benefit from a supportive social network, whereas those with greater depression severity may not utilize support from their network members given the tendency for depressed individuals to socially isolate and overlook positive aspects of their networks. Exploring the complex relationship between depression, social support, and substance use may be beneficial therapeutically in devising targeted interventions among this population in which depression and substance use are highly comorbid (Swendsen, 2000).

Hypothesis. Depression was expected to moderate the relationship between social support and substance use outcomes. Specifically, having greater depression severity compared to low or no depression symptoms (as measured by baseline scores on the Beck Depression Inventory, BDI-II; Beck, Steer, & Brown, 1996) would weaken the impact of having a larger social support network, more non-users than users in the network, and frequent contact with non-users, on substance use outcomes.

Methods

This study was part of a larger randomized controlled trial aimed at understanding the role of the baroreflex mechanism in affecting behavior change among women with substance use disorders enrolled in an intensive outpatient community treatment program (e.g., (Mun, Bates, & Vaschillo, 2010; Vaschillo, Vaschillo, & Lehrer, 2006; Vaschillo, Vaschillo, Pandina, & Bates, 2010). This broader study aims to explore whether the baroreflex mechanism can be manipulated by engaging in paced breathing to help regulate automatic-visceral reactivity to triggers of alcohol and other drugs. Participants are randomized into the experimental arm, breathing at six breaths per minute (resonance breathing), or the control arm, breathing at 14 breaths per minute (paced breathing placebo). Study participants are given an iPhone, during week three of the study, with a breathing application ("app") and are asked to use the iPhone app at least five minutes per day as well as when they experience triggers.

All participants also complete two laboratory sessions, one prior to and one following the intervention (i.e., pre-post app use) to obtain precise neurocardiac signaling data at rest and during the breathing exercise. They are also given the option to complete two fMRI sessions during week three, before the start of the breathing intervention, and week 12, at the completion of the intervention. The neuroimaging portion of the study will enable examination of changes in neural activity during paced breathing and cognitive tasks to determine whether neurobiological changes occurred pre- to post-treatment. Participants are compensated for their time with gift cards, and those who complete the study keep the iPhone as additional compensation.

The present study used self-report data collected as a part of the parent study.

Participants

Participants included 52 females, ages 18 and older, enrolled in an intensive outpatient treatment program (IOP) at the Center for Great Expectations (CGE, New Brunswick, NJ). Participants were recruited from November 2015 to July 2017 through notification about the study by the clinical or research staff. Those who expressed interest met with a member of the research team to review study procedures, goals, and incentives.

The IOP at CGE is a community-based, behavioral outpatient substance use treatment program. It uses a substance use, trauma-informed treatment model that is abstinence-based, individually tailored, and that addresses co-occurring psychopathology. This outpatient service program provides one hour per week of individual therapy and nine hours per week of group treatment. Services specialize in helping women through early parenting, alcohol and substance use, and trauma. The treatment incorporates elements of empirically supported interventions including motivational interviewing, cognitive behavioral therapy, and 12-step facilitation.

Exclusion criteria included pregnancy, due to the inability to recruit sufficient numbers of pregnant women to statistically analyze or model separately. Those who were eligible and interested in study participation provided written informed consent.

Measures

Demographic information. Socio-demographic data, including race, ethnicity, income, marital status, and education, were collected during the intake session through a self-report questionnaire. Employment status was extracted from New Jersey Substance

Abuse Monitoring System (NJSAMS) data collected at treatment entry and at treatment completion.

Psychological variables. The presence of psychopathology was assessed at intake using the MINI International Neuropsychiatric Interview (M.I.N.I., Version 7.0.0, (Sheehan et al., 2015) administered by a master's level clinical psychology graduate student. The M.I.N.I. is a short, structured diagnostic interview used to assess for psychopathology based on the *Diagnostic and Statistical Manual of Mental Disorders*, fifth edition (DSM-5, American Psychiatric Association, 2013) and ICD-10 psychiatric disorders (WHO, 1993). To date, data regarding the psychometric properties of the latest version of the M.I.N.I. are not yet available, but prior versions of the M.I.N.I have demonstrated high test-retest reliability and validity (Lecrubier et al., 1997; Sheehan et al., 1997; Sheehan et al., 2010).

Social support measure. The Important People Inventory (IPI; (Longabaugh & Zywiak, 2002) was administered at baseline to assess alcohol and substance use social support network characteristics during the prior six months. It also was administered at study completion (week 12) to assess changes in social support over the course of treatment. This measure has been widely used in alcohol research (Litt, Kadden, Kabela-Cormier, & Petry, 2009; Longabaugh, Wirtz, Zweben, & Stout, 1998; Zywiak et al., 2002). It has good validity (Zywiak et al., 2002) and excellent test-retest reliability across a two- to three-day period, r=.95 (Longabaugh et al., 1998). An adapted measure that asks about substance use in addition to alcohol use has been used in prior studies (Buckman et al., 2008; Jason, Davis, & Ferrari, 2007; Jason, Olson, Ferrari, & Lo Sasso,

2006; Majer, Jason, Ferrari, Venable, & Olson, 2002; Zywiak et al., 2009) and was used in the present study as well.

The IPI was derived from the Important People and Activities Instrument (IPA) and excludes the activities section of the measure. The IPI is a structured interview composed of two main sections (see Appendix A). In the first section, participants are asked to list up to 12 network members who have been important to them in the past six months. Participants are then asked to identify the network member's (a) first name, (b) relationship to the participant (spouse, child, parent, sibling, other-family, ex-intimate, boy/girlfriend, friend/work, AA/NA friend, other friend, coworker, other), (c) sex, (d) the number of years they have known one another, (e) their frequency of contact with the network member ("daily" to "not at all in the past 6 months"), (f) the network member's drinking status ("heavy drinker," "moderate drinker," "light drinker," "abstainer," "recovering alcoholic," "I don't know"), (g) the network member's drug use status ("heavy drug user," "moderate drug user," "light drug user," "abstainer," "recovering drug addict," "I don't know"), and (h) how the network member feels about the participant's decision to initiate alcohol/drug use treatment ("supported my getting treatment" to "opposed my getting treatment"). Participants were provided templates with the response options to assist them in answering the questions.

In the second section of the IPI, participants were asked to select up to five network members, among those identified in the first section, who have been most important to them over the prior six months. Given prior findings regarding social support characteristics that are most predictive of substance use treatment outcomes (e.g., (Groh, Jason, Davis, Olson, & Ferrari, 2007; Jason, Stone, & Stevens, 2014; Rice &

Longabaugh, 1996; Zywiak et al., 2002), only data from the first section of the IPI was used in this study.

The IPI was also administered at study completion (week 12). When the participant was re-interviewed at this time point, the format for administering the instrument was largely the same with minor changes. Firstly, participants were asked about their social support network over the course of treatment, i.e., since the last time the assessment was administered. Secondly, after the participant responded to the first two columns of the assessment, i.e., provided the names of, and relationship with, each network member, the interviewer compared this list to the one provided at the start of the study in order to identify changes in network members over time. Any new network members listed were assigned new numbers.

IPI variables were scored based on the scoring manual used in Project MATCH (Clifford & Longabaugh, 1991), with minor modifications based on more recent literature:

- *Number of People in the Network:* Number of members in overall network.

- *Amount of Contact with Network:* Number of members with whom the participant has daily contact, reported in this study as percent of network in daily contact. An additional variable termed "frequency of contact" with network was also assessed, based on the numerical average of the contact variable, ranging from 0 (no contact) to 7 (daily contact).

- *Percent of Heavy Users in the Network:* Number of heavy users, divided by the total # of network members, multiplied by 100. This was modified to include moderate users as well, and renamed "high risk," based on prior

literature (Kelly et al., 2014).

- ▪ *Percent of Abstainers and Recovering Users in Network:* Number of network members who are abstainers or in recovery, divided by the total # of network members, multiplied by 100. This was modified to include light users as well, and renamed "low risk," based on prior literature (Kelly et al., 2014).

Substance use measures. The Timeline Followback interview (TLFB, Sobell & Sobell, 1992) was used to measure the number of days during which participants used alcohol and other drugs. The TLFB is a retrospective, calendar-based measure used to estimate daily drinking and drug use. This measure was administered at the baseline visit to assess participants' daily drinking and drug use for each of the 90 days prior to study initiation. It was also administered at all subsequent visits during the 12 week study to assess participants' drinking and drug use on each day of the prior week. The TLFB has shown a high degree of reliability and validity in assessing alcohol and drug use (Ehrman & Robbins, 1994; Robinson, Sobell, Sobell, & Leo, 2014) with validity coefficients ranging from $r=.84$ to .94 (Carey, Carey, Maisto, & Henson, 2004; Maisto, Sobell, & Sobell, 1982) and with a reported test-retest reliability of .95 for days abstinent during a 90-day interval (Sobell, Sobell, Leo, & Cancilla, 1988).

Following the administration of this instrument, the interviewer converted the reported alcohol use into standard units, defining a standard drink as 12 ounces of regular beer, 5 ounces of wine, or 1.5 ounce of 80-proof distilled spirits. Cigarette use was recorded as the number of cigarettes smoked on a given day. For other substances, including opiates, stimulants, sedatives, cannabis, inhalants, PCP, and hallucinogens, participants indicated whether they used or abstained on a given day. Frequency of

alcohol and substance use was measured as the percentage of days abstinent (PDA). The number of "use" days was divided by the overall number of "valid" days, defined as any day on which the participant had the opportunity to use alcohol or other drugs (i.e., excluding days hospitalized or incarcerated). Abstinence was also assessed as a dichotomous variable (i.e., abstinent vs. non-abstinent). Quantity of alcohol use was measured as drinks per drinking day (DDD), defined as the average number of drinks an individual consumed on a given day.

Participants also were assessed at intake for lifetime or current substance use disorders using the substance use section of the Structured Clinical Interview for DSM-5 (SCID-5), research version (First, Williams, Karg, & Spitzer, 2015). Symptom severity dimensions of psychopathology assessed using the SCID-5 have shown a high degree of internal consistency (alpha =.78-.98) and test-retest reliability (Shankman et al., 2018). Prior versions of the SCID have demonstrated strong inter-rater reliability as well (Lobbestael, Leurgans, & Arntz, 2011; Schneider et al., 2004).

Depression measure. Symptoms of depression were assessed using the Beck Depression Inventory (BDI-II; Beck et al., 1996). The BDI-II is a 21-item self-report measure used to assess depression. Total scores range from 0 to 63, with higher scores indicating more severe depression. Scores of 0-13 indicate minimal depression, 14-19 indicate mild depression, scores 20-28 indicate moderate depression, and scores 29-63 indicate severe depression. The BDI-II was completed by participants at week 3 and week 12 (study completion) following the baseline interview. The BDI-II has high content validity (Richter, Werner, Heerlein, Kraus, & Sauer, 1998) and high internal consistency (alpha = .81) with test-retest reliability of .96 (Beck, Steer, & Carbin, 1988).

Procedures

Women in the CGE IOP were recruited during their second week following intake to the CGE treatment program to increase the likelihood of client engagement in treatment. Following informed consent, participants partook in baseline assessments during which demographic information was collected and the IPI, M.I.N.I., and SCID-5 were administered by a master's level clinical psychology graduate student. All testing was conducted in compliance with National Institutes of Health guidelines for the ethical treatment of human subjects and approved by the Rutgers University Institutional Review Board for the Protection of Human Subjects Involved in Research.

Data Analysis

Data Distribution and Outlier Analyses

Preliminary visual screening of the data and univariate analyses were used to ensure data normality by assessing missing data, outliers, skew, and kurtosis. If the assumption of normal distribution was violated, data were transformed as indicated. Drinks per drinking day (DDD) from the timeline follow back (TLFB) was logarithmically transformed to address notable skewness and kurtosis. None of the other variables were transformed. Testing for multivariate outliers was performed using Mahalanobis distance (De Maesschalck, Jouan-Rimbaud, & Massart, 2000) with criterion $p < 0.001$, and identified no outliers.

The social support indices used in this study have been shown to capture distinct aspects of the social network that are not highly correlated with one another (Groh et al., 2007; Zywiak et al., 2002). Multicollinearity among social support variables in this study was assessed using Pearson's correlation coefficients and variance inflation factor (VIF)

analysis of regression models, and was not statistically significant. The VIF quantifies the severity of the multicollinearity in a linear regression model, with a value of four used as a cut-off point to indicate problematic collinearity (Miles & Shevlin, 2001).

Primary Analyses

Aim 1 analyses. Descriptive statistics (mean +/- standard deviations and percentages) were used to characterize the social support networks of participants at baseline and treatment completion. Specifically, network size, sources of support (partner, child, AA/NA member, friend, parent etc.), relationship length, frequency of contact with network members, and the drinking and drug use status of network members were examined using data from the IPI. Correlation analyses were used to assess the relationship among network characteristics at each time point as well as between time points from baseline to treatment completion. The relationship between participants' demographic characteristics and the social support variables were also examined using correlation analyses and *t*-tests. Chi-squared statistics were used to assess changes in employment status from treatment entry to treatment completion.

Aim 2 analyses. Within subjects paired t-tests were used to examine changes in social support variables from baseline to treatment completion. Specifically, changes in the average network size, network composition, number of alcohol and drug users, and the frequency of contact with network members were measured.

Given the exploratory nature of the study and the small sample size, effect sizes were calculated to inform the development of testable hypotheses and to serve as a basis for future research. Within-subjects effect size measurements (calculated as Cohen's d_{av}; (Lakens, 2013) were used to assess changes in demographics, social support variables,

psychological variables, and abstinence, PDA, and DDD across the two time-points. Effect sizes of 0.2-0.5 were considered small, 0.5-0.8 medium, and 0.8 or greater large; effect sizes below 0.2 were considered trivial (J. Cohen, 1988).

Consistent with prior literature (e.g. Kelly et al., 2014), network members who were heavy or moderate users of alcohol and/or drugs were classified as "high risk" and those who were light users, abstainers, or in recovery as "low risk." Whether the percentage of high and low risk network members and the frequency of contact with these members changed from baseline to treatment completion was also examined. Finally, the number of new members who joined each network and the number of network members who left over the course of treatment were also assessed.

Aim 3 analyses. Regression analyses were then used to analyze the relationship between social support variables, at baseline and at treatment completion, and substance use outcomes (abstinence and DDD) at treatment completion. To determine which time point of social support variables was most predictive of abstinence and DDD, separate regression analyses were conducted using baseline and treatment completion social support variables. Change scores were calculated based on a difference score of treatment completion minus baseline values. The change scores from baseline to treatment completion for each social support variable of interest were also independently modeled as predictors of substance use outcomes. Specifically, whether network size, percentage of high risk users in the network, and frequency of contact with network members were predictive of abstinence and DDD a treatment completion was also examined. Additionally, demographic and psychological variables, such as age and BDI, which were

thought *a priori* to influence substance use outcomes were included as covariates in the regression model.

      Aim 4 analyses. Regression analyses were then used to assess for an interaction between each of the hypothesized predictors, the social support variables, and the moderating variable, depression (BDI). Whether the interaction terms between social support and depression variables explained a statistically significant amount of the variance in abstinence was evaluated.

Missing Data

      There were notable missing data in the final analyses due to participants dropping out of the study or out of treatment at the Center for Great Expectations (CGE) (Figure 1). Additionally, two participants were dropped from the study after initial consent as they became pregnant, which is an exclusion criterion for the parent study. Missing data ranged from 15% for baseline PDA/DDD to 40% for social support data at treatment completion. Baseline demographics, psychological data, and social support variables were complete for all participants.

      Potential bias due to study dropout was assessed by conducting between groups *t*-tests to compare those who completed the study to those who dropped out of the study with regard to baseline demographics, psychological, social support, and substance use variables. The results did not reveal significant differences between those who completed the study and those who dropped out, which suggests that the retained study cohort is not a biased sample (Supplementary Table 1).

      Given the absence of significant differences between those who completed the study and those who dropped out, and upon careful review of the missing data patterns, it

was determined that the missing data could be classified as missing at random, wherein

the probability that the data are missing is not a result of the values of the missing data

(Rubin, 1976). Therefore, multiple imputation (MI) was used to address the missing data,

thus maximizing the data available for analysis. MI is a statistical method for handling

missing data, which provides valid statistical inference using information contained in the

observed data. MI replicates the incomplete dataset multiple times with plausible values

from an imputed model that captures the uncertainty associated with the imputed values

(Little & Rubin, 2002). The statistical analysis of interest (e.g. regression) is performed

on each completed dataset separately. Then, a single MI estimate and its standard error

are calculated by combining all the estimates and standard errors from each of the

completed datasets (Little & Rubin, 2002).

All independent and dependent variables of interest that contained missing data

were entered into the imputation models along with several auxiliary variables. Auxiliary

variables are variables within the original dataset that are not included in the analyses, but

are correlated with the variables of interest (Hardt, Herke, & Leonhart, 2012; Rubin,

1996). Auxiliary variables included in these imputations included measures of anxiety,

posttraumatic stress disorder, emotion regulation, and craving, as well as social support

and substance use variables that were not included in the main analyses. In accordance

with prior literature, ten imputations were run (Dong & Peng, 2013; Rubin, 2004).

Analyses were then carried out on each data set and the final results were calculated by

averaging the parameter estimates across the multiple parameters to prevent bias (Little &

Rubin, 2002; Schlomer, Bauman, & Card, 2010).

Statistical Analyses

All analyses were performed with Stata statistical software (StataCorp. 2017. *Stata Statistical Software:* Release 15.1. College Station, TX: Stata Corp LP). *A priori* power analyses were conducted using G*Power software (Faul, Erdfelder, Lang, & Buchner, 2007) to determine an adequate sample size for detecting predictors of PDA. The results of these analyses indicated that a total of 51 participants were required to have 80% power for detecting an effect size of 0.20 with alpha set at 0.05 for three predictors in a linear regression model. As the nature of this study shifted from a hypothesis-testing to an exploratory study, additional variables (e.g. DDD) were added to the final model.

Results

Study Flow

Participants were recruited from the Center for Great Expectations (CGE) between November 2015 and June 2017. Fifty-two participants completed the baseline assessment and thirty-one participants (60%) completed the final assessment, resulting in a 40% attrition rate (Figure 1). Additionally, five participants were hospitalized prior to entering the study and therefore did not have a valid PDA at baseline. As such, 26 participants (50%) had complete baseline and treatment completion data. After multiple imputation of missing data, 52 participants (100%) had complete data for regression analyses.

Demographic Characteristics

All of the participants (N=52) in this sample were female. The average age of the participants was 31.7 (± 7.4) years, with 69% identifying as White, 23% Black, and 8%

other; 19% identified as Hispanic/Latino. The average years of education among the

participants was 11.5 (± 3.1) and 33% of the sample reported being married. The annual

income ranged from less than $10K to greater than $100K, with the majority (58%)

reporting less than $10K in annual income (Table 1).

Psychiatric Comorbidity

At baseline, participants were assessed for the presence of psychopathology using

the M.I.N.I. and for the presence of a substance use disorder using the SCID-5 (Table 2).

Participants' diagnoses included major depressive disorder (29%), bipolar disorder

(12%), generalized anxiety disorder (6%), panic disorder (23%), and posttraumatic stress

disorder (12%). Among the participants, 38% met criteria for an alcohol use disorder,

63% met criteria for a drug use disorder, and 25% met criteria for both disorders. Among

those with drug use disorders, opioid use was the most common (37% of participants),

followed by cannabis use (17%) and stimulant use disorders (15%). There was also

notable comorbidity, with 48% of all participants meeting criteria for a dual substance

use and psychiatric diagnosis, as assessed by the SCID-5 and M.I.N.I, respectively.

Social Network Characteristics

At baseline, participants were asked about their social network characteristics

during the six months prior to treatment entry using the IPI (Clifford & Longabaugh,

1991). At treatment completion, participants were again asked about their social network

characteristics, with a focus on changes in their network composition since the initial

study visit. Correlation matrices were used to assess the relationship between individual

social support variables at baseline, at treatment completion, and across time points. At

both time points, there was a strong positive correlation between the percent of high risk

users in a network and the frequency of contact with high risk members, while there were no significant associations between the percent of low risk users in a network and frequency of contact with low risk members. Rather, frequency of contact with high risk users was strongly negatively correlated with the percent of low risk users in the network. There was also a moderate negative correlation between network size and frequency of contact with low risk users at treatment completion, but not at the start of treatment (Table 3). Moderate to strong positive stabilities were seen across time points for network size, average years known, percent of high risk and low risk users, and frequency of contact with high risk users, whereas contact with low risk users and percent of women in the network did not show significant stability from pre- to post-intervention (Table 4).

Changes in characteristics of social support networks also were assessed across time points for participants who completed both baseline and treatment completion IPI measures (n=31) (Table 5). Exploratory analyses were conducted to examine qualitative and quantitative changes in network composition between the two time points. The average network size among the participants significantly increased from 6.8 (± 3.0) network members at treatment entry to 7.7 (± 3.5) at treatment completion (p=0.047). There was, however, notable turnover among the network members within each network. Twenty-eight (90%) participants' networks underwent changes in constituency over the course of treatment. Among network members who were listed at baseline, 31% were no longer listed at treatment completion. One participant had an entirely new network at treatment completion as compared to baseline and three (10%) participants' networks remained identical from baseline to treatment completion. Although overall network size increased, the percentage of high risk users (17.8% ± 19.7 to 18.2% ± 22.8, p=0.90) and

low risk users (82.2% ± 19.7 to 81.8% ± 22.8, p=0.90) in the network did not change

significantly over the course of treatment. There also was no significant change in the

frequency of contact with high risk or low risk network members. Furthermore, contact

with children remained stable from baseline to treatment completion (6.1 ± 1.1 to 6.1 ±

1.2, p=0.90).

Another change in network composition over the course of treatment included a

significant decrease in the percentage of females in participants' networks, from 57.8%

(± 20.5) to 39.3% (± 21.3) (p=0.004). Among the individual relationship types within a

network, there was a significant increase in the percentage of friends from work in the

participants' networks from baseline to treatment completion (1.2 ± 5.5 to 10.4 ± 20.9,

p=0.03) (Table 5). There was also a small effect size decrease in the percentage of light

drinkers from baseline to treatment completion (22.8% ± 24.5 to 13.5% ± 14.0, p=0.06,

d=-0.34) and a small effect size increase in the percentage of abstainers from baseline to

treatment completion (39.8% ± 33.8 to 48.4% ± 28.7, p=0.17, d=0.25), although these

failed to reach statistical significance. Similarly, there were small effect size decreases in

the percentage of heavy and moderate drug users (6.5% ± 13.4 to 3.9% ± 9.9, p=0.12, d=-

0.29 and 4.3% ± 9.6 to 2.3% ± 5.5, p=0.26, d=-0.21, respectively).

Demographic factors associated with the presence of a high risk network at

baseline, defined as a network with at least one moderate or heavy drinker or drug user,

included participant age and income. Participant age was negatively associated with the

likelihood of having a high risk network, and the average age among those classified as

having a high risk network was 29.0 (± 6.1) years versus an average age of 34.6 (± 7.7)

years among those who did not have a high risk network (p=0.005). Higher income was

associated with an increased likelihood of having a high risk network, with 68% of participants earning more than $10K annually and 40% of participants earning less than $10K annually classified as having a high risk network (p=0.04).

Differences in network composition also were observed between different races and ethnicities. Among participants who identified as Black, networks were comprised of 73% women whereas among those who identified as White, networks were 55% women (p=0.005). Additionally, participants who identified as Hispanic reported significantly larger networks on average than those who identified as non-Hispanic (8.4 vs. 6.3 individuals in the network, respectively, p=0.03).

Substance Use Outcomes

There was a small effect size increase in PDA from all substances from baseline to treatment completion, although it failed to reach statistical significance (14.3% ± 28.8 to 21.8% ± 35.4, p=0.13, d=0.31) (Table 6). This was a surprising finding and counter to the hypothesized prediction that PDA would significantly increase over the course of the study. To explore this further, I reviewed the individual patterns of substance use and found that cigarette use accounted for the majority of substance use at baseline and at treatment completion. In examining cigarette use alone, there was no significant change in PDA from baseline (22.7% ± 39.8) to treatment completion (22.5% ± 37.0, p=0.96). When excluding cigarette use, however, PDA increased significantly as expected, from 70.8% ± 34.2 at baseline to 96.5% ± 11.5 at treatment completion (p<0.001). The final PDA variable used in this study, therefore, excluded cigarette use as cigarette use was not the target of the treatment intervention. The proportion of individuals who were classified

as abstinent, i.e., PDA of 100, increased from 38.5% ± 49.6 at baseline to 65.4% ± 48.5 at treatment completion (p=0.05, *d*=0.50, Table 6).

DDD was examined among the overall population as well as among individuals with a diagnosed alcohol use disorder, and there was a small effect size decrease in both groups from baseline to treatment completion, although they failed to reach statistical significance (overall: 1.3 ± 2.5 at baseline to 0.6 ± 2.2 at treatment completion, p=0.22, *d*=-0.25; alcohol use disorder: 2.5 ± 3.3 to 1.2 ± 3.3, p=0.39, *d*=-0.27, Table 6).

Multiple regression analyses were performed to examine predictors of PDA and DDD at treatment completion. Given the high PDA at treatment completion after the exclusion of cigarette use from the analyses (mean PDA=96.5%), substance use was examined as a binary outcome variable, abstinent versus non-abstinent, using logistic regression. Predictor variables included social support variables (network size, percent high risk users in the network, and frequency of contact with high risk and low-risk users) and depression severity (BDI) at baseline, treatment completion, and as a function of change over the course of treatment. Only analyses performed following multiple imputation are reported (N=52, Tables 7-12) given the limited power to detect differences in the smaller sample.

Based on the results of the logistic regression analyses, baseline PDA was the only significant predictor of abstinence at treatment completion (Tables 7 & 8). There were no other significant predictors of abstinence with regard to the social support variables examined at baseline (Table 7), at treatment completion (Table 8), or in terms of the change in these variables over the course of treatment (Table 9). None of the

baseline, treatment completion, or change variables examined was a significant predictor of DDD at treatment completion (Tables 10-12).

Moderators of Substance Use Outcomes

Depression was hypothesized to moderate the relationship between social support variables and substance use outcomes. Depression scores were first quantified and compared between baseline (14.3 ± 11.3) and treatment completion (13.1 ± 11.3), and no significant changes were observed (p=0.49, *d*=-0.13) (Table 13). Individual regression analyses were then conducted to assess for an interaction between each of the hypothesized predictors of abstinence, i.e., the social support variables at baseline, and the moderating variable, i.e., depression at baseline, in the post-imputation model. There were no statistically significant interactions and therefore depression was not found to moderate the relationship between social support and substance use.

Discussion

The goals of the present study were to characterize and compare the composition of women's social support networks at the beginning and end of a 12-week substance use intervention and to explore the role of social support in promoting abstinence among women with substance use disorders. A unique focus of this study was on the changes in social support that occur over the course of treatment. This study aimed to fill a gap in the literature, as the impact of social support on substance use outcomes has generally been examined based on social support assessed at the start of treatment (Beattie & Longabaugh, 1997; Dobkin et al., 2002; Havassy et al., 1991; Rice & Longabaugh, 1996), but not as a dynamic factor that evolves over the course of treatment. Furthermore, this study focused on a relatively understudied population of substance-using women,

which is unique as the majority of literature exploring the relationship between social support and substance use outcomes has included predominantly male cohorts (Buckman et al., 2007; Kelly et al., 2014; Longabaugh et al., 2010). Our prior work, however, demonstrated that differences exist in the composition of social networks between men and women (Peyser et al., 2016), which highlights the importance of examining women separately.

The results of the present study shed light on the structure of social support networks among women at the start and completion of an intensive outpatient substance use treatment program. Our study population was unique in that it was comprised of women, many of whom were mothers of young children, in a diverse urban community setting. There was a mix of White, Black and Hispanic women, most of whom were not married, were not college educated, and reported low annual incomes. Additionally, nearly half met criteria for both substance use and psychiatric diagnoses.

The average network size among the participants was consistent with the mean network sizes reported in the literature (generally ranging from 5-8 individuals, e.g., (Buckman et al., 2007; Manuel et al., 2007). As hypothesized, participants also had average levels of contact (several times per week) with network members, similar to that reported in prior literature (Buckman et al., 2007; Manuel et al., 2007). Furthermore, children comprised a substantial portion of the participants' social support networks, 22% at baseline and 17% at study completion, which was expected given that many of the participants were mothers. One potentially important finding of our study was that participants' network size increased significantly over the course of treatment. This finding is contrary to the study hypothesis that overall network size would remain stable

through treatment, despite anticipated changes in the composition of the networks. One possible explanation for the increase in gross network size over the course of treatment is that at the point at which individuals with substance use disorders seek treatment, they often have isolated themselves intentionally or unintentionally from those around them (Tracy et al., 2010). Subsequently, participating in a substance use treatment program may foster increased levels of social contact and promote network growth.

Interestingly, the growing network size did not reflect an influx of non-users; instead, the overall proportions of low and high risk network members remained moderately stable over the course of treatment. This finding ran counter to prior studies (Kelly et al., 2014) and to our hypothesis that networks would be enriched with low risk users at treatment completion relative to baseline. One might speculate that perhaps the treatment intervention did not place a unique focus on improving social network choices, and thus the declining rates of substance use were somewhat independent of changes in network constituency. Furthermore, this lack of "improvement" in the social support network composition may provide a possible mechanistic underpinning to the high rate of recidivism that occurs following many substance use interventions (Bradizza, Stasiewicz, & Paas, 2006; McLellan et al., 2000; Miller, Walters, & Bennett, 2001). It may also highlight an area that is appropriate for increased awareness and targeting during treatment. Alternatively, it is also possible that not all women are impacted equally by the social support dynamics of their networks (Mohr, Averna, Kenny, & Del Boca, 2001). Future research might assess the extent to which women turn to their social networks for guidance about substance use, and/or whether particular personality characteristics affect responses to external influences.

There was no increase in AA/NA friends from baseline to treatment completion, which is contrary to the study hypothesis and prior findings that post-treatment networks include more AA/NA friends (Humphreys & Noke, 1997). It is possible, however, that the stability in this network category might reflect a decrease in outside AA/NA friends and an increase in IOP friends (i.e., 'inside' AA/NA friends) as participants may have stopped attending outside AA/NA groups when they joined the IOP. Alternatively, it is possible that given the short time span that participants knew peers from treatment, they did not list them in their social networks, despite potentially having created new friendships.

Additionally, the percentage of networks comprised of family members was stable over time, with no significant differences in individual family categories or in the sum percent of family members. Instead, the relationship type that grew most within participants' networks was friends from work. There was a numerical, but not statistically significant, increase in participant employment status from baseline to treatment completion (15% to 33%, p=0.44), which may have contributed to the observed increase in friends from work. Alternatively, perhaps as participants progressed through treatment they became more engaged at work and began to connect more with friends from work.

Another demographic change included a significant decrease in the percentage of females listed in participants' networks over the course of treatment. It is possible, given the small effect size decrease in heavy and moderate drugs users in their networks, that the women they had listed at baseline were substance-using women with whom they broke ties over the course of treatment. Another possibility is that over the course of

participating in an intensive treatment program, they developed internal coping strategies and did not turn to other women for additional support as frequently as before.

In exploring changes in substance use over the course of treatment, there was a small increase in PDA from baseline to treatment completion, although given large standard deviations and low power to detect small effect sizes, this finding did not meet statistical significance. After excluding cigarette use, however, which remained stable over the course of treatment, PDA increased significantly, up to 96.5% at study completion, as has been seen in prior literature (e.g., Litt, Kadden, Tennen, & Kabela-Cormier, 2016; Longabaugh et al., 2010). Rates of complete abstinence also increased significantly, nearly doubling over the course of treatment. In contrast, the decrease in DDD, in the overall population and in the subset of participants with alcohol use disorders, did not meet statistical significance. While this was contrary to our expectations, the lack of significant differences in DDD measured at baseline and at treatment completion may reflect power limitations, reporting bias as the average DDD at baseline was quite low for a treatment sample, and/or that a sizable minority of the women had already stopped or reduced alcohol use at treatment entry.

In examining demographic and social support variables that may predict abstinence at treatment completion, baseline PDA was the only significant predictor. As social support factors, such as daily contact with network members and having more abstainers and recovering alcoholics than users in one's network have been associated with increased PDA in prior studies (Beattie & Longabaugh, 1997; McDonald et al., 2011; Peyser et al., 2016; Zywiak et al., 2002), it is possible that the present lack of significant findings may be due to statistical power limitations associated with the high

dropout rate. Although multiple imputation was used to boost power and diminish bias, there are clear limitations to this approach given that data were missing on the outcome variables for 50% of the sample. As such, the present study was limited in its ability to identify particular components of social support that may be most predictive of substance use outcomes. Early attrition from substance use treatment is common among individuals in community substance use treatment programs and may pose a barrier to successful treatment outcomes (Brorson, Ajo Arnevik, Rand-Hendriksen, & Duckert, 2013; Palmer, Murphy, Piselli, & Ball, 2009). Risk factors for dropout among this population include logistical barriers to attending treatment, such as transportation difficulties (Palmer et al., 2009), conflicts with child care, and work responsibilities, as well as individual factors such as low motivation or readiness to change (Andersen & Berg, 2001). Designing research studies with these potential barriers in mind may improve retention. For example, providing parking or transportation, flexible session times such as evening and weekend hours, and connecting with child care services may potentially improve treatment engagement. Many of these alternative program designs, however, likely require additional funding and staffing, which may limit their widespread implementation. Additionally, working with individuals early in treatment to identify and problem-solve potential barriers to engagement in care may promote better retention. Utilizing motivational interviewing techniques and providing coping skills training, for example, may engage patients who present with low motivation or low readiness to change.

The descriptive aspects of this study, including the composition of women's social support networks at intake and treatment completion are novel and informative.

Our finding that network size increased but the percent of high risk individuals remained stable may suggest that interventions should place a stronger emphasis on the importance of reducing or eliminating contact with individuals engaged in substance use and on increasing interactions with non-using individuals. Also, although average contact with low risk users did not change from treatment entry (5.8) to treatment completion (5.9), frequency of contact with low risks users, interestingly, did not show temporal stability. As such, it is possible that individual participant's level of contact with low risk users did change over the course of the study, such that some increased and some decreased, but the average contact with low risk users remained the same on aggregate. Furthermore, the percent of low risk users in the network and the frequency of contact with low risk users were not correlated at either treatment entry or completion. Thus, while Eddie and Kelly (2017) and Kelly et al. (2014) found that contact with low risk users and percent of low risk users, respectively, were positive predictors of outcomes, it may be important to gain a more fine-grained understanding of the composition and utilization of low risk network members in unique treatment populations such as this study, and to identify factors that may moderate the likelihood that contact with low risk users increases or decreases during treatment. Lastly, the identification of significantly more female network members among Black versus White participants and significantly larger networks among Hispanic versus non-Hispanic participants highlights the importance of developing culturally-sensitive treatment interventions with regard to social support.

The analytical findings of this study should be considered exploratory in light of the study's limitations, particularly the small sample size, attrition rates, and limited

statistical power to identify relationships between social support and substance use outcomes, as noted above. However, given the ongoing nature of the study, the sample size will continue to increase, which will increase power over time. Further evaluation using this larger sample may yield additional insights, which could contribute to the development and implementation of targeted interventions focusing on changes in social support networks among women over the course of substance use treatment. Additionally, exploring the impact of social support longitudinally could be informative as to whether changes are maintained long term and may highlight the importance of ongoing care.

Other study limitations include the absence of a control group who did not undergo a treatment intervention and therefore it cannot be determined whether external factors may have contributed to changes in social networks and substance use treatment outcomes. Furthermore, the evaluation of social networks was based on a naturalistic design, as participants cannot be randomly assigned to social networks and therefore other variables could have impacted observed relationships. Additionally, the sample included women who were randomly assigned to either a slow breathing intervention or a paced breathing control group as part of the parent study. This study, however, was not powered to distinguish whether social support variables differed across these two subgroups. Finally, this study evaluated *perceived* social support, which is based on participant's own evaluations and potentially subject to biases, as opposed to *received* social support, which is based on "the actual transfer of advice, aid and affect through interpersonal networks" (Wethington & Kessler, 1986). Research, however, has shown

that the former is generally more important in predicting adjustment to life events than the latter (Wethington & Kessler, 1986).

This study also has several strengths. Firstly, it is unique as it explores changes in social support from baseline to treatment completion among a sample of adult women engaged in substance use treatment, as well as the impact of these changes on substance use outcomes. Viewing social support as a dynamic process that evolves over the course of treatment can offer a more realistic view of social factors impacting an individual participating in treatment, as well as potential treatment targets. As well, the study used measures with strong psychometric properties to gather substance use and psychiatric data. It further focused on a unique and understudied population of women, many of whom are mothers who had dual diagnoses of substance use and psychiatric illness. The eligibility criteria for this study were not restrictive and, therefore, the sample likely reflects a "real world sample" of female substance users in an urban community, which increases the generalizability of the findings, but also the heterogeneity of the sample. The present study was not powered to examine unique aspects of changes in social networks that may occur in the context of different psychiatric diagnoses, although this would appear to be an important focus for future research.

In conclusion, this study offers a detailed description and comparison of social support at baseline and at treatment completion among a unique population of understudied women. Understanding social network composition and social factors that influence support for abstinence and substance use may inform clinical practice and future research that can yield improved outcomes. Moreover, our findings that social network composition shifted over the course of treatment, including an increase in

network size, a decrease in percentage of females in network, and an increase in percentage of friends from work, highlight the potential importance of understanding the evolution of networks over the course of treatment. Given the chronic and relapsing nature of substance use disorders, future research may explore how social networks impact substance use outcomes at post-treatment time points and whether long-term interventions focusing on social support may be beneficial.

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Table 1

Demographic Characteristics of Study Participants (N=52)

Demographics	N (%)
Age, mean (SD)	31.7 (7.4)
Years of Education, mean (SD)	11.5 (3.1)
Current Student	2.0 (4.0)
Married	17.0 (33.0)
Race	
Black	12.0 (23.0)
White	36.0 (69.0)
Other	4.0 (8.0)
Hispanic/Latino	10.0 (19.0)
Annual Income	
<10K	30.0 (58.0)
11K-20K	5.0 (10.0)
21K-40K	7.0 (13.0)
41K-60K	4.0 (8.0)
61K-80K	2.0 (4.0)
>100K	3.0 (6.0)
Not reported	1.0 (2.0)

Note. SD= Standard deviation

Table 2

Psychopathology of Study Participants (N=52)

M.I.N.I. Diagnosis	N (%)
Major Depressive Disorder (MDD)	15 (29%)
Bipolar Disorder	6 (12%)
Generalized Anxiety Disorder	3 (6%)
Panic Disorder	12 (23%)
Posttraumatic Stress Disorder	6 (12%)
Eating Disorder	0 (0%)
Single M.I.N.I. Diagnosis	14 (27%)
Co-occurring M.I.N.I. Diagnoses	17 (33%)

SCID-5 Diagnosis	N (%)
Alcohol Use Disorder	20 (38%)
Drug Use Disorder	33 (63%)
Alcohol and Drug Disorders	13 (25%)
Opioid Use Disorder	19 (37%)
Cannabis Use Disorder	9 (17%)
Stimulant Use Disorder	8 (15%)
Sedative Use Disorder	3 (6%)
PCP Use Disorder	1 (2%)
Co-occurring M.I.N.I. & SCID Diagnoses	25 (48%)
Co-occurring MDD & SCID Diagnoses	12 (23%)

Note. M.I.N.I= MINI International Neuropsychiatric Interview; SCID= Structured Clinical Interview for DSM-5; PCP= Phencyclidine

Table 3

Correlations Between Social Support Variables at Treatment Entry (below diagonal, N=52) and at Treatment Completion (above diagonal, n=31)

		1	2	3	4	5	6	7
1	Network Size		0.11	-0.07	0.25	-0.46*	0.16	-0.16
2	% Female	-0.14		-0.31	0.01	0.28	0.11	-0.11
3	Years Known	0.02	0.08		-0.05	-0.01	0.04	-0.04
4	Contact with High Risk Users	0.19	-0.11	0.05		0.22	0.76*	-0.76*
5	Contact with Low Risk Users	-0.11	-0.14	-0.01	0.10		0.27	-0.27
6	% High Risk Users in Network	0.11	-0.03	-0.04	0.72*	0.12		-1.00
7	% Low Risk Users in Network	-0.11	0.03	0.04	-0.72*	-0.12	-1.00	

Note.
* $p < 0.05$

Table 4

Intercorrelations of Treatment Entry and Treatment Completion Social Support Variables (n=31)

Treatment Completion

		1	2	3	4	5	6	7
1	Network Size	**0.77***	0.21	-0.08	0.29	-0.18	0.10	-0.10
2	% Female	-0.31	**-0.26**	-0.02	-0.13	0.03	-0.14	0.14
3	Years Known	0.00	-0.08	**0.77***	0.00	0.19	0.05	-0.05
4	Contact with High Risk Users	0.03	0.21	-0.07	**0.65***	0.42*	0.57*	-0.57*
5	Contact with Low Risk Users	0.04	-0.23	0.15	0.32	**0.14**	0.26	-0.26
6	% High Risk Users in Network	0.08	0.11	-0.07	0.47*	0.32*	**0.57***	-0.57
7	% Low Risk Users in Network	-0.08	-0.11	0.07	-0.47*	-0.32*	-0.57	**0.57***

Treatment Entry (row axis label)

Note. * $p < 0.05$

Table 5

Change in Network Composition Over the Course of Treatment

	Baseline Mean (SD) (n=31)	Week 12 Mean (SD) (n=31)	p-value	d
Network Size	6.8 (3.0)	7.7 (3.5)	**0.047**	0.37
% Female	57.8 (20.5)	39.3 (21.3)	**0.004**	-0.56
Years Known	15.0 (7.5)	15.4 (8.1)	0.69	0.07
Relationship				
% Spouse	1.7 (4.7)	0.8 (2.6)	0.22	-0.22
% Children	22.4 (27.6)	17.3 (19.8)	0.23	-0.22
% Parent	17.6 (16.2)	19.6 (17.8)	0.29	0.19
% Sibling	12.6 (14.8)	11.9 (10.8)	0.77	-0.05
% Other Family	11.9 (13.9)	10.3 (15.3)	0.59	-0.10
% Ex-Intimate	4.8 (7.8)	2.2 (6.5)	0.08	-0.32
% Boyfriend/Girlfriend	6.1 (10.3)	6.9 (9.1)	0.53	0.12
% Friend/Work	1.2 (5.5)	10.4 (20.9)	**0.03**	0.41
% AA/NA Friend	11.8 (22.2)	8.0 (13.0)	0.29	-0.19
% Other Friend	7.6 (12.0)	9.9 (14.1)	0.39	0.16
% Coworker	0.9 (3.9)	0.6 (3.6)	0.33	-0.18
% Other	1.5 (4.8)	2.6 (7.2)	0.47	0.13
% of Network in Daily Contact	49.8 (32.7)	51.6 (31.9)	0.78	0.05
Alcohol Users in Network				
% Heavy Drinkers	5.6 (12.1)	5.4 (10.8)	0.94	-0.01
% Moderate Drinkers	8.9 (14.3)	10.8 (18.5)	0.62	0.09
% Light Drinkers	22.8 (24.5)	13.5 (14.0)	0.06	-0.34
% Abstainers	39.8 (33.8)	48.4 (28.7)	0.17	0.25
% Recovering Alcoholics	18.8 (25.9)	16.9 (19.1)	0.68	-0.08
% Unknown	4.2 (12.7)	4.9 (9.4)	0.83	0.04
Drug Users in Network				
% Heavy Drug Users	6.5 (13.4)	3.9 (9.9)	0.12	-0.29
% Moderate Drug Users	4.3 (9.6)	2.3 (5.5)	0.26	-0.21
% Light Drug Users	6.0 (9.0)	5.1 (10.4)	0.69	-0.07
% Abstainers	59.3 (31.0)	63.0 (24.7)	0.51	0.12
% Recovering Drug Users	20.2 (23.5)	18.5 (19.3)	0.64	-0.09
% Unknown	3.8 (10.5)	7.2 (12.5)	0.25	0.21
% High Risk Users in Network*	17.8 (19.7)	18.2 (22.8)	0.90	0.02
% Low Risk Users in Network**	82.2 (19.7)	81.8 (22.8)	0.90	-0.02

Frequency of Contact^ with High Risk Users	2.7 (2.9)	3.0 (3.0)	0.53	0.11
Frequency of Contact^ with Low Risk Users	5.8 (1.4)	5.9 (1.1)	0.57	0.10

Note. *High risk user defined as moderate or heavy user of alcohol or drugs; **Low risk user defined as light user, abstainer, or recovering user of alcohol or drugs; *d*= Cohen's d effect size estimate; ^ Frequency of contact with network members, ranging from 0 (none) to 7 (daily); SD= Standard deviation; AA= Alcoholics Anonymous; NA= Narcotics Anonymous

Table 6

Substance Use at Treatment Entry and Treatment Completion

	Baseline (n=26)	Week 12 (n=26)	p-value	*d*
Percent days abstinent, Mean (SD)				
All Substances	14.3 (28.8)	21.8 (35.4)	0.13	0.31
Cigarettes	22.8 (39.9)	22.5 (36.6)	0.95	-0.01
Excluding cigarettes	70.8 (34.2)	96.5 (11.5)	**<0.001**	0.80
Abstinent, n (%)	10.0 (38.5)	17.0 (65.4)	**0.05**	0.50
DDD, Mean (SD)	1.3 (2.5)	0.6 (2.2)	0.22	-0.25
DDD among individuals with AUDs, Mean (SD)	2.5 (3.3)	1.2 (3.3)	0.39	-0.27

Note. d=Cohen's d effect size estimate; Abstinent=100% days abstinent; DDD=Drinks per drinking day; AUD=alcohol use disorder; SD=Standard deviation

Table 7

Multivariate Regression Analyses for Baseline Predictors of Abstinence at Treatment Completion (N=52)

	OR	SE	95% CI		p-value
PDA, baseline	1.03	0.02	1.00	1.07	**0.05**
Age	1.02	0.06	0.90	1.15	0.78
Network size	1.11	0.19	0.79	1.55	0.55
Frequency of contact with high risk users	0.80	0.18	0.51	1.24	0.32
Frequency of contact with low risk users	1.21	0.40	0.64	2.31	0.55
% high risk users in network	1.04	0.04	0.97	1.11	0.26
BDI	1.01	0.04	0.94	1.09	0.69

Note. Data based on the imputed model; PDA= Percent days abstinent; BDI= Beck Depression Inventory

Table 8

Multivariate Regression Analyses for Treatment Completion Predictors of Abstinence at Treatment Completion (N=52)

	OR	SE	95% CI		p-value
PDA, baseline	1.03	0.01	1.00	1.06	**0.04**
Age	1.00	0.06	0.89	1.11	0.93
Network size	1.03	0.13	0.80	1.32	0.84
Frequency of contact with high risk users	1.00	0.16	0.73	1.38	0.99
Frequency of contact with low risk users	1.46	0.66	0.59	3.63	0.40
% high risk users in network	1.00	0.02	0.95	1.05	0.96
BDI	0.98	0.04	0.90	1.07	0.69

Note. Data based on the imputed model; PDA= Percent days abstinent; BDI= Beck Depression Inventory

Table 9

Multivariate Regression Analyses for Change Variable Predictors of Abstinence at Treatment Completion (N=52)

	OR	SE	95% CI		p-value
PDA, baseline	1.03	0.02	1.00	1.06	0.09
Age	1.00	0.05	0.90	1.11	0.99
Change in network size	0.93	0.16	0.65	1.32	0.67
Change in frequency of contact with high risk users	1.01	0.15	0.76	1.35	0.93
Change in frequency of contact with low risk users	0.97	0.18	0.67	1.40	0.87
Change in % high risk users in network	0.99	0.02	0.96	1.03	0.76
Change in BDI	1.00	0.02	0.96	1.05	0.86

Note. Data based on the imputed model; PDA= Percent days abstinent; BDI= Beck Depression Inventory

Table 10

Multivariate Regression Analyses for Baseline Predictors of Drinks per Drinking Day at Treatment Completion (N=52)

	B	SE	β	*t*	p-value
LogDDD, baseline	0.23	0.21	0.28	1.11	0.30
Age	-0.02	0.02	-0.21	-1.20	0.24
Network size	-0.04	0.07	-0.12	-0.58	0.57
Frequency of contact with high risk users	0.01	0.08	0.04	0.16	0.88
Frequency of contact with low risk users	-0.08	0.11	-0.13	-0.77	0.45
% high risk users in network	0.01	0.01	0.15	0.51	0.62
BDI	0.01	0.01	0.12	0.58	0.57

Note. Data based on the imputed model; DDD= Drinks per drinking day; BDI= Beck Depression Inventory

Table 11

Multivariate Regression Analyses for Treatment Completion Predictors of Drinks Per Drinking Day at Treatment Completion (N=52)

	B	SE	β	*t*	p-value
LogDDD, baseline	0.23	0.22	0.23	1.02	0.34
Age	-0.02	0.02	-0.16	-0.93	0.37
Network size	-0.01	0.05	-0.08	-0.24	0.82
Frequency of contact with high risk users	-0.03	0.08	-0.21	-0.36	0.74
Frequency of contact with low risk users	-0.02	0.21	-0.09	-0.11	0.92
% high risk users in network	0.01	0.01	0.46	1.02	0.34
BDI	0.01	0.03	0.16	0.35	0.76

Note. Data based on the imputed model; DDD= Drinks per drinking day; BDI= Beck Depression Inventory

Table 12

Multivariate Regression Analyses for Change Variable Predictors of Drinks Per Drinking Day at Treatment Completion (N=52)

	B	SE	β	*t*	p-value
LogDDD, baseline	0.39	0.22	0.22	1.76	0.11
Age	-0.03	0.02	-0.14	-1.55	0.14
Change in Network size	0.06	0.12	0.23	0.49	0.65
Change in frequency of contact with high risk users	0.01	0.10	0.19	0.15	0.89
Change in frequency of contact with low risk users	0.07	0.10	0.21	0.66	0.54
Change in % high risk users in network	0.00	0.02	0.00	0.17	0.89
Change in BDI	0.02	0.02	0.52	1.03	0.38

Note. Data based on the imputed model; DDD= Drinks per drinking day; BDI= Beck Depression Inventory

Table 13

Symptoms of Depression at Treatment Entry and Treatment Completion (n=31)

Depression Severity Scale	Mean (SD)	p-value	*d*
BDI, Treatment Entry	14.3 (11.3)	0.49	-0.13
BDI, Treatment Completion	13.1 (11.3)		

Note. BDI=Beck Depression Inventory; SD= Standard Deviation; *d*=Cohen's d effect size estimate

Supplementary Table 1

Comparison of Participants who Completed the Study versus those who Dropped Out

	Completed Study (n=31)	Dropped Out (n=21)	p-value
Age, mean (SD)	32.3 (8.0)	31.0 (6.6)	0.54
Years of Education, mean (SD)	11.3 (3.1)	12.0 (3.3)	0.44
Current Student, N (%)	2.0 (6%)	0.0 (0%)	0.24
Married, N (%)	8.0 (26%)	9.0 (43%)	0.20
Race, N (%)			0.81
Black	8.0 (26%)	4.0 (19%)	
White	21.0 (68%)	15.0 (71%)	
Other	2.0 (6%)	2.0 (10%)	
Hispanic	5.0 (16%)	5.0 (24%)	0.49
Annual Income ($)			0.78
<10K	18.0 (58%)	12.0 (57%)	
11K-20K	3.0 (10%)	2.0 (10%)	
21K-40K	5.0 (16%)	2.0 (10%)	
41K-60K	1.0 (3%)	3.0 (14%)	
61K-80K	1.0 (3%)	1.0 (5%)	
>100K	2.0 (6%)	1.0 (5%)	
Not reported	1.0 (3%)	0.0 (0%)	
BDI, mean (SD)	14.3 (11.3)	13.3 (8.5)	0.83
Major Depressive Disorder, N (%)	11.0 (35%)	4.0 (19%)	0.20
Bipolar Disorder, N (%)	2.0 (6%)	4.0 (19%)	0.16
Generalized Anxiety Disorder, N (%)	2.0 (6%)	1.0 (5%)	0.80
Panic Disorder, N (%)	6.0 (19%)	6.0 (29%)	0.44
Posttraumatic Stress Disorder, N (%)	5.0 (16%)	1.0 (5%)	0.21
Eating Disorder, N (%)	0.0 (0%)	0.0 (0%)	
Alcohol Use Disorder, N (%)	19.0 (61%)	11.0 (52%)	0.52
Drug Use Disorder, N (%)	26.0 (84%)	17.0 (81%)	0.78
Alcohol and Drug Disorders, N (%)	14.0 (45%)	9.0 (43%)	0.87
PDA*, mean (SD)	70.7 (34.2)	76.3 (27.8)	0.58
DDD*, mean (SD)	1.3 (2.5)	4.1 (8.9)	0.15
% High Risk Users in Network, mean (SD)	17.8 (19.7)	15.6 (20.9)	0.71
Contact with low risk users, mean (SD)	5.8 (1.4)	5.8 (0.8)	1.00
Contact with high risk users, mean (SD)	2.7 (2.9)	2.6 (3.0)	0.89

Note. *n=26 had complete Timeline Followback data at both time points; SD= Standard deviation; BDI= Beck Depression Inventory; PDA= Percent days abstinent; DDD= Drinks per drinking day
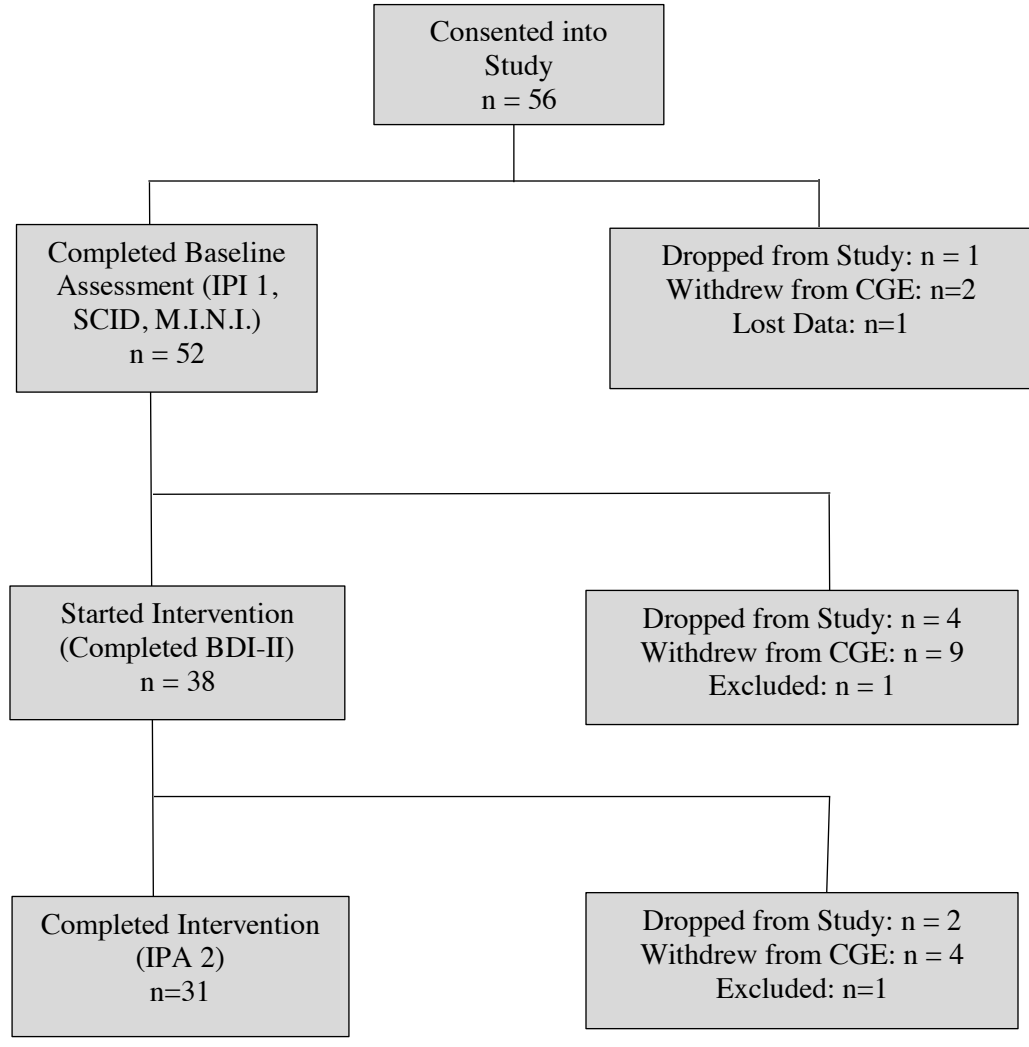
Figure 1. Schematic presentation of enrollment, retention, and treatment completion.

Appendix A.

Important People Inventory

Name	Relationship	Sex	Years known	Amount of Contact	Drinking Status	Drug Use Status	How does this person feel about your getting alcohol/drug treatment?
	1=Spouse 2=Children 3=Parent 4=Sibling 5=Other/family 6=Ex-intimate 7=Boy/girlfriend 8=Friend/work 9=AA/NA friend 10=Other friend 11=Coworker 12=Other	1=Male 2=Female		7=Daily 6=3-6 times a week 5=Once or twice a week 4=Every other week 3=About once a month 2=Less than monthly 1=Once in the past 6 months 0=Not at all in the past 6 months	5=Heavy drinker 4=Moderate drinker 3=Light drinker 2=Abstainer 1=Recovering alcoholic 7=I don't know	5=Heavy drug user 4=Moderate drug user 3=Light drug user 2=Abstainer 1=Recovering drug user 7=I don't know	5=Supported my getting treatment 4=Supported my getting treatment (though might prefer that I did it differently) 3=Neutral: Didn't say 2=Mixed: Sometimes supported, sometimes opposed 1=Opposed my getting treatment 7=Doesn't know I'm getting treatment

Of those people you have listed, please name the five that you think have been the most important to you. These would be people who have had an impact on your life, whether you liked them or not. Name or initials here. (Include number from previous sheet here.)	How much have you liked this person? 7=Totally liked 6=Very much 5=Quite a bit 4=Mixed feelings 3=Disliked 2=Disliked a lot 1=Totally disliked	How important has this person been to you? 6=Extremely important 5=Very important 4=Important 3=Somewhat important 2=Not very important 1=Not at all important	How has this person reacted to your drinking/using drugs? 5=Encouraged 4=Accepted 3=Neutral 2=Didn't accept 1=Left or made you leave when you're drinking/using 9=Unaware of my drinking/drug use	How has this person reacted to your not drinking/using drugs? 5=Encourage 4=Accepted 3=Neutral 2=Didn't accept 1=Left or made you leave when not drinking/using 9=Unaware of my not drinking/using drugs