

PEER SOCIALIZATION TO BINGE DRINKING IN EARLY ADULthood: EFFECTS OF  
IMPULSIVITY, DELINQUENCY AND CHILDHOOD ADHD

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No prospective longitudinal studies have tested whether and how social networks contribute to alcohol-related outcomes for children with Attention-Deficit/Hyperactivity Disorder (ADHD). The current study examined peer alcohol socialization in young adults with and without childhood ADHD. The presence of heavy and light drinking friends in the social network were examined as mediators of the association between adolescent behavioral dysregulation (i.e. impulsivity and delinquency) and young adult alcohol use (i.e. binge drinking and quantity/frequency) for individuals with, and without, childhood ADHD. Prediction from the number and proportion of drinking friends were tested to determine which operationalization explained more variance in young adult alcohol use.

Participants were 94 individuals with childhood ADHD and 68 demographically-similar individuals without ADHD from the Pittsburgh ADHD Longitudinal Study. At age 25, but not in earlier adulthood or for quantity/frequency, individuals with ADHD reported less frequent binge drinking than individuals without ADHD. Number and proportion of drinking friends between ages 21 and 24 predicted age 25 binge drinking for both groups but only age 25 quantity/frequency of alcohol use for individuals with ADHD. The number/proportion of light-drinking friends was not protective against alcohol use for either group and alcohol use

consumption in the social network did not mediate the association between behavioral dysregulation and alcohol use.

Overall, alcohol use was prevalent in early adulthood for both groups. However, the stronger associations between alcohol-consuming friendships and quantity/frequency of alcohol use in the ADHD group suggests that individuals with ADHD histories are more strongly influenced by social networks conducive to alcohol use than individuals without ADHD. Moreover, higher density of alcohol-involved friendships, which may affect the proportion of social time allocated to drinking opportunities, rather than number of friendships involving alcohol, may be most important. Future research may be aided by methodological improvements to distinguish selection and influence processes, consideration of college attendance, vocational factors, and ADHD symptom persistence, and other facets of social influence such as quality of relationships and alcohol use in romantic partnerships.

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## PREFACE

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## **1.0 INTRODUCTION**

### **1.1 INTRODUCTION**

Alcohol use peaks in early adulthood between the ages of 21 and 25 (Office of Applied Studies, 2009) before it declines when many individuals “age out” of frequent and/or heavy drinking (Sher & Gotham, 1999; Tarter & Vanyukov, 1994). In 2009, 70.2% of 21 to 25 year olds used alcohol in the past month; 46.5% of 21 to 25 year olds were binge drinkers (i.e. drinking 5 or more drinks on the same occasion; National Institute of Alcohol Abuse and Alcoholism, 2004); and 15.4% of 21 to 25 year olds were heavy alcohol users (i.e. binge drinking 5 or more times in the past 30 days; Office of Applied Studies, 2009). Maturation and developmental processes that begin during these years contribute to heightened drinking. The increased prevalence and variability of alcohol use in the early 20s allows for investigation of factors that drive the development of problem drinking in adulthood.

Although some heavy alcohol use in early adulthood is typical, elevated alcohol use is often associated with numerous negative outcomes. For example, binge drinking is related to negative health (e.g. alcohol poisoning, increased risk of suicide, hypertension, sexually transmitted diseases), social (e.g. interpersonal violence, drunk driving, and vandalism), economic (e.g. lost economic productivity), and legal (e.g. trouble with the police) consequences (National Institute of Alcohol Abuse and Alcoholism, 2000; Weschler, 2000). Knight and colleagues (2002) found that young adults who engage in heavy episodic binge drinking (defined as 3 or more binge episodes in

the prior 2 weeks) are 19 times more likely to be diagnosed with alcohol dependence and 13 times more likely to be diagnosed with alcohol abuse compared to individuals who do not engage in heavy episodic binge drinking. Elevated drinking may also disrupt normative developmental trajectories. For example, elevated alcohol use may negatively influence normative social development by impeding the formation of adult relationships (Brown et al., 2008). Because elevated alcohol use is associated with numerous negative outcomes, it is important to understand what factors are associated with the increase in alcohol use in early adulthood.

Several candidate factors have been proposed to explain the increased alcohol use in early adulthood including societal and cultural (i.e. norms that are favorable towards alcohol use, alcohol availability) and individual and interpersonal (i.e. physiological factors, family and peer alcohol behavior and attitudes) risk factors. During the transition to early adulthood, individuals are exposed to contextual and interpersonal risk factors and may also use alcohol to cope with developmental transitions, as a form of self-medication to compensate for existing deficits, and to facilitate social bonding (Schulenberg & Maggs, 2002). Therefore, features of the early adulthood environment increase the risk factors for elevated alcohol use. Personality traits may also increase alcohol use during the transition to adulthood. Specifically, Baer found that impulsivity/sensation seeking is strongly related to increased drinking in early adulthood (Baer, 2002). Therefore, individuals who experience difficulty with transitions, exhibit deficits in functioning, need assistance in social bonding, and are high in impulsivity/sensation seeking are particularly vulnerable to elevated alcohol use during a period critical for fostering normative functioning in adulthood.

Attention-deficit/hyperactivity disorder (ADHD) has also been studied as a risk factor for heavy alcohol use largely due to symptoms of the disorder that overlap with dispositional traits

known to increase alcoholism risk (Molina, 2011). Individuals with ADHD are characterized by inattention, hyperactivity and impulsivity that result in numerous impairments that persist into adulthood (Barkley, Murphy, & Fischer, 2008) and that may contribute to heavy alcohol use. These impairments include social impairment (Bagwell, Molina, Pelham, & Hoza, 2001) which affects normative development of social relationships and results in peer rejection and affiliation with deviant peers who promote elevated alcohol use. Although once considered a childhood disorder (American Psychiatric Association, 1994), ADHD is now considered a chronic disorder that persists into adulthood (Barkley, 2006; M. H. Sibley et al., 2012).

## **1.2 ADHD AND ALCOHOL USE**

Twenty-seven studies have examined the association between ADHD and alcohol use (Lee, Humphreys, Flory, Liu, & Glass, 2011). Considering that researchers and clinicians typically consider individuals with ADHD to have an elevated risk profile for problem behavior and negative outcomes, it is surprising that the findings regarding the association between ADHD and alcohol use have been mixed. Some research suggests that ADHD is associated with alcohol abuse, alcohol dependence (Wilens & Dodson, 2004; Wilens, Prince, Biederman, Spencer, & Frances, 1995), and alcohol problems (Faraone et al., 2007). Other studies have found age-dependent effects of ADHD on alcohol use such that ADHD increases risk for drinking in late adolescence but not early adulthood (Molina, Pelham, Gnagy, Thompson, & Marshal, 2007). Other studies suggest that ADHD does not increase risk for alcohol abuse or dependence (Biederman et al., 2008; Fischer, Barkley, Smallish, & Fletcher, 2002; Pardini, Raskin White, & Stouthamer-Loeber, 2007).

Two recent reviews aimed to address these discrepancies by using meta-analytic procedures to combine the results of studies prospectively following children with ADHD into adolescence and early adulthood. Although childhood ADHD was found to be unrelated to lifetime alcohol use (Lee et al., 2011), childhood ADHD was modestly associated with alcohol use disorders in adulthood (Lee et al., 2011). Compared to individuals without a childhood history of ADHD, individuals with childhood ADHD were 1.35 to 1.74 times more likely to develop an alcohol use disorder (Charach, Yeung, Climans, & Lillie, 2011; Lee et al., 2011). Therefore, individuals with ADHD appear to be at moderately increased risk for developing alcohol use disorders compared to individuals without ADHD who use similar levels of alcohol. These findings support the need for prospective longitudinal studies that span developmental periods and use developmentally-appropriate assessment of alcohol use in order to determine the mechanism by which ADHD confers increased risk for alcohol use disorders.

The Pittsburgh ADHD Longitudinal Study (PALS), a large longitudinal study of children with ADHD diagnosed in childhood and demographically-similar children without ADHD, found group differences in heavy drinking in individuals with and without ADHD in late adolescence but not in early adulthood (Molina et al., 2007). Preliminary findings also show that there were stronger associations between adolescent drinking and young adult binge drinking (Molina, Pelham, & Cheong, 2010) for individuals with than without childhood ADHD. There is also evidence that when individuals with ADHD drink alcohol it is more strongly associated with risky behaviors, including interpersonal violence (Wymbs et al., in prep). Thus, there may be clinically meaningful differences in the development of and impairment associated with alcohol use in individuals with and without ADHD. Together these findings suggest the possibility of an early onset chronic pathway to drinking that is more likely to persist beyond early adulthood and



to be associated with great impairment for individuals with than without ADHD. Because of the consequences of alcohol use for individuals with ADHD, it is important to understand the features that increase alcohol use for individuals with ADHD.

### **1.3 PREDICTORS OF ALCOHOL USE IN INDIVIDUALS WITH ADHD**

Understanding the traits that are related to alcohol use and how these characteristics manifest in individuals with ADHD to enhance risk of alcohol use in this vulnerable population may prove fruitful in identifying critical points for interventions to minimize alcohol use in early adulthood.

#### **1.3.1 The Role of Peers in Alcohol Socialization.**

Alcohol use in early adulthood primarily occurs in a social context with peers. College students often drink in social environments including parties, Greek events, and among members of the opposite sex (Cashin, Presley, & Meilman, 1998; O'Hare, 1990; Weschler, Dowdall, Davenport, & Castillo, 1995). Some researchers suggest that sociability expressed during a drinking event may serve as a marker of successful peer relationships and bonding (Brown et al., 2008).

Conversely, drinking may be a mechanism of achieving social benefits. For example, students report heavy drinking in order to facilitate contact with and acceptance from peers (Parish & Parish, 1991; Thombs, Beck, & Mahoney, 1993) and experience pleasant times with others (Carey, 1993, 1995; Teahan, 1987). College students also use alcohol as a means of establishing intimacy (Fondacaro & Heller, 1983; Nezlek, Pilkington, & Bilbro, 1994), closeness (Bradley, Carman, & Petree, 1991), and support (Moos, Moos, & Kulik, 1977) in peer relationships.

Therefore, drinking in early adulthood (at least among college students) often occurs in a social context and may create an environment that facilitates enjoyment of the benefits of relationships that young adults have with their peers. This is empirically-supported as incoming college

students associate heavy drinking with the positive outcome of making friends as opposed to alcohol use as a means of self-medication of negative affect (Reifman & Watson, 2003).

Given that alcohol use is a social behavior, it is important to consider the social context in which drinking occurs. Many researchers have examined how a broad social environment (i.e. Greek membership) or dyadic relationships influence alcohol use in early adulthood. However, only a few studies have examined the effects of peer socialization to alcohol use in early adulthood by examining the social network with which a young adult identifies and engages. The extant research that has been conducted on alcohol socialization in social networks has established cross-sectional correlations between the level of drinking in a young adult's social network and a young adult's drinking behavior (Fondacaro & Heller, 1983; Leonard, Kearns, & Mudar, 2000; Mohr, Aversa, Kenny, & Del Boca, 2001). However, unlike research with adolescents (e.g. Curran, Stice, & Chassin, 1997) these associations have been tested prospectively with young adults in only a few cases (e.g. Andrews, Tildesley, Hops, & Li, 2002; Poelen, Scholte, Willemsen, Boomsma, & Engels, 2007). Additionally, in a prospective study of alcoholics, approximately half of the participants' social networks before treatment included drinkers; however, after treatment the proportion of drinkers in the social network decreased while the proportion of non-drinkers in the social network increased (Mohr et al., 2001). Therefore, there may be social network effects on drinking behavior and structural changes in social networks (e.g. the number of friends in the social network who drink, the level of contact with these friends and the length of relationship) that parallel an individual's changes in drinking behavior. However, these associations have not been tested longitudinally.

There are several reasons why peers may socialize young adults to alcohol use. Young adults may be influenced by peer drinking behavior, and they may also be influenced by alcohol-

related norms and values. Early adulthood is a developmental period of increased susceptibility to attitude change (Visser & Krosnick, 1998). Thus, increased vulnerability to the attitudes of peers may increase alcohol use if peer attitudes are favorable towards alcohol use. Therefore, young adults may be at increased risk for alcohol use in the short-term because peers provide opportunities and models for drinking, and they may be at increased risk for alcohol use in the long-term because young adults internalize the norms and values of their peers (Oetting & Beauvais, 1986). Additionally, shared drinking experiences with peers may be associated with positive aspects of a relationship such as intimacy, closeness and support, leading young adults to affiliate with other young adults who consume alcohol. Therefore, early adulthood is a period when individuals are likely to engage in alcohol-related behaviors that are similar to those of their social networks and experience positive aspects of relationships that include shared alcohol use behaviors.

In addition to peer socialization that facilitates alcohol use, there may also be peer socialization that discourages alcohol use. Theoreticians suggest that there are important aspects of relationships that may be associated with the type of influence individuals exert on the behavior of a young adult. Catalano and Hawkins' Social Development Model (1996) recognizes that socialization factors influence the development of behaviors such as drinking, but that the norms and behaviors of peers will dictate whether peers will exert a positive or negative effect. For example, although families may traditionally be thought of as protective for elevated alcohol use because they endorse and model prosocial behaviors, they may increase the drinking behavior of their children if parents model substance use or abuse (Fleming, Brewer, Gainey, Haggerty, & Catalano, 1997; Foshee & Bauman, 1992). Therefore, although peers are most often conceptualized as risk factors for heavy alcohol use, peers who abstain or are light drinkers may

exert a protective effect on drinking in early adulthood. This possibility has been infrequently studied.

There are several ways in which peers may socialize young adults to light drinking or alcohol abstention (Borsari & Carey, 2006). First, light drinking peers can influence low-level alcohol use in early adulthood through social reinforcement of an environment that facilitates and encourages light alcohol use or alcohol abstention. Second, light drinking peers can influence low-level alcohol use in early adulthood by providing models for light drinking or alcohol abstention and drink-refusal skills. Finally, light drinking peers can influence low-level alcohol use in early adulthood by affecting cognitive processes of their young adult peers by reinforcing expectancies that alcohol is unnecessary to be social. Research supports protective peer socialization processes as college students whose peers disapprove of or abstain from drinking alcohol report low levels of alcohol use (Lo & Globetti, 1993; Martin & Hoffman, 1993). Furthermore, freshmen who have a social network that is characterized primarily by peers who abstain from alcohol use are less likely to initiate alcohol use and engage in binge drinking, compared to students whose social networks are primarily characterized by drinking peers (Reifman & Watson, 2003; Weitzman, Nelson, & Weschler, 2003). The protective effect of non-drinking peers is also found outside of the college environment. Although the association was only tested cross-sectionally, the proportion of non-drinking friends in alcoholics' post-treatment social networks was correlated with fewer drinks per drinking day following treatment (Mohr et al., 2001). These preliminary findings suggest that peers who abstain from alcohol can provide an important buffering effect on alcohol use during the period of development in which rates of alcohol use are their highest. However, to date this research has been cross-sectional and has not examined the directionality of these effects. Moreover, understanding whether peers may

influence alcohol use, both positively and negatively, may be particularly helpful toward understanding drinking outcomes in high-risk groups such as those with ADHD.

### **1.3.2 Social Impairment in ADHD**

Social difficulties experienced across the lifespan by individuals with ADHD (Hoza, 2007) may be relevant to their alcohol-related outcomes (Molina et al., 2012). Compared to children and adolescents without ADHD, children and adolescents with ADHD are more likely to be rejected by their peers (Erhardt & Hinshaw, 1994) and to have fewer friends (Bagwell et al., 2001; Hoza et al., 2005). When children and adolescents with ADHD are able to form friendships, they experience impairment in their ability to protect and repair friendships (Henker & Whalen, 1999). Therefore, as a result of their difficulties with peers, children and adolescents with ADHD may struggle to experience benefits from friendships which include enhancement of worth, companionship, guidance, nurturance, and emotional support, including loyalty, trust, and intimacy (Bukowski & Hoza, 1989; Hartup & Stevens, 1997). As such, individuals with ADHD may not only suffer directly from the presence of peer rejection and social isolation, but they may suffer indirectly from the absence of the protective aspects of friendship.

The presence of friends in childhood and in adolescence is associated with a variety of positive emotional, cognitive, academic and behavioral outcomes (Vitaro, Boivin, & Bukowski, 2009; Youniss, 1980). Children with friends have greater self-confidence (Hartup, 1996; Newcomb & Bagwell, 1995), are more involved in school, and are more academically proficient (Berndt, Hawkins, & Hoyle, 1986; Ladd, Kochenderfer, & Coleman, 1996; Parker & Asher, 1993; Vandell & Hembree, 1994). In addition to the direct positive effects of having friends, friends may exert indirect positive effects by being protective against the negative emotional effects of peer rejection (Parker & Asher, 1993), peer victimization (Boivin, Hymel, & Hodges, 2001; Bukowski, Motzoi, &

Meyer, 2009), and negative family relationships (Bukowski et al., 2009; Rubin, Bukowski, & Parker, 2006) by providing adolescents with sources of companionship, emotional support, intimacy and self-validation (Vitaro et al., 2009). Therefore, children and adolescents who are socially-impaired, such as children with ADHD, may lack the protective benefits of peer socialization that include minimizing the impact of risk factors (e.g. impulsivity, delinquency) for problem drinking.

Some studies have examined the social impairment of young adults with ADHD. Although they are limited by small sample sizes, they provide preliminary evidence for the persistence of social impairment (Babinski et al., 2011; Barkley et al., 2008), interpersonal difficulties (Weiss & Hechtman, 1993), and social competence deficits (Chen & Simmons-Morton, 2009) from childhood into early adulthood. Young adults with ADHD have fewer friends (Babinski et al., 2011; Weiss & Hechtman, 1993), more negative social behaviors, lower levels of social skills, and deficits in skills necessary to engage others in conversation (Shaw-Zirt, Popali-Lehane, Chaplin, & Bergman, 2005). Like children and adolescents, young adults with ADHD may experience social problem-solving skill deficits which negatively influence existing relationships (Dodge, Coie, Pettit, & Price, 1990; Dodge, Pettit, McClaskey, & Brown, 1986). Additionally, young adults with ADHD may have difficulty with self-presentation skills, including tactfulness and the ability to adjust their behavior to be appropriate to the situation (Shaw-Zirt et al., 2005). In sum, individuals with ADHD appear to experience persistent and pervasive social impairments across the lifespan that range from social skills deficits to difficulties with the formation and maintenance of peer relationships. However, to date no research has examined how interpersonal deficits influence the structure and features of social networks for individuals with ADHD in early adulthood.

### **1.3.3 Peer Socialization to Alcohol use in Individuals with Social Impairment**

Because alcohol use in early adulthood is largely a social behavior, and individuals with ADHD are characterized by social impairment, the development of alcohol use in early adulthood may be different for individuals with and without ADHD. Individuals who lack skills necessary to form prosocial peer relationships may be at risk for increased alcohol use due to rejection from social relationships that model or encourage alcohol abstinence or non-problem drinking.

Instead, individuals with social impairment may affiliate with peers who have elevated alcohol use that increases alcohol use in early adulthood compared with peers who engage in more typical alcohol use. The influence of peer relationships has been demonstrated as a risk factor for alcohol use in adolescent samples (Ary, Duncan, Duncan, & Hops, 1999; Ary, Tildesley, Hops, & Andrews, 1993; Barrera, Biglan, Ary, & Li, 2001; Dishion, Capaldi, Spracklen, & Li, 1995; Fergusson, Swain-Campbell, & Horwood, 2002; Petraitis, Flay, & Miller, 1995). However, little attention has been given to the influence of peer relationships on alcohol use in early adulthood. Although other influences may heighten the importance of social impairment in early adulthood (i.e. using alcohol to cope with social impairment; Borsari & Carey, 2006), additional research is needed on the potential influences of peer socialization to alcohol use for individuals who may be especially susceptible to these influences.

Several findings suggest reasons for potential increased vulnerability to negative drinking-related social influences in early adulthood for individuals with ADHD. Individuals with ADHD have greater turnover in their social networks due to unstable peer relationships (Erhardt & Hinshaw, 1994; Henker & Whalen, 1999; W.E. Pelham & Bender, 1982) and are more likely to affiliate with unconventional peers (Henker & Whalen, 1999; Hinshaw & Melnick, 1995). Marshal and colleagues (2003) found that deviant peers mediated the association between

ADHD and substance use such that children with ADHD are more likely than children without ADHD to have deviant peers, and as a result, more likely to use alcohol. Additionally, adolescents with ADHD were more vulnerable to the influence of peer drinking than adolescents without ADHD (Belendiuk, Pedersen, King, Pelham, & Molina, in prep). Therefore, individuals with ADHD not only have more opportunities to choose new peers due to social instability, they select friends with attitudes and behaviors that support alcohol use, and are also more susceptible to peer influence that increases the risk of alcohol use.

In addition to social impairment facilitating alcohol use, there may also be aspects of social impairment that protect against elevated alcohol use. First, due to limited contact with peers there may be decreased peer socialization to alcohol use because of decreased modeling of and social reinforcement for alcohol use (Borsari & Carey, 2006). Second, individuals with social impairment may be more likely to have relationships that are characterized by lower relationship quality. Because research has shown that high-quality relationships exert a stronger influence on drinking in early adulthood than low-quality relationships, young adults with social deficits may be less susceptible to peer socialization. This is important because, as reviewed above, peers can exert a protective effect by modeling and reinforcing low-level drinking behavior. Because heavy alcohol use in early adulthood is largely affected by peer alcohol use socialization, individuals with ADHD who experience social impairment and affiliate with heavy drinking peers may have stronger peer socialization to elevated alcohol use than individuals without ADHD.



### **1.3.4 Impulsivity in ADHD**

Persisting ADHD symptoms, including impulsivity, are associated with alcohol use (Molina et al., 2012; Molina & Pelham, 2003). There is an extensive literature examining the association between impulsivity and alcohol use and alcohol problems (Congdon & Canli, 2005; Sher & Trull, 1994; Verdejo-Garcia, Lawrence, & Clark, 2008). Specifically, research supports a prospective association between impulsivity and the development of alcohol use disorders (Clark, Vanyukov, & Cornelius, 2002; Dawes, Tarter, & Kirisci, 1997).

Impulsivity may be a marker of a genetic vulnerability to substance use problems, as evidenced by impulsivity loading onto a genetic factor with alcohol dependence, drug abuse/dependence, childhood conduct disorder, and adult antisocial behavior (Krueger et al., 2002; Young, Stallings, Corley, Krauter, & Hewitt, 2000), and twin studies that indicate that behavioral undercontrol accounts for a significant proportion of the genetic diathesis for alcohol dependence (Slutske et al., 2002). In addition, compared to individuals without ADHD, individuals with ADHD demonstrate increased alcohol-induced disinhibition (Weafer, Fillmore, & Milich, 2009) which may lead to increased levels of binge drinking (Weafer, Milich, & Fillmore, 2011). This alcohol-induced disinhibition can interact synergistically with pre-existing impulsivity to increase risk for negative consequences and further exacerbate drinking (Rubio et al., 2008) for young adults with ADHD. Importantly, impulsivity has also been associated with young adult selection to heavy drinking peer networks (Park, Sher, Wood, & Krull, 2009), suggesting that young adults with ADHD may also be at increased risk for elevated alcohol use due to increased peer alcohol socialization. Therefore, as a result of their core symptom of impulsivity, individuals with ADHD may be more likely to affiliate with heavy drinking peers and to drink heavily themselves in early adulthood. Research will benefit from understanding

whether individuals who are characterized by impulsivity are at direct and or indirect risk (via differential peer socialization) for alcohol use in order to identify targets for intervention.

### **1.3.5 Delinquency in ADHD**

Delinquent behavior commonly co-occurs with ADHD (Barkley et al., 2008; Farrington, Loeber, & Van Kammen, 1990; Loeber, Burke, Lahey, Winters, & Zera, 2000; Molina, Flory, et al., 2007). Several studies have found elevated rates of delinquency (Farrington et al., 1990; Loeber, Brinthaup, & Green, 1990; Molina, Pelham, et al., 2007; Satterfield, Swanson, Schell, & Lee, 1994) and greater delinquency severity (Molina, Flory, et al., 2007) in individuals with than without ADHD. For example, rates of conduct disorder in adolescents with ADHD range from 25-45% whereas rates of conduct disorder in individuals without ADHD are often in the single digits (Molina, 2011). Given the well-established co-occurrence of conduct problems in childhood and adolescence with substance use and abuse in adolescence (Hawkins, 1992), and connection between antisocial behaviors and alcoholism in adulthood (Compton, Conway, Stinson, Colliver, & Grant, 2005), this common comorbidity is typically targeted in research on the link between ADHD and alcohol outcomes.

Molina and colleagues (2007) identified that young adults with both ADHD and antisocial behavior reported more drinking per occasion and were more likely to meet diagnostic criteria for an alcohol use disorder than individuals without a diagnosis of ADHD. Findings from a birth-cohort in Denmark also found that above-median ADHD and conduct disorder symptom scores predicted higher rates of lifetime alcohol dependence compared to individuals who were below the median on one or both symptom domains (Knop et al., 2009). Therefore, the presence of serious behavior problems in individuals with ADHD contributes to greater drinking frequency and later problem drinking.

Prospective longitudinal studies suggest that delinquency may mediate the association between childhood ADHD and substance use-related problems (Lynskey & Fergusson, 1995; Martel et al., 2009). These studies suggest that early behavioral disinhibition leads to diagnoses of ADHD, subsequent conduct problems, and eventual problems with substance use (Molina, 2011). Additionally, Molina and colleagues (Molina et al., 2012) found that delinquency mediated the association between social impairment and alcohol use in adolescents with ADHD histories. Ironically, social impairment also predicted less drinking outside of the delinquency-mediated pathway (a direct pathway from social impairment to alcohol use versus an indirect pathway through delinquency). Therefore, delinquency is associated with alcohol use in adolescence and socialization influences may differ in the context of delinquency. To date, no studies have examined the contribution of delinquency to alcohol socialization in adulthood in the context of ADHD.

#### **1.4 METHODOLOGICAL CONSIDERATIONS OF MEASURING PEER NETWORK EFFECTS**

In order to advance research on the role of peer network socialization to early adult alcohol use, inconsistencies in the operationalization of alcohol use in the peer network need to be addressed. Some studies have examined the average level (e.g., average frequency of alcohol use across friends) of drinking in a social network (Bullers, Cooper, & Russell, 2001; Reifman, Watson, & McCourt, 2006) but this approach obscures the effect of important group members or network outliers, specifically high- and low-drinking peers. An alternative approach examines the absolute number of individuals in a peer network who are characterized as “drinking buddies” or heavy drinkers (Homish & Leonard, 2008; Leonard & Mudar, 2000, 2003). The absolute number

of drinkers in a social network is informative, but it does not provide information about the relative effect of drinking peers in the context of the social network. For example, the relative influence of a heavy drinking friend may vary in the context of smaller or larger social networks. Some researchers have examined the proportion of drinking friends in an individual's social network (Lau-Barraco & Collins, 2011; Leonard et al., 2000; Mohr et al., 2001), however a proportion of 0.5 could indicate that 1 member of a 2-member social network is a drinker or that 10 members of a 20-member social network are drinkers. There may be important differences in the magnitude of influence between these proportions, particularly if one heavy drinking friend is highly influential. Each methodological approach offers unique information about peer alcohol socialization, but to date it is unclear which operationalization is a better predictor of young adult alcohol use. Research comparing them is needed.

In sum, although research has suggested an association between childhood ADHD and later alcohol-related outcomes in adulthood, there is a dearth of prospective longitudinal studies that have tested hypotheses about the contribution of peer relationship variables. The current study will examine whether peer socialization to alcohol use during the developmental period when alcohol use peaks is different between individuals with and without ADHD, whether features of ADHD (i.e. impulsivity, delinquency, impaired social functioning) influence the association between ADHD and alcohol use, and identify whether different operationalizations of social influence (i.e. number versus proportion of heavy drinking and light drinking peers) affect observed associations between peer socialization to alcohol use and alcohol use in young adults with and without ADHD.

## **2.0 SPECIFIC AIMS**

The overarching goal of this project was to examine peer alcohol socialization in young adults with and without a childhood history of ADHD. Specifically, peer alcohol socialization (i.e. the presence of heavy and light drinking friends in a social network) was examined as a mediator of the association between late adolescent behavioral dysregulation (i.e. impulsivity and delinquency) and young adult alcohol use (i.e. binge drinking and quantity/frequency of alcohol use) for individuals with, and without, childhood ADHD. These associations were examined using two contrasting operationalizations of social network drinking to identify whether the absolute number of friends who drink or the proportion of friends who drink is more strongly predictive of alcohol use in early adulthood. Specific aims and hypotheses are as follows:

### **2.1 AIM 1.**

ADHD and nonADHD group differences in social functioning and alcohol use have been identified in childhood and adolescence but have not been examined in early adulthood. The first aim of the study is to evaluate ADHD and nonADHD group differences in social network characteristics (e.g. size, number of friends, relationship quality), and alcohol use (i.e. frequency of binge drinking and quantity/frequency of alcohol use) in early adulthood.

### **2.1.1 Hypotheses.**

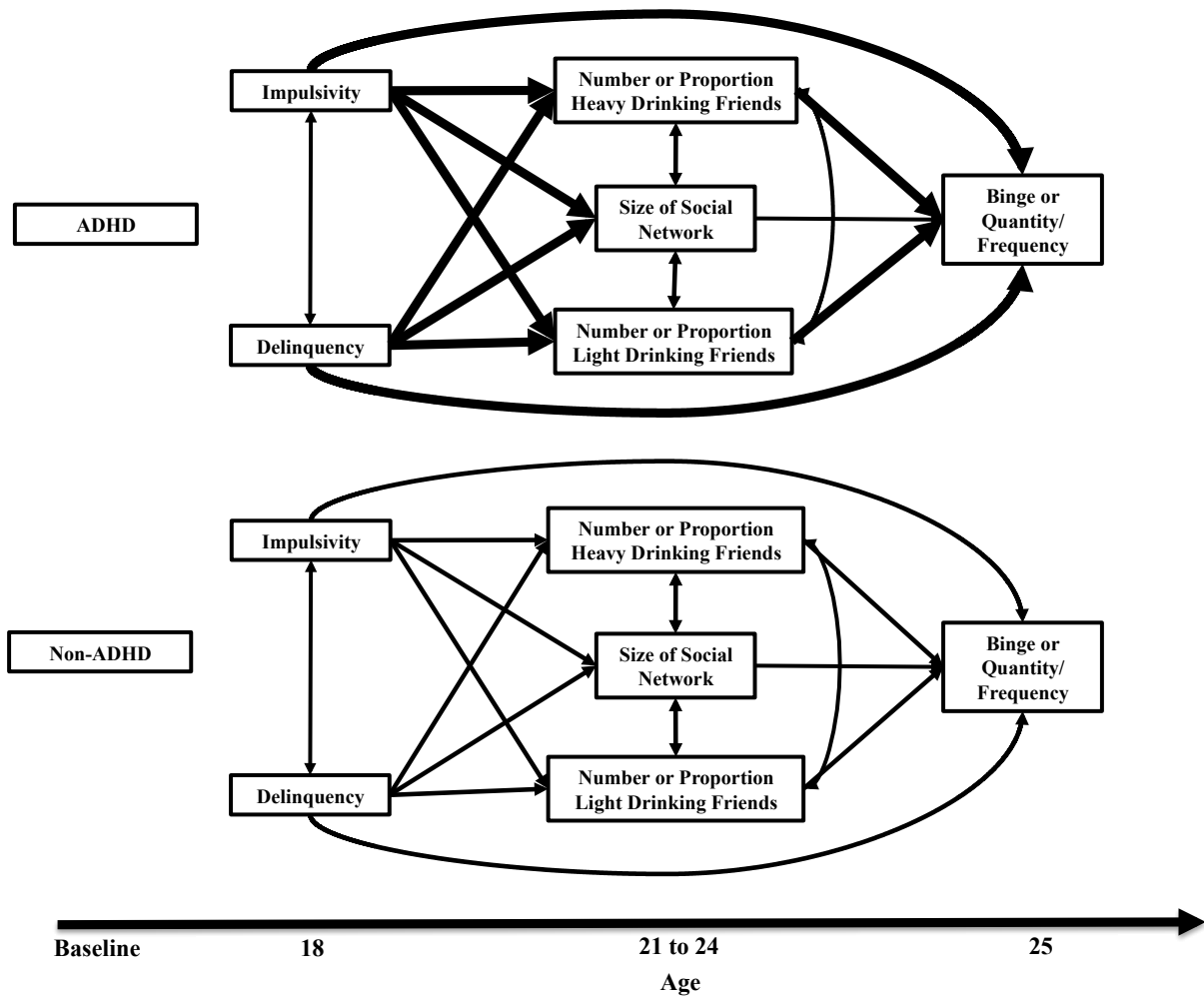
Compared to individuals without ADHD, individuals with ADHD are expected to have smaller social networks, fewer friends in their social networks, and friendships characterized by a shorter friendship duration, less assistance, advice, time spent socializing, emotional support, intimacy and higher levels of conflict. Furthermore, individuals with ADHD are predicted to have greater numbers of heavy drinking peers and drinking buddies in their social networks.

## **2.2 AIM 2.**

Evaluate the prospective associations between perceived peer alcohol use and self-reported alcohol use in early adulthood between individuals with and without ADHD. Test the prospective contribution of impulsivity and delinquency to these variables (see Figure 1 below).

### **2.2.1 Hypotheses.**

Associations between perceived peer alcohol use and self-reported alcohol use will be present for both individuals with and without ADHD and these associations will be stronger in individuals with ADHD. Additionally, impulsivity and delinquency will influence social networks in early adulthood, which will be associated with peer socialization to alcohol use in individuals with and without ADHD, and these effects will be stronger in individuals with ADHD.



**Figure 1. Proposed model to test for associations between perceived peer alcohol use and self-reported alcohol use in early adulthood (Aims 2 and 3)**

Note: Thicker black lines indicate hypothesized stronger relations between variables for individuals with than without ADHD.

### **2.3 AIM 3.**

Evaluate whether associations between perceived peer alcohol use and self-reported alcohol use vary based on the operationalization of peer drinking in the social network (see Figure 1).

#### **2.3.1 Hypothesis.**

Both the number of peers and the proportion of peers in a social network who engage in or abstain from drinking will be associated with alcohol use in early adulthood.



### **3.0 METHOD**

#### **3.1 PARTICIPANTS**

Young adults with childhood ADHD (probands) participating in the Pittsburgh ADHD Longitudinal Study (PALS) provided data for the present study. PALS probands were recruited from a pool of 516 children diagnosed with DSM-III-R or DSM-IV ADHD at the ADD Clinic at the Western Psychiatric Institute and Clinic (WPIC) in Pittsburgh, PA between 1987 and 1996. Mean age at initial evaluation was 9.40 (SD=2.27) with 90% between the ages of 5 and 12. All probands participated in the ADHD Summer Treatment Program (STP), a comprehensive 8-week intervention that included behavioral modification, parent training, and psychoactive medication trials where indicated (W. E. Pelham, Fabiano, Gnagy, Greiner, & Hoza, 2005). As part of their participation in the STP, extensive interview, rating scale, and observational data were collected.

Diagnostic information was collected in childhood using several sources, including the parent and teacher Disruptive Behavior Disorders (DBD) Rating Scale (W.E. Pelham, Gnagy, Greenslade, & Milich, 1992), which assesses the DSM symptoms of ADHD, ODD and CD. In addition, parents completed a semi-structured interview consisting of the DSM descriptors for the disorders, with supplemental questions regarding situational and severity factors. The interview also included queries about other comorbidities to determine whether additional assessment was needed (instrument available from W.E. Pelham). Following DSM guidelines, diagnoses were made if a sufficient number of symptoms were endorsed (considering

information from both parents and teachers) to result in diagnosis. Two Ph.D.-level clinicians independently reviewed all ratings and interviews to confirm the DSM diagnoses. When the 2 clinicians disagreed, a third clinician reviewed the file and the majority decision was used. Exclusionary criteria included a full scale IQ less than 80, a history of seizures or other neurological problems, and a history of pervasive developmental disorder, schizophrenia, or other psychotic or organic mental disorder.

Of the 516 eligible children with ADHD, 493 were re-contacted and 364 were interviewed (70.5% participation rate) for the follow-up study (Molina, Pelham, et al., 2007). At the time of their follow-up interview, probands were between the ages of 11 and 28 with 99% falling between 11 and 25 years of age and an average of 8.35 years having elapsed since their childhood diagnosis and summer program participation. Participants in the follow-up study were compared with the eligible individuals who did not enroll on demographic (i.e., age at first treatment, race, parental education level, and marital status) and diagnostic (i.e., parent and teacher ratings of ADHD and related symptomatology) variables collected at baseline. Only one of 14 comparisons was statistically significant at the  $p < .05$  significance level; participants had a slightly lower average CD symptom rating on a four point scale as indicated by a composite of parent and teacher ratings (participants  $M = 0.43$ , non-participants  $M = 0.53$ ).

Two-hundred and forty demographically-similar 11 to 25 year olds without ADHD (controls) were recruited on a rolling basis from the Pittsburgh area between 1999 and 2001 to provide a demographically similar comparison group to the probands. Controls were recruited through pediatric practices (40.8%), advertisements in local newspapers and the university hospital staff newsletter (27.5%), local universities and colleges (20.8%), and other methods (e.g., Pittsburgh Public Schools, word of mouth). A telephone screening interview administered to

parents gathered basic demographic characteristics, history of diagnosis and treatment for ADHD and other behavior problems, presence of exclusionary criteria, and a checklist of ADHD symptoms. Young adults (18+) also provided self-report. ADHD symptoms were counted as present if reported by either the parent or young adult. Individuals who met DSM-III-R criteria for ADHD (presence of 8 or more symptoms)—either currently or historically—were excluded. Control participants with subthreshold ADHD symptoms, or other psychiatric disorders, were retained. Controls were selected for the study to ensure between-group equivalence in proportions for demographic characteristics (age, gender, ethnic/racial minority, and highest parent education).

After recruitment into the follow-up study, all participants were interviewed annually until 2008. Beginning in late 2008, participants younger than age 23 continued to be interviewed annually; after age 23, assessments were administered at ages 25, 27, 30, and 35. For the current study, data were available for up to 11 waves of data collection. A sample participant might have enrolled in the study at age 16 and completed 9 assessments: 8 annual assessments from the ages of 16 to 23 and a ninth assessment at age 25.

### **3.1.1 Subsample for the current study.**

For the current study, a subset of the proband and control samples was selected. Participants who completed the Substance Use Questionnaire (SUQ) at age 25 and also completed the Social Network Inventory (SNI) between the ages of 21 and 24 were included in the present analyses (n=162; 94 ADHD, 68 non-ADHD). Of the 162 participants who completed the SUQ at age 25, 69 participants (36 ADHD, 33 non-ADHD) completed the SNI at age 21, 77 participants (48 ADHD, 29 non-ADHD) completed the SNI at age 22, 127 participants (75 ADHD, 52 non-ADHD) completed the SNI at age 23, and 68 participants (38 ADHD, 30 non-ADHD) completed

the SNI at age 24. Participants could provide SNI data at multiple assessment points between the ages of 21 and 24. If so, their responses were averaged (see below): 41 participants (26 ADHD, 15 non-ADHD) provided SNI data at 1 follow-up assessment, 66 participants (36 ADHD, 30 non-ADHD) provided SNI data at 2 follow-up assessments, 56 participants (33 ADHD, 23 non-ADHD) provided SNI data at 3 follow-up assessments; no participants provided SNI data at all 4 follow-up assessments.

Participants in the subsample were compared with non-participants (those who joined the follow-up study but did not provide the needed SUD and SNI data) on demographic (i.e., parental education level and income) and diagnostic (i.e., parent and teacher ratings of ADHD and related symptomatology) variables collected during adolescence and adulthood (see Table 1). Only one of 8 comparisons was statistically significant at the  $p < .05$  significance level; participants had slightly lower delinquency ratings than non-participants (participants  $M = 0.10$ , non-participants  $M = 0.16$ ; Cohen's  $d = 0.44$ ). Demographics of the subsample are presented in Table 2.

**Table 1. Group differences in participation subsample and individuals not included.**

Variable	Non-Participant, M(SD) <i>n</i> =438	Participant, M(SD) <i>n</i> =162	Test Statistic
Impulsivity (EIS)	12.95(5.79)	12.75 (5.77)	$t_{(1,577)} = 0.36$
Delinquency Proportion <sup>a</sup>	0.16 (0.16)	0.10 (0.11)	$t_{(1,422)} = 5.95^{***}$
ADHD Symptom Rating (DBD) <sup>b</sup>	1.12 (0.77)	1.22 (0.82)	$t_{(1,598)} = -1.38$
Parental Income	\$67,225 (\$47,133)	\$67,720 (\$52,317)	$t_{(1,492)} = -0.10$
Parental Education	7.18 (1.66)	7.36 (1.66)	$F_{(1,587)} = 1.43$
ADHD Status	<i>n</i> (%)	<i>n</i> (%)	$\chi^2_{(1)} = 0.37$
ADHD	269 ( 61.0)	95 (58.3)	
Non-ADHD	172 (39.0)	68 (41.7)	
Gender			$\chi^2_{(1)} = 0.03$
Male	393 (89.1)	146 (89.6)	
Female	48 (10.9)	17 (10.4)	
Ethnicity			$\chi^2_{(1)} = 0.45$
Caucasian	366 (83.0)	131 (80.4)	
Non-Caucasian	75 (17.0)	32 (19.6)	

\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$

<sup>a</sup>Proportion of items endorsed; different numbers of items were administered to adolescents and young adults

<sup>b</sup>The maximum number of items endorsed on the DBD based on self-, parent-, and teacher-reports during the first assessment completed in the study, either in adolescence or early adulthood.

Note: Results did not differ when analyzed separately by the dimensions of ADHD symptomatology (i.e. inattention and hyperactivity-impulsivity).

**Table 2. Demographic characteristics of the sample**

Variable	Non-ADHD M(SD) <i>n</i> =68	ADHD M(SD) <i>n</i> =95	Test Statistic
Parental Income	\$77,364 (\$59, 483)	\$60,816 (\$47,614)	$t_{(1,137)} = 1.819$
Parental Education	7.54 (1.66)	7.23 (1.66)	$F_{(1,161)} = 1.37$
Gender	<i>n</i> (%)	<i>n</i> (%)	$\chi^2(1)=0.22$
Female	8 (11.8)	9 (9.5)	
Male	60 (88.2)	86 (90.5)	
Ethnicity			$\chi^2(1)=0.44$
Non-Caucasian	15 (22.1)	17 (17.9)	
Caucasian	53 (77.9)	78 (82.1)	

Note: There were no statistically significant differences for demographic variables between ADHD and non-ADHD groups

### 3.1.2 Procedure.

As noted, baseline diagnostic information was gathered for the ADHD group at initial referral to the clinic during childhood. Follow-up interviews in early adulthood were conducted by post-baccalaureate research staff. All questionnaires (paper and pencil or web-based) in the current study were completed privately. During informed consent, participants were assured of the confidentiality of disclosed materials. In cases where distance prevented participant travel to WPIC, information was collected through mail, telephone correspondence, and home visits. Participants were permitted to take stimulant medication on the day of the assessment; however a minority of the ADHD group (<10%) were prescribed stimulant medication during the follow-up years.

## 3.2 MEASURES

### 3.2.1 Dependent variables.

*3.2.1.1 Frequency of binge drinking and quantity/frequency of alcohol use.* Alcohol outcomes were assessed at age 25 with self-report on the Substance Use Questionnaire (SUQ; Molina, Pelham, et al., 2007). The SUQ, an adaptation of items from the Health Behavior Questionnaire (Jessor, Donovan, & Costa, 1989) and National Household Survey of Drug Abuse interview (NHSDA, 1992), assessed the frequency of binge drinking (“In the past 12 months, how often did you drink 5 or more drinks when you were drinking?”) and the frequency of alcohol use (“In the past 12 months, how often did you drink beer, wine, wine coolers, or liquor?”) on a response scale ranging from (0) “Not at all” to (11) “Several times a day.” Quantity of alcohol use (“Think of all the times you have had a drink in the past 12 months. How much did you usually drink each time?”) was assessed on a response scale ranging from (0) “I didn't drink in the past 12 months” to (13) “More than 25 drinks.” The product of quantity and frequency responses was computed to form a composite quantity/frequency of alcohol use variable with the goal of capturing drinking behavior that is below the binge drinking threshold. As the alcohol outcomes were positively skewed, a maximum likelihood robust estimator (MLR) was used to control for non-normality.

### **3.2.2 Independent variables.**

**3.2.2.1 Peer drinking and social network characteristics.** At each assessment point, each participant provided a list of members of their social networks in the past year on the Social Network Inventory (Leonard et al., 2000), a measure used in prior research on peer and relationship alcohol socialization (e.g. Leonard et al., 2000; Leonard & Mudar, 2000, 2003; Reifman et al., 2006). These lists of social network members were developed through the use of elicitation prompts focused on the last year to identify people 1) who had provided emotional support, 2) with whom the respondent had socialized or regularly had fun, 3) who helped with practical or financial problems, and 4) any others who were important to them. Participants listed a first name and last initial for elicited individuals (up to 24) and then answered questions about various aspects of their relationship with each person in a grid format; the list of peer names was discarded after completing the questionnaire. Data collected from the questionnaire included demographics (e.g., age, gender, relationship to respondent), relationship factors (e.g., length of relationship, time spent socializing with person), support (e.g., financial and emotional support), and alcohol-related variables (e.g., respondent's perception of general drinking pattern). Length of friendship was an open-ended question with length of friendship measured in years. Ratings of assistance, advice, time spent socializing, emotional support and intimacy characterized a friendship were rated on a 4-point Likert scale ranging from 1= not at all to 4= a lot. Level of conflict that characterized the relationship was reverse-coded such that 1= a lot and 4 = not at all. For the purpose of the current study, and based on previous work (Leonard & Mudar, 2003), peers included those designated by the respondent as a close friend, friend, or acquaintance. Family members were not included, because prior research (Leonard et al., 2000) did not reveal any differences between regular and heavy drinkers with respect to family network



characteristics.

The peer drinking variables were based on the respondent's perception of the past-year drinking behavior (1 = abstainer, 2 = occasional/light social drinker, 3 = moderate/average social drinker, 4 = frequent/heavy social drinker) of each peer; the current study modified the original SNI by omitting response options of 5=problem drinker and 6=alcoholic due to concerns related to reporting another individual's problematic drinking without obtaining consent. **The number of moderate-to-heavy drinking friends** (hereafter referred to as "number of heavy drinking friends") was operationalized as the number of peers characterized as moderate/average or frequent/heavy social drinkers and the **number of abstaining-to-light drinking friends** (hereafter referred to as "number of light drinking friends") was operationalized as the number of peers characterized as abstainers or light social drinkers. **The proportion of moderate-to-heavy friends** (hereafter referred to as "proportion of heavy drinking friends") was operationalized as the proportion of peers characterized as moderate/average or frequent/heavy social drinkers of the total number of peers in the network and the **proportion of abstaining-to-light friends** (hereafter referred to as "proportion of light drinking friends") was operationalized as the proportion of peers characterized as abstainers or light social drinkers of the total number of peers in the network. Similar coding structures have been used by other groups to assess peer drinking in social networks (e.g. Leonard & Mudar, 2003; Mohr et al., 2001). As the peer drinking variables were positively skewed, a maximum likelihood robust estimator (MLR) was used to accommodate the non-normality. Because there were no hypothesized developmental differences in the number or proportion of heavy or light drinking friends in early adulthood, if a participant provided SNI data at more than one assessment between the ages of 21 and 24, their

SNI data were averaged across time points. This procedure allowed for maximal use of available data.

**3.2.2.2 Impulsivity.** The Eysenck Impulsivity Scale (Eysenck, Easting, & Pearson, 1984) is a 23-item questionnaire measure of impulsive behavior that has been shown to have good reliability ( $\alpha = 0.86-0.89$ ) in this sample. White and colleagues (1994) adapted the original British items for American dialect and simplicity of vocabulary. Each question is scored as yes or no (a “don’t know” response was provided to parents for all items). This measure was administered to all parents and participants at the first follow-up assessment followed by a single administration at age 18 as the younger participants attained that age. All ratings of impulsivity in the current study are from the age 18 assessment. Positively coded items endorsed by either the parent or the participant were summed to create an index of the subjects’ impulsivity.

**3.2.2.3 Delinquency.** Delinquency data were collected with the 32-item Self-Reported Delinquency Questionnaire (SRD; Elliott, Huizinga, & Ageton, 1985). The SRD was administered to participants who were 18 and older at the first follow-up assessment and administered annually to all other participants. The current study used the SRD that was administered to each participant and their parent(s) at age 18. Research on the SRD in general populations suggests that the measure possesses adequate validity and test-retest reliability (Huizinga & Elliott, 1986). However, analyses of the SRD in the current sample have demonstrated that probands may under-report the severity of their delinquent acts and recant previously endorsed delinquent acts (M.H. Sibley et al., 2010). As such, positively coded delinquency items (e.g. “Have you ever snatched someone’s purse or wallet?”) endorsed by either the parent or the participant were summed to create an index of the subjects’ delinquency

to increase validity (Farrington, Loeber, Stouthamer-Loeber, Van Kammen, & Schmidt, 1996; M.H. Sibley et al., 2010).

#### **4.0 ANALYTIC PLAN**

To address Aim 1, descriptive analyses (e.g. means, standard deviations) were conducted for social network characteristics (e.g. size, number of friends, relationship quality) and alcohol use (i.e. frequency of binge drinking and quantity/frequency of alcohol use). Individuals with ADHD and without ADHD were compared using t-tests, F-tests, and chi-square tests to identify whether there were significant group differences in the variables. The outcomes of the other specific aims were interpreted in the context of any observed mean group differences.

Aims 2 and 3 were tested using four structural equation models in which model fit and parameter estimates were compared between individuals with and without childhood ADHD (see Figure 1). Background covariates (i.e. parental education at the first follow-up interview for the ADHD group and the first interview for the nonADHD group), covarying impulsivity and delinquency at age 18, and covarying young adult peer alcohol use (i.e. the number and proportion of heavy and light drinking peers), were included as manifest variables. The size of social network at the assessment points when participants provided social network data, was also included in the models. Four separate models were estimated examining two operationalizations of peer socialization (i.e. number and proportion of heavy and light drinking peers) and two manifest alcohol variables (i.e. binge drinking and quantity/frequency of alcohol use). Although the four models could not be formally compared to identify whether there were statistically significant differences in peer socialization to binge drinking or quantity/frequency of alcohol

use, the relative strength of the associations between variables and the patterns of the results were examined.

First, each of the four models was estimated for the entire sample. Second, to examine the differences in the relations between parameters for the ADHD and non-ADHD groups, each of the four models were tested in a multiple group framework using childhood ADHD diagnosis as the grouping variable. The multiple group framework began with an unconstrained model where all of the parameter estimates were allowed to vary across groups. Subsequently, each parameter estimate was individually equated across groups while using Wald chi-square testing to determine whether constraining the specified parameter estimate produced a significant decrement in model fit. A decrement in model fit indicated that the strength of the association for the specified parameter significantly differed as a function of ADHD status. Because there were directional hypotheses about the group differences (i.e. impulsivity and delinquency will be more strongly predictive of drinking for individuals with than without ADHD), a critical value of  $p < 0.10$  was used to determine whether to reject the null hypothesis that there are no group differences in the parameters predicting alcohol use in early adulthood in the model-building framework. If constraining a parameter resulted in a statistically significant decrement in model fit, then the parameter was freed to vary across groups in subsequent iterations of model testing; if constraining a parameter did not result in a statistically significant decrement in model fit, then the parameter was constrained to be equal across groups in subsequent iterations of model testing. Model testing was theory-driven and iterative such that the paths of primary theoretical significance (e.g. the direct paths from predictors to alcohol outcome variables) were tested first, followed by personality predictors of social network characteristics (e.g. impulsivity as a predictor of number of heavy drinking peers), then by variable covariances (e.g. the association

between impulsivity and delinquency at age 18), finally followed by the association between parental education and predictor and outcome variables (e.g. parental education predicting alcohol use). If a path was constrained, it was constrained for all subsequent tests of path equality across groups and if it was freed, it was freed for all subsequent tests of path equality across groups. Therefore, a model building approach was used where each path was tested individually but in the context of the other parameters in the model. Indirect effects (i.e. mediational paths) of predictor variables on outcome variables were tested for each model. There were no statistically significant indirect effects for any model; had there been, these would have been tested to evaluate presence of statistically significant mediation.

Mplus Version 6 (Muthén & Muthén, 2010) was used to test the primary hypotheses due to its ability to estimate structural models with categorical outcome variables and missing data. Model fit was assessed using the chi-square goodness of fit test, comparative fit index (CFI), standard root mean square residual (SRMR), and root-mean-square error of approximation (RMSEA). For the CFI, the conventional cutoff value of .90 or greater indicated acceptable fit, and .95 or greater for good fit. For the SRMR, the conventional cutoff value of less than .08 indicated good fit (Hu & Bentler, 1999). RMSEA values between .05 and .08 represent acceptable fit, while values less than .05 indicate a good fit (McDonald & Ho, 2002). Missing data was accounted for by using maximum-likelihood model estimation assuming ignorable missingness at random (Little & Rubin, 2002; Muthén & Muthén, 2010). Skewness in the data was accommodated by using the maximum-likelihood with robust standard errors (MLR) as the estimator for all models.

## 5.0 RESULTS

### 5.1. AIM 1. DESCRIPTIVE INFORMATION AND GROUP DIFFERENCES IN SOCIAL NETWORK CHARACTERISTICS AND ALCOHOL USE VARIABLES.

Compared to individuals without ADHD, individuals with ADHD had significantly higher levels of impulsivity at age 18 ( $t=-6.52, p<0.001$ ). On average, individuals without ADHD and their parents endorsed 9.71 (SD=4.94) impulsivity items, whereas individuals with ADHD and their parents endorsed 15.10 (SD=5.26) impulsivity items, a large effect size ( $d = 1.06$ ). Additionally, compared to individuals without ADHD, individuals with ADHD had significantly higher levels of delinquency at age 18 ( $t=-2.46, p<0.05$ ). On average, individuals without ADHD and their parents endorsed 1.50 (SD=1.82) delinquency items, whereas individuals with ADHD and their parents endorsed 2.73 (SD=4.27) delinquency items, a small effect size ( $d = 0.36$ ).

As shown in Tables 3 and 4, of the social network variable comparisons, only social network size, and number of friends revealed statistically significant group differences at more than one age and showed trends in the same direction across all of the age group comparisons. Compared to individuals without ADHD, individuals with ADHD reported fewer people in their social networks at ages 22 ( $t=1.96, p<0.05, d=0.47$ ) and 25 ( $t=2.53, p<0.01, d=0.40$ ), and fewer friends, close friends and acquaintances at ages 21 ( $t=2.04, p<0.05, d=0.50$ ), 22 ( $t=2.06, p<0.05, d=0.49$ ),

**Table 3. Descriptive information and group differences in social network and alcohol use variables.**

	21			22			Age 23			24			25		
	Control (n=33)	ADHD (n=36)	t	Control (n=29)	ADHD (n=48)	t	Control (n=52)	ADHD (n=75)	t	Control (n=30)	ADHD (n=38)	t	Control (n=68)	ADHD (n=95)	t
Social Network Size†	5.76 (4.10)	4.53 (3.39)	1.36	6.21 (5.08)	4.35 (3.22)	1.96*	5.27 (3.08)	4.28 (3.11)	1.77	5.73 (4.22)	4.05 (3.03)	1.91	4.69 (3.40)	3.44 (2.89)	2.53**
Number of friends, close friends and acquaintances	4.24 (3.03)	2.83 (2.70)	2.04*	4.52 (4.58)	2.83 (2.62)	2.06*	3.73 (2.33)	2.49 (2.22)	3.03***	3.63 (3.25)	2.63 (2.32)	1.48	2.97 (2.57)	2.36 (2.46)	1.54
Average Length of Relationships	7.83 (4.83)	10.55 (5.61)	-2.07*	10.12 (4.63)	9.61 (5.52)	0.40	10.24 (5.00)	11.98 (6.02)	-1.67	13.72 (5.51)	10.95 (5.82)	1.92	12.67 (5.97)	10.36 (6.73)	2.17*
Average Assistance in Relationships	2.02 (0.81)	1.82 (0.80)	0.96	1.96 (0.76)	1.84 (0.89)	0.61	1.73 (0.72)	1.82 (0.79)	-0.63	1.89 (0.68)	1.83 (0.85)	0.3	2.11 (0.94)	1.78 (0.89)	2.20*
Average Advice in Relationships	3.19 (0.79)	2.99 (0.74)	1.02	3.18 (0.74)	3.03 (0.93)	0.67	3.13 (0.71)	3.08 (0.72)	0.37	3.24 (0.76)	2.98 (0.65)	1.46	3.29 (1.16)	2.94 (0.89)	2.07*
Average Time Spent Socializing	3.88 (2.55)	3.35 (0.57)	1.18	3.43 (0.41)	3.44 (0.64)	-0.1	3.34 (0.52)	3.41 (0.58)	-0.69	3.37 (0.60)	3.49 (0.55)	-0.81	3.35 (0.74)	3.52 (0.56)	-1.54
Average Emotional Support in Relationships	2.93 (0.82)	2.76 (0.89)	0.79	3.03 (0.78)	2.96 (1.02)	0.31	3.18 (0.72)	2.99 (0.78)	1.31	3.21 (0.66)	3.00 (0.84)	1.1	3.09 (0.79)	2.98 (1.19)	0.65
Average Intimacy in Relationships	3.29 (0.66)	3.23 (0.67)	0.33	3.41 (0.59)	3.27 (0.74)	0.82	3.42 (0.54)	3.27 (0.71)	1.33	3.41 (0.57)	3.45 (0.54)	-0.31	3.41 (0.60)	3.38 (0.72)	0.31
Average Conflict in Relationships <sup>a</sup>	3.56 (0.47)	3.28 (0.87)	1.58	3.63 (0.44)	3.56 (0.56)	0.52	3.56 (0.59)	3.48 (0.54)	0.81	3.74 (0.36)	3.32 (0.71)	2.96***	3.52 (0.58)	3.44 (0.66)	0.76
Number of Heavy Drinking Friends†	2.45 (2.58)	1.31 (1.94)	2.10*	3.07 (4.38)	1.44 (2.18)	2.18*	1.87 (2.04)	1.08 (1.37)	2.42*	1.90 (2.19)	1.05 (1.47)	1.91	1.53 (1.94)	0.92 (1.50)	2.18*
Number of Light Drinking Friends†	1.15 (1.33)	1.17 (1.30)	-0.05	1.07 (1.49)	0.94 (1.46)	0.38	1.33 (1.68)	1.11 (1.67)	0.73	1.00 (1.49)	1.11 (1.52)	-0.29	0.85 (1.40)	0.97 (1.57)	-0.48
Proportion of Heavy Drinking Friends†	0.42 (0.30)	0.22 (0.25)	2.85**	0.44 (0.28)	0.26 (0.30)	2.61**	0.36 (0.33)	0.27 (0.31)	0.40	0.27 (0.24)	0.27 (0.32)	0.01	0.27 (0.28)	0.24 (0.30)	0.62
Proportion of Light Drinking Friends†	0.22 (0.25)	0.28 (0.30)	-0.89	0.16 (0.19)	0.23 (0.30)	-1.3	0.25 (0.27)	0.23 (0.28)	0.33	0.13 (0.16)	0.24 (0.29)	-1.8	0.15 (0.22)	0.27 (0.30)	-2.62**
Number of Drinking Buddies	2.33 (3.05)	2.39 (4.77)	-0.06	3.86 (5.52)	2.10 (4.76)	1.48	1.85 (3.62)	1.39 (2.63)	0.83	2.87 (3.64)	1.97 (3.69)	1.11	2.03 (2.96)	1.48 (3.16)	1.11
Binge Drinking‡	3.34 (2.61)	2.65 (2.71)	1.06	2.93 (2.59)	2.72 (2.81)	0.31	3.23 (2.46)	3.00 (2.94)	0.47	3.63 (2.80)	2.83 (2.97)	1.04	3.21 (2.51)	1.89 (2.40)	3.37***
Alcohol Quantity/Frequency‡	9.44 (10.47)	8.88 (13.04)	0.19	6.63 (7.04)	7.32 (11.02)	-0.29	6.58 (6.41)	7.23 (10.08)	-0.41	9.15 (10.04)	10.58 (17.32)	-0.38	7.93 (8.09)	8.22 (14.60)	-0.16

<sup>a</sup>Higher numbers equal less conflict

\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

†The average of this variable between ages 21 and 24 is used in subsequent analyses

‡Age 25 variables are used in subsequent analyses



**Table 4. Effect sizes for group differences**

	Age				
	21	22	23	24	25
Social Network Size	0.33	0.47	0.32	0.47	0.4
Number of friends, close friends and acquaintances	0.5	0.49	0.55	0.37	0.25
Average Length of Relationships	0.53 <sup>a</sup>	0.1	0.31 <sup>a</sup>	0.5	0.36
Average Assistance in Relationships	0.24	0.15	0.12	0.08	0.37
Average Advice in Relationships	0.26	0.17	0.07	0.38	0.35
Average Time Spent Socializing	0.3	0.03	0.13	0.21 <sup>a</sup>	0.26 <sup>a</sup>
Average Emotional Support in Relationships	0.2	0.08	0.25	0.28	0.11
Average Intimacy in Relationships	0.08	0.21	0.25	0.08	0.05
Average Conflict in Relationships <sup>a</sup>	0.39	0.13	0.15	0.74	0.13
Number of Heavy Drinking Friends	0.51	0.52	0.47	0.47	0.36
Number of Light Drinking Friends	0.01	0.09	0.13	0.07	0.08
Proportion of Heavy Drinking Friends	0.72	0.65	0.26	0	0.1
Proportion of Light Drinking Friends	0.23	0.3	0.06	0.45 <sup>a</sup>	0.43 <sup>a</sup>
Number of Drinking Buddies	0.01	0.35	0.15	0.25	0.18
Binge Drinking	0.27	0.08	0.08	0.28	0.54
Alcohol Quantity/Frequency	0.05	0.07	0.08	0.1	0.02

<sup>a</sup>ADHD greater than non-ADHD

Lower bounds for small, medium, and large effects sizes are 0.2, 0.5 and 0.8, respectively

and 23 ( $t=3.03, p<0.001, d=0.55$ ). All of these effects were in the small to medium range of effect size.

Other social network comparisons revealed statistically significant comparisons at only one age, or had varying trends in direction of effect across all of the age comparisons. For example, compared to individuals without ADHD, individuals with ADHD reported longer average length of relationship at age 21 ( $t=-2.07, p<0.05, d=0.53$ ) but shorter average length of relationship at age 25 ( $t=2.17, p<0.05, d=0.36$ ), less assistance ( $t=2.20, p<0.05, d=0.37$ ) and advice ( $t=2.07, p<0.05, d=0.35$ ) from their social networks at age 25, and higher levels of conflict in their relationships at age 24 ( $t=2.96, p<0.001, d=0.74$ ).

In regard to alcohol-specific peer variables, compared to individuals without ADHD, individuals with ADHD identified fewer heavy drinking friends at ages 21 ( $t=2.10, p<0.05, d=0.51$ ), 22 ( $t=2.18, p<0.05, d=0.52$ ), 23 ( $t=2.42, p<0.05, d=0.47$ ) and 25 ( $t=2.07, p<0.05, d=0.36$ ), a lower proportion of heavy drinking friends at ages 21 ( $t=2.85, p<0.01, d=0.72$ ) and 22 ( $t=2.61, p<0.01, d=0.65$ ), and a higher proportion of light drinking friends at age 25 ( $t=2.62, p<0.01, d=0.43$ ). Six of ten comparisons of heavy drinking friends (number and proportion) were significantly different between groups with individuals without ADHD reporting more heavy drinking friends than individuals without ADHD. As with the social network variables, effect sizes were in the small to medium range. Broadly, there were no group differences in the number or proportion of light drinking friends between individuals with and without ADHD between the ages of 21 and 25; a significant difference at age 25 in the proportion of light drinking friends was small in effect size and would be non-significant with Bonferroni correction for multiple comparisons.

For exploratory purposes, the two self-reported alcohol variables were compared at ages 21 to 24 in addition to age 25. As described previously for this sample (Molina et al., 2007; Wymbs et al., in prep), ADHD group differences in binge drinking and in quantity/frequency were absent in nearly every comparison. Only one statistically significant group difference emerged at age 25: individuals with ADHD reported lower frequency of binge drinking compared to individuals without ADHD ( $t=3.37$   $p<0.001$ ,  $d=0.54$ ). At age 25, individuals with ADHD reported binge drinking between 1 and 7 times in the last year, on average, whereas individuals without ADHD reported binge drinking between 8 and 12 times in the last year. Twenty-six percent of young adults with ADHD reported binge drinking monthly or more frequently and 11.8% of young adults with ADHD reported binge drinking weekly or more frequently. In contrast, thirty-nine percent of young adults without ADHD reported binge drinking monthly or more frequently and 12.6% of young adults without ADHD reported binge drinking weekly or more frequently.

**5.2 AIM 2. EVALUATE ASSOCIATIONS BETWEEN PERCEIVED PEER ALCOHOL USE AND SELF-REPORTED ALCOHOL USE IN EARLY ADULTHOOD BETWEEN INDIVIDUALS WITH AND WITHOUT ADHD WHILE SIMULTANEOUSLY CONSIDERING DELINQUENCY AND IMPULSIVITY.**

All models fit the data well with non-significant chi-square values, RMSEAs less than 0.05, CFIs greater than 0.95 and SRMRs less than 0.08 (see Table 5). All models accounted for significant variance in alcohol outcomes, with variance accounted for ranging from 10% to 28% (see Table 6). Overall, models for binge drinking and quantity/frequency of alcohol use were similar, except

where noted below. A correlation matrix for the model variables is presented in Table 7 and the associations between parental education and the remaining model variables are presented in Table 8 to simplify presentation of the results in Figures 2-5.

**Table 5. Model fit indices**

Model	Chi-square	RMSEA	CFI	SRMR
Number of Drinking Friends Predicting Binge Drinking				
Full Sample	0.04	0	1	0.004
Multiple group	12.27	0	1	0.06
Number of Drinking Friends Predicting Quantity/Frequency				
Full Sample	0.04	0	1	0.004
Multiple group	11.6	0	1	0.05
Proportion of Drinking Friends Predicting Binge Drinking				
Full Sample	0.04	0	1	0.003
Multiple group	17.56	0.02	0.99	0.05
Proportion of Drinking Friends Predicting Quantity/Frequency				
Full Sample	0.04	0	1	0.003
Multiple group	17.05	0.01	1	0.05

Note: No chi-square values were statistically significant.

**Table 6. Variance in alcohol outcomes accounted for by models.**

Model	Full sample	Multiple Group Model	
		ADHD	nonADHD
Number of Drinking Friends Predicting Binge Drinking	0.16***	0.19***	0.23**
Number of Drinking Friends Predicting Quantity/Frequency	0.10*	0.13*	0.28**
Proportion of Drinking Friends Predicting Binge Drinking	0.19***	0.26***	0.24**
Proportion of Drinking Friends Predicting Quantity/Frequency	0.25***	0.19*	0.23**

\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$

**Table 7. Variable correlation matrix by group**

	Mean (SD) ADHD	1. Parents College Educated (y/n)	2. Delinquency at 18	3. Impulsivity at 18	4. Number of Light Drinking Friends	5. Number of Heavy Drinking Friends	6. Proportion of Light Drinking Friends	7. Proportion of Heavy Drinking Friends	8. Network Size	9. Binge Drinking at 25	10. Quantity/ Frequency of Alcohol at 25
Mean (SD) Non-ADHD		0.71 (0.46)	1.50 (1.82)	9.71 (4.94)	1.19 (1.29)	2.09 (1.81)	0.20 (0.17)	0.34 (0.25)	5.69 (3.28)	3.21 (2.51)	7.93 (8.09)
1. Parents College Educated (y/n)	0.56 (0.50)	--	-0.07	0.30**	-0.11	0.02	-0.05	0.12	-0.14	-0.35**	-0.30*
2. Delinquency at 18	2.73 (4.27)	-0.10	--	0.07	0.03	0.16	-0.09	0.08	0.19	0.17	0.34
3. Impulsivity at 18	15.10 (5.26)	-0.04	0.40***	--	-0.02	-0.23	0.08	-0.18	-0.10	0.13	0.11
4. Number of Light Drinking Friends	1.08 (1.32)	0.06	-0.23*	-0.15	--	0.05	0.68***	-0.25*	0.65***	-0.08	-0.07
5. Number of Heavy Drinking Friends	1.20 (1.47)	0.06	0.02	0.14	0.02	--	-0.31**	0.76***	0.63***	0.26*	0.23
6. Proportion of Light Drinking Friends	0.24 (0.26)	-0.10	-0.09	-0.04	0.71***	-0.26*	--	-0.38**	0.06	-0.26*	-0.16
7. Proportion of Heavy Drinking Friends	0.28 (0.29)	0.004	0.13	0.20	-0.28**	0.77***	0.39**	--	0.17	0.33**	0.24
8. Network Size	4.2 (2.74)	0.16	-0.20	-0.13	0.63***	0.50***	0.1	0.04	--	0.14	0.16
9. Binge Drinking at 25	1.89 (2.40)	-0.15	0.28**	0.21*	-0.29**	0.14	-0.19	0.35**	-0.23*	--	0.80***
10. Quantity/Frequency of Alcohol at 25	8.22 (14.60)	-0.02	0.10	0.06	-0.21*	0.22**	-0.22*	0.44***	-0.11	0.67***	--

\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

non-ADHD above diagonal; ADHD below diagonal

**Table 8. Associations between parental education and endogenous variables.**

Model	Standardized Betas				
	Impulsivity	Delinquency	Heavy Drinking Peers	Light Drinking Peers	Alcohol Outcome
Number of Drinking Friends Predicting Binge Drinking					
Overall	-0.21**	-0.12	0.04	-0.04	-0.19**
Multiple group					
Non-ADHD	-0.15	-0.13	0.02	-0.04	-0.36***
ADHD	-0.15	-0.06*	0.03	-0.04	-0.11
Number of Drinking Friends Predicting Quantity/Frequency					
Overall	-0.21**	-0.12	0.04	-0.04	-0.09
Multiple group					
Non-ADHD	-0.15	-0.13	0.02	-0.04	-0.19
ADHD	-0.15*	-0.06	0.03	-0.04	-0.11*
Proportion of Drinking Friends Predicting Binge Drinking					
Overall	-0.21**	-0.12	0.05	-0.08	-0.20**
Multiple group					
Non-ADHD	-0.15*	-0.13	0.05	-0.06	-0.36**
ADHD	-0.15*	-0.06	0.05	0.04	-0.10
Proportion of Drinking Friends Predicting Quantity/Frequency					
Overall	-0.21**	-0.12	0.06	-0.08	-0.10
Multiple group					
Non-ADHD	-0.15	-0.13	0.04	-0.06	-0.22*
ADHD	-0.15*	-0.06	0.04	-0.05	-0.13*

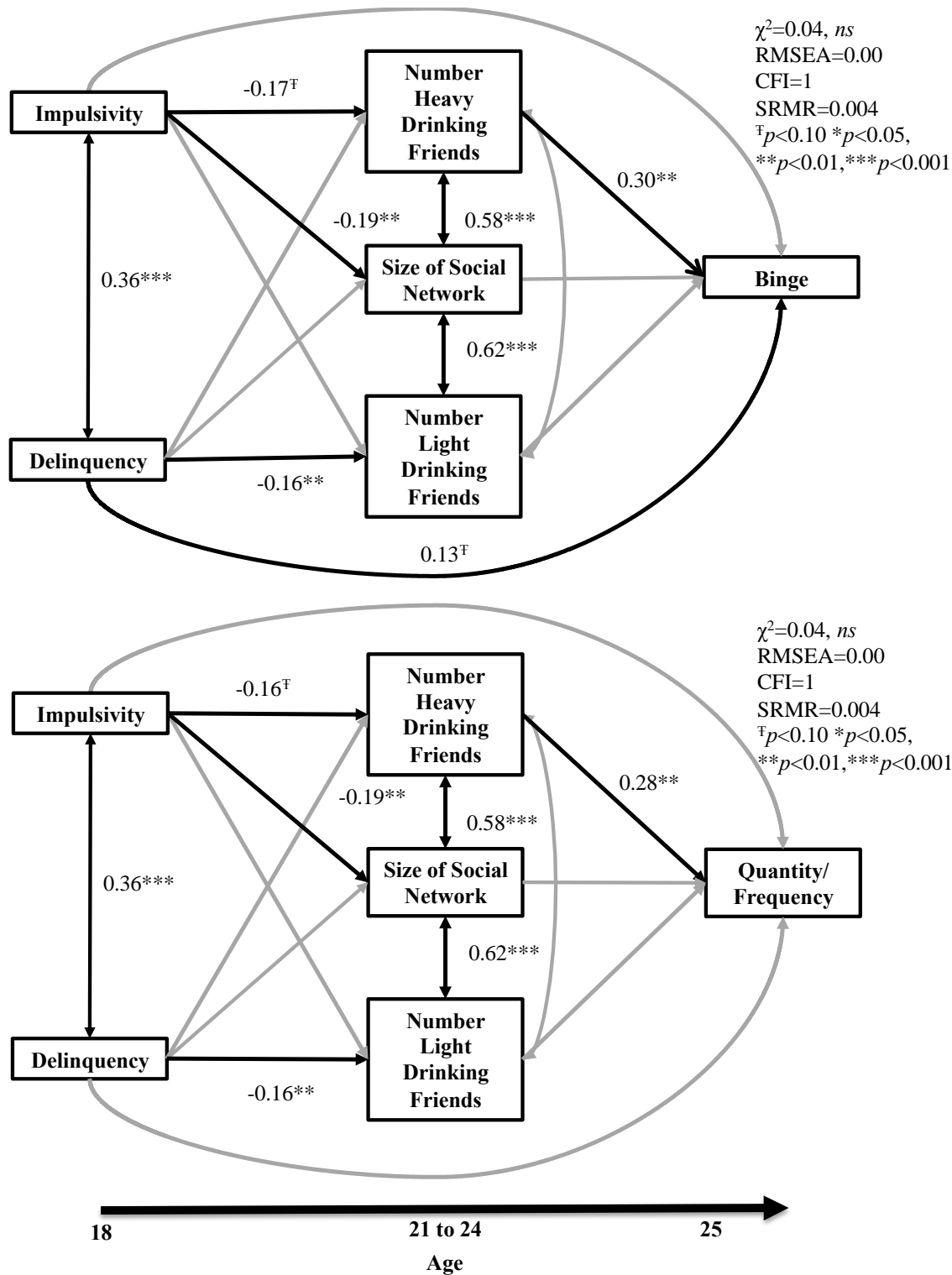
\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

As seen in the correlation matrix in Table 7, for individuals without ADHD, higher parental education was associated with decreased binge drinking and quantity/frequency of alcohol use at age 25; there was no association between parental education and binge drinking or quantity/frequency of alcohol use at age 25 for individuals with ADHD. For individuals with ADHD, delinquency and impulsivity at age 18 were correlated with binge drinking at age 25; whereas delinquency and impulsivity were associated with neither binge drinking nor quantity/frequency of alcohol use at age 25 for individuals without ADHD. The number of heavy drinking friends was associated with quantity/frequency of alcohol use at age 25 for individuals with ADHD, and with binge drinking at age 25 for individuals without ADHD. The proportion of heavy drinking friends was associated with binge drinking and quantity/frequency of alcohol use at age 25 for individuals with ADHD, and was only associated with binge drinking for

individuals without ADHD. The number of light drinking friends was associated with less binge drinking and lower quantity/frequency of alcohol use at age 25 for individuals with ADHD and was not associated with alcohol outcomes at age 25 for individuals without ADHD. The proportion of light drinking friends was associated with lower quantity/frequency of alcohol use for individuals with ADHD and less binge drinking for individuals without ADHD. As expected, binge drinking and quantity/frequency of drinking were correlated for both groups.

### **5.2.1 Overall models (Figure 2).**

Impulsivity and delinquency at age 18 were significantly and positively associated with each other ( $\beta_{\text{binge}} = 0.36, p < 0.001$ ;  $\beta_{\text{quantity/frequency}} = 0.36, p < 0.001$ ). There was a significant negative association between impulsivity at age 18 and number of heavy drinking friends ( $\beta_{\text{binge}} = -0.17, p < 0.10$ ;  $\beta_{\text{quantity/frequency}} = -0.16, p < 0.10$ ) and number of friends in an individual's social network ( $\beta_{\text{binge}} = -0.19, p < 0.01$ ;  $\beta_{\text{quantity/frequency}} = -0.19, p < 0.01$ ) in early adulthood. There was a significant negative association between delinquency at age 18 and number of light drinking friends in early adulthood ( $\beta_{\text{binge}} = -0.16, p < 0.01$ ;  $\beta_{\text{quantity/frequency}} = -0.16, p < 0.01$ ). There was a significant positive association between social network size and both the number of heavy ( $\beta_{\text{binge}} = 0.58, p < 0.001$ ;  $\beta_{\text{quantity/frequency}} = -0.16, p < 0.01$ ) and light ( $\beta_{\text{binge}} = 0.62, p < 0.001$ ;  $\beta_{\text{quantity/frequency}} = 0.62, p < 0.001$ ) drinking friends. Heavy drinking friends in early adulthood ( $\beta_{\text{binge}} = 0.30, p < 0.01$ ;  $\beta_{\text{quantity/frequency}} = 0.28, p < 0.01$ ) were positively and significantly associated with alcohol use at age 25.



**Figure 2. Full sample models predicting alcohol use from the number of drinking friends.**

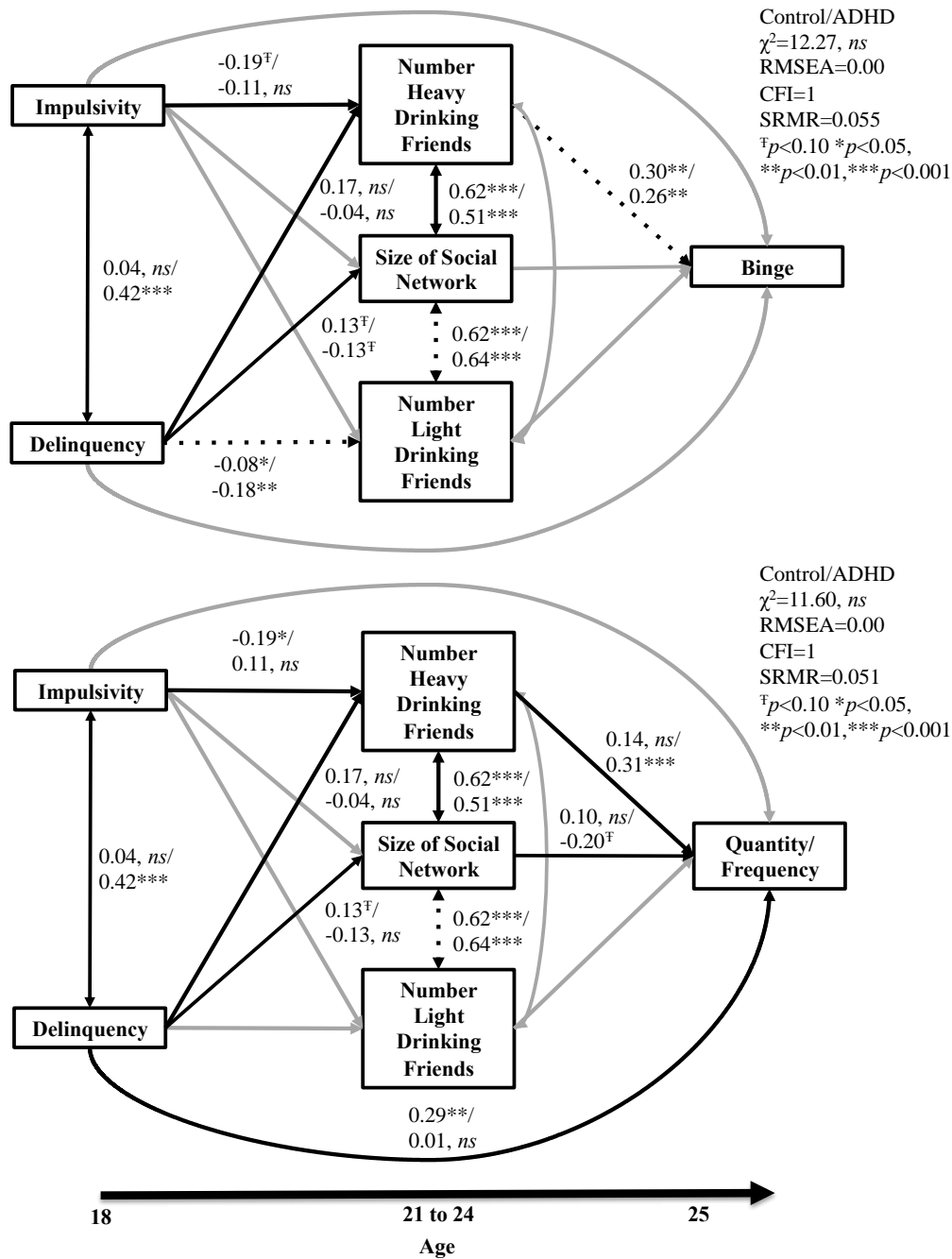
Note: Solid black lines indicate significant paths; betas are standardized.



### 5.2.2 Multiple-group model (Figure 3).

When the models were compared between individuals with and without childhood ADHD, there was a significant positive association between impulsivity and delinquency at age 18 for individuals with childhood ADHD ( $\beta_{\text{binge}} = 0.42, p < 0.001$ ;  $\beta_{\text{quantity/frequency}} = 0.42, p < 0.001$ ) but not for individuals without childhood ADHD ( $\beta_{\text{binge}} = 0.04, ns$ ,  $\beta_{\text{quantity/frequency}} = 0.04, ns$ ; Wald  $\chi^2_{\text{binge}} = 8.93, p < 0.01$ , Wald  $\chi^2_{\text{quantity/frequency}} = 9.02, p < 0.001$ ). Impulsivity was significantly positively associated with number of heavy drinking friends for individuals without ADHD ( $\beta_{\text{binge}} = -0.19, p < 0.10$ ;  $\beta_{\text{quantity/frequency}} = -0.19, p < 0.05$ ), but not for individuals with ADHD ( $\beta_{\text{binge}} = -0.11, ns$ ,  $\beta_{\text{quantity/frequency}} = -0.11, ns$ ; Wald  $\chi^2_{\text{binge}} = 4.08, p < 0.05$ , Wald  $\chi^2_{\text{quantity/frequency}} = 4.04, p < 0.05$ ). Delinquency was significantly and negatively associated with the number of light drinking friends for individuals with and without ADHD ( $\beta_{\text{ADHD}} = -0.18, p < 0.01$ ;  $\beta_{\text{nonADHD}} = -0.08, p < 0.05$ ) in the binge drinking model.

Although there were no significant associations between delinquency at age 18 and number of heavy drinking friends or size of social network in early adulthood for either group, there were significant ADHD group *differences* in these associations (Wald  $\chi^2_{\text{binge-delinquency}} = 3.12, p < 0.10$ , Wald  $\chi^2_{\text{quantity/frequency-delinquency}} = 3.12, p < 0.10$ ; Wald  $\chi^2_{\text{binge-network size}} = 5.08, p < 0.05$ , Wald  $\chi^2_{\text{quantity/frequency-network size}} = 5.07, p < 0.05$ ). For individuals without ADHD, level of delinquency at age 18 was positively, but not significantly, associated with the number of heavy drinking friends ( $\beta_{\text{binge}} = 0.17, ns$ ;  $\beta_{\text{quantity/frequency}} = 0.17, ns$ ) and social network size ( $\beta_{\text{binge}} = 0.13, p < 0.10$ ;  $\beta_{\text{quantity/frequency}} = 0.13, p < 0.10$ ) in early adulthood. In contrast, for individuals with ADHD, level of delinquency at age 18 was negatively, but not significantly, associated with the number of heavy drinking friends ( $\beta_{\text{binge}} = -0.04, ns$ ;  $\beta_{\text{quantity/frequency}} = -0.04, ns$ ) and social network size ( $\beta_{\text{binge}} = -0.13, p < 0.10$ ;  $\beta_{\text{quantity/frequency}} = -0.13, ns$ ) in early adulthood.



**Figure 3. Multiple group model predicting alcohol use from the number of drinking friends.**

Note: Solid black lines indicate paths that are significantly different between groups; dotted lines indicate paths that are statistically significant, but not statistically significantly different between groups. Betas are standardized. Therefore, although the paths that are not significantly different between groups have been constrained to be equal in iterative model building, there are different parameter values due to standardization relative to group.

There was a significant positive association between social network size and number of heavy drinking peers in early adulthood for both individuals with ( $\beta_{\text{binge}} = 0.51, p < 0.001$ ;  $\beta_{\text{quantity/frequency}} = 0.51, p < 0.001$ ) and without ( $\beta_{\text{binge}} = 0.62, p < 0.001, \beta_{\text{quantity/frequency}} = 0.62, p < 0.001$ ; Wald  $\chi^2_{\text{binge}} = 2.87, p < 0.10$ , Wald  $\chi^2_{\text{quantity/frequency}} = 2.87, p < 0.10$ ) ADHD, and this association was stronger for individuals without ADHD. There was also a significant positive association between social network size and number of light drinking peers in early adulthood for both individuals with ( $\beta_{\text{binge}} = 0.64, p < 0.001$ ;  $\beta_{\text{quantity/frequency}} = 0.64, p < 0.001$ ) and without ADHD ( $\beta_{\text{binge}} = 0.62, p < 0.001, \beta_{\text{quantity/frequency}} = 0.62, p < 0.001$ ; Wald  $\chi^2_{\text{binge}} = 2.87, p < 0.10$ , Wald  $\chi^2_{\text{quantity/frequency}} = 2.87, p < 0.10$ ), and there were no significant group differences in this association for either alcohol outcome.

There was a significant difference in the association between early adult social network characteristics and quantity/frequency of alcohol use, but not binge drinking, at age 25 such that the number of heavy drinking friends was positively associated ( $\beta_{\text{quantity/frequency}} = 0.31, p < 0.001$ ), and social network size was negatively associated ( $\beta_{\text{quantity/frequency}} = -0.20, p < 0.10$ ), with quantity/frequency of alcohol use for individuals with ADHD, but not for individuals without ADHD ( $\beta_{\text{heavy dinking friends}} = 0.14, ns$ ;  $\beta_{\text{social network size}} = 0.10, ns$ ; Wald  $\chi^2_{\text{heavy dinking friends}} = 3.93, p < 0.05$ , Wald  $\chi^2_{\text{social network size}} = 4.91, p < 0.05$ ). There was a significant positive association between binge drinking and the number of heavy drinking friends for individuals with and without ADHD ( $\beta_{\text{ADHD}} = 0.26, p < 0.01$ ;  $\beta_{\text{nonADHD}} = 0.30, p < 0.01$ ), and there were no significant group differences in this association.

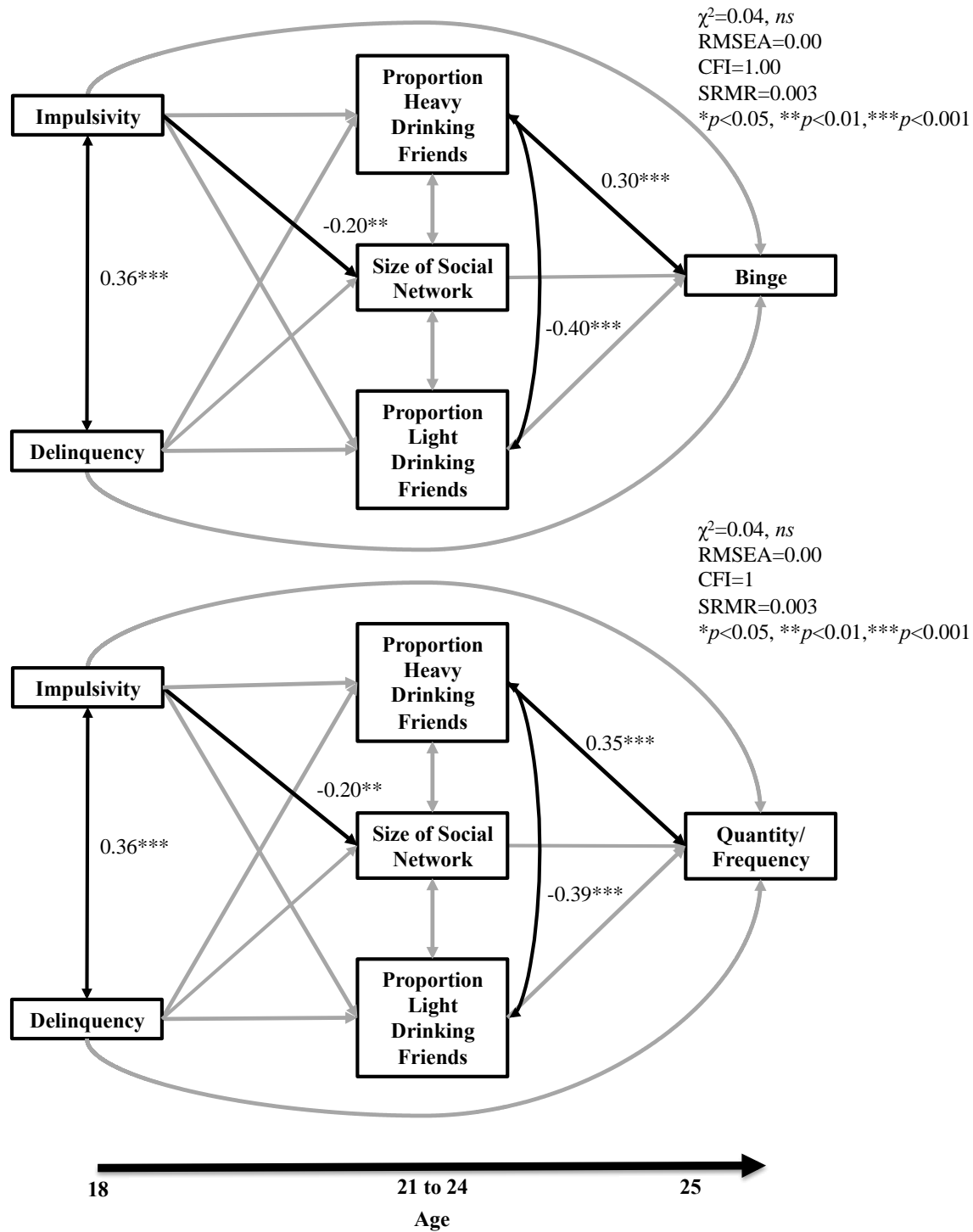
### **5.3 AIM 3. EVALUATE WHETHER ASSOCIATIONS BETWEEN PERCEIVED PEER ALCOHOL USE AND SELF-REPORTED ALCOHOL USE VARY BASED ON THE OPERATIONALIZATION OF PEER DRINKING IN THE SOCIAL NETWORK.**

All models fit the data well with non-significant chi-square values, RMSEAs less than 0.05, CFIs greater than 0.95 and SRMRs less than 0.08 (see Table 5). Overall, models for binge drinking and quantity/frequency of alcohol use were similar, except where noted below.

#### **5.3.1 Full sample models (Figure 4).**

Findings for the proportion of drinking friends were largely similar to the findings for the number of drinking friends with two exceptions: 1) there was not a significant association between levels of impulsivity and the *proportion* of heavy drinking friends, whereas level of impulsivity was negatively associated with *number* of heavy drinking friends; 2) there was not a significant association between level of delinquency and the *proportion* of light drinking friends, whereas level of delinquency was negatively associated with *number* of light drinking friends.

Impulsivity and delinquency were strongly positively associated with each other at age 18 ( $\beta_{\text{binge}} = 0.36, p < 0.001$ ;  $\beta_{\text{quantity/frequency}} = 0.36, p < 0.001$ ). Level of impulsivity at age 18 was negatively associated with the proportion of friends in an individual's social network ( $\beta_{\text{binge}} = -0.20, p < 0.01$ ;  $\beta_{\text{quantity/frequency}} = -0.20, p < 0.01$ ) in early adulthood. The proportion of heavy and light drinking friends were strongly negatively associated with each other in early adulthood ( $\beta_{\text{binge}} = -0.40, p < 0.001$ ;  $\beta_{\text{quantity/frequency}} = -0.39, p < 0.001$ ). The proportion of heavy drinking friends in early adulthood ( $\beta_{\text{binge}} = 0.30, p < 0.001$ ;  $\beta_{\text{quantity/frequency}} = 0.35, p < 0.001$ ) was significantly and positively associated with alcohol use at age 25.



**Figure 4. Full sample models predicting alcohol use from the proportion of drinking friends.**

Note: Solid black lines indicate significant paths; betas are standardized.

### 5.3.2 Multiple-group model (Figure 5).

When the models were compared between individuals with and without childhood ADHD, there was a significant positive association between impulsivity and delinquency at age 18 for individuals with ADHD ( $\beta_{\text{binge}} = 0.42, p < 0.001$ ;  $\beta_{\text{quantity/frequency}} = 0.42, p < 0.001$ ) but not for individuals without ADHD ( $\beta_{\text{binge}} = 0.04, ns$ ,  $\beta_{\text{quantity/frequency}} = 0.04, ns$ ; Wald  $\chi^2_{\text{binge}} = 8.68, p < 0.001$ , Wald  $\chi^2_{\text{quantity/frequency}} = 8.78, p < 0.001$ ). Delinquency at age 18 was positively associated with social network size for individuals without ADHD ( $\beta_{\text{binge}} = 0.20, p < 0.05$ ;  $\beta_{\text{quantity/frequency}} = 0.19, p < 0.05$ ), but was negatively associated with social network size for individuals with ADHD ( $\beta_{\text{binge}} = -0.16, p < 0.05$ ,  $\beta_{\text{quantity/frequency}} = -0.16, p < 0.05$ ; Wald  $\chi^2_{\text{binge}} = 9.80, p < 0.001$ , Wald  $\chi^2_{\text{quantity/frequency}} = 8.91, p < 0.001$ ).

Although there were no significant associations between impulsivity at age 18 and proportion of heavy drinking friends for either group in the model predicting quantity/frequency of alcohol use, there were significant differences in these associations between individuals with and without ADHD. For individuals without ADHD, higher levels of impulsivity at age 18 were negatively, but not significantly, associated with the proportion of heavy drinking friends ( $\beta_{\text{quantity/frequency}} = -0.16, ns$ ) in early adulthood. In contrast, for individuals with ADHD, higher levels of impulsivity at age 18 were positively, but not significantly, associated with the proportion of heavy drinking friends ( $\beta_{\text{quantity/frequency}} = 0.15, ns$ ; Wald  $\chi^2_{\text{quantity/frequency}} = 2.92, p < 0.10$ ) in early adulthood.

The significant negative association between the proportion of heavy and light drinking friends was significant for individuals with and without ADHD for both binge drinking ( $\beta_{\text{ADHD}} = -0.40, p < 0.001$ ;  $\beta_{\text{nonADHD}} = \beta_{\text{binge}} = -0.37, p < 0.001$ ) and quantity/frequency ( $\beta_{\text{ADHD}} = -0.30, p < 0.001$ ;  $\beta_{\text{nonADHD}} = -0.46, p < 0.001$ ) of drinking. There were no group differences in this

association for quantity/frequency of drinking, but this association was stronger for young adults with than without ADHD in the binge drinking model (Wald  $\chi^2=2.76$ ,  $p<0.10$ ).

There was also a significant difference in the prediction of binge drinking, but not quantity/frequency of alcohol use, at age 25 such that social network size was negatively associated with binge drinking for individuals with ( $\beta_{\text{binge}} = -0.17$ ,  $p<0.05$ ), but not without ( $\beta_{\text{binge}} = 0.04$ , *ns*; Wald  $\chi^2_{\text{binge}}=3.03$ ,  $p<0.10$ ) ADHD. There was a significant group difference in the association between delinquency at age 18 and quantity/frequency of alcohol use, but not binge drinking, at age 25 such that delinquency was positively associated with quantity/frequency of alcohol use at age 25 for individuals without ADHD ( $\beta_{\text{quantity/frequency}} = 0.31$ ,  $p<0.01$ ) but not for individuals with ADHD ( $\beta_{\text{quantity/frequency}} = -0.02$ , *ns*; Wald  $\chi^2_{\text{quantity/frequency}}=2.81$ ,  $p<0.10$ ). A greater proportion of heavy drinking friends was significantly associated with increased quantity/frequency of alcohol use, but not binge drinking, for individuals with ADHD ( $\beta_{\text{quantity/frequency}} = 0.39$ ,  $p<0.001$ ), but not for individuals without ADHD ( $\beta_{\text{quantity/frequency}} = 0.23$ ,  $p<0.10$ ; Wald  $\chi^2_{\text{quantity/frequency}}=2.92$ ,  $p<0.10$ ). There were significant positive associations between the proportion of heavy drinking friends and binge drinking for individuals with and without ADHD ( $\beta_{\text{ADHD}} = 0.33$ ,  $p<0.001$ ;  $\beta_{\text{nonADHD}} = 0.27$ ,  $p<0.001$ ), and there were no significant group differences in this association.





## 6.0 DISCUSSION

The current study aimed to examine group differences in alcohol socialization between young adults with and without a childhood diagnosis of ADHD. First, young adults with ADHD had higher levels of impulsivity and delinquency, smaller social networks, and fewer friends than young adults without ADHD. They had fewer heavy drinking friends, a lower proportion of heavy drinking friends, and they endorsed lower levels of binge drinking than young adults without ADHD. Therefore, this study demonstrated that ADHD group differences in social functioning persist into early adulthood. The number and proportion of heavy drinking friends were associated with binge drinking for both groups, but they were associated with quantity/frequency of drinking only for individuals in the ADHD group. Although the hypothesis that young adults with ADHD are more susceptible to peer alcohol socialization than individuals without ADHD was partially supported, there was no support for the hypothesized mediating role of social network variables in the association between impulsivity, delinquency, and alcohol use in early adulthood.

## **6.1 AIM 1. DESCRIPTIVE INFORMATION AND GROUP DIFFERENCES IN SOCIAL NETWORK CHARACTERISTICS AND ALCOHOL USE VARIABLES.**

As is consistent with study hypotheses, compared to individuals without ADHD, individuals with ADHD reported fewer people in their social networks and fewer friends, close friends and acquaintances. Existing literature shows differences in social functioning in individuals with and without ADHD in childhood and adolescence and the current study demonstrated the persistence of different social functioning in individuals with and without ADHD into adulthood. This finding is particularly important because social functioning in children with ADHD has been strongly linked to symptoms of hyperactivity and impulsivity (Mrug, Hoza, & Gerdes, 2001), which decrease with age (Biederman, Mick, & Faraone, 2000). Therefore, although symptoms of ADHD often decrease into adulthood and adults with ADHD develop coping techniques to manage their symptoms (Barkley, 2006), social impairment persists into adulthood. Because social relationships have been associated with numerous positive outcomes (Bukowski & Hoza, 1989; Hartup & Stevens, 1997), having fewer individuals in a social network (i.e. fewer social relationships) may deny young adults with ADHD some of the benefits of relationships, which is particularly important given the observed impairments in this population.

In addition to smaller social networks and fewer friendships, young adults with ADHD reported receiving less assistance and advice in their relationships than young adults without ADHD. However, this finding was only found at one time point (i.e. age 25) when the sample size was the largest. Given that friendships are traditionally considered to have direct positive effects and also indirect positive effects by protecting against negative effects of peer rejection (Parker & Asher, 1993), it is concerning that young adults with ADHD have relationships that are less characterized by the positive qualities of traditional friendships. This finding is consistent with

other research that demonstrates individuals with ADHD are less likely to experience the benefits of friendship (Bukowski & Hoza, 1989; Hartup & Stevens, 1997), and lower levels of assistance and advice in friendship may contribute to negative outcomes for young adults who may lack support from other relationships (i.e. romantic partners; Biederman et al., 2006). Another manifestation of social impairment is that young adults with ADHD are more likely than young adults without ADHD to have shorter length of friendship at age 25 and also have higher levels of conflict. Higher levels of conflict for individuals with ADHD is particularly important because individuals with ADHD have difficulty repairing friendships (Henker & Whalen, 1999). Therefore, when individuals with ADHD experience conflict they may not be able to repair relationships and will experience greater relationship turnover than individuals without ADHD with similar levels of conflict. The current study largely supported existing findings of persistent social impairment in individuals with ADHD, however, at many time points there were no significant group differences and the present differences would be mitigated by Bonferroni correction. These findings expand the existing literature by examining social impairment in a new stage of development (i.e. early adulthood).

At nearly every time point, young adults with ADHD reported having fewer heavy drinking friends than individuals without ADHD and there were no differences in the number of light drinking friends. These findings are inconsistent both with the literature, and study hypotheses, but are consistent with young adults with ADHD having fewer friends and also smaller social networks. Fewer heavy drinking friends could be indicative of social impairment or a history of problematic drinking. First, because the majority of young adults drink (Office of Applied Studies, 2009), young adults with ADHD may not only have difficulty forming relationships, but they may have difficulty forming relationships with peers who use alcohol.

Whereas in early adulthood individuals without ADHD may be engaged in Greek organizations, sports, or other community involvement that involves networks of peers who use alcohol socially (Lisha & Sussman, 2010; Weschler, Dowdall, Maenner, Gledhill-Hoyt, & Lee, 1998), young adults with ADHD may be less involved than their peers without ADHD in these social groups. The decreased affiliation of young adults with ADHD to peers who use alcohol may be related to primary deficits in social functioning or secondary deficits related to ADHD (i.e. decreased college attendance; Kuriyan et al., 2013). Second, because individuals with childhood ADHD are 1.35 to 1.74 times more likely to develop an alcohol use disorder (Charach et al., 2011; Lee et al., 2011), it is possible that significant alcohol-related problems have already occurred for this population by early adulthood. Some young adults with ADHD may have fewer heavy-drinking friends because they have already cut down their drinking due to drinking behavior that began in adolescence (Molina et al., 2007), and subsequently affiliate with adult friends who support reduced alcohol use as is supported by a significantly larger proportion of light drinking friends. Importantly, because young adults with ADHD have fewer heavy drinking friends, it suggests that they may be socialized to alcohol use by different means. For example, young adults with ADHD may be socialized to alcohol use by co-workers, partners, or family members (Scholte, Poelen, Willemsen, Boomsma, & Engels, 2008). Alternatively, alcohol norms and expectancies in the larger community, as opposed to the alcohol-related behaviors of social networks (Perkins & Weschler, 1996), may affect alcohol consumption.

Importantly, the current study is consistent with prior research that shows similarity in young adult drinking behavior in individuals with and without ADHD. Although young adults with ADHD were found to have lower rates of binge drinking at age 25, this finding was only present one of five time points and this difference in alcohol use was not consistent across

operationalization of alcohol use. Features of ADHD that may be contributing to lower rates of binge drinking at age 25 include lower college attendance, which may mitigate exposure to environmental risk factors (i.e. Greek affiliation) that are associated with elevated alcohol use. Additionally, symptoms of ADHD have been shown to decrease across development, so future studies should examine whether ADHD symptom desistance is protective against elevated alcohol use. Therefore, lower binge drinking in individuals with ADHD could be indicative of different developmental processes between groups, the importance of considering drinking topography, or simply a result of Type-I error inflation.

The absence of consistent and statistically significant differences in binge drinking are important to consider in the context of local and national rates of binge drinking. Forty percent of young adults nationally and 43% of young adults in Pittsburgh report binge drinking in the past month (SAMHSA, 2012), suggesting that binge drinking between the ages of 18 and 25 is a prevalent behavior. However, only 31.5% of the current study sample endorsed binge drinking once a month or more frequently, suggesting that this sample may not be representative of larger populations. Although the rates of binge drinking are lower in the current sample than in other groups, binge drinking is a behavior that is associated with numerous negative outcomes, and understanding the factors that contribute to binge drinking is important for intervention efforts. Additionally, there were no differences in the quantity/frequency of alcohol use between individuals with and without ADHD, and this finding is expected given the high rates of drinking in this age range. Furthermore, the current findings support the extant literature that suggests heterogeneity in drinking outcomes for young adults with ADHD and is consistent with research that found that children with ADHD were not more likely to use alcohol in adulthood (Lee et al., 2011). Because some research indicates that young adults with ADHD may be at increased risk

for alcohol use disorders (Lee et al., 2011), it will be an important future direction to understand the development of drinking behavior beyond the period where drinking is most normative to identify whether aspects of young adult drinking increase risk for alcohol use disorders later in adulthood. Additionally, persisting symptoms of ADHD may increase risk for alcohol use due to core symptoms including impulsivity, or indirectly due to associated features of ADHD such as delinquency and social impairment. Existing research (Molina et al., 2012; Molina, Pelham, et al., 2007) has established that young adults with ADHD and co-occurring behavior problems (e.g. delinquency and antisocial personality disorder) have the highest risk for alcohol use compared to individuals with ADHD only and individuals without ADHD. Therefore, future research should include ADHD symptom persistence when evaluating elevated risk for alcohol use and alcohol use disorders in early adulthood.

**6.2 AIM 2. EVALUATE ASSOCIATIONS BETWEEN PERCEIVED PEER ALCOHOL USE AND SELF-REPORTED ALCOHOL USE IN EARLY ADULTHOOD BETWEEN INDIVIDUALS WITH AND WITHOUT ADHD WHILE SIMULTANEOUSLY CONSIDERING DELINQUENCY AND IMPULSIVITY.**

Overall, the findings suggest some differences in peer alcohol socialization between individuals with and without ADHD. The relations between number of heavy drinking friends, proportion of heavy drinking friends, and binge drinking, were not significantly different between the ADHD and nonADHD groups. However, despite reporting fewer friends and smaller social networks, there was a stronger association between the number of heavy drinking friends and the quantity/frequency of drinking for young adults with than without ADHD. Moreover, the

association between the number of heavy drinking friends and the quantity/frequency of alcohol use was only statistically significant for young adults with ADHD.

In spite of possible methodological limitations, the current findings are consistent with existing research that demonstrates the importance of peer socialization to alcohol for individuals with ADHD. Specifically, Marshal and colleagues (2003) found that having peers who used and tolerated substances mediated the relationship between ADHD and substance use such that adolescents with childhood ADHD were more likely than adolescents without childhood ADHD to have peers who used and tolerated substances, and as a result were more likely to use alcohol. Additionally, adolescents with ADHD were more likely to be influenced by peer drinking than adolescents without ADHD (Belendiuk et al., in prep; Marshal et al., 2003). Young adults with ADHD may be more susceptible to the influence of heavy drinking peers because they are characterized by impaired social functioning, and use alcohol as a means of enhancing social bonding and/or compensating for their social deficits (Schulenberg & Maggs, 2002). Therefore, in an environment where their friends are using alcohol, individuals with ADHD may have an increased likelihood of using alcohol as a means of relationship enhancement whereas individuals without ADHD can use relational skills to enhance social bonding. The current study did not consider aspects of relationship quality to determine whether the friends who are identified as heavy drinking friends are also the friends with whom a young adult reports drinking. Understanding relationship quality will be important for future studies because high-quality relationships exert a stronger influence on drinking in early adulthood than low quality relationships (Reifman et al., 2006).

Statistically significant associations were found between the number of heavy drinking friends and the frequency of binge drinking for young adults with and without ADHD. This

finding supports the role of peer alcohol socialization in early adulthood for both young adults with and without ADHD. This finding partially supports the hypothesis that the association between perceived peer alcohol use and self-reported alcohol use will be present in individuals with and without ADHD. The association between perceived peer drinking and self-reported drinking in both groups may be related to the high rates of alcohol use in early adulthood for both peers and young adults. Importantly, the peer alcohol use variable does not capture whether peers are engaging in binge drinking, instead assessing whether peers are “moderate/average” or “frequent/heavy” social drinkers. Future research will benefit from improved characterization of peer drinking to evaluate whether the topography of peer drinking behavior predicts young adult drinking topography or whether alcohol socialization is generally predictive of alcohol use or other risk behavior. Given the prevalence of binge drinking in early adulthood, the absence of significant group differences in peer alcohol socialization may be time-limited. Future research that extends into later adulthood will be able to evaluate whether there are group differences in alcohol socialization that differ across development.

Furthermore, the presence of light drinking friends was not protective for individuals with or without ADHD. Socializing with light drinking friends may only be protective when alcohol use is less normative or in the absence of heavy-drinking friends. The small and non-statistically significant correlation between heavy and light drinking friends suggests that the influence of light drinking friends should be considered in the context of the influence of heavy drinking friends. Additionally, it is important to note that, on average across early adulthood, individuals with and without ADHD reported having only one friend who was a light drinker. In this period of development there may be few light drinking friends with whom to identify and the



influence of these friends may not be sufficient to outweigh the pro-drinking social environment of early adulthood.

The association between social network size between 21 and 24 and quantity/frequency of alcohol use at 25 was different for young adults with and without ADHD. There was a negative association between social network size and quantity/frequency of alcohol use for individuals with, but not without, ADHD. Larger social networks for individuals with ADHD may be indicative of better functioning because young adults with ADHD who have better social functioning also have lower symptoms of hyperactivity (Barkley, Fischer, Smallish, & Fletcher, 2006). Therefore, compared to young adults with higher symptoms of ADHD, individuals with lower ADHD symptoms may have better social and behavioral adjustment that translates into decreased drinking risk.. As such, larger social networks may one indicator of a profile of individuals with ADHD who have decreased symptom persistence, lower functional impairment, and are also less likely to use alcohol. Furthermore, if a small social network is an indicator of impaired social functioning then this may affect alcohol use because individuals also use alcohol to cope with social deficits and to facilitate social bonding (Borsari & Carey, 2006; Schulenberg & Maggs, 2002). Therefore, individuals with ADHD who have smaller social networks may use alcohol at increased levels as a compensatory strategy for social difficulties. This is important because the combination of ADHD symptomatology and elevated drinking behavior may increase the risk of alcohol-related disorders and impairments for young adults with ADHD. Importantly, the negative association between social network size and alcohol use was only present in one model and was marginally significant.

Although zero-order correlations between impulsivity and delinquency at age 18 and binge drinking at age 25 were statistically significant in the ADHD group, there were no

statistically significant indirect paths from these variables to alcohol use in the larger models. It is likely that impulsivity and delinquency account for variance in alcohol-related outcomes in early adulthood, but that including peer socialization in the moderated mediational models reduces the relative impact of these variables. Additionally, impulsivity and delinquency may confer risk for elevated alcohol use in individuals with ADHD through pathways other than peer socialization. Future research should consider other domains of functioning that may be affected by elevated impulsivity and delinquency and that may also be prognostic of alcohol use. One specific domain that may prove fruitful is the evaluation of educational and vocational functioning as increased impulsivity and delinquency may negatively impact educational and vocational outcomes and increase risk for alcohol use.

Delinquency at age 18 predicted social network characteristics differently between young adults with and without ADHD. These group differences were in the direction of the associations between delinquency and the number of drinking friends and size of social network, and were rather unimpressive due to their lack of statistical significance. Nevertheless, the associations suggested that young adults with ADHD who were high in delinquency had smaller social networks and fewer heavy drinking friends whereas individuals without ADHD who were high in delinquency had larger social networks and more heavy drinking friends. The opposite direction of effect between delinquency and social network characteristics for individuals with and without ADHD may result from heterogeneity in symptoms of delinquency. Delinquency items in the current study ranged in severity from “skipping classes or school without an excuse” to “attacking someone with a weapon or with the idea of seriously hurting or killing them.” Although group differences in the types and severity of delinquency were not examined in the current study, other studies have shown greater delinquency severity in young adults with than

without ADHD in the larger study sample (M.H. Sibley et al., 2011). Severely delinquent behaviors and associated negative outcomes (e.g. danger to self or others; legal difficulties) may alienate peers, resulting in smaller social networks and fewer drinking friends. In contrast, 92% of young adults without ADHD abstain from delinquent behavior or engage in mild “delinquent” behavior (M.H. Sibley et al., 2011) that is more normative (i.e. be loud or rowdy in a public place to be the life of the party) and compatible with social functioning. Therefore, the few individuals without ADHD who engage in delinquent behaviors are unlikely to have dangerous or enduring negative effects and are also more likely to have friends, including friends who drink alcohol.

Importantly, for both individuals with and without ADHD there was a negative association between delinquency and the number of light drinking friends. If higher levels of delinquency predict fewer light-drinking friends then this could suggest that delinquent behaviors occur in the context of alcohol use. There is an extensive literature that has established an association between disinhibited behavior and affiliation with substance using peers, and future research should examine whether delinquent behavior decreases affiliation with peers who control their drinking. Additionally, the question, “Did you lie about your age... to buy alcohol” was included in the delinquency measure. Individuals who lie about their age in order to buy alcohol would be less likely to affiliate with light-drinking peers who have different attitudes and behaviors surrounding alcohol use. Additionally, future research should aim to better characterize delinquency to understand in what ways young adults with and without ADHD differ in their delinquent behavior and whether these differences are directly or indirectly (via peer socialization) associated with alcohol use.

### **6.3 AIM 3. EVALUATE WHETHER ASSOCIATIONS BETWEEN PERCEIVED PEER ALCOHOL USE AND SELF-REPORTED ALCOHOL USE VARY BASED ON THE OPERATIONALIZATION OF PEER DRINKING IN THE SOCIAL NETWORK.**

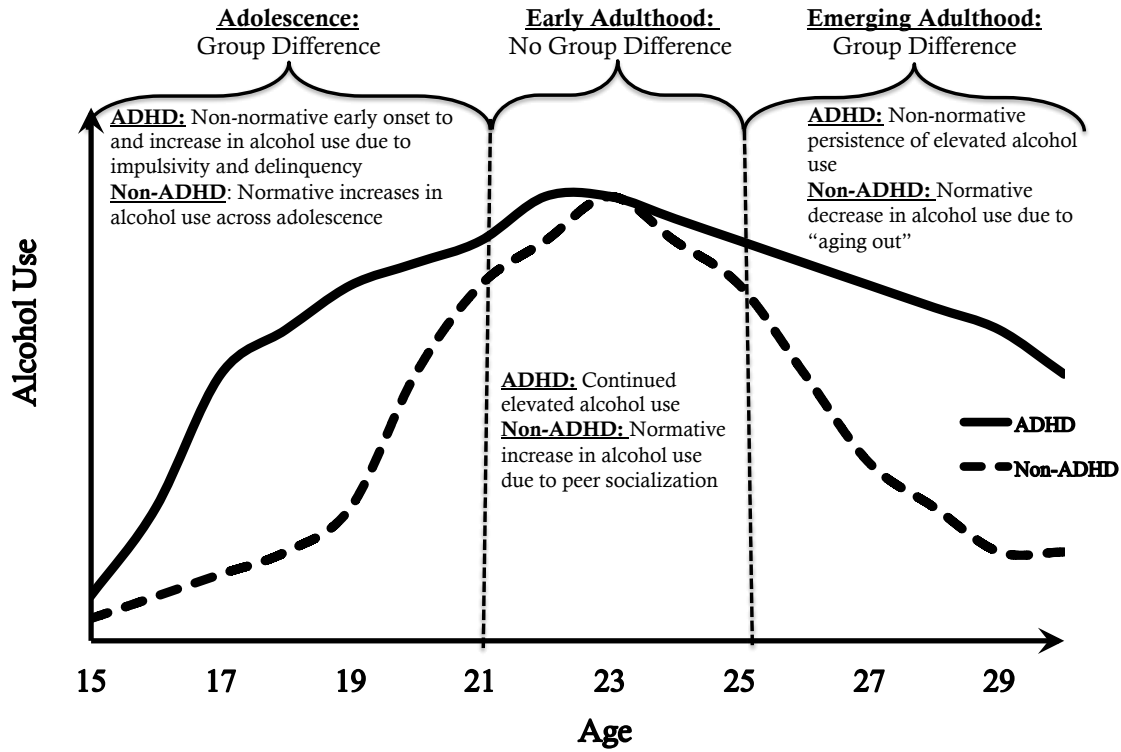
The third aim of the study was to evaluate whether associations between perceived peer alcohol use and self-reported alcohol use vary based on the operationalization of peer drinking in the social network. Largely, the models examining the proportion of heavy (or light) drinking friends and the number of heavy (or light) drinking friends produced similar findings. The presence of heavy drinking friends, regardless of absolute number or proportion of friends, was associated with binge drinking for both groups and quantity/frequency of alcohol use for the ADHD group. Importantly, the models that examined proportion of heavy (or light) drinking friends accounted for greater variance in age 25 drinking outcome ( $R = 0.19$  and  $0.25$  for binge drinking and quantity/frequency, respectively) than the models that examined the number of heavy (or light) drinking friends ( $R = 0.16$  and  $0.10$  for binge drinking and quantity/frequency, respectively). Although all models accounted for statistically significant variance in drinking outcomes, it is notable that the proportion models explained up to 15% more variance in quantity/frequency of drinking at age 25. The proportion of drinking friends, compared to the number of drinking friends, considers the relative influence of friendships in the context of the social network. Therefore, proportion of drinking friends in a social network may account for greater variance because the calculation provides more information about the relative strength of alcohol use socialization in the immediate social network. Finally, the stronger association between proportion of heavy drinking friends and alcohol use suggests an opportunity for intervention by increasing social network size to dilute the effect of heavy drinking friends. In sum, the current

study suggests that the proportion of individuals who use alcohol in a social network provides greater predictive power than number of drinking friends. This finding suggests that this operationalization is an important and informative operationalization of social network alcohol use for future research.

There are several important future directions that will help elucidate how different operationalizations of social network drinking influence alcohol use in early adulthood. First, as discussed above, examining which members of a social network influence alcohol use and how social networks change over time in response to individual behavior will facilitate the understanding of the reciprocal processes that affect alcohol use in a social environment. Second, identifying young adults who have similar proportions (i.e. 0.5) but different numbers (i.e. 1 versus 10) of drinking friends will help determine whether proportion or number of drinking friends is more strongly predictive of alcohol use.

#### **6.4 LIMITATIONS AND FUTURE DIRECTIONS**

Although the current study yielded important information about ADHD vulnerability to peer alcohol socialization, there are also limitations. First, the current study may have been underpowered to detect mediational pathways and group differences in these paths because of small sample sizes in each group. Therefore, while the current study provides an important foundation for additional analysis, replicating these analyses with a larger sample will allow for improved statistical power to test mediational hypotheses. Second, the current study was able to examine change over time due to longitudinal methodology, but this study only examined a period of development from age 18 to 25. As highlighted in Figure 6, early adulthood is a period when heavy alcohol use is common which may not only limit the ability to detect important



**Figure 6. Notional development of alcohol use over time in individuals with and without ADHD**

group differences, but it also neglects different stages of developmental processes. It will be important to continue to follow the current sample to determine if there are socialization differences as young adults enter the period when “aging out” of alcohol use is more normative than using alcohol frequently and at elevated levels. There is significantly less binge drinking in individuals with than without ADHD at age 25 in the current sample. This difference could be representative of the onset of decreased alcohol use with the transition to adulthood. This preliminary group difference, which was unexpected, suggests the need to follow the entire sample into older adulthood to determine if such differences persist with a larger and older sample.

The current study was able to determine that peer alcohol use between the ages of 21 and 24 was associated with young adult alcohol use at age 25. However, the current study did not assess whether alcohol-using young adults select friends who have similar levels of alcohol use as their own. This question could be tested by examining self-reported alcohol use as a predictor of peer alcohol use. Significant research has been conducted on the roles of peer influence and peer selection, but this literature is typically limited to adolescent alcohol use and has infrequently been extended to early adulthood. Understanding whether young adults select peers who use alcohol at similar levels, in addition to adjusting their drinking in response to peer behavior, will help capture dynamic and proposed bidirectional social processes that were not evaluated with the current study design. Additionally, including prior alcohol use accounts for change over time in young adult drinking. The current study did not control for alcohol use prior to early adulthood and doing so in future analyses will simultaneously allow for greater understanding of bidirectional associations between young adult alcohol use and peer alcohol use while strengthening the ability to make causal inferences about these associations.

Social network information was averaged over time to maximize the use of available data. Therefore, although there may be important individual changes in social network composition in early adulthood, the current study did not examine such variability. Averaging multiple time points might have diluted some important variability (i.e. the change from no drinking friends to 10 drinking friends would be represented as the presence of 5 drinking friends). Future studies will benefit from the utilization of statistical methodology that is more sensitive to capturing change in social network structure over time to determine whether there are group differences in peer network change that are associated with young adult alcohol use. Additionally, averaging social networks over time mitigates examination of temporal effects within this age range. In the current study design, social networks at age 21 are equated with social networks at age 24 so it is unclear whether peer socialization at age 24 is accounting for most of the association in peer networks and young adult drinking. If social networks at age 21 influence alcohol use four years later, such a finding would provide support for early interventions to ameliorate enduring negative peer effects. Finally, examining social skills, known to be impaired in ADHD, will clarify whether differences in social network characteristics (e.g. size of social network, number of friends) are related to functional impairment and provide a possible alcohol use intervention in the form of social skills training.

Furthermore, the current study only assessed perceived peer alcohol use. First, individuals with ADHD have well-documented reporting biases, and adolescents and young adults may be poor reporters of the alcohol use of others (Belendiuk, Molina, & Donovan, 2010). Research outside of the field of ADHD has also shown that individuals are likely to over report others' alcohol use and that these perceptions are a strong predictor of alcohol use behavior (Bauman & Fisher, 1986; Iannotti & Bush, 1992; Iannotti, Bush, & Weinfurt, 1996). Therefore,



asking young adults with ADHD to report on the alcohol use in their social networks may capture considerable perceptual bias relative to individuals without ADHD, which may account for the effects of social networks on alcohol use for young adults with, but not without, ADHD. Future studies will benefit from assessing peer alcohol use by interviewing peers directly. Second, the current study only assessed perceived and self-reported alcohol use and did not assess norms, attitudes, and values. Prior research has demonstrated that both peer attitudes and behaviors predict alcohol use in individuals with ADHD (Belendiuk et al., in prep) and it is possible that over time the persistent influence of social networks and behaviors that are supportive of alcohol use may shape young adult norms, attitudes, and values. Future studies should examine both attitudes and behaviors to understand the mechanisms by which alcohol-related behavior change occurs.

Finally, a strength of the current study is that two operationalizations of drinking (frequency of binge drinking and quantity/frequency) were examined, although there is a limitation inherent to the operationalization of the quantity/frequency of alcohol use. One young adult may drink one drink a day for a week whereas another young adult may drink 7 drinks once a week. Both young adults have an equal value (i.e. 7) to represent their quantity/frequency of alcohol use, but their alcohol use would be different clinically and may be associated with different socialization processes because binge drinking occurs at a higher rate in social contexts (Clapp & Shillington, 2001), and different impairments because binge drinking is more likely to be associated with negative outcomes (National Institute of Alcohol Abuse and Alcoholism, 2000; Weschler, 2000). Importantly, there were no group differences in the quantity of alcohol consumed in the current sample. Therefore, while the examination of alcohol topography should be considered in future studies, there are no differences in the current study.

There are several additional areas for future research. First, the current study did not examine whether relationship characteristics of individuals in the social network affected peer alcohol socialization. For example, the current study did not differentiate whether young adults were drinking with drinking friends or whether young adults had drinking peers in their social network with whom they did not drink. Future research should examine whether the co-occurrence of drinking behavior in young adults and their friends is more important in predicting young adult alcohol use than the perception of drinking in the social environment. If the perception of drinking behavior in the environment affects young adult alcohol use then interventions that provide information about rates of alcohol use in the environment (Lewis, Neighbors, Lee, & Oster-Aaland, 2009) may ameliorate the risk of alcohol use for young adults who are susceptible to the influence of distorted perceptions of environmental alcohol use. Additionally, relationship characteristics, such as the amount of time spent with heavy drinking peers, may yield additional information about drinking in early adulthood and may also clarify the group differences in peer alcohol socialization. Specifically, young adults with ADHD may identify heavy drinking peers in their social network but due to social impairment may not spend time with these peers and/or may drink in isolation. Furthermore, the current study examined peer alcohol socialization because peer relationships are one area of impairment for individuals with ADHD. However, young adults with ADHD are also impaired in their romantic relationships (Babinski et al., 2011). Therefore, the risk or protective role of romantic relationships in early adulthood on drinking may be different for individuals with ADHD. Specifically, marriage, cohabitation, and dating have all been found to be protective against alcohol use, even when controlling for adolescent drinking (Fleming, White, & Catalano, 2010). Romantic relationships have shown to be directly protective against alcohol use due to social

support and control (Maume, Ousey, & Beaver, 2005; Sampson & Laub, 1993), and indirectly protective via reduced exposure to substance-using peers (Bachman et al., 2002; Warr, 1998). Therefore, complete characterization of social networks to understand risk of alcohol use will be most important for individuals with ADHD who are also more likely to experience impairments in romantic relationships. The social network inventory used in the current study extensively characterizes multiple aspects (i.e. time spent together, length of relationships, relationships quality) of different relationships (i.e. partner, friend, co-worker, family member) in the social network, providing valuable data for a more complete understanding of the alcohol socialization processes that may increase risk for young adult alcohol use, particularly for individuals with ADHD.

In addition to aspects of social functioning that may influence alcohol use in early adulthood, several other features of ADHD that were not included in the current study due to model complexity should be included in future studies examining differential risk for alcohol use in individuals with and without ADHD. First, research suggests that ADHD symptom persistence is associated with alcohol and substance use in adolescence (Molina et al., 2012) and that worsening symptoms of inattention and delinquency are associated with the highest rates of binge drinking in early adulthood (Howard et al., in prep). Therefore, future studies should examine persistence of ADHD symptoms (i.e. inattention, hyperactivity, impulsivity) and behaviors (i.e. delinquency) in the prediction of alcohol use outcomes. Additionally, young adults with ADHD are less likely than young adults without ADHD to attend college (Kuriyan et al., 2013) and college attendance is associated with heavy drinking (Molina, Walther, Pelham, Pedersen, & Gnagy, under review). Therefore, when examining alcohol use in early adulthood, it will be important to consider how college attendance affects alcohol use and whether inclusion

of this variable in alcohol socialization models affects conclusions about ADHD-related alcohol consumption. Finally, future studies should include prior alcohol use to strengthen causal inferences in the prediction of later alcohol use.

The current study aimed to examine group differences in alcohol socialization between young adults with and without a childhood diagnosis of ADHD. This study demonstrated that some differences in social functioning between individuals with and without ADHD persist into early adulthood. Additionally, social functioning in the form of social network characteristics was somewhat differentially associated with alcohol use for individuals with and without ADHD. Specifically, although the presence of drinking friends prospectively predicted binge drinking for both the ADHD and nonADHD groups, this prediction was only significant in the ADHD group for quantity/frequency of drinking alcohol. The presence of light drinking friends, regardless of its construction, did not predict alcohol use (either binge drinking or quantity/frequency) in either group. Although delinquency and impulsivity at age 18 were correlated with the age 25 drinking measures for the ADHD group, social network characteristics did not mediate these zero-order associations. Future research should focus on ADHD symptom persistence and other aspects of ADHD (e.g. college attendance) to better understand the mechanisms by which ADHD may confer risk for alcohol problems, given the universally high rates of alcohol use in early adulthood. In sum, this study provides preliminary information that, although childhood ADHD does not predict overall higher rates of heavy drinking in early adulthood, individuals with ADHD who drink may be somewhat more susceptible to peer alcohol socialization than individuals without ADHD. This finding, coupled with other research showing increased risk for alcohol disorders (Lee et al., 2011), and our earlier findings of apparent greater vulnerability to peer substance use (Marshall et al., 2003), suggests the need for continued research on ADHD-

related alcohol socialization and its development through adulthood. Eventually, results may inform drinking interventions for a population with heightened vulnerability to the negative effects of alcohol use.

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