DISSERTATION

FAMILY TIES: EXAMINING FAMILY FUNCTIONING AND ALCOHOL USE AMONG AMERICAN INDIAN YOUTH

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ABSTRACT

FAMILY TIES: EXAMINING FAMILY FUNCTIONING AND ALCOHOL USE AMONG AMERICAN INDIAN YOUTH

Objective: American Indian (AI) adolescents report earlier initiation and higher frequencies of alcohol use than their non-AI peers. Early initiation and higher frequency alcohol use are associated with worse health outcomes. Researchers have been called to identify factors which protect AI youth from harmful alcohol use behaviors and other risk factors such as peer use. **Method:** This study is a secondary data analysis of an ongoing epidemiological research survey with AI youth. Data was collected in the Fall of 2021 and Spring of 2022. Participants were 4,373 AI adolescents from grades 6-12 across seven regions of the contiguous United States. Structural Equation Modeling (SEM) was used to test a second-order latent variable of family functioning built from measures of family cohesion, family norms against adolescent alcohol use (FN), and parental monitoring. Structural paths and interaction terms between peer use and family functioning were added to the SEM to explore direct effects and moderations **Results:** Family cohesion, FN, and parental monitoring were best represented by a second-order latent variable of family functioning. Family functioning was related a later initiation of alcohol use and lower alcohol use frequency. Family functioning moderated the relationship between peer use and alcohol outcomes. **Conclusions:** The latent variable of family functioning and its component measures are appropriate for use in AI samples. Additionally, family functioning, which is an inherent resilience factor in AI communities, was shown to be protective against harmful alcohol use behaviors. Results have implications for prevention/intervention research.

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Introduction

Adolescent alcohol use is a public health concern in the United States that is associated with negative consequences such as academic disruptions, anxiety, depression, alcohol related mortality, and impairments to brain development (Henry et al., 2012; Henson et al., 2017). Despite consequences associated with early alcohol use, around 78% of adolescents in the United States report engaging in alcohol use by late adolescence, and 24.6% report use between the ages of 14 and 15 (National Institute on Health [NIH], 2019; Swendsen et al., 2012). A variety of factors influence alcohol use. However, adolescents' alcohol use is often linked to their social relationships, primarily through peers and family (NIH, 2019; Substance Abuse and Mental Health Services Administration [SAMHSA], 2019). Peer use is a well-established risk factor for more frequent alcohol use via modeling behaviors (NIH, 2019; Nuño & Herrera, 2022). Family influences may serve as either risk or protective factors. Modeling of alcohol use in the household is associated with more frequent alcohol use with 96.5% of 12- to 14-year-olds reporting that the last drink they had was free, typically obtained from a family member (SAMHSA, 2019), whereas family norms against alcohol use (FN) predict later initiation and lower lifetime alcohol use frequency (SAMHSA, 2019).

Alcohol use for any adolescent is concerning. However, longitudinal studies have shown that specific groups of people within the United States are at increased risk for adolescent alcohol use, including American Indians (AI). Research documenting trends in alcohol use have shown that since at least 1975, AI youth have consistently reported alcohol use at higher national rates than their non-AI peers (Stanley, 2014b). When compared to nationally representative data (Monitoring the Future), AI youth alcohol use is disproportionally higher when compared to their non-AI peers up until the 12th grade when rates of use begin to converge across groups (8th grade: AI: 52.8% vs non-AI: 33.1%, 10th grade: AI: 62.5 vs non-AI: 57.8%, 12th grade: AI: 67.5% vs non-AI: 71.1%); Stanley et al., 2014b). These findings are concerning and highlight the need for additional research that will facilitate the development of prevention strategies which can help reduce harmful alcohol use consequences for AI youth.

Initiation of Alcohol Use

In addition to higher rates of use, data shows that AI youth are more likely to initiate alcohol use at a younger age than their non-AI peers, with typical ages of alcohol initiation for AI youth between ages 10 and 13 years (Beauvais, 1996; DeWit et al., 2000; Stanley & Swaim, 2015; Stanley et al., 2020; Whitbeck & Armenta, 2015), compared to a nationally representative mean age of 16.5 years (Alcover & Thompson, 2020). Initiation of alcohol use at younger ages has been linked to several negative health consequences such as more frequent alcohol use in adolescence (Bolland et al., 2016; Komro et al., 2010; Maldonado-Molina et al., 2010; Mason et al., 2010), and more harmful patterns of alcohol use (Henry et al., 2011; Grant & Dawson, 1997; Novins & Barón. 2004; SAMHSA, 2016; Stanley & Swaim, 2015). Earlier initiation of alcohol use has also been linked to a higher likelihood of developing an alcohol use disorder, such that those who use alcohol before the age of 14 are six times more likely to develop an alcohol use disorder (Hingson et al., 2006; SAMHSA, 2016; Windle & Windle, 2012). Additionally, initiating alcohol use at younger ages has been connected to a host of risky behaviors such as intoxicated driving, academic failure, and risky sex (Biglan et al., 2004; Windle et al., 2008). The higher rates of risky behaviors for younger drinkers may be explained by the disinhibiting effects of alcohol on the adolescent brain, which has an under-developed pre-frontal cortex, making adolescents more impulsive and prone to risk taking (Winters & Arria, 2011). Elevated risk for alcohol use, as well as earlier age of initiation, indicates that AI youth are likely at a unique risk for experiencing consequences related to their alcohol use.

A significant amount of research on AI communities has been dedicated to establishing that there are high rates of alcohol use for this population (McLeigh, 2010; SAMHSA, 2016). However, research has also found that when AI youth choose not to initiate alcohol use, they have significantly lower rates of use compared to their non-AI peers (Cunningham et al., 2016; Chen et al., 2016). Even in adulthood, AI alcohol abstinence rates are significantly higher than their white peers with roughly 60% of AI individuals reporting abstinence from alcohol use compared to 43% of white peers (Cunningham et al., 2016). These findings are encouraging, specifically for AI youth, as research on delayed initiation of alcohol shows that the probability of developing a substance use disorder (SUD) can decrease by 5% to 9% for each year of delayed initiation. The presence of high abstinence rates indicate that there may be factors already operating within AI communities that keep individuals from engaging in alcohol use when they have access to these resources. If factors related to abstinence or delayed initiation can be identified, prevention efforts can focus on the factors which will help AI youth avoid harmful alcohol use patterns and alcohol related consequences (Grant et al., 2001; Henson et al., 2017).

Historical Trauma Theory

In discussing disparities in alcohol use for a specific group of people, it is important to acknowledge the unique historical contexts which may influence substance use. One possible explanation for higher rates and earlier initiation of alcohol use among AI youth is the Historical Trauma Theory. Historical trauma is defined as a collective trauma or traumas experienced by a group of people that are then passed down through the group's collective memories (Hirschberger, 2018). Health disparities commonly linked to historical trauma (HT) include outcomes such as suicidality, heart disease, and substance misuse (Heart et al., 2011; Gone et al., 2019; Heart, 2003; Subica and Wu, 2018). Historical trauma theory posits that HT outcomes among AI communities may be tied to three major traumas: colonization, residential education, and forced assimilation (McLeigh, 2010). These traumas have had long lasting effects on AI communities through the introduction of recreational substance use (which is noted to be distinct from culturally motivated substance use), disruption of family systems, and loss of cultural resources (McLeigh, 2010). While it may be difficult to fully explain disparities in use, the historical trauma theory may shed light on why disparities exist, and even provides evidence as to where research efforts should focus if we wish to counter the effects of HT, such as in disrupted family systems.

Research on alcohol use among AI communities has largely focused on prevalence rates, negative health outcomes, and risk factors unique to AI communities. While past efforts have helped to establish a basis for continued research and increased attention to health disparities, researchers have been called by AI communities to shift focus to examine factors which are associated with later initiation of alcohol use among AI youth (McLeigh, 2010; SAMHSA, 2016).

Peer Influences

A major factor in adolescent alcohol use are peer influences (Ali & Dwyer, 2010). Adolescence is a time of extreme development not only for physical maturation, but for increased social engagement and expectations (Leung et al., 2014). In adolescence, individuals may spend a greater proportion of their time engaging with and modeling the behavior of their peers (Leung et al., 2014). As adolescents begin to depend on their peers for support, guidance, and companionship, they may also feel the increased effects of peer influence (Leung et al., 2014; Goldstein et al., 2005; Maxwell, 2002).

A large body of research has shown a significant connection between peer use, personal use, and age of alcohol initiation for both AI and non-AI youth, with many researchers identifying peer use as one of the most salient alcohol use factors for youth (Boyd-Ball et al., 2014; Chen et al., 2012; Heavy Runner-Rioux & Hollist, 2010; Keyes et al., 2012; Keyes et al., 2011). Borsari and Carey (2001) posit two possible causes for this relationship, with the first being that exposure to alcohol through peer use increases the likelihood that an individual will engage in use themselves. Secondly, having peers who use alcohol may lead to a positive view of the substance as acceptable or even beneficial in some aspect (Borsari & Carey, 2001). Prior research has established that peer pressure has been shown to be even more strongly predictive of alcohol use and misuse than other, classically protective factors such as self-esteem and locus of control (Dielman et al, 1987).

Given the consistent findings in the literature that deviant peers groups are related to increased risky behavior for the individual, specifically alcohol use, researchers are being called the further investigate interventions or factors which may buffer the effects of peer use (Tingey et al., 2016). Given the highly influential nature of social relationships (i.e., peers & family) on adolescent alcohol use behaviors, some researchers have started to explore the family influences as a way of moderating the risks associated with peer alcohol use (Boyd-Ball, 2014; Cwik et al., 2017).

Family Functioning

A multitude of factors can decrease an individual's likelihood of engaging in substance use, most notably for AI populations. These include holding traditional AI spiritual beliefs, connection to and identification with culture, positive self-image, wanting to be a role model, and awareness of life goals (Henson et al., 2017; Woods et al., 2022). However, for AI youth, it has been family factors which have been identified as most highly influential, as both protective (Henson et al., 2017) and risk factors (Novins and Barón, 2004; Novins and Mitchell, 1998; Spicer et al., 2003). As previously noted, family influences often work on a continuum, with more family influences being related to lower rates of alcohol use, and less family influences being related to higher rates of use. Family influences are unique in that they are particularly amenable to intervention programs (Henson, 2017); this contrasts with peer influences which are typically harder to intervene on, powerfully influential on personal use, and typically related to riskier outcomes (Ali & Dwyer, 2010; Borsari & Carey, 2001). Given the major role peers and family play in the initiation of use and lifetime alcohol use frequency, understanding how these factors influence each other may be helpful in directing future prevention efforts.

AI Family Influences

AI communities, while unique between tribes and regions, have historically placed a high value on family and community relationships (Red Horse, 1997). In turn, familial relationships have been shown to be particularly effective at protecting against harmful behaviors such as substance use (Henson et al., 2017; Tingey et al., 2016).

Traditional AI communities are unique in the way they approach and view family systems, with children and youth becoming more involved with the family unit as they age, which is different from traditionally western families where age is often synonymous with independence (Red Horse, 1997). This may help to explain why practices which emphasize family interaction with the adolescent, such as parental monitoring, are so effective for AI youth (Boyd-Ball et al., 2014; Pu et al., 2013). Discipline styles also vary significantly between traditional AI and western families, with AI families often focusing on modeling pro-social behaviors rather than punishing anti-social behaviors such as substance use (Red Horse, 1997; Sutton & Broken Nose, 1996).

The importance of family in AI communities indicates that this may be an important area for substance use prevention efforts, which must then also be considered in a context that is culturally appropriate. In exploring these distinctive family systems, several family factors have consistently been identified as protective against alcohol use, including family cohesion, parental monitoring, and FN (Boyd-Ball et al., 2014; Cheadle & Hartshorn, 2012; Connell et al., 2006; Dishion et al., 2003; Henson et al., 2017; Mason et al., 2003; Swaim et al., 2011).

Family Cohesion. Family cohesion is described as the degree to which family members are concerned for one another, committed to the family structure, and how helpful or supportive family members are of each other (Moos & Moos, 1986). For many AI families, high family cohesion is integral and has even been described as essential for the survival of AI peoples and their culture (Teufel-Shone et al., 2005). In the literature, high levels of family cohesion have been found to buffer against negative outcomes such as externalization of problems (Richmond & Stocker, 2006), feelings of depression, challenges in social adjustment (Johnson et al., 2001), and substance use for youth (Henson et al., 2017). A 2017 literature review examining protective factors among AI communities identified family cohesion as being protective against not only the initiation of alcohol use and lifetime alcohol use frequency, but also against suicide attempts and violent behavior, while also increasing substance refusal skills (Cheadle & Whitbeck, 2011; Henson et al., 2017; Galliher et al., 2007). High family cohesion has been identified as beneficial across ethnic groups but appears to be specifically beneficial for AI communities as it stems from innate values held by this population. Additionally, some literature suggests that high family cohesion can even influence the way in which families perceive alcohol use with those who are high on cohesion, being less punitive and more forgiving of use (Scherer et al., 2012).

Family Norms Against Adolescent Alcohol Use. A significant amount of research has linked parental alcohol use to genetic markers which increase the likelihood of lifetime alcohol use frequency (Chartier et al., 2017; Cheadle & Hartshorn, 2012). However, the influences of family alcohol use go beyond genetic risk factors. Family socialization around alcohol use and FN have been shown to be significant predictors of adolescent alcohol use (Sieving et al., 2000). Within AI populations researchers have shown that these norms influence youth bilaterally; sanctions against use predict lower alcohol use (Swaim et al., 1993), whereas acceptance and modeling of use was related to higher alcohol use (Mail, 1995). These results indicated that AI youth may be uniquely aware of family values and norms, possibly due to the value placed on family cohesion, which then has a significant impact on their behavior. More specifically, examinations of FN indicate that AI youth who perceived their parents as being less approving of alcohol use were less likely to engage in alcohol use at younger ages, meaning that especially at younger ages, FN may act as a buffer for alcohol initiation (Swaim et al., 2011). In addition, youth who perceived more FN were also more cognizant of peer disapproval of use, which may also help to buffer the harmful effects of peer alcohol use (Mrug & McCay, 2013).

Parental Monitoring. Another family variable which has been linked to lower rates of adolescent alcohol use is parental monitoring. Parental monitoring is conceptualized as parental knowledge of a child's activities and whereabouts, limit setting for the child, parental solicitation of child behavior, and voluntary report of behaviors to the parent (Kerr & Stattin, 2000; Stattin & Kerr, 2000). However, these factors have more recently been conceptualized as three distinct parent-child interactions: parental knowledge (PK), parental control (PC), and a union of child disclosure and parental solicitation (CDPS) (Swaim & Stanley, 2022). The protective effects of parental monitoring on lifetime alcohol use frequency have been well established among white populations (Lac & Crano, 2009; Racz & McMahon, 2011) with both longitudinal (Chassin et al. 1992) and random assignment interventions (Connell et al. 2006; Dishion et al. 2003; Mason et al. 2003) showing that higher levels of parental monitoring are related to less frequent alcohol use for youth. Additionally, parental monitoring has been shown to buffer the effects of risk factors such as peer alcohol use on lifetime use, in that those with more parental support have been shown to seek out friend groups with less substance use (Boyd-Ball et al., 2014). Research on parental monitoring in AI populations is limited, but ultimately supports the inverse relationship between parental monitoring and alcohol use (Barrera et al. 1999; Boyd-Ball et al., 2014; Forehand et al. 1997; Mohatt et al. 2004). Additionally, studies indicate that parental monitoring within AI communities may operate uniquely from monitoring behaviors in non-AI groups (Kulis et al., 2016; McKinley et al., 2021; Swaim & Stanely, 2022; Walls et al, 2019). For example, Swaim & Stanley (2022) found that AI youth reported less perceived monitoring than their white peers, with levels of perceived monitoring remaining stable between middle and high school. These findings contrast with parental monitoring trends among white youth who typically experience a decrease in parental monitoring as they age (Lionetti et al., 2018; Swaim & Stanley, 2022). These findings highlight the need for additional research exploring parental monitoring within an AI sample as parental monitoring is likely one of several important factors in reducing adolescent alcohol use and delaying the initiation of alcohol use.

Family Functioning as a Latent Variable

Given the overlap in how parental monitoring, family cohesion, and FN affect AI adolescent alcohol use, it is important to understand if these factors operate as stand-alone constructs, or if they are better explained by one overarching construct of family functioning.

Higher-order and Bifactor models are both commonly used when examining domains which are believed to be highly related (Gignac, 2008), such as for family functioning in the current study. A key difference in higher-order and bifactor modeling approaches is their theoretical implications. Higher-order, or second-order (more specifically in the case of family functioning) models are best suited to data in which the first-order factors (parental monitoring, family cohesion, and FN) are highly correlated and best explained by a higher-order latent variable (i.e., family functioning). Three important distinctions are made in second-order factor theory: 1) the shared variance between the group-level factors is explained by higher order variable, 2) the positive correlation across first order factors is due to the shared variance between group-level factors, 3) the higher order factor does not directly influence the first order factors or their items (Gignac, 2016). In sum, a second-order model implies that family cohesion, FN, and parental monitoring, are pieces of a higher domain of family functioning. Additionally, a second-order model inherently recognizes, through its treatment of unexplained variance, that there may be other factors contributing to family functioning which haven't been captured in the current model (Gignac, 2016). Given what we know about AI communities and the importance of family systems, it is likely that other factors play a role in family functioning that our survey didn't capture, or measure. A major benefit of the higher-order model is that it respects that there are unexplained dimensions that are not captured by the current model, allowing for model expansion as other factors are identified or measured.

Bifactor models, on the other hand, best handle data where the overlap in items is explained by multiple uncorrelated domain specific factors. Domain specific factors in the bifactor model account for different aspects of a general variable. (Holzinger & Swineford, 1937). Any of the unexplained variance left over by the domain specific factors loads onto a general factor typically referred to as "G". If data were analyzed using a bifactor model, we would view family functioning as capturing variance in the observed items unexplained by the individual latent factors (i.e., parental monitoring, family cohesion, and FN). Using a bifactor model would imply that all items captured by family functioning have been included in the model. In the current model using bifactor approach may be limiting as it does not allow for the expansion of our operational definition of family functioning beyond the items included.

Typically, when competing models are available for hypothesis testing it would be prudent to test both and then compare model fit to identify the best approach. However, a significant amount of research has been dedicated to comparing higher-order and bifactor models with many researchers determining that accurate comparisons are challenging and at times even impossible (Mansolf & Reise, 2016; Molenaar, 2016; Morgan et al., 2015; Murray & Johnson, 2013). Mansolf & Reise (2016) identify chi-square and Bayesian Information Criterion (BIC) as the best indices of model fit for comparing higher-order models to bifactor models. However, they also note that there is an inherent statistical bias causing chi-square and BIC to favor bifactor models even when the underlying structure is that of a higher-order model, particularly in large samples with large degrees of violation (Mansolf & Reise, 2016). Given the known challenges of model fit when comparing higher-order and bifactor models, researchers recommend looking instead to theory to guide choice of model (Mansolf & Reise, 2016; Morgan et al., 2015; Murray & Johnson, 2013). Therefore, given the better theoretical fit of a higher-order model, this approach will be used for subsequent conceptualizing and analysis of the family functioning latent variable.

Current Study

Researchers have established the unique effects of specific family and peer factors on AI adolescent alcohol use, although, this research base is limited when compared to studies of white youth. (Henson et al., 2017). However, research on the influence of multiple family factors simultaneously (e.g., family cohesion, parental monitoring, and FN) within AI populations is limited (Swaim & Stanley, 2016), and fewer studies still have explored how any of these factors effect age of alcohol initiation (Boyd-Ball et al., 2014). The goal of this research is to explore various ways of composing a latent variable with different combinations of family factors to determine whether pro-social family functioning can reduce alcohol use, delay age of initiation, and buffer the effects of other risk factors such as peer alcohol use.

This study is novel in its exploration of a latent variable for family functioning, and its focus on family functioning's relationship to age of alcohol initiation, a factor which can have major impacts on alcohol consequences among AI youth.

Hypotheses

Aim 1: Latent Variable Testing

1. Hypothesis 1: Family cohesion, FN, and parental monitoring will aggregate into a single second-order latent variable of family functioning.

Aim 2: Direct Effects

2. Hypothesis 2: Pro-social family functioning will be negatively associated with alcohol use.

3. Hypothesis 3: Pro-social family functioning will be positively associated with age of initiation of alcohol use.

Aim 2: Moderation Effects

4. Hypothesis 4: Pro-social family functioning will buffer the relationship of peer alcohol use on both age of initiation and alcohol use frequency, such that those with higher levels of pro-social family functioning will have a weaker relationship.

Methods

Participants and Procedure

This study is a secondary data analysis of survey data collected as part of an ongoing epidemiological research study with AI youth (grant number NIH/NIDA R01DA003371; M-PIs Prince, Swaim, & Stanley). Data collection for the epidemiological study has occurred over multiple grant cycles including: 1993-2000, 2001-2006, 2009-2013, 2015-2020, and 2020-2025. The current study uses data collected in the Fall of 2021 and Spring of 2022. The data includes questions related to family and peer factors, as well as substance use risk factors. Moreover, this sample has been expanded from grades 7-12 to include 6th graders which, for the first time, allows for earlier detection of alcohol initiation and comparisons across Middle & High school students. Data for the epidemiological study was collected using the American Drug and Alcohol Survey (ADAS) version 7-9, the Prevention Planning Survey (PPS) versions 1 & 2 (Beauvais & Swaim, 2013), and the Our Youth, Our Future (OYOF) survey. The ADAS is a validated measure intended for use with minority populations and has been specifically refined for use with AI youth (Oetting & Beauvais, 1990). The ADAS assesses substance use, substance-use related consequences, and peer influences on substance use. The PPS was developed internally as a supplement to the ADAS survey (Oetting et al., 1996). The PPS is not a formally published measure, however, items from the PPS which were included in the survey are comparable to items from existing and validated surveys (i.e., American Drug and Alcohol Survey [ADAS], Monitoring the Future [MTF]) or validated stand-alone measures (i.e., Orthogonal Cultural Identity Scale; Oetting et al., 1998). The PPS assess risk and protective factors for substance use such as cultural identity, parental and peer influences, and school engagement (Oetting et al., 1996). From 1993-2006 the ADAS and PPS were administered as independent surveys and then were combined for data collection. Starting in 2015, the survey was renamed "Our Youth, Our Future" (OYOF), with items being revised to be more comparable with other large scale epidemiological research such as MTF.

Sampling Frame

Samples for the study were taken from three sources including the NCES Common Core of Data (CCD), the NCES Private School Universe Survey (PPS), and the Bureau of Indian Education (BIE) National Directory. To be considered for inclusion only high schools with grade 7 were included in the final sample. Other requirements for inclusion in the study were: 1) Schools located on or near (i.e., within 25 miles) reservations within the contiguous United States, 2) A minimum of 20% enrollment of AI youth, and 3) Total enrollment of at least 20 students in each grade.

Regions for sampling were identified through regional distributions used by the Bureau of Indian Affairs (BIA). The 12 regions identified by the BIA account for factors such as culture, geography, and population and are as follows: Northwest, Pacific, Western, Southwest, Rocky Mountain, Great Plains, South Plains, Midwest, Eastern, Navajo, Eastern Oklahoma, and Alaska. Seven regions were ultimately included in the final sampling frame after considering cultural distinctions, number of potential schools in each region, and confidentiality. The seven regions included were: Northwest (includes Northern California reservations), Southwest (includes Southern California reservations), Northern Plains, Upper Great Lakes, Southern Great Plains, Southeast, and Northeast. Within the 7 regions included 327 schools were identified for the final sampling frame.

Demographics

From the sampling frame approximately 29% of identified schools participated in the Fall 2021 and Spring 2022 survey. Within the sampled schools, 6,797 students grade 6-12 participated with 64% of those students self-identifying as AI (n = 4,373). Sample sizes per grade for AI identifying students are as follows: 6th grade 357 respondents (50.2% female; 49.8% male), 7th grade 684 respondents (48.4% female; 51.6% male), 8th grade 616 respondents (48.0% female; 52.0% male), 9th grade 743 respondents (48.9% female; 51.1% male), 10th grade 663 respondents (48.1% female; 51.9% male), 11th grade 606 respondents (49.3% female; 50.7% male), 12th grade 496 respondents (56.2% female; 43.8% male). For ease of analyses students were separated by grade group into middle and high school groups. See Table 1.

The regional distribution of participants is as follows: Northern Plains (NP): 8.1%; Northwest (NW) 3.3%; Upper Great Lakes (UGL): 8.9%; Northeast (NE): 3.5%; Southern Great Plains (SGP): 10.8%: Southwest (SW): 39.3%.

Table 1

Demographic Breakdown by Sex, Grade-Group, and Alcohol Initiation

	Middle School Females	Middle School Males	High School Females	High School Males
No Alcohol Use Initiation	630	682	789	837
Alcohol Use Initiated	141	127	409	347
Total	771	809	1198	1184

Planned Missingness

The OYOF survey includes a planned missingness design and is structured so that participants first answer demographics and substance use items (e.g., lifetime, last year, last 30-day use; age of initiation), and then were given a random sample of items from a larger pool of measures (racial-ethnic/cultural identity, substance use, community/reservation, COVID). Blocks of items were randomly ordered so that the data was missing completely at random (MCAR), randomization of order reduces the chance of systematic missingness in the data (Enders, 2022). Items for family cohesion, and parental monitoring were included in MCAR blocks and had response completion rates ranging from 57% - 58%. To account for missing data a full information maximum likelihood (FIML) estimator was used. FIML maximizes model fit of the data by identifying parameter values which have the highest likelihood of representing the observed data (Enders, 2022).

Measures

The survey was collected using a cross-sectional design. Thus, items such as age of initiation required participants to think back to their age of first use, whereas, items such as peer use required participants to report on their current peers' alcohol use.

Alcohol Use Questions

Age of alcohol use initiation was assessed through the following question: "How old were you when you first drank ALCOHOL – more than just a few sips". Response options ranged from 1 (10 years old or under) to 9 (18 years old). Those who had not yet initiated alcohol use were coded as 19.

Lifetime alcohol use frequency was assessed through the following question: "In your lifetime, how many times have you drank ALCOHOL – more than just a few sips". Response options ranged from 1 (0 times) to 5 (10 times or more).

Peer Alcohol Use

Peer use was assessed through two questions: "How many of your friends drink alcohol" and "How many of your friends get drunk". Response options ranges from 1 (none) to 4 (most of them). Items were be averaged to create a mean score which maintained the original scale. This score was then mean centered to aid interpretation in structural equation models.

The Brief Family Relationship Scale

The Brief Family Relationship Scale (BFRS) is a brief measure of family relationship functioning which was adapted from the Family Environment Scale (FES; Moos & Moos, 1986) for use with a native youth population (Fok et al., 2014). The BRFS consists of three subscales with nine items each and asks participants to indicate how true each statement is for their family, with scores ranging from 1 (never) to 5 (always). The subscales on the BRFS include scales for cohesion, expressiveness, and conflict. In this study, the subscale of cohesion was used to assess family cohesion which included 7 items. Studies of measurement invariance have shown that the family cohesion subscale is a valid measure of mean differences across groups (Feaster et al., 2010).

Parental Monitoring Short Scale

Parental monitoring was evaluated using the parental monitoring short scale (PMSS; Swaim & Stanley, 2022). The PMSS is a short parental monitoring scale adapted for use with reservation-based youth from established measures of parental knowledge, parental solicitation, and child disclosure. The PMSS is a 13-item measure with scores ranging from 1 (never) to 5 (always) with higher scores indicating more parental monitoring. The PMSS includes three subscales which measure parental knowledge (PK), parental control (PC), and the third assessing a combined factor for child disclosure, and parental solicitation (CDPS). The three-factor model of the PMSS has demonstrated good model fit (CFI = .97; RMSEA=.05; SRMR=.03; Swaim & Stanley, 2022). Due to the three-factor nature of this measure, the PMSS was treated as a latent variable with PK, PC, and CDPS being treated as factors of the overarching latent variable of parental monitoring. The PMSS has been tested for measurement invariance and has been shown to be appropriate for use across sexes (male vs female) and grade groups (middle vs high school) (Swaim & Stanley, 2022).

Family Norms Against Adolescent Alcohol Use

FN was calculated using two questions: “How much would your family disapprove if you drank alcohol” and “How much would your family disapprove if you got drunk”. Participants responses to these items range from 1 (Not at all) to 4 (A lot). Previous studies have used the average score of the two items for a mean score of FN with higher scores indicating greater family disapproval of alcohol use (Swaim et al., 2011).

Latent Variable of Family Functioning

Each facet of family functioning described above has been examined indirectly. A goal of this study was to look at how these variables operated together as a latent variable of family functioning. Family functioning can serve as either a protective (high family cohesion, FN, & parental monitoring) or risk factor (low family cohesion, family norms approving alcohol use, & low parental monitoring) for adolescent alcohol use. For the purpose of this study protective or pro-social family functioning is indicated by higher family functioning scores. Below I will outline analytic strategies for examining family functioning as a higher order latent variable.

Analysis Plan

Descriptive Statistics

Means, standard deviations, and frequencies were calculated for all variables as well as bivariate correlations. Additionally, I examined univariate descriptive statistics including tests for assumptions of linearity, normality, and outliers for all variables. One of the assumptions I tested for was independence of observations. Data were nested by design with students nested in schools which can violate the independence assumption. Therefore, I tested for the independence assumption using the intraclass correlation (ICC), with values higher than 0.05 indicating a violation of independence. Violations of independence require additional modeling considerations such as a sandwich estimator in order to appropriately model the nested data by adjusting the standard errors (Croux et al., 2004).

Data Considerations and Modeling Approaches

Structural Equation Modeling. A primary goal of this study was to examine the feasibility of a second-order latent variable of family functioning, which included evaluating model fit and invariance testing of all first-order constructs and the second-order latent variable.

The process of psychometric testing typically starts with exploratory factor analysis (EFA) which is used to identify the number of factors (i.e., latent variables) from a set of items. EFA makes no specifications as to the relationship between items, or the number of factors (Brown & Moore, 2012). Instead, all items are allowed to freely load on to all factors, resulting in identification of the underlying factor structure. Next, the best fitting EFA model is constrained using confirmatory factor analysis (CFA). In CFA the model has a specified number of factors and relationships between items and the factor/s (determined by the EFA; Brown & Moore, 2012). The primary goal of a CFA is to verify the factor structure which can be done through evaluation of model fit and factor loadings. If the CFA fits well, it is then subjected to invariance testing across groups to confirm that the latent variable is equivalent across groups. Each step relies on assessing model fit. I followed recommendations by Hu and Bentler's (1999) who suggest cutoffs including: comparative fit index (CFI) >.95, Tucker-Lewis Index (TLI) >.95, root mean square error of approximation (RMSEA) < .06, and standardized root mean square residual (SRMR) <.08. Additionally, Chi-Square test of model fit was used with a non-significant test indicating perfect fit of the model to the data. In addition to these overall model fit indices, model comparisons were made using chi-square difference tests and comparing CFI values across models. Cut-offs for factor loadings vary, with recommendations for acceptable values ranging from .20 to .40 (Peterson, 2000). Once the final measurement model is established using this procedure then the latent variables can be added to a structural equation model (SEM).

Given that this is a secondary data analysis, it is important to note that Swaim & Stanley (2022) previously conducted EFA, CFA, and invariance testing of the parental monitoring short scale using the OYOF sample. However, due to differences in sample inclusion criterion between studies, CFA and invariance testing steps were replicated for the parental monitoring short scale to confirm the factor structure and test for invariance. For family cohesion and FN, I followed the standard procedure outlined above.

Invariance testing was conducted for all first-order factors by sex (male vs. female) and grade group (middle vs. high school) at the configural, metric, and scalar levels which continuously adds more constraints at each step. Invariance at the configural level indicates that the same concepts are being measured across groups, allowing for between-group comparisons (Rudnev, et al., 2018). Invariance at the metric level is more constrained, indicating that constructs have comparable structure and measurement units, meaning that factor loadings can be compared across groups (Rudnev, et al., 2018). Finally, invariance at the scalar level, which is the most constrained of the three models, indicates that the structure, factor loadings, and intercepts are equal across all groups (Rudnev, et al., 2018). Obtaining scalar invariance allows for comparison of covariances, unstandardized regressions, and means of latent variables across groups. When testing invariance, it is recommended that researchers use the most parsimonious model rather than the best fitting one (Brown, 2015). Parsimonious models are those that fit well with the most constraints and highest possible level of invariance, allowing for more cross-group comparisons. In assessing invariance models, Hu & Bentler's (1999) guidelines for CFI, RMSEA, and SRMR are typically used in addition to chi-square difference tests. However, as noted by Chen (2007) and Cheung & Rensvold (2002), chi-square tests are sensitive to large sample size. It is therefore recommended that in sample sizes over 300, additional indices should be used to evaluate model fit including a CFI difference no larger than 0.01, and sample-adjusted Bayesian information criterion (SABIC; lower SABIC indicates more parsimony) (Chen, 2007; Cheung & Rensvold, 2002).

Once tested for model fit and invariance between groups, first-order latent variables represent the relationship between items and an underlying concept (i.e., latent variable). To then build my second-order latent variable, I took the best fitting models from the previous steps and loaded those latent variables onto a higher-order latent variable using Mplus (Version 8.5; Múthen & Múthen, 1998–2020). Second-order latent variables operate similarly to first-order factors with the second-order latent variable accounting for the relationships between the first-order factors and an overarching concept. The second-order latent variable was then tested for model fit using CFA and invariance between groups. To build the second-order latent variable I followed modeling procedures outlined by Rudnev, et al., (2018; See Table 2). To conduct invariance testing with my second-order model I followed Mplus model constraint recommendations from by Rudnev, et al., (2018; See Appendix B), and followed model fit guidelines set by Chen (2007) and Cheung & Rensvold (2002).

Table 2

Model identification steps for the second-order latent variable

Invariance Test	Second-order factor	
	Factor Loadings	Latent Means
Configural	Free, but one factor per variable is fixed to 1	Fixed to 0
Metric	Equal across groups, one factor per variable was fixed to 1	Fixed to 0
Scalar	Equal across groups, one factor per variable was fixed to 1	Free, but fixed to 0 in one group (family cohesion)

Note. Model identification steps were replicated from those established by Rudnev et al., (2018).

Moving from the measurement model to the structural model. For the structural components of the SEM the main outcomes were alcohol use and age of alcohol use initiation. Researchers have noted that alcohol use count data tends to be highly skewed due to a preponderance of zeros (Neal & Simons, 2007). Analyses of count data require the use of generalized linear models (GLM) because highly skewed count data violates assumptions of the general linear model (e.g., Ordinary Least Squares regression). The current best practice is to use quasi-Poisson (QP) regressions as they are robust to distributional characteristics present in skewed count data in the addiction field (Baggio et al., 2018). However, QP regressions have not yet been implemented in Mplus, thus SEMs run in Mplus use a negative binomial specification which has been shown to be an appropriate choice for alcohol use data (Neal & Simons, 2007). QP regressions are available in R, therefore, lifetime alcohol use was analyzed using QP regressions to account for the skewed count distribution of the data for analyses conducted in R.

The outcome variable for age of alcohol use initiation was collected with responses ranging from 10 years of age to 18 years of age, causing a ceiling effect in the data as most individuals initiate alcohol use at a later age. To appropriately model data with a ceiling effect, I used a censored regression with responses being censored from above. Specifying the data as censored allowed me to identify those who had not yet initiated alcohol use to a single value (e.g., the ceiling value; in the present study set to 19), while allowing for a continuous distribution (i.e., skewed normal) among remaining responses. Censored regression models have two parts: a logistic regression being used to predict initiated vs. has not initiated, and a normal regression portion that predicts age of alcohol use initiation among those who have ever used. Censored regressions have been shown to be an effective modeling approach when analyzing alcohol use data (Hansen & Graham, 1991).

Moderations with Latent Variables. Another goal of the present study was to test whether family functioning could attenuate the relationship between peer use and age of initiation and alcohol use frequency. A traditional approach to examining moderation is to create a product term between the predictor and the moderator and add it to a multiple regression. If the product term is significant then traditional approaches involve probing the interaction using simple slopes analysis. However, recent findings by McCabe and colleagues (2022) on analyzing moderation effects in the context of generalized linear models (GLMs) suggest that analyzing the product term in interaction effects with count and probability dependent variables is ineffective because interaction effects are functions of the predictor model rather than the product terms. McCabe and colleagues found that when using GLM product terms coefficients to estimate the interaction, researchers are likely to make errors in inferences, especially when the interaction effects are exponentiated back to a natural scale (McCabe et al., 2022).

To appropriately analyze interactions in GLMs McCabe and colleagues developed the ModGLM package in R. Unfortunately, ModGLM is not equipped to handle latent variables and it is an open question in the literature on how to address this. Therefore, I used two approaches to analyze moderations with count data and the logistic portion of the censored regressions. In the first approach I exported the factor scores from Mplus into R for each person allowing me to analyze the moderation with cross partial derivatives as recommended by McCabe and colleagues (2022). However, the use of assigned factor scores is a long-debated topic with some arguing that factor scores are often incorrectly computed with the resulting scores having large non-zero intercorrelations (Glass & McGuire, 1996). Additionally, when using factor scores with latent moderations there are notable trade-offs as this approach tends to produce a less biased point estimate but is also more easily influence by “sampling noise”, particularly in smaller samples (Ng & Chan, 2020). The second approach I took was probing the latent variables in MPlus which is more traditional and accounted for the possibility of error in the factor score approach. However, this approach is also limited due to Mplus’ inability to calculate cross-partial derivatives (Muthén & Muthén, 1998-2017). Given that there are critiques to both cross-partial derivatives with exported factor scores and model constraints that do not implement cross-partial derivatives, I used both and then compared the results to see if conclusions changed based on the approach.

As an aside, per recommendations by McCabe and colleagues (2022), interactions in the current study were interpreted as “change in marginal effect of one variable as a function of change in another variable” (McCabe et al., pg.1, 2022) using cross partial derivatives to quantify the effects. The data was analyzed in R (R Core Team, 2022) using the ModGLM package which was designed by McCabe and colleagues (2022) for handling moderations with GLMs. McCabe et al. (2022) also recommend data visualization to aid interpretation of the moderations. Data visualizations were created using ggplot2 (Wickham, 2016).

Hypothesis 1.

EFA, CFA, and Invariance testing were used to establish the best fitting models for family cohesion, FN, and parental monitoring. These latent variables were then used to create a second-order latent variable of family functioning which was then tested using CFA and invariance testing. See Figure 1.

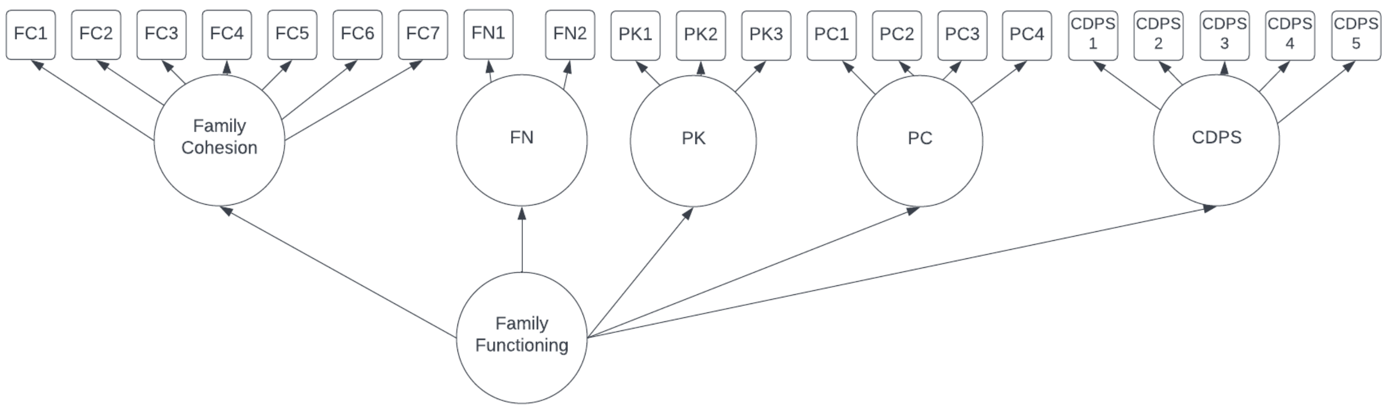

Figure 1

Note. See Appendix A for item referencing; FN = Family Norms Against Adolescent Alcohol Use; PK = Parental Knowledge; PC = Parental Control; CDPS = Child Disclosure Parental Solicitation.

Hypothesis 2.

Step two of the SEM entailed adding structural paths (i.e., regressions). Paths leading to lifetime alcohol use were analyzed using negative binomial regressions (nb) in Mplus. Direct effects of peer use and family functioning were included in this model predicting alcohol use.

Hypothesis 3.

A SEM with censor-inflated regression was conducted in Mplus to analyze alcohol initiation. Censor-inflated paths have two parts, i.e., a logistic part that predicts the likelihood of being at the censored value, and a normal part that predicts the level of the non-censored portion of the outcome. In the normal portion of the regression peer use and family functioning predicted age of alcohol use initiation. In the logistic portion of the regression, peer use and family functioning predicted initiated vs. has not initiated alcohol use.

Hypothesis 4.

To test hypothesis 4, a latent variable interaction term between peer use and family functioning was added to the SEM. Moderations were analyzed in two ways. First, statistically significant product terms were probed using simple slopes analyses in Mplus. Next, factor scores were exported to R and two regressions were used to test the moderation hypotheses. A QP regression was used to examine the moderation of family functioning on the peer alcohol use to personal alcohol use relationship. A logistic regression was used to examine the moderation of family functioning on the direct relationships of peer alcohol use to likelihood of initiation. A normal regression was used to examine the moderation of family functioning on the direct relationship between peer alcohol use and age of initiation for those who had initiated prior to age 18. These interactions were further explored using recommendations by McCabe et al., (2022). See Figure 2.

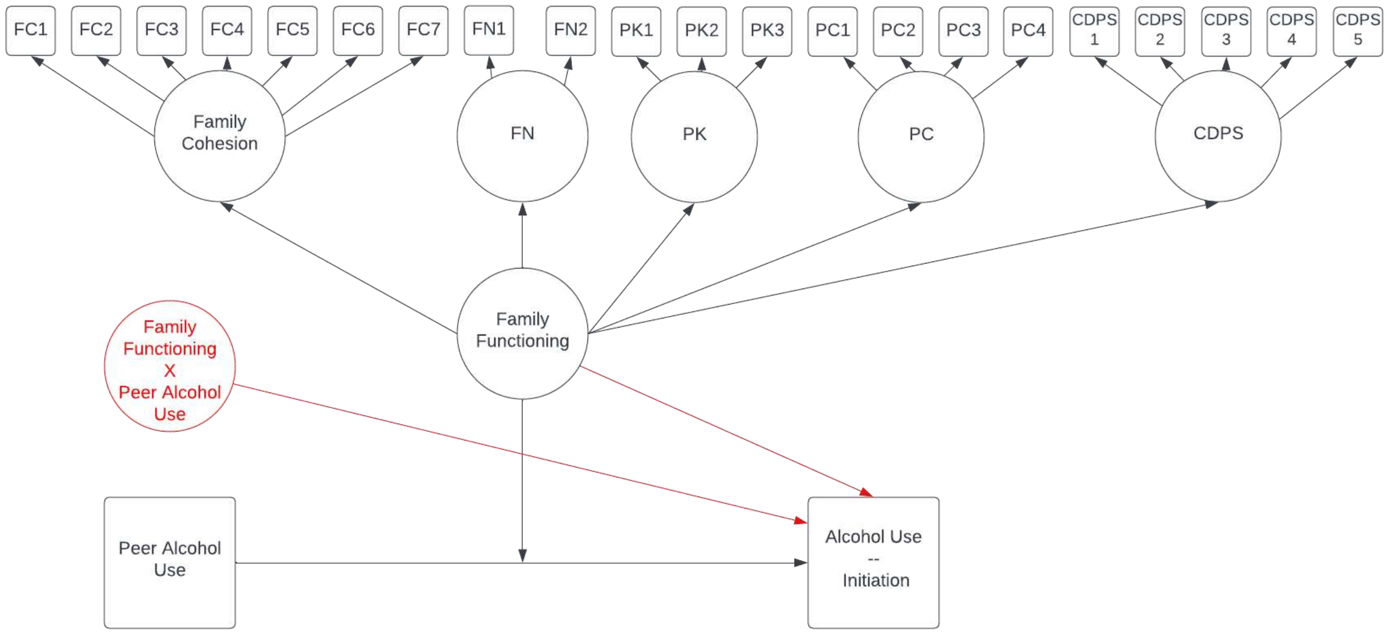

Figure 2

Note. See Appendix A for item referencing; FN = Family Norms Against Adolescent Alcohol Use; PK = Parental Knowledge; PC = Parental Control; CDPS = Child Disclosure Parental Solicitation.

Results

Tables 4-7 present CFA and invariance testing for family cohesion, FN, parental monitoring, and family functioning. Tables 8 & 9 present results from two SEMs; one with alcohol use frequency and one with age of initiation as outcomes, respectively. Numbers in tables 8 & 9 include rate ratios (RR) for the count outcome alcohol use and odd ratios (OR) for the binary outcome capturing the likelihood of having initiated alcohol use, which were calculated by exponentiating the unstandardized coefficients (logits). Table 10 presents simple slope analyses for alcohol use and likelihood of initiation at low, medium, and high levels of family functioning. Tables 11 & 12 respectively present moderation results for peer use on alcohol use by family functioning and peer use on likelihood of initiation by family functioning using the cross partial derivatives approach.

Descriptive Statistics

Examination of family functioning indicator variables indicated no violations of linearity, normality, or independence. Alcohol use outcomes were non-normal, such that alcohol use was a highly skewed count variable, and age of initiation was censored from above. Means, standard deviations, ICCs, and percent of responses completed for each item are presented in Table 3. Family functioning and peer use were mean centered to aid interpretation in structural equation models, i.e., 0 was the mean value for each when used in analysis.

Table 3

Means, standard deviations, ICCs and percent of responses completed for indicator variables

Item	**Mean (SD)**	**ICC**	**% Complete**
Family Cohesion			
1) In our family we really help and support each other.	3.14 (0.93)	0.023	58%
2) In our family we spend a lot of time doing things together at home.	2.72 (1.01)	0.026	58%
3) In our family we work hard at what we do in our home.	3.07 (0.96)	0.020	58%
4) In our family there is a feeling of togetherness	2.89 (1.04)	0.021	58%
5) My family members really support each other.	3.08 (0.98)	0.036	58%
6) I am proud to be a part of our family.	3.33 (0.96)	0.022	58%
7) In our family we really get along well with each other.	2.89 (0.98)	0.023	58%
FN			
1) How much would your family disapprove if you drank alcohol?	3.18 (1.17)	0.017	84%
2) How much would your family disapprove if you got drunk?	3.24 (1.17)	0.016	84%
Parental Monitoring			
PK			
1) When I go out at night, my parents know where I am.	4.16 (1.20)	0.010	58%
2) My parents know where I am after school.	4.35 (1.05)	0.018	58%
3) When I go out at night, my parents know who I am with.	4.15 (1.24)	0.018	57%
PC			
1) When I go out on weekend nights, I have to be home by a set time.	3.57 (1.44)	0.007	58%
2) I have to tell my parents who I'm with and what I'm doing at night with friends.	3.95 (1.36)	0.011	58%
3) I have to tell my parents my plans for weekend nights.	3.82 (1.41)	0.014	57%
4) I need permission to be out late on weeknights.	4.02 (1.37)	0.018	57%
CDPS			
1) I tell my parents how I'm doing in school.	3.55 (1.34)	0.020	58%
2) My parents ask about things that happen at school.	3.63 (1.34)	0.016	58%
3) I tell my parents about my activities with friends.	3.76 (1.35)	0.017	58%
4) My parents talk to my friends.	2.87 (1.47)	0.023	58%
5) My parents ask what I do in my free time.	2.93 (1.48)	0.012	57%

Note. FN = Family Norms Against Adolescent Alcohol Use; PK = Parental Knowledge; PC = Parental Control; CDPS = Child Disclosure Parental Solicitation; SD = standard deviation; ICC = intraclass correlations.

Hypothesis 1. Measurement Models

Family Cohesion

EFA of family cohesion indicated that it was best represented by a one factor model, which was confirmed by CFA. CFA model fit for family cohesion was excellent (see Table 4). Model fit indices were all in the excellent range. The factor loadings for family cohesion ranged from .73 to .88 and were all statistically significant. Invariance testing indicated that the scalar model was the most parsimonious for both sex and grade group.

Table 4

Model fit, factor loadings, and invariance testing of Family Cohesion.

CFA MODEL FIT						
RMSEA	CFI	TLI	SRMR	χ^2		
0.05 [.04, .06] p = .40	0.98	0.98	0.02	(χ2(21) = 10897, p <.01)		
FACTOR LOADINGS						
Items						Factor 1
1. In our family we really support each other.						0.84
2. In our family we spend a lot of time doing things together						0.78
3. In our family we work hard at what we do in our home.						0.73
4. In our family there is a feeling of togetherness						0.87
5. My family members really support each other.						0.88
6. I am proud to be a part of our family						0.78
7. In our family we really get along well with each other.						0.78
INVARIANCE TESTING						
Sex						
	χ^2 (*df*)	CFI	CFI difference	RMSEA	SRMR	SABIC
Configural	154 (28)	0.98	0	5	0.02	37300
Metric	176 (34)	0.98	0.002	0.05	0.03	37292
Scalar	209 (40)	0.98	0.004	0.05	0.04	37296
Grade Group						
	χ^2 (*df*)	CFI	CFI difference	RMSEA	SRMR	SABIC
Configural	179 (28)	0.98	0.002	0.05	0.02	38979
Metric	186 (34)	0.98	0.002	0.05	0.03	38956
Scalar	219 (40)	0.98	0.004	0.05	0.03	38959

Note. RMSEA = root mean square error of approximation; CFI = comparative fit index; TLI = tucker-lewis index; SRMR = standardized root mean square residual; χ^2 = chi-square; *df* = degrees of freedom; CFI difference = difference in CFI from the prior model; SABIC = sample-adjusted Bayesian information criterion.

Family Norms Against Adolescent Alcohol Use

EFA of FN indicated that it was best represented by a one factor model. In order to achieve an identified model, I fixed the latent variable variance to 1. In addition, there was a variance that was less than 0, also known as a Heywood case (Asparouhov & Muthén, 2010). Heywood cases refer to instances where values in the data are either very rare or impossible and can be a result of misspecification models (Asparouhov & Muthén, 2010). To address this, I fixed the residual variance of "How much would your family disapprove if you got drunk" to 0, which resulted in a correctly specified model and acceptable model fit for the one-factor model of FN (see Table 5). The factor loadings for FN ranged from 0.93 to 0.1 and were all statistically significant. Invariance testing indicated that the scalar model was the most parsimonious for both sex and grade group.

Table 5

Model fit, factor loadings, and invariance testing of FN.

CFA MODEL FIT						
RMSEA	CFI/TLI	TLI	SRMR		χ^2	
0.1 [.08, .13] p = <.01	0.99	0.99	0.15		($\chi^2(1) = 7628$, p <.01)	
FACTOR LOADINGS						
Items						Factor 1
1. How much would your family disapprove if you drank alcohol?						0.93
2. How much would your family disapprove if you got drunk?						1
INVARIANCE TESTING						
Sex						
	χ^2 (*df*)	CFI	CFI difference	RMSEA	SRMR	SABIC
Configural	77 (2)	0.99	0.004	0.15	0.19	14799
Metric	77 (1)	0.99	0.004	0.21	0.19	14804
Scalar	77 (2)	0.99	0.004	0.15	0.19	14799
Grade Group						
	χ^2 (*df*)	CFI	CFI difference	RMSEA	SRMR	SABIC
Configural	62 (2)	0.99	0.002	0.13	0.17	15504
Metric	59 (1)	0.99	0.002	0.18	0.16	15505
Scalar	59 (2)	0.99	0.002	0.12	0.16	15500

Note. FN = Family Norms Against Adolescent Alcohol Use; CFA = confirmatory factor analysis: RMSEA = root mean square error of approximation; CFI = comparative fit index; TLI = tucker-lewis index; SRMR = standardized root mean square residual; χ^2 = chi-square; *df* = degrees of freedom; CFI difference = difference in CFI from the prior model; SABIC = sample-adjusted Bayesian information criterion.

Parental Monitoring

The CFA for parental monitoring confirmed the three-factor model established by Swaim & Stanley (2022). CFA model fit for parental monitoring was good (see Table 6). The factor loadings for parental monitoring ranged from 0.55 to 0.86 and were all statistically significant. Invariance testing indicated that the scalar model was the most parsimonious for both sex and grade group.

Table 6

Model fit, factor loadings, and invariance testing of Parental Monitoring.

CFA MODEL FIT					
RMSEA	CFI	TLI	SRMR		χ^2
0.07 [.06, .07] p = <.01	0.94	0.92	0.04		($\chi 2(66) = 12508$, p <.01)

FACTOR LOADINGS			
Items	Factor 1 (PK)	Factor 2 (PC)	Factor 3 (CDPS)
1. My parents know where I am after school.	0.69		
2. When I go out at night, my parents know who I am with.	0.86		
3. When I go out at night, my parents know where I am.	0.80		
4. When I go out on weekend nights, I have to be home by a set time.		0.66	
5. I have to tell my parents who I'm with and what I'm doing at night with my friends.		0.78	
6. I have to tell my parents my plans for weekend nights.		0.79	
7. I need permission to be out late on weeknights.		0.71	
8. I tell my parents how I'm doing in school.			0.72
9. I tell my parents about my activities with friends.			0.81
10. My parents ask what I do in my free time.			0.66
11. My parents ask about things that happen at school.			0.70
12. My parents talk to my friends.			0.55

INVARIANCE TESTING						
Sex						
	χ^2 (*df*)	CFI	CFI difference	RMSEA	SRMR	SABIC
Configural	946 (102	0.93	0.007	0.07	0.04	87191
Metric	978 (111)	0.93	0.009	0.07	0.05	87178
Scalar	1022 (120)	0.92	0.012	0.07	0.05	87177
Grade Group						
	χ^2 (*df*)	CFI	CFI difference	RMSEA	SRMR	SABIC
Configural	936 (102)	0.93	0.002	0.07	0.04	91263
Metric	955 (111)	0.93	0.003	0.06	0.05	91236
Scalar	964 (120)	0.93	0.003	0.06	0.05	91200

Note. CFA = confirmatory factor analysis; PK = Parental Knowledge; PC = Parental Control; CDPS = Child Disclosure Parental Solicitation; RMSEA = root mean square error of approximation; CFI = comparative fit index; TLI = tucker-lewis index; SRMR = standardized root mean square residual; χ^2 = chi-square; *df* = degrees of freedom; CFI difference = difference in CFI from the prior model; SABIC = sample-adjusted Bayesian information criterion.

Second Order Family Functioning

The CFA model fit for the second-order family functioning latent variable was excellent (see Table 7). The factor loadings for family functioning ranged from 0.28 (FN) to 0.93 (PC) and were all statistically significant. While the factor loading for FN was low, it was ultimately kept in the final model as items capturing FN were broad and likely more conceptually distant than the other domains contributing to family functioning. Invariance testing indicated that the scalar model was the most parsimonious for both sex and grade group.

Table 7

Model fit, factor loadings, and invariance testing of Family Functioning.

CFA MODEL FIT						
RMSEA	CFI/TLI	TLI	SRMR			χ^2
0.04 [.04, .04] p = 1	0.96	0.95	0.05			(χ2(210) = 32627, p <.01)
FACTOR LOADINGS						
Latent Variables						Factor 1
1. Family Cohesion						0.52
2. Family Norms (FN)						0.28
3. Parental Knowledge (PK)						0.88
4. Parental Control (PC)						0.93
5. Child Disclosure Parental Solicitation (CDPS)						0.87
INVARIANCE TESTING						
Sex						
	χ^2 (*df*)	CFI	CFI difference	RMSEA	SRMR	SABIC
Configural	1989 (374)	0.95	0.008	0.05	0.06	138381
Metric	2075 (394)	0.95	0.011	0.05	0.06	138367
Scalar	2169 (402)	0.94	0.013	0.05	0.07	138421
Grade Group						
	χ^2 (*df*)	CFI	CFI difference	RMSEA	SRMR	SABIC
Configural	2038 (374)	0.95	0.007	0.05	0.06	144870
Metric	2066 (394)	0.95	0.007	0.05	0.06	144797
Scalar	2089 (402)	0.95	0.008	0.05	0.06	144779

Note. CFA = confirmatory factor analysis; RMSEA = root mean square error of approximation; CFI = comparative fit index; TLI = tucker-lewis index; SRMR = standardized root mean square residual; χ^2 = chi-square; *df* = degrees of freedom; CFI difference = difference in CFI from the prior model; SABIC = sample-adjusted Bayesian information criterion.

Hypothesis 2. Direct Effects in the Structural Equation Models Predicting Alcohol Use.

All direct and interaction effects in hypothesis two were significant and are presented in Table 8. Family functioning predicted alcohol use such that a one unit increase in family functioning was related to a 37% decrease in alcohol use. Peer alcohol use also predicted alcohol use such that a 1-unit increase in peer use was related to a 141% increase in personal alcohol use.

Investigation of the intercept indicated that when family functioning and peer use were at their average, the expected count of alcohol use frequency was less than 1. See Table 8.

Table 8

SEM with Negative Binomial Regression of Alcohol Use on Peer Use and Family Functioning

Alcohol Use		RR	SE	p-value
Intercept		0.38	0.08	<0.001
Direct Effect	Family Functioning	0.63	0.05	<0.001
	Peer Alcohol Use	2.41	0.12	<0.001
		logit	SE	p-value
Interaction	Peer Use X Family Functioning	0.12	0.04	0.003

Note: RR = Rate Ratio SE = standard error; logit = unstandardized regression coefficients.

Hypothesis 3 Direct Effects in the Structural Equation Models Predicting Age of Initiation

Results from hypothesis 3 are presented in Table 9. Family functioning was significantly and positively related to the likelihood of being at the censored value (i.e., not having initiated alcohol use). This was such that for each 1-unit increase in family functioning participants were 1.5 times less likely to have initiated alcohol use. Peer use significantly and negatively predicted a lower likelihood of being at the censored value. This was such that for each 1 unit increase in peer alcohol use, participants were 2.63 times more likely to have initiated alcohol use. The product term for family functioning and peer use on initiation was not statistically significant. See Figure 3 for data visualization. Investigation of the intercept indicated that when family functioning and peer use were at their average, we would expect 78% of participants to have initiated alcohol use.

Family functioning was not significantly related to age of alcohol use initiation. Peer use significantly and positively predicted age of alcohol initiation such that for each 1-unit increase in peer use, the predicted age of initiation increases by 0.2 years. Investigation of the intercept indicated that when family functioning and peer use were at their average, we would expect the average age of initiation to be 13.4 years. See Table 9.

Table 9

SEM with Censored Regression of Age of Initiation on Peer Use and Family Functioning

Outcome				
Likelihood of Initiation		OR	SE	p-value
Intercept		0.78	0.04	<0.001
Direct Effect	Family Functioning	1.51	0.06	<0.01
	Peer Alcohol Use	0.38	0.05	<0.001
		logit	SE	p-value
Interaction	Peer Use X Family Functioning	0.03	0.06	0.66
Age of Initiation		b	SE	p-value
Intercept		13.40	0.1	<0.001
Direct Effect	Family Functioning	0.2	0.13	0.12
	Peer Alcohol Use	0.19	0.08	0.03
		b	SE	p-value
Interaction	Peer Use X Family Functioning	0.15	0.11	0.17

Note: OR = odds ratio; SE = standard error; logit = unstandardized regression coefficients.

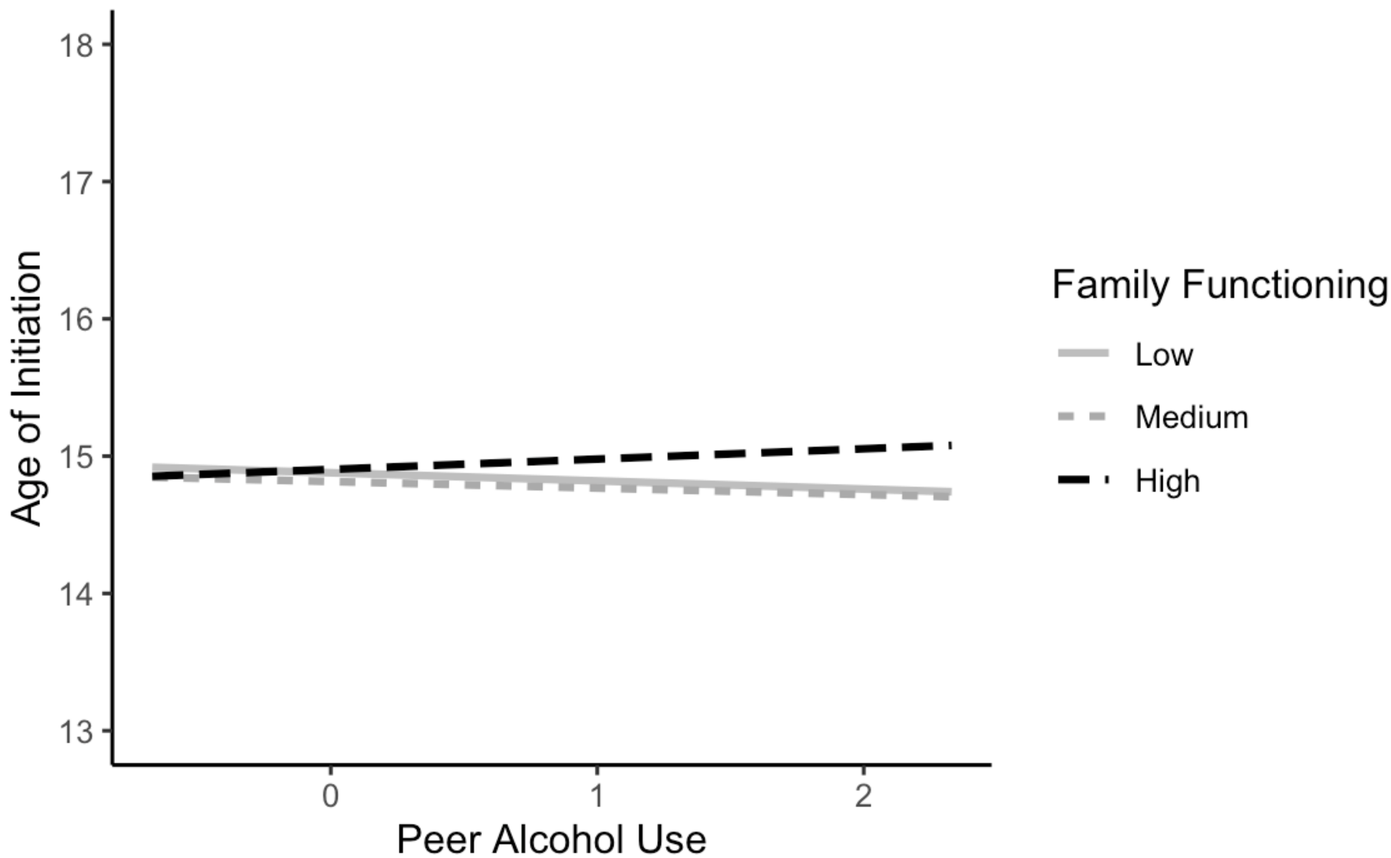

Figure 3

Note. The plotted relationship between peer alcohol use and age of initiation at low medium and high levels of family functioning following recommendations by McCabe et al., (2022).

Hypothesis 4. Moderation effects in the SEMs

SEM Predicting Alcohol Use

Both approaches (i.e., interaction and simple slopes presented in Tables 8 & 10; cross-partial derivatives presented in Table 11 & Figure 4) for modeling the interaction of peer use on alcohol use, moderated by family functioning were statistically significant. In the first approach (Peer Use X Family Functioning on Alcohol Use) the interaction was probed in MPlus (see Table 8) using simple slopes analyses (see Table 10) with the interaction being significant at low, medium, and high levels of family functioning.

Exporting the factor scores and analyzing the moderation with a QP regression and cross-partial derivatives also indicated that the product term between peer use and family functioning significantly predicting alcohol use. See Table 11. Visual inspection of the interaction plot, intercepts, and slopes revealed that individuals with high levels of family functioning had the lowest intercept and steepest slopes, indicating that they were expected to have a lower count of alcohol use frequency but were more influenced by their peer's use than those with medium or low levels of family functioning. See Figure 4 & Table 10. There was a significant average interaction in the sample between peer alcohol use and family functioning as 0 was not included in the confidence interval (CI). The interaction ranged from -0.16 to 0.02, and a total of 94% of these were significant negative effects. Taken together, all evidence points to a significant interaction effect that is best captured by the visual presentation of the data. See Figure 4.

SEM Predicting Likelihood of Initiation

Results for modeling the interaction of peer use on likelihood of initiation, moderated by family functioning differed by approach (i.e., interaction and simple slopes presented in Tables 9 & 10; cross-partial derivatives presented in Table 12 & Figure 5). Mplus analyses resulted in a non-significant interaction term between peer use and family functioning. See Table 9. For completeness, the interaction was probed using simple slopes analyses (see Table 10) with intercepts and slopes being significant at low, medium, and high levels of family functioning.

Exporting factor scores and analyzing the moderation with a QP regression and cross-partial derivatives resulted in a product term between peer use and family functioning that significantly predicted likelihood of alcohol initiation. See Table 12. Visual inspection of the interaction plot, intercepts and slopes revealed that individuals with high levels of family functioning had the lowest intercept and steepest slopes, indicating that they were less likely to initiate alcohol use, but were more influenced by their peer's use than those with medium or low levels of family functioning. See Figure 5 & Table 10. There was a significant average interaction in the sample between peer alcohol use and family functioning as 0 was not included in the confidence interval (CI). The interaction ranged from -0.04 to -0.01, and a total of 85% of these were significant negative effects. Taken together, all evidence points to a significant interaction effect that is best captured by the visual presentation of the data. Figure 5.

Table 10

Simple Slopes for Alcohol Use and Likelihood of Initiation at low, medium, and high levels of Family Functioning

Alcohol Use			
Simple Slopes	RR	95% CI	p-value
Low			
Intercept	0.61	0.53, 0.69	<0.001
Slope	2.02	1.86, 2.20	<0.001
Medium			
Intercept	0.41	0.36, 0.47	<0.001
Slope	2.19	1.99, 2.41	<0.001
High			
Intercept	0.26	0.21, 0.31	<0.001
Slope	2.43	2.13, 2.77	<0.001
Likelihood of Initiation			
Simple Slopes	OR	95% CI	p-value
Low			
Intercept	0.39	0.34, 0.45	<0.001
Slope	2.61	2.28, 3.00	<0.001
Medium			
Intercept	0.33	0.29, 0.38	<0.001
Slope	2.53	2.18, 2.94	<0.001
High			
Intercept	0.17	0.15, 0.21	<0.001
Slope	2.55	2.16, 3.01	<0.001

Note: RR = rate ratio; OR = odds ratio; CI = confidence interval.

Table 11

Cross-Partial Derivatives for Alcohol Use

	γ^2	95% CI	% of Significant Effects
Alcohol Use	-0.09	-0.13, -0.06	94%

Note: γ^2 = gamma squared (i.e., average interaction effect); CI = confidence interval.

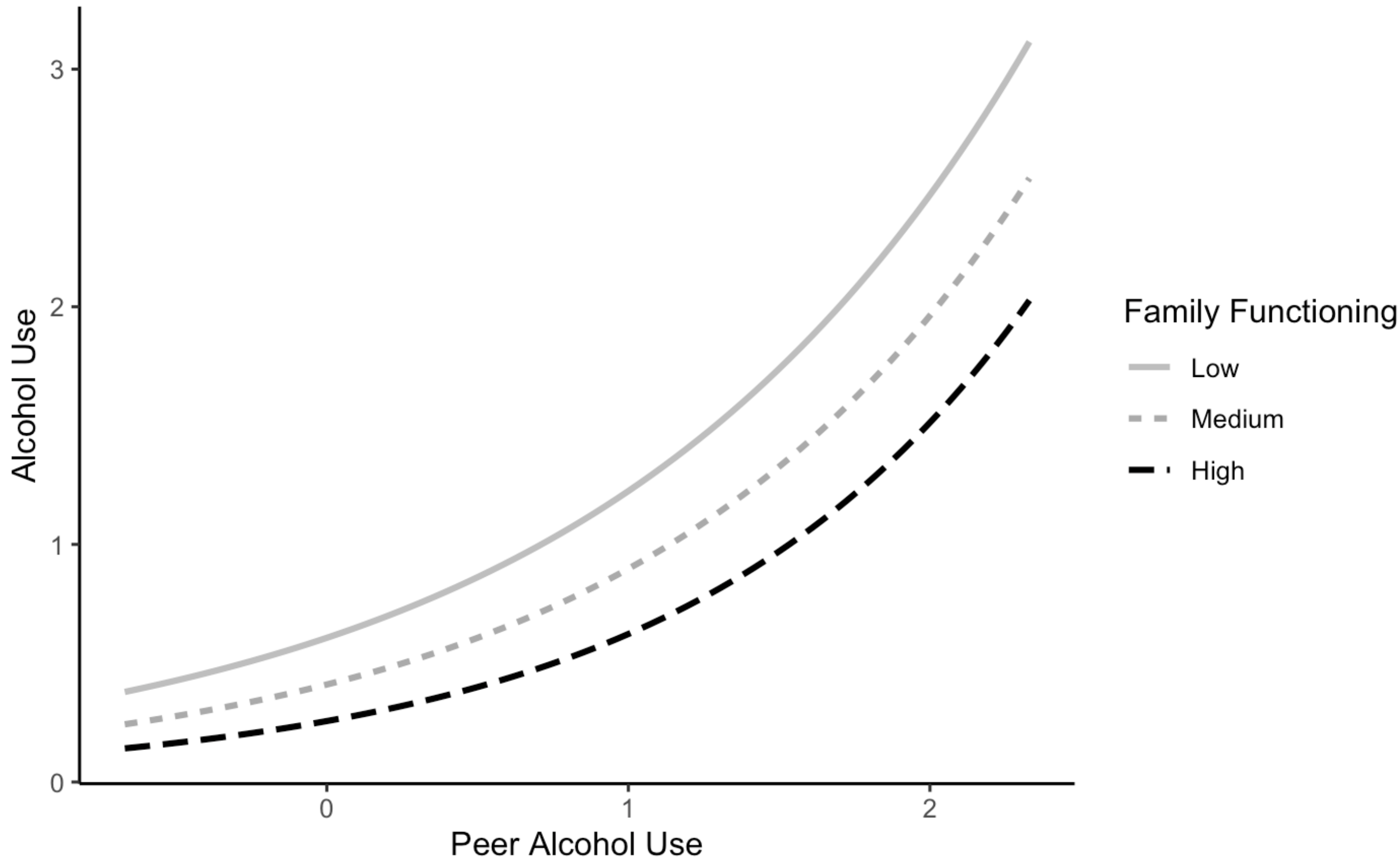

Figure 4

Note. The plotted relationship between peer alcohol use and personal alcohol use at low medium and high levels of family functioning following recommendations by McCabe et al., (2022).

Table 12

Cross Partial Derivatives for Likelihood of Initiation

	γ^2	95% CI	% of Significant Effects
Likelihood of Initiation	-0.03	-0.04, -0.01	85%

Note: γ^2 = gamma squared (i.e., average interaction effect); CI = confidence interval.

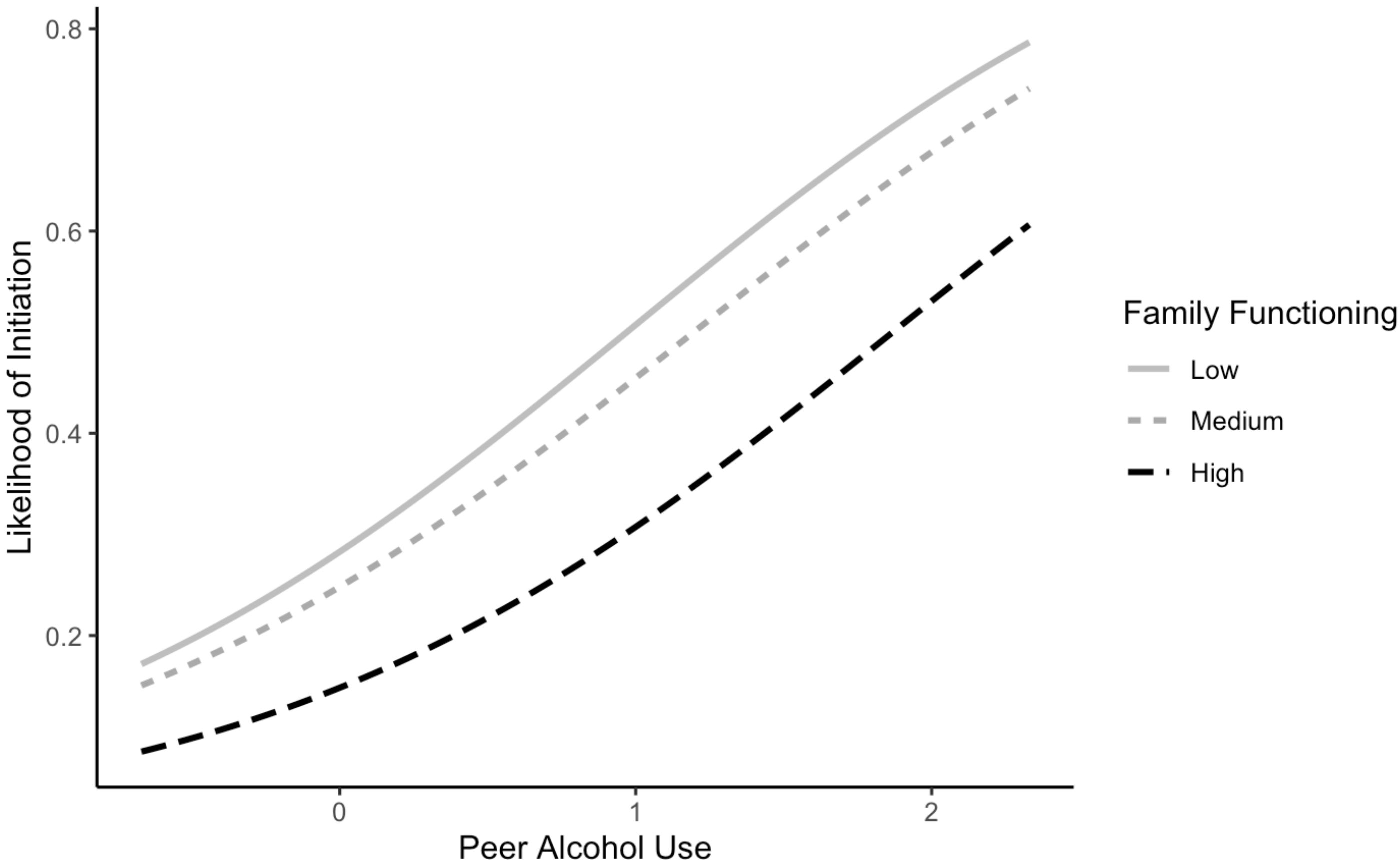

Figure 5

Note. The plotted relationship between peer alcohol use and likelihood of initiation at low medium and high levels of family functioning following recommendations by McCabe et al., (2022).

Discussion

Summary

The primary finding in this study is that family cohesion, FN, and parental monitoring are best represented by a second-order latent variable of family functioning. Working from the higher-order model, this would mean that family functioning is a broader construct than family cohesion, FN, or parental monitoring alone. This finding is important because it informs our conceptualization of the first-order factors as interconnected rather than independent constructs influencing an individual. Shifting how we conceptualize family functioning may have important implications for both research and clinical work which will be discussed further below.

A second, crucial finding in this study, was that the second-order latent variable of family functioning influenced participants alcohol use frequency, and their likelihood of initiating alcohol use. These relationships were both such that higher levels of family functioning were related to better outcomes for participants (i.e., less frequent alcohol use & less likely to have initiated alcohol use). However, family functioning did not significantly predict age of initiation which was a hypothesized outcome of this study. Surprisingly, greater peer use was predictive of older age of initiation, such that a 1-unit increase in peer use was related to a 0.2-year older age of alcohol use initiation. When interpreting this finding it is important to note that data used in the present study is cross-sectional, and therefore directionality cannot be inferred. It is likely that the positive relationship between age of initiation and peer use is more nuanced than could be understood from this data. For example, a possible explanation could be that older adolescents are more likely to have peers who drink alcohol at higher levels. All other structural paths indicated that more peer use was related to worse outcomes (i.e., more frequent alcohol use &

more likely to have initiated alcohol use). To summarize, the structural paths in the SEM indicate that higher levels of family functioning were related to better alcohol outcomes for AI adolescents, and that in most cases (excluding age of initiation), peer use was related to worse outcomes.

Despite the present findings, it is important to note that the influence of each first order factor (family cohesion, FN, parental monitoring) could be positively or negatively related to alcohol use when examined alone. For example, there is evidence that families with high family cohesion may be more permissible of their child's alcohol use due to perceived closeness, a type of enabling which is related to earlier initiation and heavy alcohol use (Maggs & Staff, 2018). However, in the current study the gestalt of family functioning was protective. Gestalt therapy identifies that often the whole is greater than the sum of the parts (Yontef & Fairfield, 2008), thus, when combined with FN and Parental Monitoring, Family Cohesion was protective. More specifically, in a family with high levels of parental monitoring and strong family norms against alcohol use, family cohesion serves as a protective factor against alcohol use.

I used two methods (i.e., interaction and simple slopes; cross-partial derivatives) to explore the moderating effect of family functioning on the relationship between peer alcohol use and both personal alcohol use and likelihood of alcohol initiation. I found that family functioning moderated the relationships. I expected to see a weaker relationship between peer use and the outcome variables at high levels of functioning. However, the primary effect of family functioning was on the intercept, such that those who had high family functioning were less likely to initiate alcohol use and were expected to have a lower count of alcohol use frequency. Interestingly, those with high family functioning also had the steepest slopes in the interaction, indicating that they were the most likely to be influenced by their peer's alcohol use. These findings indicate that adolescents with high family functioning are less likely to initiate alcohol use and have a lower frequency of use, but when they do begin drinking, it is likely their peers who are influencing this behavior. For those with low family functioning, results indicate that they are more likely to use alcohol, but their use is less likely to be influenced by their peers. A speculative interpretation of this is that the influence of low family functioning may be influential on an adolescent's alcohol use above and beyond that of their peer's use. This interpretation is supported by prior research which has shown that parental modeling and perceived permissibility of alcohol use has been associated with worse alcohol related outcomes for adolescents (Abar et al., 2009).

Findings for the moderating effect of family functioning on the relationship between peer and personal alcohol use were consistent across methods. However, when examining the moderating effect of family functioning on the relationship between peer use and likelihood of alcohol initiation, results varied. When product terms and simple slopes were used to examine the interaction of family functioning and peer use on likelihood of initiation there was not a significant product term. However, when factor scores were exported to R, family functioning significantly moderated the relationship between peer use and likelihood of alcohol initiation. An embedded goal of this study was to test differing methods for examining moderations with latent variables. Therefore, interpretation implications of these results and recommendations for future analysis approaches will be discussed below.

Placing Results from the Present Study in the Existing Literature

My findings expand on existing literature regarding adolescent alcohol use in two important ways: 1) establishing a latent variable of family functioning, and 2) extending our understanding of how family functionating influences adolescent alcohol use in AI communities.

Prior research has shown that high levels of family cohesion (Reeb et al., 2015, Stanley et al., 2014a), FN (Sieving et al., 2000, Swaim et al., 1993), and parental monitoring (Boyd-Ball et al., 2014, Schick et al., 2022) are related to better outcomes for adolescents in both AI and non-AI communities. The current study is the first to model family cohesion, FN, and parental monitoring as components of a second-order latent variable (i.e., family functioning). Support for the second-order latent variable indicates that for AI adolescents, it may be important to measure not only having a cohesive family unit, but also assessing whether parents are aware of and involved in their children's lives, including speaking to them about alcohol use.

Another important contribution of the current study is the examination of family functioning and alcohol use specifically within an AI sample. A majority of the literature on AI adolescents has focused on alcohol use, identifying that they engage in use at higher rates than their non-AI peers (McLeigh, 2010; SAMHSA, 2016). Given the high rates of alcohol use among AI adolescents, it is vital that researchers identify protective factors for this population. However, literature reviews of AI research note a substantial gap regarding protective factors (Henson et al., 2017; Soto et al., 2022), and stress the need for research on the innate strengths and resiliencies unique to AI communities that may keep youth from engaging in alcohol use (Nuño & Herrera, 2022). One such strength specific to AI communities is the high value placed on familial relationships (Henson et al., 2017; Red Horse, 1997), although it has been noted that several facets of family functioning may operate uniquely among AI communities (McKinley et al., 2021; Mmari et al., 2010; Walls et al., 2019). Given the limited research on protective factors, and the unique characteristics of family functioning, the goal of my study was to provide empirical support for the protective nature of family functioning on alcohol use among AI adolescents. This study adds to the existing literature by showing that family functioning, a resilience factor inherent to AI communities, is related to later initiation and lower frequency of alcohol use among adolescents. These findings are bolstered by the sample used in the study which is unique from prior research due to the large sample size (n = 4,373), geographic diversity (seven regions within the contiguous United States), and demographic range (i.e., sex & grade-group) of adolescents surveyed. The diversity in adolescents included in the study allows for a generalization of results that is often difficult to achieve in AI research.

Methodological Challenges & Implications for Research

In designing the current study, several important methodological decisions had to be made, both in modeling and analyzing the data. One of the first decisions I had to make in this study was how best to conceptualize the hypothesized relationship between family cohesion, FN, and parental monitoring. Both higher-order and bifactor models have shown empirical efficacy for modeling multidimensional data with an underlying structure, and both were considered for application in the current study. My decision to use the higher-order model was influenced by two factors: theoretical fit, and treatment of unexplained variance. Based on my literature review and theoretical understanding of the constructs, I proposed that the relationships among family cohesion, FN, and parental monitoring were best explained by a higher-order construct, i.e., family functioning. Measurement testing of the higher-order model ultimately resulted in excellent model fit, providing support for the chosen model. However, I acknowledge that in choosing the higher-order model there may be some theoretical roads left untraveled. For example, had I chosen the bifactor model, methodologically my results may have provided additional findings regarding the unique variance each domain contributed to the outcome variables. I believe that the higher-order model was best suited to answering the research questions I proposed in this study, even if my chosen model leaves others unanswered. In considering the methodological choices I made in designing my study, I ultimately take the position of George E.P. Box in that "Essentially all models are wrong, but some are useful." (Box & Draper, 2007).

The next methodological challenge I encountered in this study was how to handle moderations with latent variables. State of the science research advises against analyzing interaction effects using product terms in GLMs with count (i.e., alcohol frequency) or probability (i.e., likelihood of initiation) dependent variables (McCabe et al., 2022; Mize, 2019). However, the alternative to probing significant interactions required exporting factor scores and analyzing moderations using cross partial derivatives. As both analytic strategies (i.e., probing significant interactions or cross-partial derivatives) have their own critiques (described above in *data considerations and modeling approaches*), I ultimately decided to test my models using both approaches to determine how analytic strategy would change my results. In the case of family functioning moderating the relationship between peer use and personal alcohol use, both analytic strategies identified family functioning as a significant moderator of the relationship. However, when conducting the moderation with likelihood of initiation as the outcome variable, family functioning was a significant moderator only while using the cross-partial derivatives approach. While findings for both methods trended in the same direction (i.e., family functioning working to moderate the harmful effects of peer use), the variation in significance required me to decide which analysis method was best capturing the true nature of the data. To aid in my interpretation of these findings, I referred to recommendations by McCabe and colleagues (2022) and Mize (2019), who note that estimating the interaction term back on the natural scale is likely to cause in errors in inference, as the interaction effects are functions of the predictor model rather than the product terms between the predictor variables. Given these warnings against over-interpretation of product terms in GLMs with probability dependent variables, I ultimately concluded that the cross-partial derivatives approach provided the most accurate and empirically supported analyses of my data. In reflection, I advise researchers follow recommendations by McCabe et al., (2022) and Mize (2019) when analyzing GLMs with count or probability dependent variables as the use of the more traditional method alone (i.e., interpretating interaction effects) would have resulted in the misinterpretation of my findings.

Implications for Prevention and Intervention

Existing research examining the independent domains of family functioning have influenced both prevention and intervention science, with researchers aiming to reduce adolescent alcohol use by improving adolescent-family relations (Gerrard et al., 2006; Hurley et al., 2019; Wang et al., 2019). The goal of *prevention programs* is to strengthen protective factors and weaken risk factors, in order to reduce the likelihood of engaging in harmful behaviors (Cicchetti & Hinshaw, 2002). In comparison, *interventions* focus on individuals who are already engaging in harmful behaviors and seeks to minimize the harm they experience (Cicchetti & Hinshaw, 2002). Results from the moderations in this study can be separated by their implications for either prevention or intervention research.

My findings regarding the initiation of alcohol use apply specifically to prevention programs, with the intercepts in the moderations highlighting how family functioning serves as a protective factor for the initiation of alcohol use. These findings indicate that programs working towards alcohol prevention may be best served by focusing on family-based programs. Prevention scientists can bolster existing programs by incorporating all three components of family functioning when designing curriculum. Programs may include the following interventions which have been shown to be effective within AI communities for building family cohesion, FN, and parental monitoring skills: 1) *Family Cohesion* - parent training or parent-child interaction therapy (Baumann et al., 2015; BigFoot & Funderbuck, 2011), 2) *FN* - talking circles wherein family members share FN with the adolescent, and personal experiences of alcohol use (Momper et al., 2017), 3) *Parental Monitoring* – psychoeducation for both parents and adolescents around healthy communication and the benefits of parental monitoring (Patel et al., 2021).

In turn, moderations examining frequency of alcohol use provide important data for intervention science. The magnitude of the slopes in the moderations show that for those adolescents who have already initiated alcohol use, peer use is powerfully influential, regardless of family functioning. This implies that for AI adolescents who are already drinking it may be more effective to target peer influences by implementing interventions in school or community settings. Unfortunately, there is little to no empirical research on school-based alcohol intervention programs in adolescent AI samples (McDonald et al., 2019). One intervention which has been shown to be effective in targeting the peer alcohol relationship for AI adolescents is a peer-led intervention which teaches adolescents to serve as role models for pro-social behaviors (Vujcich et al., 2018). Outside of AI samples, strategies which have shown promise in reducing adolescent alcohol use and can be implemented in school or community setting include: 1) *Cognitive Behavioral Therapy (CBT)* - CBT can be used to teach adolescents how to recognize high risk situations as well as skills for coping with personal and peer use (e.g., strategies for leaving environments where alcohol is present; Beck, 2020; Deas, 2008; Stoner, 2016), 2) *Normative Feedback* – Many adolescents overestimate their peer's substance use (Borsari & Carey, 2003). Normative feedback can be used to provide the adolescent with an accurate representation of their peer's use, a strategy which has been shown to be effective as young adolescents have a tendency to imitate peer behavior (Davis et al, 2016; Veenstra & Laninga-Wijnen, 2022), 3) *Protective behavioral strategies (PBS)* – PBS are behaviors an adolescent can use to limit drinking, avoid risky alcohol use behaviors, or reduce harms related to their alcohol use (e.g., putting soda in a cup instead of alcohol; Litt et al., 2020; Martens et al., 2005). PBS can teach adolescents strategies for engaging in safe use and strategies for avoiding or saying no to peers who are engaging in use, 4) *Psychoeducation* – Psychoeducational programs can be delivered via presentations in schools or community centers wherein adolescents are given information regarding alcohol use and the risks of engaging in use (Hennessy & Tanner-Smith, 2015). It should be noted that strategies 1-4 outlined above were not developed initially for AI populations and have not been empirically tested for cultural adaptability. As such, researchers should exercise caution and consider the cultural fit of any intervention before attempting to implement it within a community sample.

Many programs targeting AI adolescent alcohol use have been criticized for their lack of effectiveness (Hurley et al., 2019), theoretical support (Richer & Roddy, 2022), and ability to meet community needs (Kelley et al., 2018; Richer & Roddy, 2022). The outlined implications of this study serve to fill this gap in the literature by providing empirically based recommendations for prevention and intervention scientists. While the findings in this study indicate that prevention programs for family functioning would be most effective at the family level, I acknowledge that this approach may put additional burden on clinicians. Most prevention programs initially begin in the school rather than in the home due to the built-in resources (e.g., personnel, funding) required to carry out the necessary programming.

Strengths

The primary strength of the current study is the focus on family-based protective factors and the generalizability of the results facilitated by the large sample size and range in participant demographics. Large scale AI research is sparce, in part due to a history of mistrust between AI communities and researchers, caused by the misuse and unethical handling of AI data (SAMHSA, 2010). Additionally, researchers have been criticized for focusing on the perceived deficits of AI communities and ignoring the many strengths inherent to AI peoples (SAMHSA, 2010). Psychometric testing of the family functioning latent variable and its subscales within an AI sample provides support for use of these measures in future research focusing on strengths and protective factors. An additional benefit of validating the family functioning latent variable is that the behaviors measured by family functioning are already valued and utilized in AI communities. Therefore, the recommendations drawn from my findings are ultimately aimed at supporting and bolstering skills AI peoples already possess, rather than introducing new behaviors or skills which would require time, resources, and training that communities may not have access to.

Other strengths of the current study include the use of multiple analytical strategies. While using multiple analysis methods may add additional burden to researchers, it allows for a more nuanced interpretation of the available data. For example, probing simple slopes *and* using data visualization from the cross-partial derivatives approach allowed me to see the variation in intercept and slopes at low, medium, and high levels of family functioning in the moderations. These findings, which may have been overlooked without data visualization, had major implications for how findings should be interpreted, and the recommendations made for prevention and intervention scientists. Methods used in the current study are likely appropriate for application in future studies and could be used to model effective techniques for analyzing moderations with latent variables. However, it should be noted that the methods used in this study may not be appliable or appropriate for use with small samples.

Limitations

An important trade-off of large studies, which result in more representative findings, is that they often lack the depth smaller studies are able to achieve. Therefore, one of the primary limitations of the current study is the brief nature of the epidemiological survey. To reduce participant burden, the current survey includes a small number of items assessing family functioning, peer use, and personal use relative to the possible scope of questions available in the broader literature. The survey used in this study would benefit from deeper coverage to capture all components of family functioning, as there may be other aspects which contribute to the latent variable. Future research would benefit from exploring additional facets of family functioning. Additional measures may look to capture adolescent experiences with extended family relations and test more expansive measures of peer use (e.g., perceived peer pressure, peer imitation, peer alcohol use frequency), and FN (e.g., does your family talk to you about alcohol, does your family model alcohol use, does your family provide you with alcohol). The broad nature of the survey may also explain the relatively small factor loading of FN in the second-order latent variable. Measuring additional aspects of FN, such as those recommended above, may result in a stronger factor loading and more refined understanding of its influence on family functioning.

The current study is also limited by the sampling frame which was restricted to those living on or near a reservation within the contiguous United States. This sampling requirement (grant number NIH/NIDA R01DA003371) excludes many native peoples including urban natives, Alaska Natives, and Native Hawaiians. As these populations were not sampled, results should not be generalized outside of AI peoples living on or near a reservation within the contiguous United States or to non-Native American people. Generalization of results outside of the sampled population is unadvisable as unique differences between populations may influence results (e.g., family functioning values between populations). For example, research with urban native adolescents shows that this population endorses a higher degree of historical trauma than adolescents on or near reservations, which in turn is related to worse alcohol outcomes and lower family cohesion (Wiechelt et al., 2012). An additional consideration is the heterogeneity within the current sample. AI communities are not homogenous and it is possible that the effects presented were predominately driven by a small number of communities. Future research is needed at the region or tribal level to discern whether the findings from this representative sample are applicable at the community level. Moreover, additional research is needed to test the psychometric validity of family functioning across groups before it can be reliably used within other native communities.

It should also be noted that these findings rely on retrospective self-report data which may lead to misreporting of data, especially in relation to alcohol use outcomes. It is possible that adolescents may misreport on retrospective measures of alcohol use due to recall bias, stigma around alcohol use, or fear of getting in trouble. However, researchers studying retrospective recall bias show that adolescents have a tendency towards underreporting frequency of alcohol use (Collins et al., 1985), and overestimating their age of initiation (Prause et al., 2007; Shillington & Clapp, 2000), tendencies which are unlikely to affect probable significance found in this study. Therefore, findings should be interpreted as accurate representations of participant experiences.

One consideration related to the measurement strategy used in the present study is that measures were not temporally sequenced (e.g., age of initiation and peer use were assessed simultaneously but may have occurred at distinct moments in time), therefore causal inferences are not available from the current data. One example of the potential influence of the measurement strategy was the counter-intuitive finding that higher peer use was associated with older age of initiation. I hypothesized the effect would be in the opposite direction. It is possible that the fact that participants were reporting on their age of initiation, which likely occurred in the past, and their peers' alcohol use at the present moment, may have biased the results. Thus, these findings should be interpreted with caution.

A final potential limitation of the current data is that sampling occurred during the severe acute respiratory syndrome-related coronavirus 2 (i.e., SARS-CoV2 also known as COVID-19) pandemic. It is unclear if changes to home or school environments influenced adolescents' experiences of family functioning or peer alcohol use. Replication of these findings after the return to in-school learning may help to rule-out the pandemic as a confounding variable is warranted.

Conclusions

In summary, I used psychometric testing to validate the use of the latent variable of family functioning within an adolescent AI sample. This provides empirical support for the use of family functioning and its subscales when conducting research with AI populations. Family functioning was also shown to be a significant predictor of adolescent alcohol use, with high family functioning predicting a lower likelihood of alcohol initiation and alcohol use frequency. These findings are an important contribution to the literature base on AI adolescents, which has highlighted the need for alcohol use interventions, but lacks research on empirically supported protective factors.

Family functioning was also found to buffer the harmful influence of peer alcohol use on AI adolescents. Data visualization and inspection of the slopes and intercepts in the moderations (i.e., family functioning moderating the relationship between peer use and alcohol outcomes – age of initiation & alcohol use frequency) revealed that family functioning had the greatest influence on adolescent alcohol use *before* initiation (i.e., lower likelihood of initiation for those with high family functioning), after which point peer use became powerfully influential on use (i.e., high peer use correlated with high personal use regardless of family functioning). Recommendations based on these findings are that prevention scientists may utilize family functioning as a protective factor against the initiation of alcohol use, and intervention scientists should target skills which help adolescents managing or reduce the influence of peer use.

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Appendix

Appendix A

<u>OYOF Survey Items</u>

<u>Demographics</u>
How old are you?

1. 10
2. 11
3. 12
4. 13
5. 14
6. 15
7. 16
8. 17
9. 18 or older

How would you describe yourself?

1. Male
2. Female
3. Another

Are you…

1. American Indian/Native American
2. White
3. Latino or Hispanic
4. Black or African American
5. Alaska Native
6. Hawaiian or Pacific Islander
7. Asian American
8. Other

<u>Lifetime Alcohol Use Frequency</u>
In your lifetime, how many times have you drank ALCOHOL -- more than just a few sips?

1. 0 times
2. 1-2 times
3. 3-5 times
4. 6-9 times
5. 10-19 times
6. 20-39 times
7. 40 or more times

Age of Alcohol Use Initiation
How old were you when you first drank ALCOHOL – more than just a few sips?
1. 10 years old or under
2. 11 years old
3. 12 years old
4. 13 years old
5. 14 years old (7-12 only)
6. 15 years old (7-12 only)
7. 16 years old (7-12 only)
8. 17 years old (7-12 only)
9. 18 years old (7-12 only)

Peer Use
How many of your friends:
1. None
2. One or Two
3. Some of Them
4. Most of Them

Drink Alcohol.
Get Drunk

Brief Family Relationship Scale (Cohesion Subscale)
Please rate how true each statement is for your family:
1. Never
2. Rarely
3. Sometimes
4. Most of the time
5. Always

(FC1) In our family we really help and support each other.
(FC2) In our family we spend a lot of time doing things together at home.
(FC3) In our family we work hard at what we do in our home.
(FC4) In our family there is a feeling of togetherness.
(FC5) My family members really support each other.
(FC6) I am proud to be a part of our family.
(FC7) In our family we really get along well with each other.

Family Norms Against Adolescent Alcohol Use
How much would your family disapprove if you:

1. Not at all
2. Not Much
3. Some
4. A lot

(FN1) Drank alcohol.
(FN2) Got drunk.

Parental Monitoring
The following questions are about your parents (or stepparents or guardians):

1. Never
2. Rarely
3. Sometimes
4. Most of the time
5. Always

(PK1) When I go out at night, my parents know where I am.
(PK2) My parents know where I am after school.
(PK3) When I go out at night, my parents know who I am with.
(PC1) When I go out on weekend nights, I have to be home by a set time.
(PC2) I have to tell my parents who I'm with and what I'm doing at night with friends.
(PC3) I have to tell my parents my plans for weekend nights.
(PC4) I need permission to be out late on weeknights.
(CDPS1) I tell my parents how I'm doing in school.
(CDPS2) My parents ask about things that happen at school.
(CDPS3) I tell my parents about my activities with friends.
(CDPS4) My parents talk to my friends.
(CDPS5) My parents ask what I do in my free time.

Appendix B

<u>Mplus Second Order Configural Invariance Testing Abbreviated Syntax</u>

```
GROUPING IS Q3 (1=male 2=female);
 MODEL:
 FC BY FC1@1 FC2 FC3 FC4 FC5 FC6 FC7;

 FN BY FN1@1 FN2;
   FN@1;
   FN2@0;

 PK BY PK1@1 PK2 PK3;
 PC BY PC1@1 PC2 PC3 PC4;
 CDPS BY CDPS1@1 CDPS2 CDPS3 CDPS4 CDPS5;

 FF BY FC@1 PK PC CDPS FN;

 model male:
 FC BY FC2 FC3 FC4 FC5 FC6 FC7;

 FN BY FN2;

 PK BY PK2 PK3;
 PC BY PC2 PC3 PC4;
 CDPS BY CDPS2 CDPS3 CDPS4 CDPS5;

 [FC1@0 FC2 FC3 FC4 FC5 FC6 FC7
  FN1@0 FN2@0
  PK1@0 PK2 PK3
  PC1@0 PC2 PC3 PC4
  CDPS1@0 CDPS2 CDPS3 CDPS4 CDPS5];

  FF BY PK PC CDPS FN;


  [FC PK PC CDPS FN];
  [FF@0];

 model female:
 FC BY FC2 FC3 FC4 FC5 FC6 FC7;

 FN BY FN2;
```

```
PK BY PK2 PK3;
PC BY PC2 PC3 PC4;
CDPS BY CDPS2 CDPS3 CDPS4 CDPS5;

[FC1@0 FC2 FC3 FC4 FC5 FC6 FC7
 FN1@0 FN2@0
 PK1@0 PK2 PK3
 PC1@0 PC2 PC3 PC4
 CDPS1@0 CDPS2 CDPS3 CDPS4 CDPS5];

 FF BY PK PC CDPS FN;


 [FC PK PC CDPS FN];
 [FF@0];

  OUTPUT: STDYX;
```

Note: See Appendix A for Item Referencing

<u>Mplus Second Order Metric Invariance Testing Abbreviated Syntax</u>

```
GROUPING IS Q3 (1=male 2=female);
 MODEL:
 FC BY FC1@1 FC2 FC3 FC4 FC5 FC6 FC7;

 FN BY FN1@1 FN2;
   FN@1;
   FN2@0;

 PK BY PK1@1 PK2 PK3;
 PC BY PC1@1 PC2 PC3 PC4;
 CDPS BY CDPS1@1 CDPS2 CDPS3 CDPS4 CDPS5;

 FF BY FC@1 PK PC CDPS FN;

 model male:
 FC BY FC2 FC3 FC4 FC5 FC6 FC7 (FC1-FC6);

 FN BY FN2 (FN1);

 PK BY PK2 PK3 (PK1-PK2);
 PC BY PC2 PC3 PC4 (PC1-PC3);
 CDPS BY CDPS2 CDPS3 CDPS4 CDPS5 (CDPS1-CDPS4);
```

```
 [FC1@0 FC2 FC3 FC4 FC5 FC6 FC7
  FN1@0 FN2@0
  PK1@0 PK2 PK3
  PC1@0 PC2 PC3 PC4
  CDPS1@0 CDPS2 CDPS3 CDPS4 CDPS5];

  FF BY PK PC CDPS FN (FF1-FF4);


  [FC PK PC CDPS FN];
  [FF@0];

model female:
FC BY FC2 FC3 FC4 FC5 FC6 FC7 (FC1-FC6);

FN BY FN2 (FN1);

PK BY PK2 PK3 (PK1-PK2);
PC BY PC2 PC3 PC4 (PC1-PC3);
CDPS BY CDPS2 CDPS3 CDPS4 CDPS5 (CDPS1-CDPS4);

 [FC1@0 FC2 FC3 FC4 FC5 FC6 FC7
  FN1@0 FN2@0
  PK1@0 PK2 PK3
  PC1@0 PC2 PC3 PC4
  CDPS1@0 CDPS2 CDPS3 CDPS4 CDPS5];

  FF BY PK PC CDPS FN (FF1-FF4);


  [FC PK PC CDPS FN];
  [FF@0];

   OUTPUT: STDYX;
```

Note: See Appendix A for Item Referencing

Mplus Second Order Scalar Invariance Testing Abbreviated Syntax

```
 GROUPING IS Q3 (1=male 2=female);
  MODEL:
  FC BY FC1@1 FC2 FC3 FC4 FC5 FC6 FC7;

  FN BY FN1@1 FN23;
    FN@1;
    FN2@0;

  PK BY PK1@1 PK2 PK3;
  PC BY PC1@1 PC2 PC3 PC4;
  CDPS BY CDPS1@1 CDPS2 CDPS3 CDPS4 CDPS5;

  FF BY FC@1 PK PC CDPS FN;

  model male:
  FC BY FC2 FC3 FC4 FC5 FC6 FC7 (FC1-FC6);

  FN BY FN2 (FN1);

  PK BY PK2 PK3 (PK1-PK2);
  PC BY PC2 PC3 PC4 (PC1-PC3);
  CDPS BY CDPS2 CDPS3 CDPS4 CDPS5 (CDPS1-CDPS4);

  [FC1@0 FC2 FC3 FC4 FC5 FC6 FC7
   FN1@0 FN2@0
   PK1@0 PK2 PK3
   PC1@0 PC2 PC3 PC4
   CDPS1@0 CDPS2 CDPS3 CDPS4 CDPS5] (INT1-INT21);

   FF BY PK PC CDPS FN (FF1-FF4);


   [FC PK PC CDPS FN] (INT22-INT26);
   [FF@0];

  model female:
  FC BY FC2 FC3 FC4 FC5 FC6 FC7 (FC1-FC6);

  FN BY FN2 (FN1);

  PK BY PK2 PK3 (PK1-PK2);
  PC BY PC2 PC3 PC4 (PC1-PC3);
  CDPS BY CDPS2 CDPS3 CDPS4 CDPS5 (CDPS1-CDPS4);

  [FC1@0 FC2 FC3 FC4 FC5 FC6 FC7
```

```
FN1@0 FN2@0
PK1@0 PK2 PK3
PC1@0 PC2 PC3 PC4
CDPS1@0 CDPS2 CDPS3 CDPS4 CDPS5] (INT1-INT21);

FF BY PK PC CDPS FN (FF1-FF4);


[FC PK PC CDPS FN] (INT22-INT26);
[FF*];

 OUTPUT: STDYX;
```

Note: See Appendix A for Item Referencing

Appendix C

Table 13

Supplemental Table: Alcohol Outcomes by Sex and Grade-Group

	Likelihood of Initiation Mean (SD)	Age of Initiation Mean (SD)	Alcohol use Frequency Mean (SD)
Middle School Females	0.18 (0.39)	11.51 (1.29)	0.37 (0.97)
Middle School Males	0.16 (0.37)	11.53 (1.75)	0.29 (0.84)
High School Females	0.34 (0.47)	14.21 (2.00)	0.87 (1.55)
High School Males	0.30 (0.45)	14.07 (2.31)	0.77 (1.53)