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A LATENT CLASS GROWTH MODEL OF RURAL ADOLESCENT DRINKING: AN EXAMINATION OF THE ANTECEDENTS TO AND YOUNG ADULT CONSEQUENCES OF ADOLESCENT ALCOHOL USE TRAJECTORIES

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ABSTRACT

The current investigation applies latent class growth analysis to define the multiple developmental pathways of change in adolescent drinking behavior (drinking to intoxication) from age 14 to age 18 among a sample of 629 rural-dwelling individuals. The subjects' adolescent drinking was represented by six overall patterns: chronic weekly (6.50% of the sample), consistent monthly (16.75%), rapid increasers (11.11%), decreasers (5.92%), normative users (25.28%), and non-abusers (34.28%). Both the antecedents and consequences of the trajectories were examined. Four antecedents were considered, including early onset intoxication (first intoxication by age 13), engagement in delinquent behavior at age 13, gender, and family history of alcohol and other drug (AOD) problems. The synergistic effect of the antecedents and the trajectory classes were investigated to explore their ability to predict young adult substance use, including intoxication, drug use, and alcohol-related consequences. The investigation elucidated the following findings:

- Males were more likely to engage in delinquent acts at age 13, but no more likely to have experienced their first intoxication by age 13 than females. Males were less likely to have reported a family history of AOD problems.
- Male and female adolescents who experienced their first intoxication by age 13 were more likely to have a family member with an AOD problem. In addition, males with a family member with an AOD problem were more likely to engage in frequent delinquent behavior at age 13.

- Adolescents who experienced their first intoxication by age 13 were more likely to drink to intoxication throughout adolescence.
- Adolescents who experienced their first intoxication by age 13 were more likely to use illicit drugs and forget where they were or what they did due to alcohol abuse in young adulthood. Early onset intoxication did not have a direct effect on young adult intoxication, frequent hangovers, nor getting into trouble with police due to alcohol abuse.
- A six-class LCGM described the patterns of drinking to intoxication from age 14 to age 18 in the sample. The following classes emerged: chronic high, consistent monthly, rapid increaser, decreaser, normative user, and non-abuser.
- No significant differences between the non-abusers and normative users were observed with respect to the covariates (early onset intoxication, delinquency at age 13, gender, and family history of AOD).
- Members of the chronic high, consistent monthly, and the decreasing classes were more likely to have experienced their first intoxication by age 13 than the members of the non-abusing class.
- Members of the chronic high, rapid increasing, and decreasing classes reported more delinquent acts at age 13 than members of the non-abusing class.
- Members of the chronic high, consistent monthly, and the rapid increasing classes were more likely to be male than the members of the non-abusing class.
- Gender had a direct effect on the young adult outcomes (intoxication, forgetting where one was or what one did as a result of alcohol abuse, and alcohol-induced

trouble with the police) after controlling for the adolescent alcohol use trajectory.

- The normative user class members were more likely to drink to intoxication, use drugs, and experience hangovers in young adulthood than members of the non-abusing class.
- Members of the consistent monthly and rapid increasing classes were more likely to drink to intoxication, use illicit drugs, and experience hangovers than members of the low-use group (aggregate of the normative user and non-abusing classes).
- Members of the chronic high class were more likely to experience all five of the negative young adult outcomes (drink to intoxication, use illicit drugs, experience hangovers, forget where he/she was or what he/she did as a result of alcohol abuse, and experience alcohol induced trouble with the police) than members of the low-use group.
- Students who were abusing alcohol at ages 13 and 14, but proceeded to cease use in later adolescence were no more likely than the low-use group to abuse substances in young adulthood.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

Go confidently in the direction of your dreams! Live the life you've imagined. -Thoreau

As my life as a graduate student comes to a close I find myself both eager for what lies before me and melancholy for what I'm leaving behind. Wise souls will tell you that happiness is in the journey not the destination, and I feel blessed that my journey thus far has transcended my greatest expectation. As I marvel at how far I've come, I know that my success would not have been possible without the brilliant individuals who I have met along the way.

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Chapter 1

INTRODUCTION

Alcohol is the drug of choice for adolescents and young adults. In the 2000 wave of the Monitoring the Future (MTF) (Johnston, O'Malley & Bachman, 2001) survey, 25% of 8th graders reported having been drunk at least once in their lifetime and 7% reported that their first occasion of intoxication had occurred before the end of 6th grade. The percentage of students who have experienced alcohol intoxication increases as students grow older. By 12th grade 62.3% of the students participating in the 2000 MTF study reported lifetime drunkenness. These statistics are not limited to only lifetime use, as 8.3% of 8th graders and 32.3% of 12th graders reported having been drunk within the 30 days prior to the survey. Furthermore, epidemiological data suggest that 300,000 American teenagers are dependent on alcohol (Kinney & Leaton, 1987).

Adolescent alcohol behavior is a salient issue as problems associated with alcohol impose a staggering burden on our Nation, resulting in consequences to both the individual and society at large (Shalala, 2000). Nearly 14 million Americans (7.4%) were found to meet the diagnostic criteria for alcohol abuse or alcoholism, including 16% of young adults aged 18-29 (Grant, Harford, Dawson, Chou, Dufour & Pickering, 1994). As a result, alcohol abuse costs the U.S. $184.6 billion each year (Harwood, 2000), not to mention the devastating consequences to the individual and his or her family.

Despite these statistics, the fact remains that alcohol is widely and mostly responsibly used in our society. The majority of alcohol consumers' drinking patterns do not negatively affect their lives or the lives of others. Even among adolescents, some experimentation with alcohol is normative and has been associated with desirable levels of psychosocial functioning and adjustment in some investigations (Labouvie, 1990; Maggs, 1997; Marlatt, 1987; Silbereisen & Noack, 1998). Furthermore, persistence of heavy alcohol use into adulthood is relatively rare in the general population (Schulenberg, Wadsworth, O'Malley, Bachman & Johnston, 1996).

However, in far too many cases, adolescent alcohol experimentation leads to alcohol abuse, dependence, and other related problems. Alcohol abuse and dependence are disorders that most often manifest themselves early in life (Lewinsohn, Rohde & Seeley, 1996). Helzer, Burnam and McEvoy (1991) estimated that over 80% of adults diagnosed with an alcohol abuse or dependence problem developed their first symptom before the age of 30, and over 35% of alcohol dependent adults developed one or more symptoms between the ages of 15 and 19 years of age. As such, some social and behavioral scientists are focusing their efforts on discovering and describing the life course trajectories of individuals who develop alcohol abuse and dependency. This description includes the investigation of variables that distinguish between adolescents who moderately experiment with alcohol yet progress to demonstrate healthy levels of alcohol use in adulthood and those whose adolescent alcohol use leads to life course persistent patterns of abuse and dependence.

For example, Zucker, Fitzgerald, and Moses (1995) suggest the importance of mapping out the developmental pathways for different types of drinkers. They emphasize that "the notion of a single progressive and irreversible pathway of outcome is no longer workable" (p. 686). Moreover, while conclusive evidence exists to suggest a relationship between adolescent alcohol abuse (early initiation, patterns of high frequency and intensity of use, and frequent binge drinking) and subsequent alcohol problems in adulthood, information is lacking regarding the circumstances under which adolescent alcohol-related behavior leads to adult abuse. That is, a better understanding of time-specific variation of adolescent alcohol use and the impact of discontinuation or reduction of use during adolescence on lowering the risk of adult abuse needs to be investigated (Guo, Collins, Hill & Hawkins, 2000).

The role of alcohol in the lives of adolescents and young adults has been the focus of many investigations. This period of development is critical in the study of alcohol behavior as it represents the time frame in which the vast majority of individuals begin experimenting with alcohol (Johnston et al., 2001). For example, Hill, White, Chung, Hawkins, and Catalano (2000) described four sub-populations of adolescent binge drinkers. While the vast majority (70%) of adolescents were classified as non-bingers from age 13 to age 18, 23% of adolescents were classified as late-onsetters, 4% as increasers, and 3% as early high binge drinkers These different trajectories were useful in predicting alcohol problems in young adulthood. The increasers had the highest likelihood of alcohol abuse or dependence at age 21. In addition, the late onsetters were more likely than nonbingers to be alcohol dependent at age 21, suggesting that frequent,

heavy episodic drinking in later adolescence increases the likelihood of demonstrating an alcohol problem in young adulthood. Guo et al. (2000) followed up the study of Hill and colleagues with a Latent Transition Analysis (LTA) of the same sample. Using the presence of DSM-IV criteria alcohol abuse and/or dependence (AAD) at age 21 as a grouping variable (AAD vs. non-AAD) they investigated the course of alcohol use from age 10 and onward. While there were no differences between the AAD and non-AAD group in drinking practices in elementary school, those classified as AAD were more likely to have transitioned from being a nonuser to a current user during the elementary school to middle school progression. Furthermore, the AAD group was significantly more likely to have progressed into heavy-episodic drinking during high school than the non-AAD group.

Zucker et al. (1995) described the mechanisms by which adolescent alcohol experimentation leads to more problematic outcomes. They pointed to evidence suggesting that adolescence is a time of development of independence and includes many behavioral and attitudinal changes including increased rebelliousness, heightened acceptance for deviant behavior, and greater alcohol and other drug involvement. This period of time can be contrasted with the expectations and experiences of young adulthood, including achievement, conventionality, and marriage. Based on the role and expectation differences between adolescence and young adulthood, Zucker and colleagues suggest that "if one makes it through adolescence without drug involvement, one misses the window of exposure, availability, and peer pressure which drives onset of the phenomenon. Thereafter, without earlier use, even if the biopsychological structure is

appropriate for a pattern of abuse, the environmental triggers and the significant substance availability are absent – hence the notion of a critical period for risk based upon the mediating effects of stage-specific contextual factors" (p. 686). In other words, Zucker et al. suggest that an individual who initiates alcohol use during adolescence is more likely to progress to more problematic patterns of use than an individual who initiates use later in life because of the role and expectation differences between adolescence and young adulthood.

Recently age of onset of alcohol use has become one of the variables of interest that may help to differentiate between adolescents who develop alcohol problems as compared to those who do not. *Table 1–1* represents the grade of first alcohol use and drunkenness as retrospectively reported by 12th graders in the Monitoring the Future Study in 2000 (Johnston, O'Malley & Bachman, 2001). Many existing empirical studies have reported an association between early onset of alcohol use and subsequent alcohol problems. For example, Grant and Dawson (1997) found that individuals who initiated drinking at age 14 and younger were four times as likely to become alcohol dependent (as defined by the criteria of the DSM-IV) as those who initiated use at age 20 or older. In fact, almost all of the published studies assessing the role of age at onset have found a significant association between age at onset and adult alcohol abuse; however, debate exists as to the nature of the relationship. Grant and Dawson (1997) of the National Institute of Alcohol Abuse and Alcoholism recently stated that there is "an urgent need to integrate epidemiologic and etiologic research…to ascertain if it is the delay in alcohol

use or more likely, the other associated factors that account for the inverse relation between age at first drinking and the risk of lifetime alcohol use disorders" (p. 109).

Table 1–1: Grade of first alcohol use as reported by 12th graders

Grade	Alcohol Use %	Cumulative %	Been Drunk %	Cumulative %
6th or below	7.8	7.8	2.9	2.9
7th-8th	21.7	29.5	13.3	16.2
9th	19.2	41.5	16.5	32.3
10th	14.5	49.3	12.9	35.2
11th	11.6	74.8	11.3	56.9
12th	5.5	80.3	5.4	62.3

Source: 2000 survey data from MTF (Johnston, O'Malley & Bachman, 2001)

Some researchers believe that this association is causal while others believe the relationship to be confounded. The former believe that the relationship is at least partially causal and may mediate the relationship between individual risk factors and subsequent alcohol abuse. That is, early experimentation with alcohol explains why or how the presence of risk factors lead to alcohol abuse. This notion suggests that at-risk children who do not engage in early alcohol use may be at less risk for abusing alcohol. The latter perspective suggests there is no causal effect of early alcohol initiation on subsequent alcohol patterns and consequences, but rather that some of the same individual characteristics (genetics, toleration for deviance, etc.) that cause alcohol abuse and alcohol-related consequences also lead to an earlier onset of alcohol use. Furthermore, it has been suggested that "interventions designed simply to delay onset age will not markedly reduce the number of individuals who go on to develop alcohol-related disorders" (Prescott & Kendler, 1999, p. 106).

A complete understanding of the course of drinking trajectories during adolescence and into adulthood underlies the ability to create effective prevention and intervention programs. If, in fact, the age at onset plays a deterministic role, then efforts to delay the onset of alcohol use initiation are imperative. On the other hand, if age at onset is merely a correlate of drinking trajectories throughout adolescence and it can be determined that non-normative or high-risk drinking during adolescence increases risk for alcohol abuse in adulthood, then programming aimed at decreasing the amount of drinking and harm prevention techniques may better serve our youth. Of course, it is also possible that both the age at onset and the adolescent's drinking trajectory work together to determine adult alcohol use, in which case both primary and secondary prevention efforts would be needed. For example, perhaps an individual's adolescent drinking trajectory mediates the relationship between early onset drinking and later alcohol problems.

Research Questions

As the reader will find in Chapter 2, many studies have aimed to address these issues. This investigation will seek to determine the impact of adolescent alcohol use on young adult alcohol abuse utilizing a longitudinal sample of 629 individuals from one rural school district followed from 7th, 8th, or 9th grade to young adulthood (22-24 years of age). Specifically, this study will answer the following questions:

Question 1: What is the impact of early onset intoxication on drinking behavior during adolescence (ages 14-18)?

Question 2: What is the impact of early onset intoxication on alcohol-related behavior in young adulthood; including frequency of intoxication, use of other substances, and negative consequences due to drinking?

Question 3: Does early onset intoxication affect the trajectory of drinking from ages 14-18?

Question 4: Are certain drinking trajectories more likely to be associated with young adult substance-use behavior and alcohol-related consequences?

Question 5: Does early onset intoxication have an independent effect on young adult outcomes beyond the effect explained by trajectory class? To what extent does trajectory class mediate the relationship between early onset intoxication and adult substance abuse and related consequences?

In addition to investigating the impact of adolescent alcohol use and abuse patterns on young adult substance abuse, this study also provides valuable information about a population that is understudied. Rural youth represent one-quarter of American adolescents, yet they have been largely neglected in research investigations (Preston & Mansfield, 1990). The National Center on Addiction and Substance Abuse (CASA) at Columbia University (2000) released a report entitled *No Place to Hide: Substance Abuse in Mid-Size Cities and Rural America*. Utilizing data from the 1999 wave of the Monitoring the Future study (conducted by the University of Michigan Institute for Social Research), CASA chronicled the epidemic of substance abuse in America's rural

towns. Their findings suggest that rural adolescents are at an equal, and possibly increased risk, for alcohol abuse than their non-rural peers. They note, in fact, that a higher percentage of rural 8th, 10th, and 12th grade students reported past month use of alcohol than students in non-rural areas. Despite this evidence, there has been little research conducted to better understand the patterns of alcohol use among rural adolescents and young adults, including the initiation of use, the trajectory of use over time, and the consequences of abuse.

Chapter 2

REVIEW OF THE LITERATURE

Examining alcohol use in adolescence and young adulthood

The role of alcohol in the lives of adolescents and young adults has been the focus of many investigations. This period of development is critical in the study of alcohol behavior as it represents the time frame in which the vast majority of individuals begin experimenting with alcohol (Johnston et al., 2001). Longitudinal studies have documented the relationship between drinking patterns throughout adolescence and adult drinking behavior. In reviewing the literature, Guo et al. (2000) noted that while some investigations have reported a relationship between moderate alcohol experimentation in adolescence and positive psychosocial functioning (Labouvie, 1990; Maggs, 1997; Marlatt, 1987; Silbereisen & Noack, 1988), others have documented the potential consequences of adolescent drinking on adult drinking outcomes (Hill et al., 2000, Newcomb & Bentler, 1988; White, 1987; & Kandel, 1980). Guo and colleagues insist that while conclusive evidence exists to suggest a relationship between adolescent alcohol abuse (early initiation, patterns of high frequency and intensity of use, and frequent binge drinking) and subsequent alcohol problems in adulthood the information is lacking to fully understand the particular pathways that lead from alcohol use in adolescence to alcohol abuse and dependence.

New advances in methodology and evaluation have allowed for the development

of exciting and innovative techniques for the assessment of change. Recently, several published investigations have utilized a person-centered, as opposed to a variable-centered, approach to examine the young adult consequences of adolescent drinking. Person-centered methods are concerned with intra-individual change and allow for the identification and investigation of multiple developmental pathways (Bates, 2000). This approach can serve as a valuable tool to researchers interested in identifying distinct groups of individuals possessing a similar trajectory of change over time, yet are different from individuals in the other identified groups (Muthén & Muthén, 2000a). Such techniques have allowed alcohol researchers to better understand the relevance of different alcohol use trajectories, including initiation, persistence, escalation, and remission (Bates, 2000). Wohlwill (1973) describes the attributes of trajectories that can be assessed, including presence, direction, and rate of change; shape of the trajectory; values of maxima, minima, or terminal levels; and sequencing and timing of events.

Hill et al. (2000) utilized a person-centered and cluster approach to examine the young adult outcomes of adolescent binge drinking among their sample of 808 individuals involved in the Seattle Social Development Project. The subjects were followed from age 10 to age 21. Four drinking trajectories were identified: early highs, increasers, late onsetters, and nonbingers. After controlling for adolescent use of other drugs and socio-economic status (SES), several significant predictions remained. The increasers had the highest likelihood of alcohol abuse or dependence at age 21. In addition, the late onsetters were more likely than nonbingers to be alcohol dependent at age 21, suggesting that frequent, heavy episodic drinking in later adolescence increases

the likelihood of demonstrating an alcohol problem in young adulthood. Guo et al. (2000) followed up the study of Hill and colleagues with a Latent Transition Analysis (LTA) of the same sample. Using the presence of DSM-IV criteria alcohol abuse and/or dependence (AAD) at age 21 as a grouping variable (AAD vs. non-AAD) they investigated the course of alcohol use from age 10 and onward. While there were no differences between the AAD and non-AAD group in drinking practices in elementary school, those classified as AAD were more likely to have transitioned from being a nonuser to a current user during the elementary school to middle school progression. Furthermore, the AAD group was significantly more likely to have progressed into heavy-episodic drinking during high school than the non-AAD group.

In a similar study, Chassin, Pitts, and Prost (2002) modeled the heterogeneity of binge drinking during adolescence among a sample of subjects with an alcoholic parent and a group of matched controls (N=454). At the beginning of the study, the subjects, ranging in age from 10.5 to 15.5, were followed for a period of five to seven years. Using semi-parametric group based modeling, the subjects' binge drinking trajectories were described by four different classes: non-binge, early-heavy, late-moderate, and infrequent. All three of the latter groups were significantly more likely to abuse alcohol or be alcohol dependent in young adulthood, with the early-heavy group demonstrating the worst young adult outcomes of all.

Zucker et al. (1995) described the mechanisms by which adolescent alcohol experimentation leads to more problematic outcomes. They pointed to the evidence suggesting that adolescence is a time of development of independence and includes many

behavioral and attitudinal changes including increased rebelliousness, heightened acceptance for deviant behavior, and greater alcohol and other drug involvement. This period of time can be contrasted with the expectations and experiences of young adulthood, including achievement, conventionality, and marriage. Based on the role and expectation differences between adolescence and young adulthood, Zucker and colleagues suggest that "if one makes it through adolescence without drug involvement, one misses the window of exposure, availability, and peer pressure which drives onset of the phenomenon. Thereafter, without earlier use, even if the biopsychological structure is appropriate for a pattern of abuse, the environmental triggers and the significant substance availability are absent – hence the notion of a critical period for risk based upon the mediating effects of stage-specific contextual factors" (p. 686). In other words, Zucker and colleagues suggests that an individual who initiates alcohol use during adolescence is more likely to progress to more problematic patterns of use than an individual who initiates use later in life because of the role and expectation differences between adolescence and young adulthood.

Based on the evidence linking problematic adolescent drinking patterns to young adult alcohol problems, alcohol researchers have begun investigating the mechanisms of this relationship. As such, some researchers have considered the role of age at first use of alcohol as a potential explanatory variable. The remainder of the review will focus on the potential role that age of onset plays in the identification of adolescents that develop alcohol problems.

Age of onset of alcohol use and subsequent alcohol misuse

Over the past decade, a number of studies have suggested that the age at which a person first begins using alcohol has a significant impact on the course and patterns of alcohol use over one's lifetime. Although relatively consistent findings have been presented, the investigations have utilized varying methodologies and have operationalized their constructs and definitions differently. In addition, differing viewpoints and theoretical foundations have lead researchers to question the causal flow of the relationship. While some argue that early age of onset leads to later use through varying mechanisms, others assert that age of onset is simply a correlate of other factors that are the true cause of later alcohol abuse. Therefore, careful examination of the evidence is necessary to derive appropriate and reliable conclusions. To this end, a description of the methodological issues associated with the age of onset hypothesis will be presented first. Next, a synthesis of the literature regarding the impact of age at alcohol onset will be presented. Finally the theoretical framework for the mechanisms by which age of onset affects subsequent ATOD use will be explored.

Assessing alcohol age of onset

Researchers have employed two main methods of assessing the role of alcohol age of onset on subsequent alcohol abuse. One method utilizes cross-sectional studies of adult and adolescent populations to assess their self-reported retrospective recall of age of onset on their lifetime health and behavioral outcomes. The second relies on longitudinal

datasets to follow an adolescent from alcohol use initiation into adulthood.

While cross-sectional designs have allowed for larger-scale epidemiological analysis of the questions, it suffers from the obvious problems associated with recall. Prospective longitudinal studies have suggested that there is a systematic tendency for most individuals to shift their estimation of age of onset upward as they progress in age (Labouvie, Bates & Pandina, 1997). Individuals are also likely to report less use of alcohol retrospectively than they reported prospectively, perhaps due to memory errors. Collins, Graham, Hansen, and Johnson (1985) found that current alcohol use affects the reporting of past alcohol use. In their sample, the contribution of current alcohol use was twice that of the prospective report for predicting the individual's retrospective recall of alcohol use. Moreover, in reporting on the test-retest reliability of self-reported age of onset, Bailey, Flewelling, and Rachal (1992) found that 23.3% of their adolescent subjects committed a logical error (reported an age of onset at time 1 but reported never having tried alcohol at time 2) across two time points separated by one year. In addition, estimation errors were common. For example, over 19% of the subjects reported an age of onset at time two that was discrepant with the age given at time one (46% of the subjects were off by one year, 31.2% by two years, and 22.1% by three or more years). Brewer (1998) offers an explanation for these types of inconsistencies, suggesting that an individual's memory can rarely recall information pertaining to absolute time. Therefore, retrospectively recalled information about events in one's past may not be reliable, especially when those events become further and further in one's past.

Longitudinal methods on the other hand, while not suffering from recall bias,

often suffer from left censoring. That is, it is likely that a portion of the sample will have already initiated alcohol use at the initial survey. Therefore, the left censored data would require adjustment through statistical strategies or the subjects would need to supply a retrospective report of their age at first use. In addition, Johnston et al. (2001) discuss several potential problems associated with assessing alcohol behaviors among adolescents. Depending on the age of the subject, the question may have different meanings. For example, an 11th grade student might not consider their first sip of alcohol as a first experience, but an 8th grader might be more likely to report this same episode as their first experience. Of course, an explicit and well thought out survey item can help to remedy this situation. Johnston and colleagues also consider another problem specific to comparing age of onset across school-aged children. The lower grades are more likely to contain more of the problem prone adolescents, as these adolescents are more likely to drop out of school and not be present for data collection in later grades. However, cross-sectional studies also suffer from attrition and possess the added detriment of providing no informative information about who was missing.

Clearly, the benefits of prospective, longitudinal measurement outweigh the censoring drawback as longitudinal studies allow alcohol initiation and subsequent use patterns to be studied as a dynamic process. As such, few scientists would dispute that longitudinal methods are the preferred choice for evaluating the age of onset hypothesis; however, few longitudinal datasets exist that contain the necessary information to address the hypotheses at hand.

Classifying and defining early age of onset

Another methodological consideration lies in the classification and definition of early onset. In constructing the early onset variable, there are two choices. One method is to allow the variable to represent a continuous age distribution, while the other is to construct a categorical variable that differentiates between early onset adolescents and other types of drinking initiation. Hingson, Heeren, Jamanka, and Howland (2000), Zhang, Wieczorek, and Welte (1997), and Gruber, Di Clemente, Anderson, and Lodico (1996) have suggested 13 years of age and younger as a sound point for classifying early age of initiation of alcohol use as drinking at this age or younger violates society's age-role norm, while initiating use at 14 years or older may be viewed as more acceptable and normative (Lo, 2000). Unfortunately this classification has significantly varied from investigation to investigation, causing interpretation of results across studies to be difficult.

Another inconsistency across studies lies in the definition of early age of onset. The meaning of first use must be clearly stated; that is, is first use determined by one's first sip, one's first full drink, one's first experience with intoxication, or one's first entrance into regular or patterned drinking. This definition has greatly varied among the published investigations and therefore must be taken into consideration when comparing results.

Defining the dependent variable

Just as researchers have employed several different definitions for and classifications of age of alcohol initiation, the classification of the dependent variable has varied as well. Several pertinent and relevant outcomes regarding alcohol behavior can be assessed, including amount of alcohol consumed (quantity and frequency), frequency of intoxication, engagement in risky alcohol-related behavior (i.e. drinking and driving, drinking and unsafe sex), alcohol-induced consequences (i.e. suffering injury, missing school or work, damaged relationships), and transition to other substances. Some of the studies have differentiated between levels of problematic drinking in adulthood and normative, non-problematic drinking, while others have utilized continuous outcomes. The choice of a continuous/ordered discrete (e.g. number of drinks consumed per week) or categorical (e.g. presence or absence or an alcohol disorder) dependent variable greatly affects the type of analyses available.

Selecting covariates

Finally, the choice of covariates has a great potential to affect the interpretation of the results. For example, a researcher might be interested in examining the impact of age of onset after controlling for family history of alcoholism. Likewise, it might be important to control for the presence of delinquent behavior as age of onset may be a correlate of a tolerance for deviance. Other covariates that have been used include peer and parental feelings about deviance, parental use of substances, friends' use of

substances, and personal use of other substances. Labouvie and White (2002) warn alcohol researchers of the danger of overestimating the role of age of onset when common risk factors predicting both age at initiation and trajectory of use throughout adolescence are not measured and modeled in equations. A wide variety of covariates have been used to assess the age of onset hypothesis in the published literature. Based on one's hypotheses, a different set of covariates may be warranted. However, the discerning reader must carefully consider the covariates used when comparing findings.

If one is interested in assessing the causal role of age of onset on subsequent development of alcohol problems, it is necessary to control for confounding variables. That is, it would be difficult for a researcher to make the case that an early first experience with alcohol plays a causal role in later alcohol abuse/dependence without controlling for personal, biological, and environmental variables that have the potential to affect both age of onset and subsequent abuse/dependence. It is important to partial out certain covariates from the perspective of both basic and applied research. While alcohol researchers desire to understand the mechanisms by which early age of onset affects risk of later alcohol abuse and/or dependence, prevention and intervention researchers need to understand the relationship so as to design programming that will have the greatest potential for success.

The following sections will describe the published studies that have addressed the role of age of onset of alcohol use in predicting subsequent alcohol behavior. First, the investigations that employed a longitudinal design and relied mostly on prospective reporting of age of onset will be discussed. Then, the cross-sectional studies and

longitudinal studies that began following individuals at some point after most of the sample had initiated drinking will be discussed as these investigations relied on retrospective recall of age of onset. These retrospective studies will be broken down into three age categories: adults, college students, and adolescents.

Alcohol age of onset and subsequent alcohol use: Prospective reporting

As reported earlier, Chassin, Pitts, and Prost (2002) modeled the heterogeneity of binge drinking during adolescence in a sample of subjects with an alcoholic parent (COA – children of an alcoholic) and a group of matched controls (N=454). At the beginning of the study, the subjects ranged in age from 10.5 to 15.5. Each subject provided four waves of data, with the final wave of data collected five to seven years after the initial wave. Using semi-parametric group based modeling, the subjects' binge drinking (number of times the subject drank five or more drinks in a row in the past year) trajectories over the second, third, and fourth wave of data collection were described by four different classes: non-bingeing, early-heavy, late-moderate, and infrequent. These four classes were regressed on covariates measured at the initial wave of data collection, and included age, gender, binge drinking, family structure, peer drinking, antisocial behavior, depression, anxiety, and COA status. Binge drinking at the initial survey was the strongest predictor of trajectory class membership. As expected, the early-heavy members demonstrated the highest rate of binge drinking at the initial survey, followed by the infrequent members, and finally the late-moderate members.

Pedersen and Skrondal (1998) followed 465 Norwegian adolescents over a six-

year period of time. The subjects ranged in age from 12 to 15 at the first wave of data collection. Age of onset was collected prospectively for those students who had not yet begun drinking at the beginning of the study and retrospectively for the 94 students who had. Onset was classified as the age at which the student first consumed alcohol, other than a few sips (actual quantities were defined, e.g. half a bottle of beer). Several potential confounders were modeled in addition to the independent variable, including perceived peer and parental feelings about deviant behaviors, parental alcohol and cigarette use, parental presence of alcohol-related problems, and friends' use of alcohol and cigarettes. Those who had the earliest age of onset demonstrated the highest consumption throughout adolescence. At the fifth year of the study, those who began drinking before the age of 13 had an annual alcohol consumption nearly twice that of those who began drinking after the age of 17. With regards to alcohol-related problems, early onsetters (before the age of 13) demonstrated a mean score of 10.2 on the Rutgers' Alcohol Problem Index (White & Labouvie, 1989) at wave five, while those initiating after the age of 17 demonstrated a mean score of 5.0. The authors deduced from their model that "a 10% delay in debut age will lead to a 35% decrease in subsequent alcohol consumption" (p.32). These results were consistent across gender. Furthermore, the relationship between several ATOD initiation risk factors and subsequent alcohol misuse were fully mediated by age of onset, including parental alcohol use and norms, peer norms, and friends' use of ATOD.

Hawkins, Graham, Maguin, Abbott, Hill, and Catalano (1997) utilized their longitudinal sample of Seattle youth to discover the nature of the relationship between

age of onset and alcohol patterns throughout adolescence. Eight-hundred-and eight students were surveyed at age 10/11 and again at age 17/18. They utilized an innovative latent variable method for constructing the age of initiation variable. Three items composed the latent variable; "Have you ever drunk alcohol?" (collected prospectively), "At what age did you first have more than a sip or two of alcohol?" (collected retrospectively at age 17/18) and "How old were you when you first began drinking alcohol regularly?" (collected retrospectively at age 17/18); therefore, both retrospective and prospective accounts of age of onset were utilized. Hawkins and colleagues also utilized a latent construct to represent the outcome variable of alcohol misuse. It was developed from three scales measured at age 17/18: driving while intoxicated in the past year, frequency of past month binge drinking (5 or more drinks in a row), and existence of alcohol-related consequences (e.g. hurt your performance in school, hurt your relationship with parents). The study confirmed the relationship, finding early age of onset to be strongly associated with alcohol misuse in late adolescence. Furthermore, age of onset mediated the relationship between many known alcohol abuse predictors and subsequent alcohol abuse, including parental drinking, proactive parenting, school bonding, peer alcohol initiation, and ethnicity. The Hill et al. (2000) paper discussed in detail in the first section of the literature review, utilized the same dataset. Instead of looking at the effect of age at first regular use, they investigated the role of binge drinking throughout adolescence in predicting young adult outcomes. Using semi-parametric group based modeling they identified four drinking trajectories: early highs, increasers, late onsetters, and nonbingers. Interestingly, classification as an early high

binge drinker did not predict alcohol abuse at age 21. However, alcohol abuse was significantly predicted by both increasers and late onsetters.

Labouvie et al. (1997) assessed the predictive utility of age at first use on alcohol use at ages 20 and 30. Their sample of 839 men and women provided four waves of longitudinal data spanning the age range from 15 to 31. At each wave, all of the subjects were asked whether or not they had tried alcohol. If they had, they were asked to report their age at first use. Due to the late assessment of first use and the spacing of the adolescent surveys (three years apart), the age of onset variable was a retrospective account for many individuals. Age at first use (analyzed as continuous age) did not predict current drinking (defined by the product of quantity x frequency) at age 20 after controlling for the age of initiation of illicit substances. Neither age at first alcohol use nor age at first illicit drug use predicted drinking at age 30. However, in 1998 Labouvie and White analyzed the same data to assess the combined effect of both age of onset and intensity of use over time and found that young adult alcohol use could be significantly predicted. That is, the interaction of the early drinking and high intensity of use did significantly predict adult drinking. In a review of these analyses, Labouvie and White (2002) reported that age of onset and trajectory of use are more predictive of use within a short-term perspective, and have less predictive utility with regards to adult substance use. This notion is supported by Muthén and Muthén (2000b) who found age of onset to be more predictive of heavy drinking at age 18 than heavy drinking at later ages. Likewise, age of onset was predictive of DSM-IV alcohol problem severity scores at ages 25-37, but was not predictive at later ages.

Poikolainen, Tuulio-Henriksson, Terhi, Marttunen, and Lonnqvist (2001) followed a sample of 611 Finnish subjects from age 15-19 to age 20-24 through two surveys spaced five years apart. Due to the chronologically late assessment of age of onset and their study design (only two waves of data), they had to rely on retrospective reporting of age of onset for some subjects. Defining age of onset as the initiation of alcohol consumption with a frequency of at least once per month, an inverse relationship between age of onset and the frequency and amount of alcohol consumption at the second survey was found. No potential confounding variables were controlled for in the analyses.

Fergusson, Lynskey, and Horwood (1994) used a prospective, longitudinal design to assess the effects of age of onset among 1,265 children from New Zealand surveyed at ages 11, 12, 13, and 15. The surveys administered at ages 11-13 included questions regarding alcohol age of onset. The children were asked to recall their age at first drink and report whether or not they had drunk alcohol in the last year. These two variables were used to classify the children's alcohol initiation into one of the following four categories: (a) 0-5 years old, (b) 6-10 years old, (c) 11-12 years old, or (d) after the age of 12 (not yet initiated). At age 15, the subjects reported several alcohol behaviors, including their frequency of alcohol consumption during the past three months, estimates of the quantity of alcohol consumed on a typical occasion, estimates of the largest amount of alcohol consumed in the past three months, and occurrence of alcohol-related problems. After controlling for potential confounders (SES, parental alcohol consumption, parental attitude toward alcohol, gender, and conduct disorders) a small,

but statistically significant negative association between age of onset and both misuse of alcohol (frequency x quantity) and occurrence of drinking-related problems at age 15 persisted.

Thomas, Reifman, Barnes, and Farrel (2000) collected age of onset data from 561 adolescents aged 15 to 18. Data for the analyses were taken from the 3rd and 4th data collection time points of a larger study, which were administered at a one year interval. Defining onset to be the first time a student became drunk or very high from alcohol, the authors classified early onset as age 14 or younger. The dependent variable, adolescent alcohol misuse, included three indicators: total alcohol consumption (quantity and frequency), number of times drunk, and frequency of binge drinking (5 or more drinks in a row). The onset variable was asked at the 3rd wave of data collection along with measures of alcohol misuse, parental monitoring, and sexual activity (as part of another hypothesis). One year later, the subjects were administered a second survey to assess their current drinking patterns. After controlling for family structure, gender, race, age, sexual activity, parental monitoring, and alcohol misuse, age at first intoxication significantly predicted alcohol misuse at wave 4.

Alcohol age of onset and subsequent alcohol use: Retrospective reporting

Adult populations

A large number of studies have surveyed adults to assess their current alcohol behaviors and inquire about their age of onset of alcohol use. The National Longitudinal

Alcohol Epidemiologic Survey (NLAES) has allowed for investigation of the effects of alcohol age of initiation on adult health behaviors and outcomes. The survey was directed through a face-to-face interview with 42,862 noninstitutionalized adults residing in the U.S in 1992. In order to ascertain age of initiation, respondents were asked how old they were when they first started drinking, not counting small tastes or sips of alcohol. Based on data from the NLAES, Grant and Dawson (1997) reported that adolescents who initiated drinking at age 14 and younger were four times as likely to become dependent on alcohol (as defined by the criteria of the DSM-IV) as those who initiated use at age 20 or older. A 14% reduction in the odds of lifetime alcohol dependence was observed with each increasing year of age at first use. Likewise, an eight percent reduction in the odds of lifetime alcohol abuse was demonstrated with each year that drinking onset was delayed. The relationship between age of onset and lifetime alcohol dependence persisted after controlling for family history of alcoholism, race, and gender (Grant, 1998). Hingson et al. (2000) also utilized the NLAES data and found that early initiators were much more likely to report heavy drinking (5 or more drinks in a row) both in the year prior to the survey and during their period of heaviest drinking than respondents who waited until they were 21 to drink. Compared with those who initiated alcohol use on or after their 21st birthday, those who initiated alcohol use before the age of 14 were 1.4 times more likely to binge drink (drink five or more drinks) and 2.8 times more likely to drink to intoxication at least weekly in the past year. These results persisted after controlling for diagnosis of alcohol dependence (current, former, never), age, sex, race, education, drug use (current, former, never), smoking status (current,

former, never), marital status, and family history of alcoholism.

Muthén and Muthén (2000b) reported on the predictors of heavy drinking in adulthood. The subjects were 7,859 men and women age 18-37 involved in the National Longitudinal Survey of Youth. Defining age of onset as the age one first started drinking, they found early onset to have a significant detrimental impact on heavy drinking (the number of times one consumed six or more drinks in the past 30 days) at age 18, that leveled off yet remained significant through age 37. Likewise, early onset predicted alcohol-related problems at age 25. However, the effect diminished over increasing ages and became insignificant by age 37. The analyses accounted for several pertinent covariates, including gender, ethnicity, family history of alcoholism, high school graduation, and college education.

Kraus, Bloomfield, Augustin, and Reese (2000) reported a significant relationship between early age of onset of regular alcohol use (monthly or more often) and the presence of life-time alcohol-related problems. Their sample included 7,501 German adults aged 18-59, surveyed by phone. Only gender and age were used as covariates.

Dewit, Adlaf, Offord, and Ogborne (2000) surveyed 5,856 Canadian adults to model a survival analysis of time to alcohol onset. Age of onset was defined as the individual's first drink, not counting small tastes or sips, and was collected and analyzed as a continuous variable. After controlling for race, SES, childhood conduct problems, negative childhood life events (frequent moves, school failure, parental death, parental separation), and childhood family strain (physical abuse, sexual abuse, lack of close relationships, parental mental disorders), a rapid progression toward alcohol disorders

(according to the DSM-III-R criteria) was revealed among those who began drinking between the ages of 11 and 14. Ten years after their debut to alcohol, nearly 14% of the early initiators (aged 11-14) qualified under DSM-IV criteria for alcohol abuse as compared to 2% of those waiting until 19 years of age to begin drinking. Similarly, nearly 16% of those initiating at age 11-12, nearly 14% of those with an onset age of 13, and 9% of those initiating at age 14 qualified for DSM-IV alcohol dependence 10 years after their first alcohol experience. Comparatively, only 1% of those with an onset age of 19 or above qualified as alcohol dependent. While these results appear to support the onset hypothesis, Dewit and colleagues uncovered an anomaly in their data. The subjects who had initiated alcohol at the earliest age (before 11-years-old) were at less risk of alcohol abuse and dependence than those initiating between the ages of 11 and 14; however, they were still at a significantly higher risk than those initiating at nineteen years or older. The authors attributed this finding to three possibilities. First, extremely early alcohol use "that arrives well ahead of the social clock set by society for contested behaviors is likely to provoke a swift response" (p. 749). That is, these children were likely identified and referred to assistance. Therefore, their use was likely an isolated or rare occurrence and not a behavior that was practiced often. Second, the authors suggest that those who began using at an extremely early age were less likely to have regular access to alcohol than children who began at a later age. Finally, the extremely early on-setters may have been largely representative of children who drank at home as part of the family's culture. "Consumption is considered the norm in these contexts and thus is less likely to lead to the development of problems" (p.740). Likewise, Yu and Williford

(1992) discovered a similar pattern. Using the 1986 New York State Alcohol Survey data to investigate the effect of age at alcohol onset on current drinking among 3,000 16-24 year old individuals, they found that initiating use between the ages of 13 and 16 resulted in more frequent current alcohol use than initiation of use before the age of 13 or after the age of 16. However, in inquiring about age of onset, the subjects were simply asked their age at first drink and did not account for small tastes or sips. In addition, the dependent variable only represented frequency of alcohol use (number of times alcohol was consumed in the past 28 days) and didn't take into consideration problematic alcohol patterns, abuse or dependence symptoms, or alcohol-related consequences.

Prescott and Kendler (1999) assessed the age of onset hypothesis in a twin registry sample of 8,746 adults aged 18-62. Age of onset was determined by asking the subjects their age at first drink, other than as part of a religious ceremony. The dependent variable, lifetime presence of an alcohol disorder, was constructed utilizing the DSM-IV criteria. Results of the analyses suggested that for each additional year that drinking was delayed, the risk for developing alcohol dependence declined by 21%. While the effects were significant across genders, the effect was stronger for females. In addition to testing the bivariate relationship, the authors utilized the twin design to partition the variance into genetic, common environmental, and individual-specific sources. They posited that if age of onset directly caused alcoholism, then the relationship between age of onset and subsequent development of alcoholism would be primarily due to individual-specific sources of variation. On the other hand, if the variation is primarily accounted for by factors shared by the twins then early initiation can be considered as an "outcome of

familial liability rather than a contributing step to the development of alcoholism" (p. 103). The resulting analyses suggested the former explanation, that the relationship between age of onset and alcoholism is noncausal based on their reasoning. They therefore considered the effect of age of onset to be a confounder to the relationship between the true causes (familial liability) and adult alcohol dependence.

Clapper, Buka, Goldfield, Lipsitt, and Tsuang (1995) assessed the adult drinking patterns of 693 males and females age 18-27. Eleven percent of the variance in current alcohol abuse or dependence (as determined by the DSM-III criteria) was accounted for by age at first intoxication. However, 55% of the variance was accounted for by the number of times the individual reported being drunk before the age of 16. These findings persisted even with potential confounders added to the equation, including delinquent behaviors and lack of religious participation. Unfortunately, the authors did not enter these two independent variables into the same regression analysis to produce partial regression weights, nor did they report the predictive ability of age of onset on frequency of drunkenness.

York (1995) examined 152 adult social drinkers and 273 adult alcoholics. Through comprehensive interviews, the subjects reported on their drinking patterns (quantity and frequency) from the time they first started drinking regularly up to the present. The subjects diagnosed with alcoholism began drinking regularly at an earlier age and began drinking more per occasion (after controlling for weight) than the social drinkers. At drinking onset, the alcoholics were drinking approximately 70% more than the social drinkers. In addition, the escalation of drinking was rapid for the alcoholics,

while the social drinkers remained constant over time.

Chou and Pickering (1992) utilized the 1988 National Health Interview Survey, a nationally representative survey of individuals 18 years of age and older, to examine the effect of age of onset of drinking on lifetime alcohol-related problems. Defining early age of onset to be any drinking at fifteen years old or younger, an odds ratio of 2.70 (CI 2.52-2.90) was determined for the likelihood of earlier initiators to report adult presence of three or more of the alcohol dependence symptoms as defined by the DSM-III criteria.

Collegiate populations

Several studies have investigated the role of age of onset on current drinking among college students in cross-sectional designs. Gonzalez (1989) found age of onset to be predictive of the frequency and quantity of alcohol consumption and alcohol-related problems among college students. University students reporting their age at first drink to have occurred in elementary school or middle school drank more and experienced more alcohol-related problems than those reporting their age of initiation at high school or older. Likewise, Samson, Maxwell, and Doyle (1989) reported a negative association between both age at first taste of alcohol and age at first intoxication (both measured as continuous variables) and level of current drinking (average weekly consumption).

Shuckit and Russel (1983) surveyed 1,012 male college students and found that the early use of alcohol (under the age of 14) was related to increased frequency of drinking, increased quantity of alcohol consumption, and increased rates of alcohol-related problems. College men initiating alcohol use before the age of 14 experienced

between three and seven times more alcohol-related problems than those initiating use after the age of 17, and up to five times as many problems as those initiating use between the ages of 14 and 16.

Humphrey and Friedman (1986) and Friedman and Humphrey (1985) found that college students reporting their first drink (drinking criterion not defined) of alcohol at or before 15 years of age (as compared to those 16 or older) were twice as likely to report current drinking to intoxication four or more times per month. The subjects also reported on the frequency of their drinking at onset. Those reporting onset intoxication of once per month were twice as likely to report current intoxication of once per week, while those reporting onset intoxication of twice per month or more were over four times more likely to get drunk at least once per week as college students. Overall, 9.5% of the variance was accounted for by age of onset, while 20% of the variance in undergraduate intoxication was accounted for by frequency of intoxication at onset of drinking. After controlling for several potential confounders, including race, SES, population of hometown, family relationships, and familial alcohol problems, age of onset and frequency of onset intoxication remained significant predictors.

Secondary student populations

Finally, several studies have surveyed secondary students to investigate their current drinking with respect to their age of onset. Lo (2000) utilized 1977-1997 data from the Monitoring the Future study to explore the changing role of age of onset over two decades. Only students who were seniors in high school were included in the

analyses and debut age was defined as age at first drink excluding small sips. Onset drinking age surfaced as a consistent and stable predictor of late adolescent alcohol use over the specified time period. Moreover, age of onset accounted for over 20% of the variance of annual alcohol use and up to 50% of lifetime alcohol use.

Lewinsohn et al. (1996) utilized a sample of 1,507 male and female adolescents between the ages of 14 and 18 randomly selected from nine high schools to investigate alcohol use patterns. They used interview data to classify the students into one of five alcohol use categories: abstainers (never having had more than a sip of alcohol), experimenters (defined as having had alcohol but fewer than five drinks during their lifetime), social drinkers (having consumed more than five drinks in their lifetime but having no DSM-IV symptoms of alcohol abuse or dependence), problem drinkers (met the criteria for one or more DSM-IV symptoms, but did not qualify for diagnosis), and abuse/dependence (met the criteria for DSM-IV diagnosis of alcohol abuse or dependence). The abuse/dependence class reported a significantly earlier age of first drink (defined as more than a sip or taste).

Gruber et al. (1996) found age of alcohol onset to be predictive of alcohol abuse and dependence symptomatology among their sample of 2,650 6^{th}, 9^{th} and 12^{th} grade students. Defining early age of onset to be 12 years old or younger, they found that early initiator, male high school seniors drank more frequently, drank larger quantities, got drunk more often, demonstrated a higher alcohol tolerance, and experienced more negative consequences of alcohol use (blackouts, violent activity, injuries, missed work and school, and loss of relationships) than those who initiated alcohol use at 13 years old

or older. The females demonstrated similar but less severe findings. Risk for problems in later adolescence peaked when alcohol onset took place before the age of 13 and then began to decline. Finally, the authors calculated the resultant decreased risk associated with delaying onset to 13 years of age and found that this action would reduce the likelihood of several negative health and behavioral outcomes as reported by high school seniors. Delaying initiation to 13 decreased the risk of getting drunk by 13% and alcohol dependency symptoms by 40%.

Donnermeyer and Park (1995) examined survey data from 456 7^{th} and 11^{th} grade students from four rural schools in northern Illinois. Defining the age of onset as the age the students "first started or experimented with drinking," 30% of the variance of frequency of alcohol use in the past three months was predicted by age of onset. Covariates in the model included gender, age, family structure, time with family, time with friends, and religious participation.

Barnes and Welte (1986) surveyed 27,335 students from randomly selected public schools in New York State. After controlling for age, gender, race, school misconduct problems, parental attitudes about underage drinking, grades in school, and peer drinking, age at first intoxication was reported as the second best predictor of current drinking level (quantity and frequency), second only to school misconduct problems. Those subjects who had reported experiencing their first alcohol intoxication by age 11 drank an average of nearly four drinks per day, while those students who had never before been intoxicated drank an average of one drink per month.

Rachal, Guess, Hubbard, and Maisto (1982) analyzed cross-sectional data from

9,901 10^{th}-12^{th} grade students and found that alcohol misusers (reported drunkenness at least six times in the past year or negative consequences from drinking two or more times in the past year in at least three of the five following areas: trouble with teachers or principal, difficulties with friends, driving under the influence, criticism by a date, trouble with the police, and trouble with family members) initiated alcohol use at an earlier age than alcohol users (those who reported alcohol use but did not qualify as a misuser) and, as would be expected, abstainers. Over half of the misusers reported their first drink at 13 years of age or younger, compared with one-third of the users.

Summary of published studies

There appears to be substantial evidence for the relationship between age at first use of alcohol and subsequent alcohol misuse. All of the published studies found a relationship between earlier age of onset and greater frequency of drinking, intensity of drinking, and/or incidence of alcohol-related problems. However, Labouvie et al. (1997) found that age at alcohol onset did not have predictive utility at age 20 after controlling for age at first use of illicit substances. In addition, age of onset was not predictive of drinking at age 30 even without the covariate of age at illicit drug use. Recall, however, that Labouvie and colleagues (1998) found support for the hypothesis with the addition of an interaction variable between age at first use of alcohol and trajectory of drinking throughout adolescence. In addition, the Prescott and Kendler (1999) results suggest a unique interpretation of the relationship, suggesting that the association isn't causal, but rather a spurious effect. This point will be further discussed below.

The final section of the review will focus on the theories that have been suggested to describe the mechanisms by which age of onset is associated with subsequent alcohol use patterns.

Theories describing the relationship between age of onset and subsequent alcohol misuse

Several hypotheses have been formally deduced or implied to explain the mechanisms by which age of onset affects subsequent alcohol abuse and/or dependence. It is important to note that these hypotheses are not mutually exclusive and most researchers agree that there are multiple pathways linking early onset and later use.

Age of onset as a stepping stone to subsequent misuse

Not only is early age of alcohol onset associated with negative alcohol outcomes, it is also predictive of other substance abuse problems. Kandel and colleagues (Kandel & Faust, 1975; Kandel, Kessler & Margulies, 1978) were the first to suggest the gateway or stepping stone hypothesis. The hypothesis suggests that adolescents tend to progress through developmental stages of drug use initiation and that the use is cumulative in nature. That is, adolescents using a single drug are likely to initiate use of other drugs. Kandel's initial hypothesis suggested the following sequence: (a) beer or wine, (b) cigarettes or hard liquor, (c) marijuana, and (d) other illicit drugs. Glantz (1992) reported that although subsequent examinations of the gateway hypothesis (Collins, Graham, Long & Hansen, 1994; Donavan & Jessor, 1983; Huizinga, Menard & Elliot, 1989; Newcomb

& Bentler, 1986, 1990; Voss & Clayton, 1987; Yamaguchi & Kandel, 1984) have not found support for an "inevitable fixed sequence for all populations, the basic stage concept has been verified as a common etiologic pattern" (p. 397).

In their examination of the hypothesis, Collins and colleagues (1994) tested a model with eight drug use stages among a population of seventh graders as they transitioned to the eighth grade. The most common sequence of advanced use (recent use of alcohol or cigarettes, or any use of marijuana) began with alcohol, progressed to cigarette smoking, drunkenness, and finally advanced use.

Also in support of the gateway hypothesis, other investigations have found associations between alcohol age of onset and subsequent initiation of other substances, including tobacco (Yu & Williford, 1992; Schuckit & Russel, 1983), marijuana (Lo, 2000; Gruber et al., 1996; Yu & Williford, 1992; Jessor & Jessor, 1975), cocaine (Lo, 2000; Gruber et al., 1996), inhalants (Gruber et al., 1996), amphetamines (Gruber et al., 1996), and sedatives (Gruber et al., 1996).

This theory suggests that once an adolescent has initiated use, he or she has opened the gateway to higher levels of use (drunkenness, binge drinking) and/or other substances. It is perhaps by this mechanism that one progresses from initiation to more advanced use and potentially to alcohol abuse or dependence. This notion is supported by the findings of Labouvie and White (1998) in which the relationship between age at first use of alcohol and adult alcohol use at age 20 became insignificant with the addition of age at first use of illicit drugs as a covariate. This finding suggests that age at drinking onset and age at illicit drug use share variance. Moreover, early onset of illicit drugs

significantly predicted young adult alcohol abuse/dependence.

Age of onset as a step towards increased exposure to alcohol

Several researchers have hypothesized that age of onset affects subsequent alcohol patterns because the likelihood of an adolescent being exposed to additional alcohol increases once initiation has taken place (Robins & Pryzbeck, 1985; Kandel, 1998; Yamaguchi, 1990; Graham, Marks & Hansen, 1991). This notion is an applied example of the concept of 'cumulative continuity' put forth by Caspi, Elder, and Bern (1987). They posit that circumstances and events are maintained through the accumulation of their own consequences. That is, students who begin drinking are more likely to find themselves in situations where alcohol is present and even encouraged.

Akers (1985) reported that early onset increases the likelihood of an adolescent learning deviant behavior by prolonging the risk-taking period of his or her life. Others have suggested that early onset may cause a child to be more vulnerable to later misuse of alcohol (Fergusson et al., 1994).

The work of Labouvie and White (1998) also supports this notion. Their research suggests that the role of age of onset may best predict young adult drinking outcomes when adolescent drinking trajectories are also considered. That is, age of onset of alcohol use may only predict abuse or dependence to the extent that it is strongly correlated with more intense trajectories of use throughout adolescence. Ayers, Williams, Hawkins, Peterson, Catalano, and Abbott (1999) stated that "for most youths, delinquent acts are rather minor and infrequent, and engagement in delinquency is of a fairly short duration"

(p.278). Ayers and colleagues suggest that three important behavioral characteristics must be differentiated in order to understand the etiology of delinquent behavior: (a) initiation of the behavior, (b) change in the seriousness of the behavior, and (c) discontinuance of the behavior once initiated. Therefore, it is possible that the initiation of alcohol use alone is not predictive of adult abuse. Rather, early initiation followed by risky patterns of alcohol use throughout adolescence may interact to predict young adult alcohol abuse.

Age of onset as a mediator

Age of onset has been theorized to act as a mediator in the relationship between personality, peer influence, and parental impact in earlier life and later alcohol abuse. That is, the relationship between adolescent ATOD risk factors and young adult alcohol problems can be explained by an early age at first use. Hawkins et al. (1997) tested a mediation hypothesis and found that many predictors of alcohol abuse were mediated by age of onset, including parental drinking, proactive parenting, school bonding, peer alcohol initiation, and ethnicity. Gender was the only predictor of alcohol use at age 17/18 that was not mediated by age of onset. Likewise, Pedersen and Skondral (1998) found that age of onset mediated the relationship between several adolescent ATOD risk factors (parental alcohol use and norms, peer norms, friends' use of ATOD) and later alcohol misuse.

Dawson (2000) reported evidence in support of the Hawkins and colleague's hypothesis regarding parental influence in her analysis of the NLAES data. She

investigated the role of family history of alcoholism to test whether early onset alcoholism results from early age at alcohol initiation, a more rapid trajectory of use toward dependence once drinking has begun, or both. Using survival analysis, she found that the percentage of alcoholic relatives was positively associated with the hazard of early initiation of drinking. Those individuals with a family history of alcoholism were more likely to initiate use before the age of 15. The analysis also suggested that family alcoholism was more predictive of early age of initiation than a more rapid development of dependence. Dawson attributes part of this finding to the potential role of the dopaminergic and serotoninergic systems in the genetics of alcoholism. Both of these biological processes have been associated with novelty seeking and impulsivity, which may lead to an earlier onset of drinking. Dawson suggests, however, that the familial role in the early onset of drinking is likely to be more attributable to environmental factors (easier access to alcohol in the home, familial acceptance of alcohol, poor parental monitoring) than genetic factors. She points to Rose's (1998) twin study in which she concluded that 'the influence of genetic factors on initiation of drinking was negligible relative to environmental effects, but that after initiation of drinking, genetic influence played a significant role in drinking behavior" (p. 638). Taken together, the findings of Dawson and Rose may suggest that the family environment created by an alcoholic parent puts a child at risk for an early debut to alcohol. Ferguson et al. (1996) support this notion, stating that early age of onset may be an indicator of a family environment that possesses a permissive attitude toward their child's alcohol use. Similarly, Chassin, Barerra, and Montgomery (1997) reported that children of alcoholics are more likely to

be members of a family characterized by a single parent, a high degree of conflict, less consistent support, and less discipline.

Age of onset as a spurious effect of subsequent misuse

The mediational hypothesis has been challenged by Prescott and Kendler (1999); the authors insist that the association between age of onset and subsequent alcohol abuse is noncausal. Rather, they find the relationship to be "consistent with the shared vulnerability hypotheses - that onset and diagnosis are both manifestations of familial vulnerability to problem alcohol use….and provides little support for the mediational hypothesis – that early drinking mediates the risk for alcoholism" (p. 105). Similarly, Robins (1992) suggested that age of onset is nothing more than a correlate of other factors that are the actual causes of later alcohol abuse, including family dysfunction, academic performance, and a tendency towards deviance. Jessor and Jessor's (1975) longitudinal study of adolescents found that prior to drinking initiation, future adolescent drinkers could be differentiated from adolescent non-drinkers by several variables, including personality, personal behavior, parental behavior, and peer behavior. Pedersen et al. (1998) believe alcohol age of onset to be an important phenomenon, however, they added a caveat to their research findings (reported above), stating that "variables assumed to influence the development of alcohol consumption are connected with the age when debut occurs. Therefore, we cannot exclude the possibility that we are really estimating the effect of these mutual, underlying variables instead of age at alcohol debut" (p.37).

Based on the evidence presented, it is possible that there is no causal effect of

early alcohol initiation on subsequent alcohol patterns and consequences, but rather that some of the same individual characteristics (genetics, personality, family environment, etc.) that cause alcohol abuse and alcohol-related consequences also lead to an earlier onset of alcohol use. However, Zucker and colleagues (1995) warn that some researchers have wrongly considered age of onset as merely a marker of risk which only manifests itself as an adult alcohol problem without considering the possibility that age of onset is in fact "part of the intervening process, and needs to be present in order for the adult pathology to manifest itself" (p. 697).

Age of onset as an indicator of problem behavior

Lo (2000) suggests that toleration of deviance predicts both age of initiation and subsequent use of alcohol and other substances. Her theory was based on Jessor and Jessor's (1977) problem behavior theory that suggests a problem behavior syndrome indicative of an adolescent's general social-psychological make-up. She points to Hirschi and Gottfredson's (1994) self-control theory as an additional support of her argument, a theory that also puts forth the notion that problem behaviors are related to one another and adds that all are results of poor self-control.

Weber, Graham, Hansen, Flay, and Johnson (1989) reported on an investigation to identify two paths of alcohol use onset. In noticing the seemingly conflicting theories of problem behavior theorists (Jessor and Jessor, 1977;1980) and socialization theorists (Huba, Wingar, and Bentler, 1979; 1980), Weber and colleagues hypothesized that both theories have validity because there may in reality be two types of substance users. One

type of substance user can be described as individuals who are normally socialized, while the second type consists of individuals whom are problem behavior prone. In testing their hypothesis of two distinct types of users, the authors used cluster analysis to define user types among adolescents in Project SMART (Hansen, Johnson, Flay, Graham, & Sobel, 1988). Their analyses confirmed the existence of two different developmental pathways of alcohol use onset during adolescence. Those classified as problem behavior prone users differed from the normally socialized users in several ways: problem behavior prone adolescents were more likely to (a) be less concerned about their parents' and peers' reaction to alcohol use, (b) perceive their parents to have indifferent feelings about their alcohol use, (c) possess less aversive feelings about the negative consequences of alcohol use, and (d) have friends who use alcohol. Furthermore, those students identified as the problem behavior prone type drank significantly more at a second survey than those adolescents classified as normally socialized alcohol users.

Age of onset as a change agent

Intertwined with generality of deviance theories, problem behavior theorists as well as others have suggested that age of onset plays a role in subsequent use partially because of the change that takes place once alcohol initiation has occurred. Lo (2000) suggests that "problem behavior theorists have noted that the onset of drinking marks a significant change among youths with regard to their beginning role as deviants" (p. 528). Jessor and Jessor (1975) stated that initiation of alcohol use may be seen as an

adolescent's desire to move from a less mature to a more mature state. The authors based this hypothesis on the work of Maddox and McCall (1964) in which they hypothesized that drinking onset can be conceptualized as a "symbolic means of dissolving the adolescent status and identifying the user with the life style of adults" (pp. 61-62). Pedersen and Skrondal (1998) contribute to this theory by stating "we suggest that something happens to people when they start engaging in certain behaviors. They change, in their own eyes and those of others. With more marginal acts (e.g., injection of drugs), the most important factor is that this event takes place at all. As regards alcohol, the important factor is that the event takes place before other adolescents take part in the same behavior, and it is conjecture that a wide range of changes take place: behavior repertoire, relations, and identity or role may all be influenced" (p. 40). If alcohol initiation occurs at an age that violates the age norm, perhaps it will set an adolescent on a continued course of non-normative alcohol consumption that may lead to alcohol abuse and/or dependency.

Age of onset as a disrupter of developmental processes

Early onset of alcohol use has the potential to increase the risk for later substance use problems by affecting normal developmental processes that are necessary for successful adaptation during adolescence and adulthood (Glantz & Pickens, 1992). Glantz and Pickens reported on high risk children who were unable to develop adaptive strategies, suggesting that alcohol use (as well as other substance use) allows a child to develop a greater reliance on substance abuse as an adaptive mechanism, and precludes

the development of more desirable adaptive strategies. Children who initiate use of alcohol and other drugs as a mechanism for dealing with stress are more likely to adopt continued and more frequent use of alcohol as a means of coping (McCubbin, Needle, and Wilson, 1985). Dewitt et al. (2000) describe the social and psychological changes taking place in early adolescence that can be considered potential stressors, including self-concept formation and acquisition of social skills.

Likewise, Clayton (1992) argued that early onset of any substance use interferes with the acquisition of developmental tasks. The developmental lag perspective, hypothesized by Baumrind and Moselle (1985), posits that drug use at this early stage of an adolescent's development may harm psychosocial maturation processes and impede identity formation.

This theory is consistent with the social development model (Catalano & Hawkins, 1996), which describes the process by which early antisocial behavior interferes with the development of prosocial protective factors at the proceeding stage of an individual's life. While some alcohol experimentation is considered normative among adolescents, alcohol initiation that occurs well before the age-graded norm can be considered an antisocial behavior.

Summary

Based on the evidence presented, the best course of investigation appears to be one which describes the patterns of adolescent use as a person-centered, dynamic process that models the age of initiation, the trajectory of alcohol use through adolescence, and

the sequencing of other drug use. Labouvie and White (2002) suggest a course of action in which "individual differences in ages of onset and sequencing of drug use must be considered in conjunction with intraindividual changes in use intensity and individual differences in those changes". Furthermore, the clear need to control for covariates that may predict both age of onset and subsequent alcohol abuse and/or dependency is apparent if one desires to assess age of onset's impact on young adult alcohol abuse/dependence independently of other risk factors.

Chapter 3

METHODS

Design

The data for this project were collected through a prospective, longitudinal study that followed adolescents in one rural, disadvantaged school district from junior high though young adulthood. The study was conducted in a rural northern Appalachian community, beginning in 1985. The original investigation, the Rural Adolescent Development study (RAD), funded by the Office of Adolescent Pregnancy Prevention Programs (grant # 000933-01, Dr. Judith R. Vicary, Principal Investigator), began following the students who were in 7^{th} (7^{th} grade cohort) 8^{th} (8^{th} grade cohort), or 9^{th} (9^{th} grade cohort) grades in the fall of 1985 (Figure 1) as part of a longitudinal cohort sequential design (Baltes, Reese, & Nesselroade, 1977). The RAD study surveyed the students every fall from 1985-1990. After high school graduation, the two older cohorts were surveyed by mail. In addition, a seventh unfunded pilot survey was mailed to all subjects in the winter of 1991-1992, constituting the first young adult survey. The seventh survey was conducted to determine the feasibility of an extensive adult follow-up. The subjects' response to the survey was encouraging and in 1995 a second investigation was initiated. The Rural Young Adult Transition Study (RYATS) funded by the National Institute on Alcoholism and Alcohol Abuse (grant # 1 R01 AA096787, Dr. Elizabeth J. Crockett, Principal Investigator and Judith R. Vicary, Co-Principal

Investigator), consisted of a comprehensive young adult follow-up of the subjects through the use of a mailed survey and a telephone interview.

	Grade of Subjects												
Cohort	7th	8th	9th	10th	11th	12th	ph1	ph2	ph3	ph4	ph5	ph6	ph7
7th grade cohort	85	86	87	88	89	90	91				95		
8th grade cohort		85	86	87	88	89	90	91				95	
9th grade cohort			85	86	87	88	89	90	91				95

ph=post high school

Figure 3–1: Survey administration by year for each cohort

Procedure

Following human subjects' approval from the Penn State Office for Regulatory Compliance for the initial RAD study, the local school board approved the study. In accordance with the school district's protocol, the parents in the school district were notified of the survey and asked to contact the school if they did not wish their child to participate. In addition, informed consent was obtained from each student. Refusal rates were very low, as approximately 95% of eligible students agreed to participate in the in-school survey in any given year. However, the data from students who were classified as learning disabled/special education were not included in subsequent analyses.

During the fall of each school year, the students completed the survey in classrooms separated by gender, and supervised by research project staff. The students were assured of the confidential nature of their survey responses and no names were used

on the survey form. Over the course of the study, some students moved in or out of the district. The new students were added to the survey sample, thereby increasing the total sample size slightly. The 8th and 9th grade cohorts continued to complete the survey via mail after high school graduation, allowing one additional post-high school assessment for the 8th grade cohort and two post-high school assessments for the 9th grade cohort. Incentives for participation in the survey were offered each year through a raffle.

The first young adult follow-up, Survey 7, took place in the winter of 1991/1992. A small grant from The Pennsylvania State University was used as a pilot study to determine the feasibility of surveying previous participants. All subjects who had completed at least one survey during the first six years of the study were targeted for follow-up.

The second young adult follow-up, Survey 8 (RYATS), constituted a more comprehensive, funded effort to track and survey the subjects. This project focused on subjects who had completed two or more surveys during the first seven survey administrations (N=686). A variety of tracking methods was used, including school transfer records, postal forwarding addresses, Bureau of Motor Vehicles registration, voter registration records, auto registration, marriage license records, key-informants mailings to classmates, and family referrals.

After being located, subjects were sent a letter to explain the follow-up study, request their participation, and offer a participation incentive of $20.00. Following the letter, a phone call was placed to the subjects by project staff to answer any questions and obtain verbal consent to participate. Those willing to participate were then mailed the

survey for consent and completion along with a return self-addressed stamped envelope. The survey required approximately 1½ hours to complete. A follow-up reminder postcard was mailed to participants not immediately returning the survey. In order to maximize responses, a second survey was mailed six weeks after the initial survey packet. The second survey was followed by a final post-card that emphasized the importance of returning the survey and reminded participants of the $20.00 incentive.

Community

The subjects were recruited from one rural school district located in the Allegheny Range of the Appalachian Chain in the Eastern United States. The surrounding community is a geographically contained area that includes a number of small boroughs and townships, including seven municipalities. The community spans 25 miles in diameter and is situated in two counties. It is located approximately three to four hours from any large urban area.

The residents of the community were and continue to be mostly white and of low to low-middle income. Many of the families have been in the area for three to four generations and originally located to the town to work in the then active mining industry. The community thrived for many years; however, beginning in the early 1980's the community began to experience severe economic stress as the major industries began to lay off its workers. Over 45 businesses closed and by 1987, unemployment was at 19.6%.

Subjects

The data were collected utilizing a cohort sequential design; therefore, students entering the study were at different ages. Although the students were in three different grades at the first survey (7^{th}, 8^{th}, or 9^{th}), they represented an age span of 5 years (12 years old to 16 years old). A total of 686 students comprised the sample; 158 of the students were 12 years of age at the initial survey, 241 were 13, 230 were 14, 46 were 15, and 11 were 16. *Figure 3–2* depicts the mean frequency of intoxication by age throughout adolescence. These figures were determined by imputing a single dataset from EM parameters (EM converged in 24 iterations). The imputation model included frequency of drunkenness at each survey wave (the A and B version, the details of this strategy are presented in the Measures section), age at survey one, and gender. As can be seen by the figure, the students who were 12, 13, or 14 at survey one appeared to be more similar than those students who were 15 or 16 (Note that the students who were 12 at survey one were assessed at age 18. Their mean at age 18 was exactly the same as those who were 13 at survey one.).

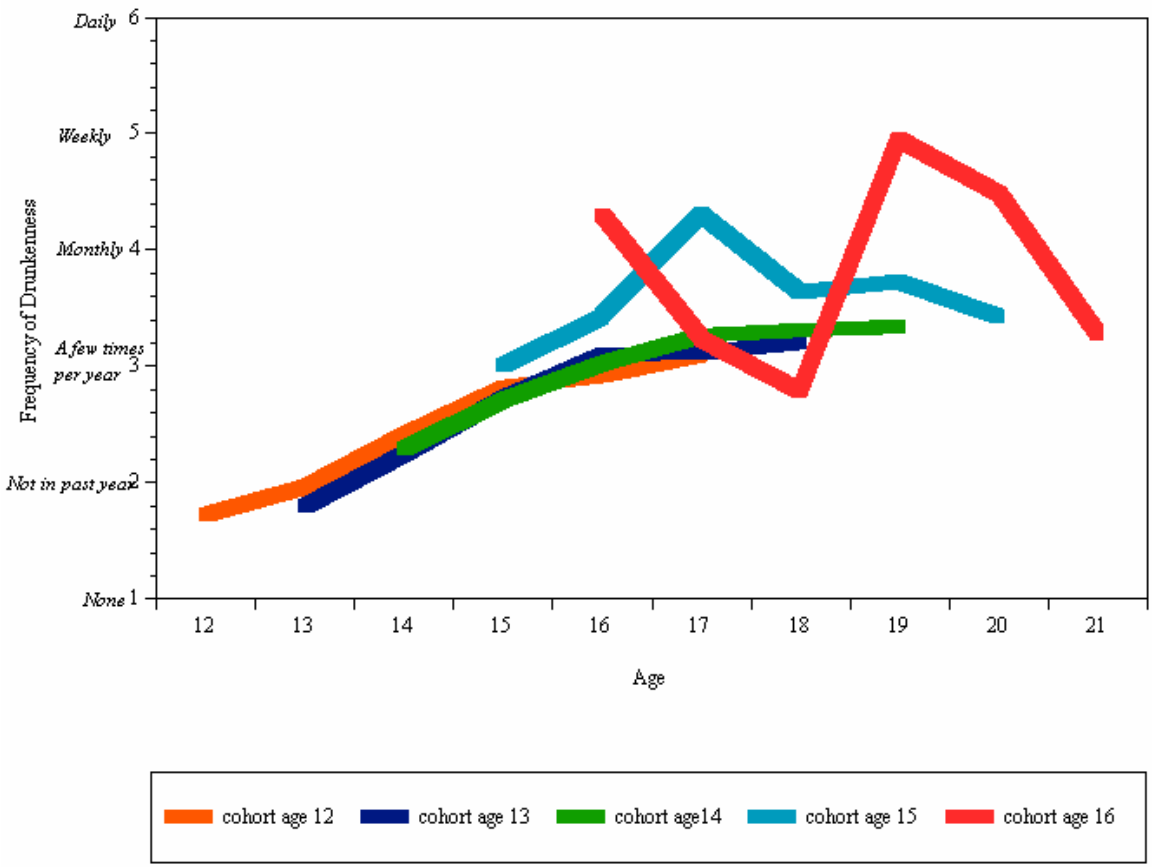


Figure 3–2: Frequency of adolescent drunkenness by age at the first survey

The basis for many of the analyses performed for this investigation involves longitudinal growth curve (LGC) modeling. Within this framework the concept of time is integral to the model as LGC models imply that the means, variances, and covariances among the measured variables are conditional on time. The very reason for modeling a LGC is to evaluate a hypothesis that inquires about the relationship between a phenomenon of interest and change over time. Therefore, in order to obtain LGC results that are meaningful, one must carefully consider the element of time. Perhaps one of the

most important considerations is the scaling of time, as LGCs represent explicit mathematical models that underlie the interpretation of the results gained from their analysis.

The consequences of this point are a salient issue for the present study as the study represents a cohort-sequential design. Two options are available for considering these data in a LGC framework. One option involves defining time as simply T1, T2, T3…Tj to correspond with the survey administrations. In this model, the subjects are age heterogeneous at each time point, and age at the first survey must be modeled as a covariate. In addition, the level and shape of the trajectory indicate something different in terms of age across the cohorts. For example, the subjects beginning the study at age 12 represent a very different developmental phase than those subjects beginning at age 14. It is clear that this technique leads to the analysis of heterogeneous subpopulations and may result in a misleading interpretation of the findings. In a simulation study, Mehta and West (2000) demonstrated the potential problems associated with this approach and concluded that appreciable bias can be expected whenever the intercept factor is modeled as either an independent or dependent variable in a structural equation model.

A second option is to consider the model within a missing data framework. That is, to make the testable assumption that the students are part of the same population and due to planned missingness a portion of their data was not collected. Under the assumption of planned missingness, the data can be considered missing at random (Schafer & Graham, 2002). Each cohort represents a different pattern of observed data

and therefore contributes to a different portion of the developmental curve. Therefore, a complete developmental curve can be simultaneously constructed from the data provided by all three cohorts. This approach has the benefit of allowing the element of time to be equal across all subjects, resulting in simpler interpretation of the growth parameters. Furthermore, by allowing age (rather than survey wave) to define the time axis, one obtains a "spreading out of the time axis" and allows more time points to be included in the growth model (Muthén, 2000). This technique is referred to as an accelerated longitudinal design (Duncan, Duncan & Hops, 1996) as more time points are available than the actual number of data collection points.

However, in order to proceed with this approach it must be ensured that the cohorts can in fact be considered as subgroups of the same population. The test of convergence is easily accomplished through a multiple group structural equation model in which the LGC is fit to each of the age cohorts. This type of model is referred to as an age convergence model.

In the present application, frequency of drunkenness from age 14 to18 was modeled as a LGC with an intercept (centered at age 17), a linear slope, and a quadratic term. *Figure 3-2* suggests that age cohorts 15 and 16 exhibited different mean trajectories of adolescent drunkenness than the younger age cohorts. In addition, the nature of the hypotheses being tested in this thesis would require that alcohol intoxication and delinquent behavior be imputed for up to three years before the subjects in age cohorts 15 and 16 were first surveyed. Based on these two points, an a priori decision was made to eliminate the subjects in age cohorts 15 and 16. As such, the remaining

three age cohorts (12, 13, and 14-years-old at survey one) were assessed using an age convergence model.

First, the data were imputed using NORM. The imputation model included only variables that had the potential of being observed by all three cohorts. EM converged in 62 iterations. Data augmentation was utilized to create 10 imputed data sets, allowing 100 iterations between each imputation.

An initial model was tested that allowed all of the parameters to vary across the three age cohorts. The X^2 for the model (for each of ten imputed data sets) is reported in *Table 3–1*. The model provided a good fit to the data. Next, cross-group equality constraints were placed on all latent means, variances, covariances, and residual time-specific variances to be equal across the three age cohorts. The X^2 difference between the two models was significant (as reported in *Table 3-1*); however, X^2 is known to be sensitive to sample size, such that with sample sizes as large as that used in this study (N=629) even trivial deviations from a perfect model are statistically significant. For that reason, three indices of practical fit were also utilized to make the main judgments about model fit (Rho, also known as NNFI [Tucker & Lewis, 1973; Bentler & Bonnet, 1980]; CFI [Bentler, 1990]; and RMSEA [Browne & Cudeck, 1993]). The changes in the practical fit indices suggest that the three cohorts did not differ in important ways. Therefore, it was concluded that the three age cohorts could in fact be considered as subgroups of the same population and an age convergence model was applied. As such, the subjects for the proposed analyses represent 629 individuals, 328 males and 301 females.

Table 3–1: Chi-square values for the age convergence model across the 10 imputed datasets

All parameters freely estimated					All parameters restricted across groups					Difference between models				
X^2	df	Rho	CFI	RMSEA	X^2	df	Rho	CFI	RMSEA	X^2	df	Rho	CFI	RMSEA
18.62	18	0.999	1.000	0.013	77.48	46	0.987	0.980	0.057	58.86	28	-0.012	-0.019	0.044
30.64	18	0.987	0.992	0.058	94.28	46	0.980	0.970	0.007	63.64	28	-0.006	-0.022	-0.051
30.79	18	0.987	0.992	0.058	97.77	46	0.980	0.969	0.073	66.98	28	-0.007	-0.023	0.015
18.59	18	0.999	1.000	0.012	72.38	46	0.989	0.983	0.052	53.79	28	-0.010	-0.016	0.040
22.22	18	0.996	0.997	0.033	81.62	46	0.986	0.978	0.061	59.40	28	-0.010	-0.019	0.027
39.18	18	0.977	0.986	0.075	96.90	46	0.979	0.967	0.073	57.72	28	0.001	-0.019	-0.002
36.28	18	0.980	0.988	0.070	112.93	46	0.972	0.957	0.083	76.65	28	-0.008	-0.031	0.014
37.83	18	0.979	0.987	0.007	107.85	46	0.974	0.960	0.080	70.02	28	-0.005	-0.027	0.073
30.35	18	0.988	0.993	0.057	87.53	46	0.984	0.975	0.066	57.18	28	-0.004	-0.018	0.008
26.27	18	0.991	0.995	0.047	77.84	46	0.987	0.979	0.057	51.56	28	-0.004	-0.015	0.011

Measures

The models specified carefully considered the recommendations put forth by the impressive published literature. The literature suggests that several important covariates must be considered in order to properly evaluate the effect of early onset intoxication on subsequent substance use behaviors. First, the literature suggests that early delinquency may actually be the catalyst for later problems, while early drinking is simply a byproduct of problem behavior. However, contrary to some reported studies, early drinking in the sample considered here predicted subsequent delinquent behavior. That is, it appears that early drinking was more likely to lead to early delinquency than early delinquency leading to early drinking in the sample. This conclusion was drawn based on data from the youngest cohort (those who began providing data at age 12). Two regression analyses were used to investigate the causal flow. First, frequency of intoxication at age 13 was regressed on frequency of intoxication at age 12 and

delinquency at age 12. While intoxication at age 12 was a significant predictor of intoxication one year later (β=.587, S.E.=0.123, T=4.77, p<.0001), delinquency at age 12 did not provide unique prediction to the equation (β=.060, S.E.=0.069, T=.87, p=.3882). Next, delinquency at age 13 was regressed on intoxication and delinquency at age 12. While delinquency at age 12 significantly predicted delinquency at age 13 (β=.455, S.E.=.104, T=4.37, p=.0001), intoxication at age 12 lent significant unique prediction to the model (β=.462, S.E.=.194, T=2.38, p=.0191).

As such, it would be inappropriate to control for delinquent behavior in the model as it would be a clear case of included variable bias (Clogg & Haritou, 1997). That is, by controlling for delinquency at age 13, variance would be unjustly taken away from early onset intoxication. Therefore, delinquency at age 13 was not used as a control variable in the analyses presented in this thesis. However, delinquency at age 13 was found to provide a great deal of discrimination among the trajectory classes in the LCGM's. As such, it was included as a predictor of class membership in the final three research questions.

Gender and family history of AOD problems were included as covariates in the models. It is clear both are causally prior to early onset intoxication and are therefore legitimate and important covariates. Other familial factors would also be important variables to consider, including parental use of substances, parental feelings about substance use, parental monitoring, and familial relationships. However, these variables were not measured in the early survey administrations.

Adolescent Measures

Frequency of intoxication

Frequency of intoxication at ages 14-18 was utilized to construct the growth model in the analyses. This survey item requested subjects to indicate the frequency with which they had "been drunk." At Surveys 1 and 2, students reported their frequency of alcohol intoxication on the following scale: (1) "never happened," (2) "happened but not in the last year," (3) "happens once per month," (4) "happens once per week," (5) "happens almost everyday" (hereto referred to as the reduced scale). Beginning with the third survey, the scale of the item was changed to: (1) "never happened," (2) "happened but not in the last year," (3) "happens a few times a year" (4) "happens once or twice per month," (5) "happens once or twice per week," (6) "happens almost every day" (hereafter referred to as the expanded scale). In order to compensate for this change, and optimize the scaling of the variable to facilitate growth curve modeling, a missing data technique was employed. Certain assumptions can be made with regards to how the subjects at Surveys 1 and 2 might have answered the items had they been given the opportunity to use the expanded scale. It is safe to assume that a student who responded "never happened" on the reduced scale would have also responded "never happened" on the expanded scale. The same assumption can be made for the response "happens once per week" or "happens almost every day." However, the students that responded as "happened but not in the last year," or "happens once per month" may have chosen a different response if given the chance to respond on the expanded scale. Therefore two new variables were created for each original variable: Version A and Version B. At

Survey one and 2, Version A represented the original variable, while Version B represented a new variable that was the same answer for those who responded as "never happened," 'happens once per week," or "happens almost every day" and was set to missing for those that responded "happened but not in the last year," or "happens once per month."

For Surveys 3 through 8, Version B represented the original variable. For those who responded "never happened," "happened but not in the last year," "happens once or twice a month," "happens once or twice a week," or "happens almost everyday," Version A represented the same response as Version B. However, because it is difficult to assume how an individual that responded "happens a few times a year" would have responded on the reduced scale, the Version A value was set to missing for those individuals.

Finally, one last change was made to the Version B variables. Because the hypotheses being tested in this investigation required the intoxication variables during adolescence to represent current intoxication, the scale was collapsed so that a response of "never happened" or "happened but not in the past year" were coded as 1. A value of one was then subtracted from all others' scores. This change was initiated after the protocol presented above was performed.

As a result, each individual was assigned two versions of the drunkenness item at ages 14-18, Version A and Version B. Both versions of the item were included in the multiple imputation model; however, only Version B was used in the subsequent

analyses. As a result, the drunkenness item represented the expanded scale for each individual and each time point.

Early onset drunkenness

Students who had reported ever being drunk by age 13 were classified as early onset (assigned a value of 1), while those who had not experienced their first intoxication by age 13 were assigned a 0. The oldest age cohort utilized in this investigation was 14 at the first survey and therefore was left censored. In order to compensate for this censoring, those students who had reported never having been drunk in their lifetime at age 14 were classified as non-early onset, while those that had already begun drinking to intoxication were classified as missing on this variable, as it is impossible to determine whether or not they were drinking to intoxication at age 13.

Delinquent behavior

Delinquent behavior was assessed at each wave of the first seven waves of data collection. The scale assessed the frequency with which the subjects engaged in the following problem behaviors: damaged property, vandalized property, stole from someone, shop-lifted, stole money from parents, cheated on a test, sent out of the classroom by a teacher, had sexual intercourse. The items represented engagement in the behavior on a monthly basis (coded as a 1 if the student reported the behavior in the past month, 0 if not). The items were summed to represent a total number of problem behaviors engaged in on a monthly basis. Delinquent behavior at age 13 was used in the

mixture models. Delinquent behavior at ages 14-17 was used in the imputation model. The variable was grand mean centered.

Family history of alcohol/drug problems

Family history of alcohol and other drug (AOD) problems was assessed beginning with the second survey. The subjects were asked to report whether any member of their family "has or has had problems with AOD." The student's response to this item at age 15 was used as a covariate in the analyses. This age was chosen as it represents the youngest age for which the variable was collected for all students. The test re-test correlations for the variable was reasonably high (.67) for the report at age 15 and 16. A value of 1 represented having a family member with an alcohol or drug problem as opposed to a 0 for those students who reported no family problems.

Gender

Gender was coded as 1 for female and 0 for male.

Age

Although an age convergence model was utilized for the first seven points of data collection, the young adult measures vary by age. That is, depending on the age cohort, the subjects were 22, 23, or 24 years of age at the final assessment. As such, age at survey one (representing year plus month) was utilized in the models that include the

young adult variables as well as in the imputation model. The variable was grand mean centered.

Survey 8 (young adult) dependent variables

Frequency of intoxication was assessed through a question inquiring about how often the subject "gets drunk" and was measured on a six-point scale including: (1) "never happened," (2) "happened but not in the last year," (3) "happens a few times a year" (4) "happens once or twice per month," (5) "happens once or twice per week," (6) "happens almost every day."

In order to assess the role of adolescent drinking on young adult use of other substances, a general drug question was asked: "How often have you been high on drugs?" The possible responses included (1) "never happened," (2) "happened but not in the last year," (3) "happens a few times a year" (4) "happens once or twice per month," (5) "happens once or twice per week," (6) "happens almost every day."

Finally, seven negative consequences of drinking were utilized (Wechsler, Davenport, Dowdall, Moeykens, and Castillo, 1994). The items represented a count of the number of times each consequence was experienced by the subject during the 12 months previous to the survey. The subjects were asked to report the number of times their drinking caused each consequence to occur. The consequences included: "have a hangover," "miss school or work," "do something you later regret,", "forget where you were or what you did," "damage property," "get into trouble with police,", and "get hurt or injured". All of the items were measured on a seven-point scale: (1) "never," (2)

"once," (3) "twice," (4) "three to five times," (5) "six to nine times," (6) "ten to fifteen times," (7) "more than fifteen times." While all seven of the consequences were included in the multiple imputation model in their logged form, only three were utilized in the analyses - "have a hangover," "forget where you were or what you did," and "get into trouble with police." These items were chosen as they represent a mild, moderate, and serious consequence respectively.

Missing data

Multiple imputation (MI) was originally proposed by Rubin (1987) as a method for handling missing data problems. MI replaces each missing value with a user predetermined number (*m*) of simulated values, thereby producing *m* plausible versions of complete data. MI does not impute for the sake of replacing the missing value itself, rather it imputes the values with the goal of preserving important aspects of the data distribution. The *m* data sets are then analyzed as any complete data set would be; however, the results from each of the *m* data sets are combined using Rubin's rules to obtain final, overall estimates and standard errors.

These estimates represent both missing data uncertainty and finite-sample variation. That is, MI restores the necessary variability in the imputed values. This variability must be replaced because regression-based imputation causes loss of variability due to two reasons. First, each imputed value is estimated without error as the predicted values of regression are not exact representations of the true value. The residual describes the difference between the actual and predicted value. MI makes the

assumption that the distribution of the residuals for the observed data are the same as the distribution of the residuals for the missing data. Therefore, this lost variability can be restored by drawing one element (randomly with replacement) from the distribution of the residuals for the observed data for each missing value and adding it to each imputed value.

The second cause of loss of variability occurs because the imputed values are generated from a single estimate of the covariance matrix. This single covariance matrix is estimated with error; therefore, MI must restore this variability through the generation of multiple plausible covariation matrices. This process can be achieved through a bootstrapping procedure or through data augmentation.

MI makes assumptions about the mechanism of missingness. Graham, Cumsille, and Elek-Fisk (in press) describe three general categories of missing data patterns. First, the data may be missing completely at random (MCAR). That is, the mechanism for the missingness is due to a completely random process. Missing data may be considered MCAR if the reason for missingness is uncorrelated with the variable containing missingness. An example of MCAR data includes attrition due to a student moving out of the school district in order for his/her parent to accept a new job. Second, data may be missing at random (MAR). In this scenario, the probability of missingness is correlated with the variable(s) with missing data; however, the mechanism for the missingness has been measured and is available for inclusion in the missing data model. For example, some of a student's data may be missing because he/she was unable to complete the survey due to poor reading ability. By collecting data on reading ability or a viable

proxy, the researcher can model the missing data mechanism. Finally, data may be missing not at random (MNAR). Like the MAR scenario, data that are MNAR have a missing data mechanism that is correlated with the variable(s) containing the missingness; however, the cause or mechanism of the missingness has not been measured. For example, survey absence due to a hangover would be considered MNAR within the context of an ATOD prevention study. MI assumes that data are MCAR or MAR; however, Graham et al. (in press) suggest that even in cases of MNAR these types of strategies are viable as it likely that at least part of the cause of missingness is accessible.

The data involved in the present study were missing mainly due to the cohort-sequential design. Therefore, this portion of the missingness was considered as planned. *Table 3–2* presents the sample size by age cohort for each of the surveys. Under the assumption of planned, the data are missing at random (Schafer & Graham, 2002). The second largest cause of missingness was due to survey absence or attrition. Collins, Schafer, and Kam (2001) recommend including variables of non-substantive interest to the missing data model in order to increase the likelihood that data meet the assumption of MAR and reduce bias due to non-ignorable missing data patterns. Therefore, this technique was utilized to best estimate the missing data.

Table 3–2: Sample size by age cohort for each survey

	Age of Subjects												
Cohort	12	13	14	15	16	17	18	19	20	21	22	23	24
12-years-old	142	144	143	131	135	125	116				116		
13-years-old		226	214	201	196	181	99	152				157	
14-years-old			217	213	172	172	118	72	144				143

In order to account for missingness in the data, MI using NORM (Schafer, 2001) was utilized. EM converged in 66 iterations. Data augmentation was used to impute 20 data sets, allowing 150 iterations between each imputation. In addition, a single dataset imputed from EM parameters was created in order to describe the relationships between the variables of interest in a clear and simple way (Graham et al, in press). The EM algorithm creates a maximum-likelihood variance-covariance matrix and vector of means which may be used directly for subsequent analysis or for single-imputation of a full raw dataset. The values imputed in this way represent values in the middle of the parameter space and are therefore very close to the most likely value of parameters based on incomplete data. While the EM imputed dataset is very helpful for obtaining relatively unbiased parameter estimates (Graham et al, in press), it is not adequate for hypothesis testing as standard errors are not provided. As such, the EM imputed dataset was used for descriptive purposes only and the twenty multiply imputed datasets were used for hypothesis testing.

Analytic strategy

Question 1: What is the impact of early onset intoxication on drinking behavior during adolescence (ages 14-18)?

Defining early onset drunkenness as reported drunkenness by age 13, the first research question assessed the impact of early onset drunkenness on the frequency of drunkenness at each subsequent adolescent survey. Furthermore, the ability for early onset drunkenness to exist as a significant predictor at each subsequent survey after controlling for relevant covariates was evaluated.

LGC modeling has emerged as a valuable technique for studying change over time. LGC models allow researchers to not only understand the change over time in a particular domain for a certain population, but also to investigate the interindividual differences in the level and shape of change. That is, LGC models allow for hypothesis testing at both the group and individual level.

In the present application an unconditional latent growth curve (LGC) was fit. The LGC represented the change in frequency of drunkenness from age 14 to age 18. To estimate the LGC, the five repeated measures of frequency of intoxication were specified to load on the growth parameters. Both a linear and quadratic model was tested.

Next, a series of five conditional models were fit to assess the predictive utility of drunkenness by age 13 and relevant covariates on the growth factors of the LGC model. A centering approach (as explained by Muthén, 2000) was utilized in which early onset and three covariates (delinquent behavior at age 13, gender, and family history of AOD problems) were used to predict the slope and quadratic terms and the intercept (centered

to capture the systematic part of the development for a particular age). As Muthén suggests, "the influence of the background variables need not be the same at different ages. The estimates will be different as will the standard errors and the t-values. In this way, a background variable that is insignificant with a certain centering point may be significant with another" (p. 118). Mplus (Muthén & Muthén, 1998) was utilized to fit the models across the 20 imputed datasets.

Question 2: What is the impact of early onset intoxication on alcohol-related behavior in young adulthood; including frequency of intoxication, use of other substances, and negative consequences due to drinking?

The second research question assessed the role of early onset drunkenness on young adult intoxication, substance use outcomes, and alcohol-related consequences at the eighth and final survey, that is, when the subjects were between the ages of 22 and 24. A simple path model was specified in Mplus (Muthén & Muthén, 1998) to test the hypotheses.

Question 3: Does early onset intoxication affect the trajectory of drinking from ages 14-18?

Question 3 involved the estimation of adolescent trajectory classes to account for the different patterns of alcohol use present in the population from ages 14 through18. Mplus (Muthén & Muthén, 1998) was utilized to predict latent class membership. The technique utilized, commonly referred to as latent class growth modeling (LCGM) or semi-parametric group-based modeling (Nagin, 1999), utilizes a person-centered

approach to define trajectories, and allows for grouping of individuals into categories for which individuals in a given category are similar to one another yet different from individuals in other categories (Muthén & Muthén, 2000a). Each latent class represents a different growth model. That is, each class has its own intercept and shape. As such, individual variation in frequency of drunkenness from ages 14 through18 was captured and predicted by early onset drunkenness.

Muthén (2001) describes the benefit of utilizing latent trajectory classes rather than continuous growth factors to predict subsequent outcomes. He explains that the growth factors interact to determine the shape for each individual. This resultant shape is of prime interest and importance. When one predicts just the slope, or uses just the slope to predict a subsequent outcome, the overall shape is lost. However, latent growth mixture modeling allows the entire shape of the trajectory to be utilized. For example, consider two types of adolescent drinkers. One exhibits no drinking from ages 14 through18 while the other drinks at the highest level on the scale from ages 14 through 18. Both will demonstrate a slope value of 0. If a slopes as outcomes model was utilized to predict drinking over time by several independent variables, then these two types of drinkers would be treated as the same because the intercept of the model is not being taken into account. However, a latent growth mixture model places these two drinkers into two different classes and the variation from their entire adolescent drinking trajectory can be evaluated.

One can further examine the differences between LGC modeling and latent class mixture modeling by considering the fixed and random effects. Latent growth curves

attempt to estimate a single fixed effect for the population. The variance around the fixed effect (the random effect) is of interest. That is, the variation around the fixed effect can be both explained and used to explain other phenomena of interest. In latent class mixture modeling, a fixed effect for multiple underlying latent classes is estimated. The resultant fixed effect for each class represents the differing trajectories of change in the variable over time. Covariates of interest may be used to discriminate membership in a certain class, and class membership may be used to predict distal outcomes. The technique referred to as latent class growth modeling (Nagin, 1999) is concerned only with the fixed effect in each class and specifies the within class variation to be zero. That is, random effects are not allowed. Muthen and Muthen (2000) have developed a technique called general growth mixture modeling in which random variation within a class is allowed. The current investigation utilized the LCGM approach to estimate the trajectory classes.

In order to specify the LCGM, the guidelines suggested by Nagin (1999) were followed. It was determined that a censored normal distribution best fit the drunkenness items over time. Next, a polynomial relationship to model the change in frequency of drunkenness over time was explored. Both linear and quadratic equations were evaluated; however, a quadratic model proved to provide the best fit. The growth parameters were allowed to vary across classes, but not within class, allowing for different shapes of developmental trajectories across the groups. Nagin's technique differs from Muthén's (2000) growth mixture modeling technique in that the latter allows within class variance whereas the former does not. As mentioned, Nagin's technique was

utilized in the present analyses. However, rather than specifying the LCGM using Nagin's Proc Traj procedure, the model was specified using Muthén & Muthén's (1998) Mplus program.

In order to determine the number of trajectory classes that best describe the data, a series of LCGMs were specified in which each successive model added one additional class. The model testing began with a single class model and continued until the addition of a new class resulted in non-convergence. Three criteria suggested by Muthén and Muthén (2000a) were used to determine the best fitting model. First, the Bayesian Information Criterion (BIC) was compared across models. A well-fitting model as determined by the BIC has a high Log Likelihood value, but is parsimonious with regards to the number of parameters. A lower BIC is associated with a better fitting model. Muthén and Muthén's second criterion concerns the posterior probabilities. The probability describes the likelihood that the individual belongs to a given class. As such, a good fitting model is one in which subjects have a high likelihood of belonging to one class, and a low likelihood of belonging to the other classes. This concept is akin to obtaining a simple structure in factor analysis. Finally, the third criterion considers the practical usefulness of the classes. The Muthéns suggest considering the similarity of the trajectory shapes, class sizes, the number of estimated parameters, and the differences in the prediction of the distal outcomes.

Once an unconditional LCGM was specified, time-invariant predictors were added to the model to determine the predictors of class membership. As described by Muthén and Muthén (2000a) multinomial logistic regression is used to predict the latent

class variable. That is, each class is compared to a reference class. In the analyses discussed here, class membership was regressed on early onset drunkenness and the covariates of interest.

Question 4: Are certain drinking trajectories more likely to be associated with young adult substance-use behavior and alcohol-related consequences?

The fourth research question utilized the latent trajectory classes estimated in Research Question 3 to predict young adult substance use behaviors. The hypotheses put forth in this thesis require that the latent trajectory class variable represent only information about adolescent behavior. As such, the final model arrived at for Research Question 3 was restricted to be constant (equal to the model without the distal outcomes), allowing only the young adult outcomes to be estimated freely. As a result, the distal outcomes were not allowed to influence class membership.

Mplus mixture models allow the coefficients associating trajectory class to the continuous young adult outcomes to represent the mean level for each class. A series of nested models were used to test for significant differences on the young adult outcomes as a function of class. The difference in the Log Likelihood given the change in the degrees of freedom was used to determine a significant effect.

Question 5: Does early onset intoxication have an independent effect on young adult outcomes beyond the effect explained by trajectory class? To what extent does trajectory class mediate the relationship between early onset intoxication and adult substance abuse and related consequences?

Question 5 evaluated the extent to which the covariates had predictive power beyond that of trajectory class. The coefficients associating the covariates with the young adult outcomes were evaluated. In this way, both direct and indirect (mediated though trajectory class) effects of the covariates on the young adult outcomes were assessed.

Chapter 4

RESULTS

This chapter presents the results of the analyses performed to evaluate each of the research questions posed in this thesis. First, a description of the sample is presented in order to provide a foundation for understanding the sample as a whole with regards to the variables of interest. Next, the findings based on each of the research questions are reported.

Descriptive statistics

It is important to understand the sample as a whole in order to begin dissecting the underlying characteristics of certain groups within the population and investigating the interrelationships among the variables of interest. In order to best achieve this understanding, a single dataset imputed from EM parameters was created. First, the interrelationships among the covariates were considered. Based on figures from this dataset, it was estimated that 28.46% of the sample experienced their first intoxication by age 13. Comparatively, the 2000 wave of the Monitoring the Future (MTF) study found that 23.4% of 8th graders had been drunk in their lifetime (Johnston et al., 2001). While the percentage in the RAD sample is higher, a slight downward trend in national levels of adolescent drinking has been observed over the past two decades. The MTF studies

earliest survey of 8th graders took place in 1991. At that time, 26.7% of 8th graders reported having already experienced their first intoxication. Slightly more of those reporting early onset in the RAD sample were male (58%); however, the difference was not statistically significant across the 20 imputed datasets.

The mean delinquency score in the sample was estimated to be 1.459 (S.D.=1.672). Recall, the delinquency score represented the number of delinquent behaviors that the adolescent engaged in on a monthly basis at age 13. Participation in delinquent behavior can be more clearly described by rounding each adolescent's delinquency score to the nearest whole number. In this way, it was found that 37% of the sample reported no delinquent behaviors during the past month, while 40% reported engaging in just one or two delinquent behaviors. A remaining 23% reported frequent (3 or more behaviors) delinquent behavior. More males than females were committing frequent delinquent acts (β (207)=-.656, S.E.=0.237, T=-2.77, p=.0061). Overall, 63% of those subjects engaging in three or more delinquent behaviors were male.

As mentioned in Chapter 3, it appears that early drinking is more likely to lead to early delinquency than early delinquency leading to early drinking in the sample. This conclusion was drawn based on the youngest cohort (those who began providing data at age 12). Two regression analyses were used to investigate the causal flow. First, frequency of intoxication at age 13 was regressed on frequency of intoxication at age 12 and delinquency at age 12. While intoxication at age 12 was a significant predictor of intoxication one year later (β=.587, S.E.=0.123, T=4.77, p<.0001), delinquency at age 12 did not provide unique prediction to the equation (β=.060, S.E.=0.069, T=.87, p=.3882).

Next, delinquency at age 13 was regressed on intoxication and delinquency at age 12. While delinquency at age 12 significantly predicted delinquency at age 13 (β=.455, S.E.=.104, T=4.37, p=.0001), intoxication at age 12 also lent significant unique prediction to the model (β=.462, S.E.=.194, T=2.38, p=.0191).

As expected, delinquent behavior was highly correlated with early onset intoxication (by age 13) in the sample as a whole (β (184) =1.288, S.E.=.169, T=7.63, p<.0001), and by gender (β (246)=1.520, S.E.=.239, T=6.35, p<.0001 for males and β(153) =.950, S.E.=.228, T=4.17, p<.0001 for females). Among the males, a family history of AOD problems was predictive of higher levels of delinquency (β (126) =.838, S.E.=.309, T=2.71, p=.0076); however, a significant relationship between delinquency at age 13 and family history of AOD problems did not exist among the females.

An estimated 26% of the subjects reported having a family member with an AOD problem. This estimate is similar to national figures which report that one in four youth are exposed to family alcoholism or alcohol abuse (Grant, 2000). Slightly more females reported a family history of AOD problems (β (778) =.407, S.E.=.198, T=2.06, p=.0399). In addition, adolescents reporting a family history of AOD problems were more likely to have experienced their first intoxication by age 13 (β (366) =.799, S.E.=.216, T=3.71, p=.0002). This finding was similar among males β (340) =.954, S.E.=.310, T=3.07, p=.0023) and females (β (209) =.726, S.E.=.325, T=2.23, p=.0266). Based on estimates from the EM imputed dataset, 24% of adolescents reporting no family history of AOD problems experienced their first intoxication by age 13, as compared to 40% of adolescents with a family history.

The EM dataset was also used to explore trends in mean drunkenness through adolescence. *Figure 4–1* depicts the differences in the mean frequency of drunkenness from age 14 to age 18 by gender. At each age the males reported a higher frequency of intoxication than the females. The mean curves of both genders suggest that, on the whole, the students drank to intoxication with a frequency of a few times per year throughout adolescence. The mean frequency exhibited by males began to approach monthly intoxication by the end of high school. It was estimated that approximately 29% of the students at age 15 (34% of males and 23% of females) and 40% of the students at age 17 (50% of males and 28% of females) were getting drunk on a monthly basis. Comparatively, 23.5% of 10^{th} graders and 32.5% of 12^{th} graders reported monthly drunkenness in the 2000 wave of MTF ((Johnston et al., 2001). As such, it appears that the subjects in the RAD sample (mid to late 1980's) were drinking at a higher frequency throughout adolescence than adolescents today are reporting. Furthermore, it is important to note that the gender gap once observed for male and female adolescents in the U.S. no longer exists (Centers for Disease Control and Prevention, 2000).

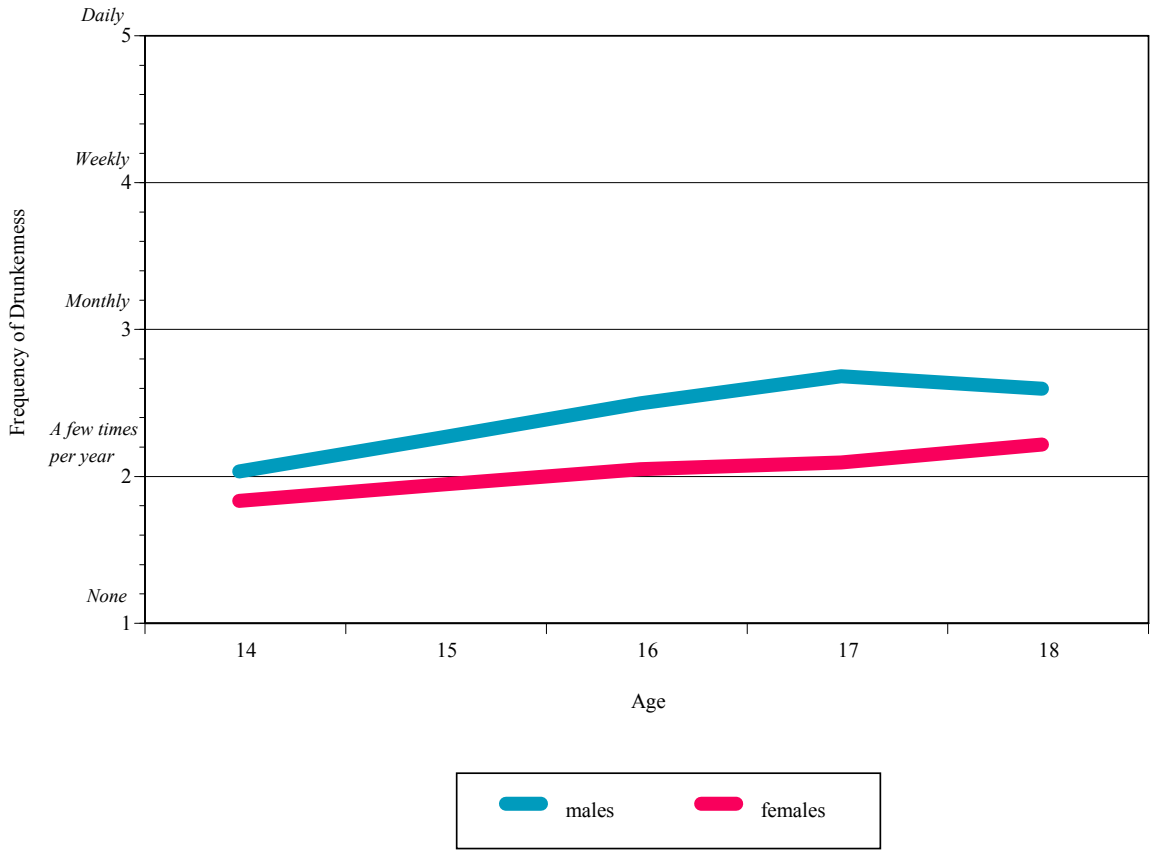


Figure 4–1: Mean frequency of drunkenness by gender

Mean drunkenness frequencies can also be examined by early onset drunkenness status. That is, the differences in drinking patterns throughout high school can be evaluated for those who had experienced their first intoxication by age 13 as compared to those who had not. *Figure 4–2* depicts this difference by simply plotting the means estimated from the EM dataset. As demonstrated by the line chart, early onset adolescents followed a steady trajectory of drunkenness over time, reporting monthly

intoxication throughout high school. Later onset adolescents exhibited a slow increase in intoxication over time.

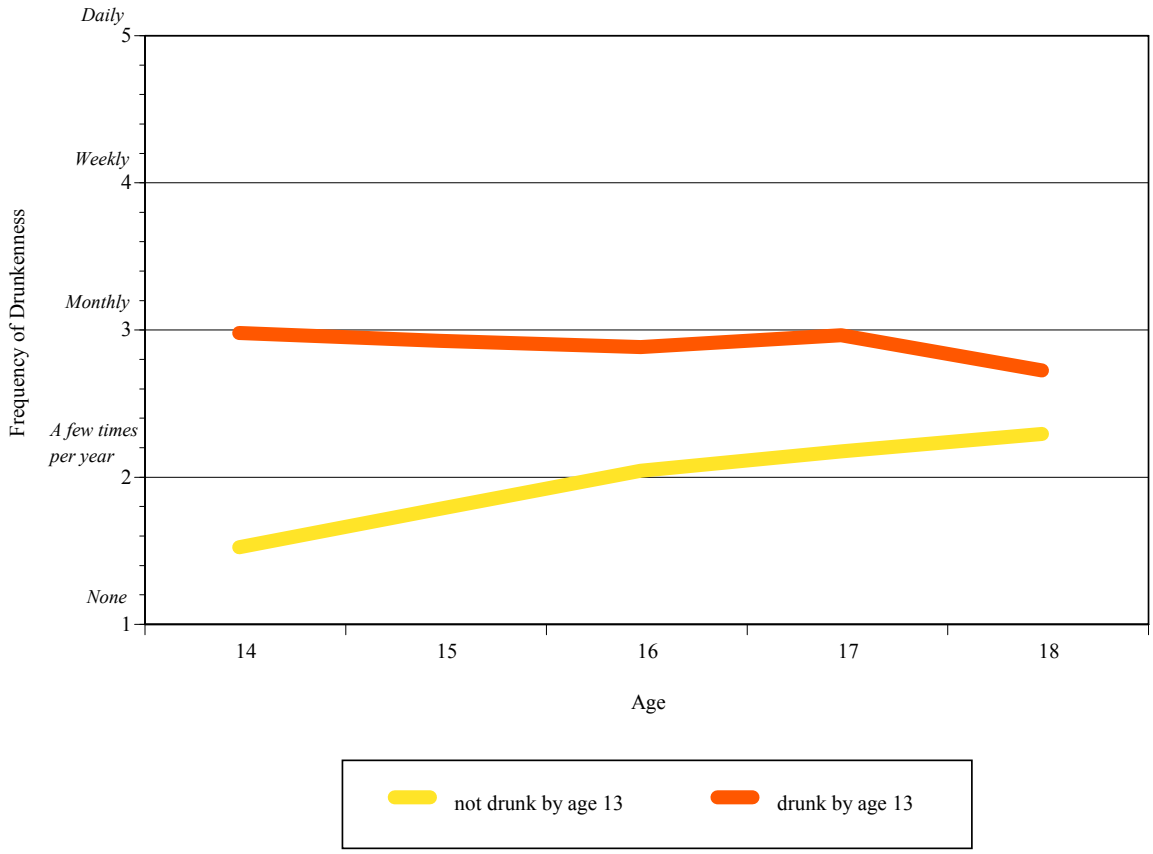


Figure 4–2: Mean frequency of drunkenness by early onset status

In addition to observing the data by onset status, the differential patterns of adolescent drinking by onset status can be evaluated separately for males and females. *Figure 4–3* describes the data in this way. In both early onset and non-early onset individuals, the males demonstrated a higher frequency of intoxication throughout

adolescence. It is interesting to note, however, that the early onset females mean frequency of drinking during adolescence remained higher than the non-early onset males through age 17. Also, the disparity due to early onset status seemed to decrease over time for the females more so than for the males. Finally, it appears that the early onset females demonstrated a downward trend over time, while the early onset males remained steady.

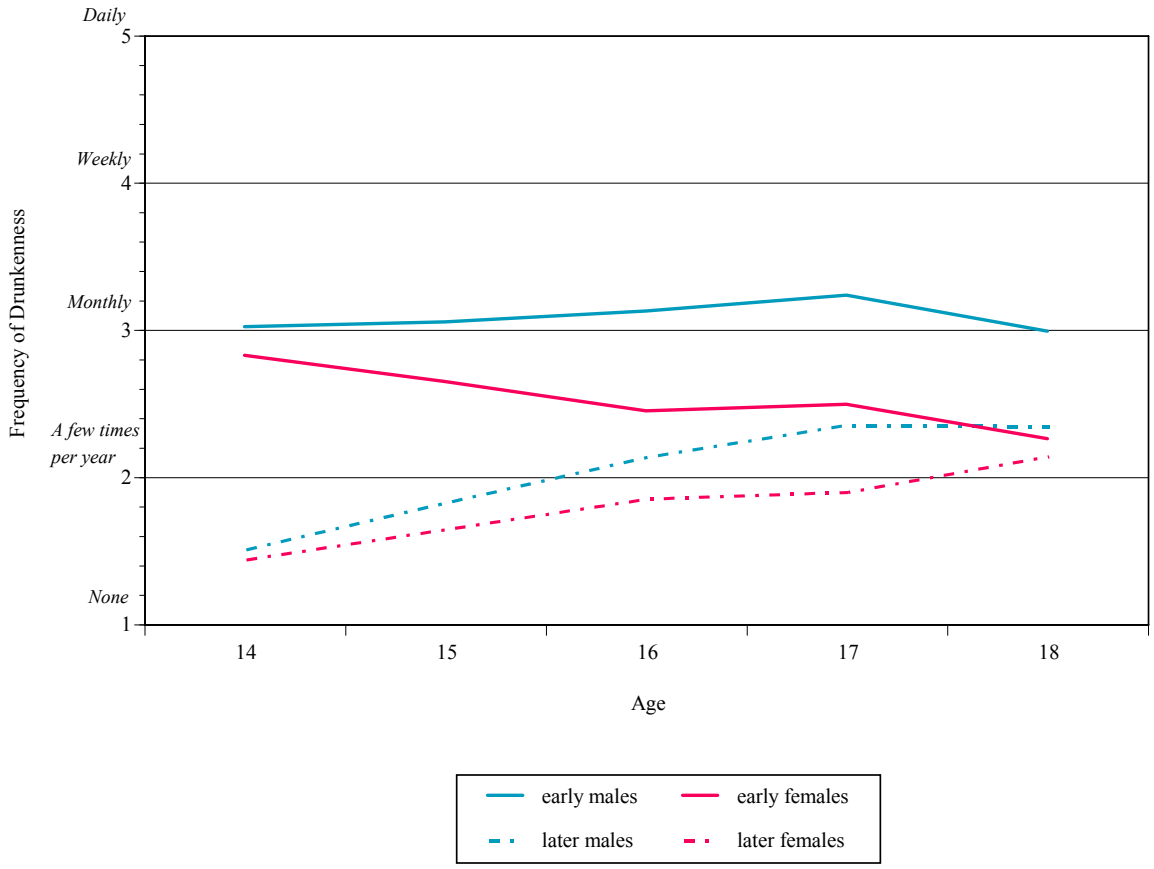


Figure 4–3: Mean frequency of drunkenness by early onset status and gender

It is also helpful to observe the mean levels of drunkenness throughout adolescence by delinquency. As performed earlier, the delinquency variable was categorized to differentiate between students who reported no delinquent behavior at age 13, those who reported one or two delinquent behaviors, and those who reported three or more delinquent acts. *Figure 4–4* presents the varying trajectories as a function of the number of delinquent acts.

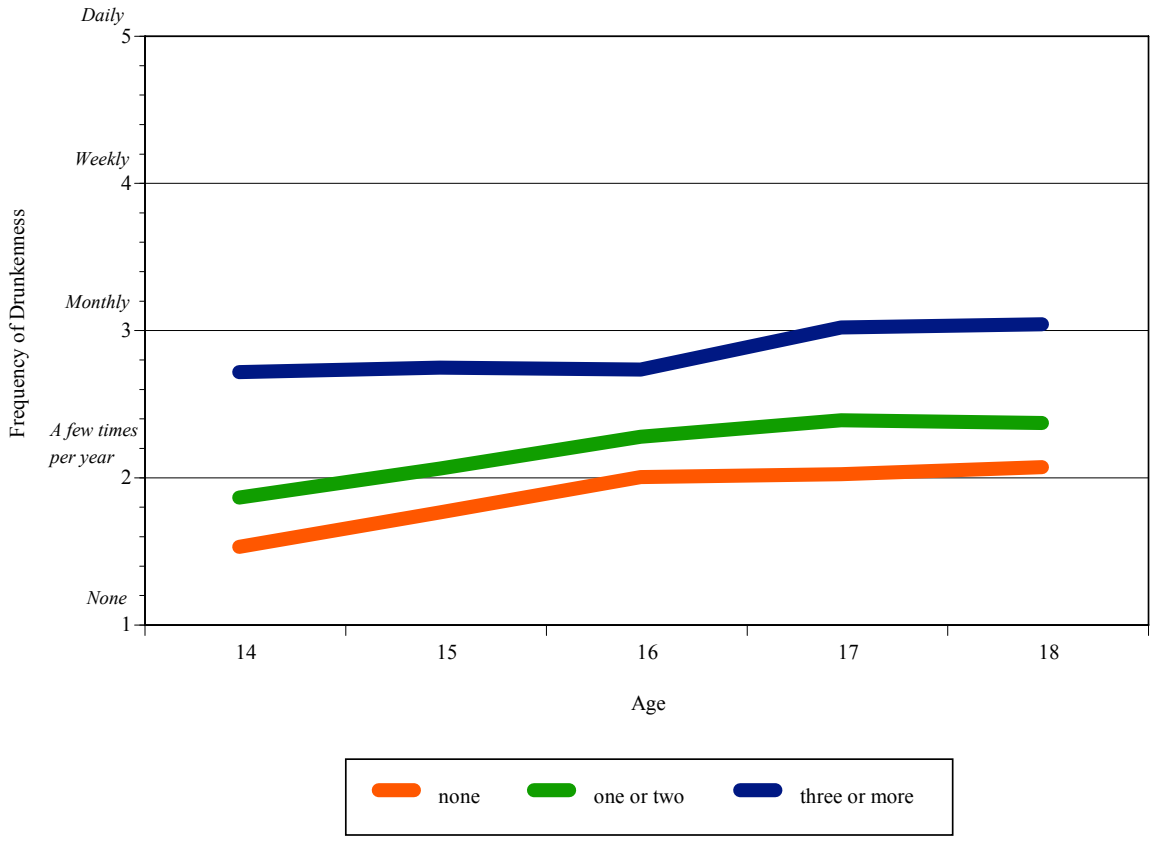


Figure 4–4: Mean frequency of drunkenness by number of delinquent acts

Likewise, *Figure 4–5* presents the differential trajectories for individuals reporting a family history of AOD problems as compared to no family history of AOD problems.

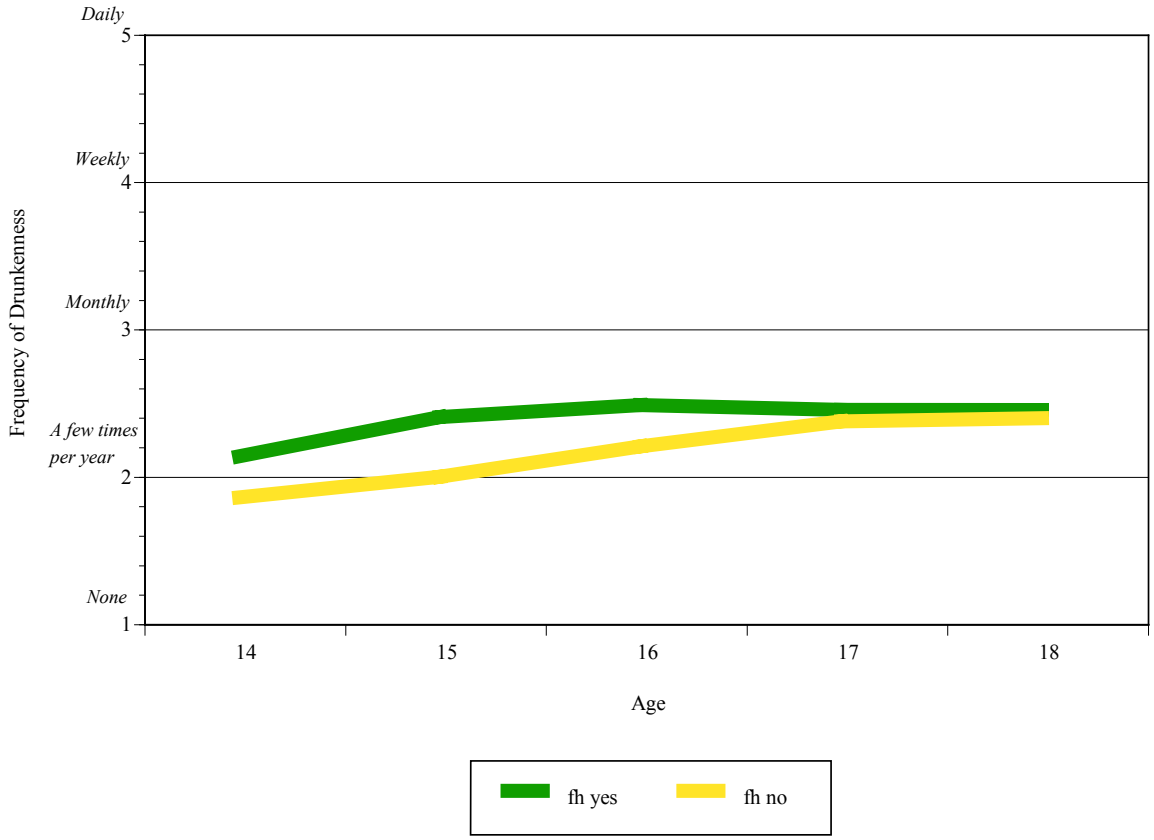


Figure 4–5: Mean frequency of drunkenness by family history of AOD problems

It is also informative to observe the mean levels of the three young adult outcomes considered in this investigation, frequency of intoxication, illicit drug use, and drinking-related consequences. For *Figure 4–6*, the EM dataset was utilized to describe

the frequency of intoxication in adulthood. According to the data, approximately 29% of the subjects (15% of the females and 40% of the males) reported being drunk on a monthly basis in young adulthood. Though not a direct comparison, it is of interest to note that 31.8% of young adults aged 19-32 (23.9% of females and 42.7% of males) in the 2000 wave of the MTF study (Johnston et al., 2001) reported drinking five or more drinks in a row in the two weeks preceding the survey.

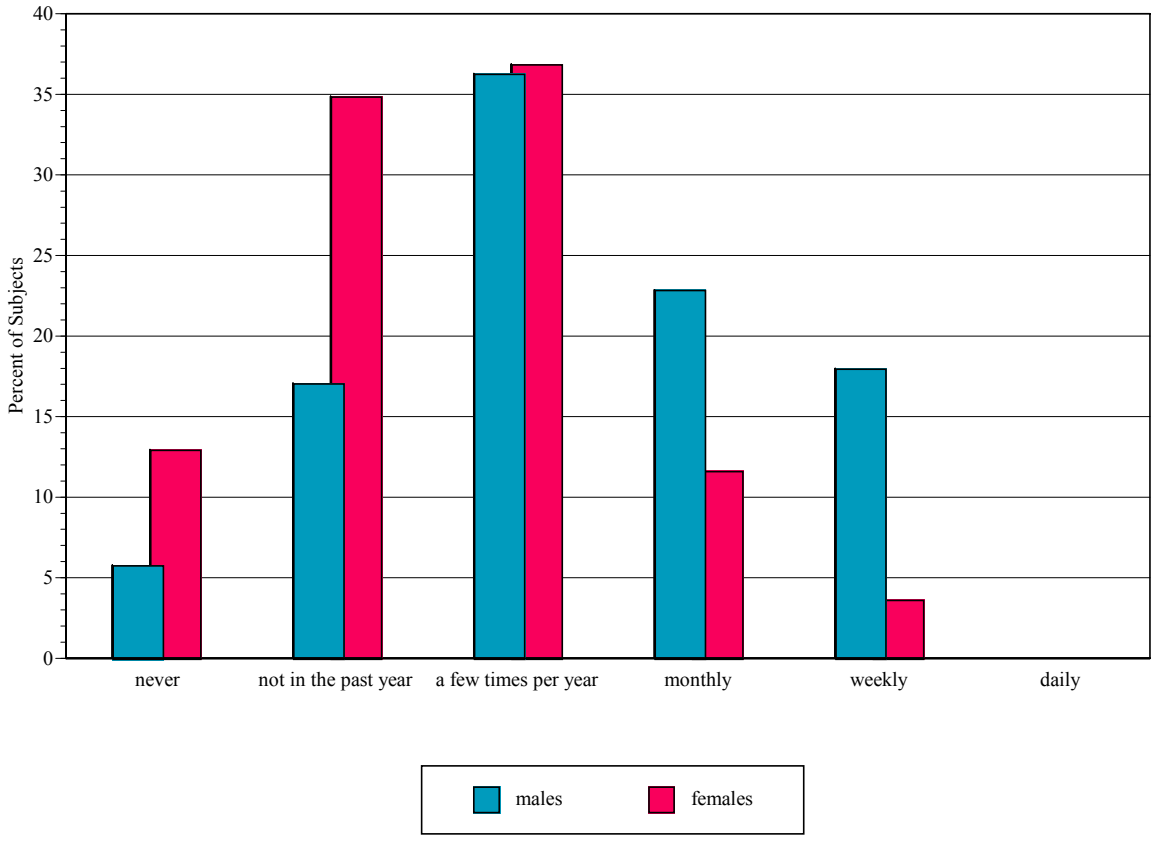


Figure 4–6: Frequency of intoxication in young adulthood by gender

Figure 4–7 describes the mean frequency of illicit drug use in young adulthood by gender. Based on these frequencies, it appears that males were using illicit drugs at a greater frequency. Approximately 9% of the subjects reported at least monthly use of illicit drugs - 6% of females and 12% of males. Young adult subjects in the 2000 wave of the MTF study (Johnston et al., 2001) reported using illicit drugs at a slightly higher frequency. Overall, 15.9% of the MTF young adults (age 19-32) reported past month use of an illicit drug (13.5% of females and 19.1% of males).

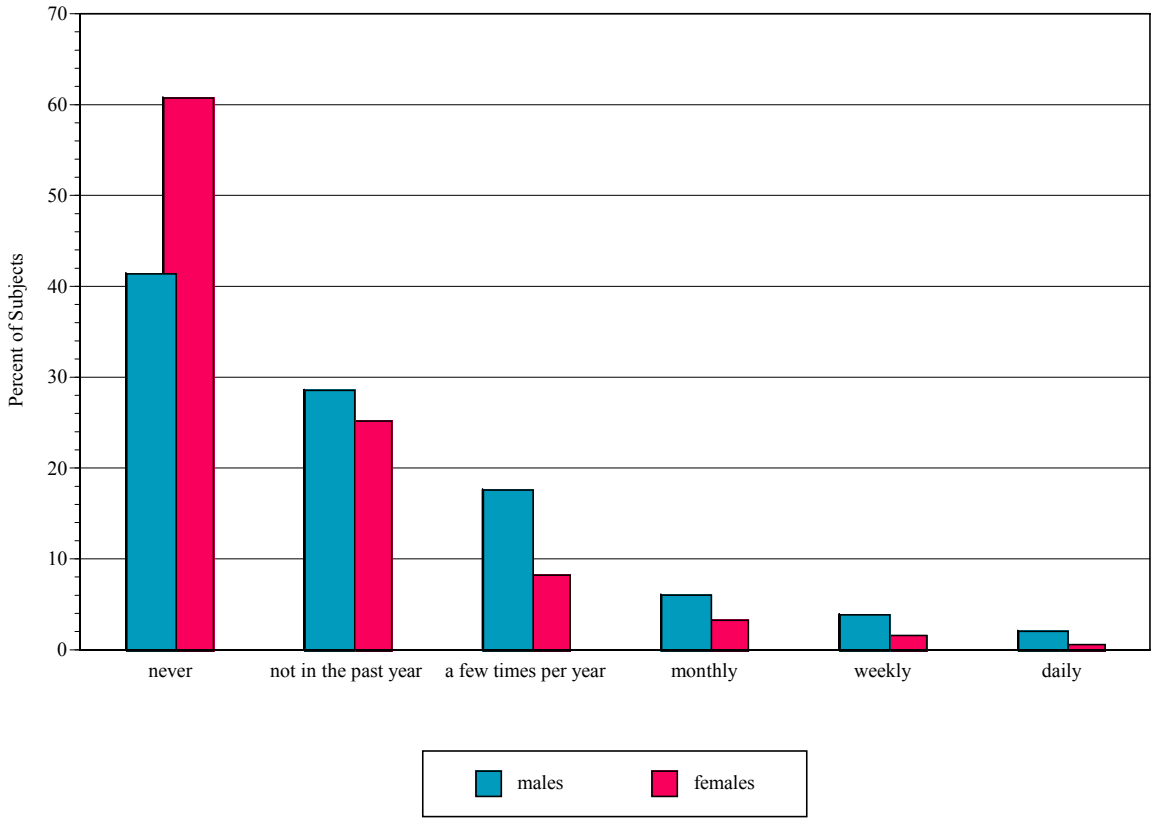


Figure 4–7: Frequency of illicit drug use in young adulthood by gender

Figure 4–8 displays the number of alcohol-induced hangovers in the past year and *Figure 4–9* displays the number of times in the past year the subject had forgotten where he/she was or what he/she did due to alcohol misuse.

Very few of the subjects reported that his/her alcohol use had caused he/she to get into trouble with the police. Among the females, 98.34% reported no police episodes, while 1.33% reported one episode and .33% reported police episodes three to five times in the past year. Among the males, 89.63% reported no episodes, 8.23% reported one, .91% reported two, and 1.21% reported three or more episodes.

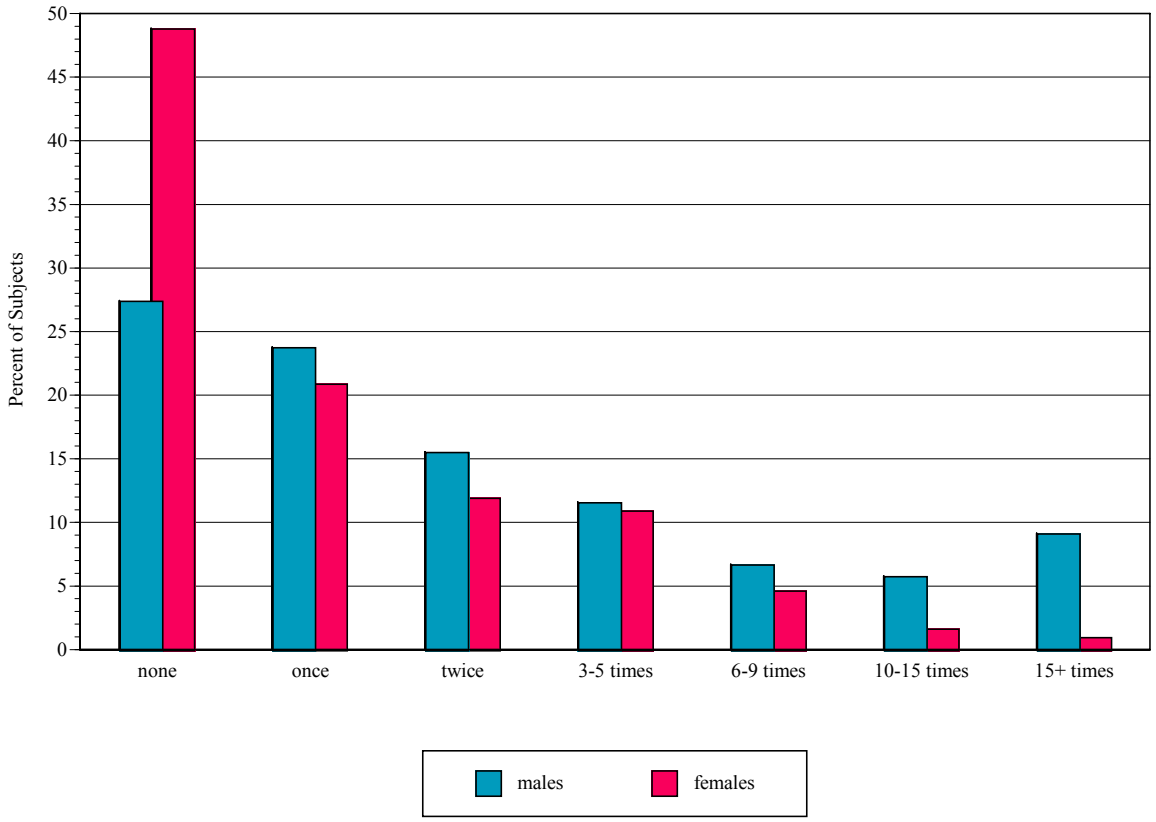


Figure 4–8: Past year number of alcohol-induced hangovers in young adulthood by gender

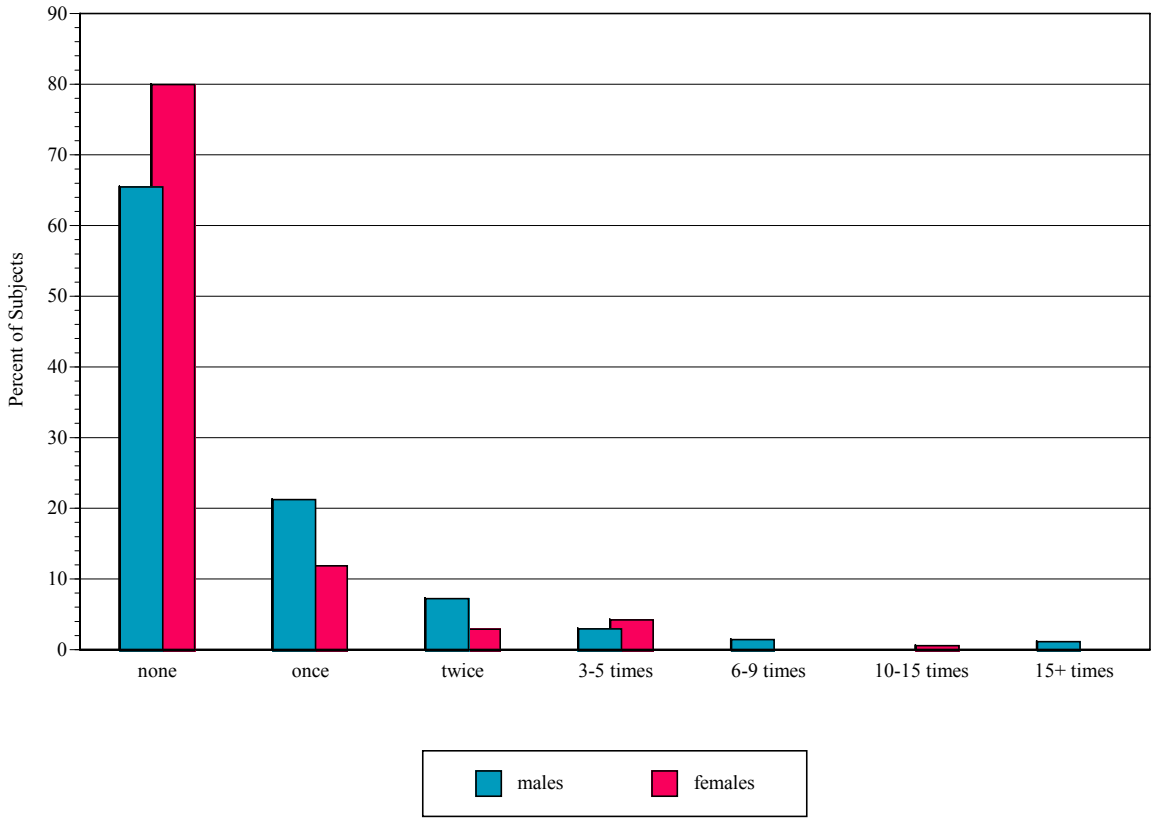


Figure 4–9: Past year number of times the subject forgot where he/she was or what he/she did due to alcohol abuse in young adulthood by gender

Finally, the differences in young adult outcomes can be observed by considering both gender and early onset drunkenness. In order to present these data in a clear and concise manner, the young adult outcome variables were dichotomized to represent regular use. The intoxication and drug use variables differentiated between those who reported being drunk or using illicit drugs at least once per month as compared to those using less frequently. The hangover consequence was dichotomized to compare those who reported three or more hangovers in the past year as compared to those who had

experienced none, one, or two. The number of times the subject forgot where he/she was or what he/she did as a result of alcohol abuse and got into trouble with police due to alcohol abuse were dichotomized to compare those who had experienced the event one or more times in the past year to those who hadn't experienced the event in the past year. *Figure 4–10* presents the results of the frequency analysis. For the males, the most marked differences were observed for drug use, forgetting where one was or what one did as a result of alcohol abuse, and alcohol induced trouble with the police. More than three times as many early onset males had used an illicit drug in the past month as compared to later-onset males. About half (48%) of the early onset males had drank to the point where he forgot where he was or what he did in the past year. Comparatively, 28.13% of the non-early onset males had done the same. Finally, twice as many early-onset males, 16% as compared to 8%, reported getting into trouble with the police due to alcohol in the past year. Less disparity by onset status was observed among females; however, the early onset females reported more alcohol use, drug use, and alcohol-related consequences than the later onset females.

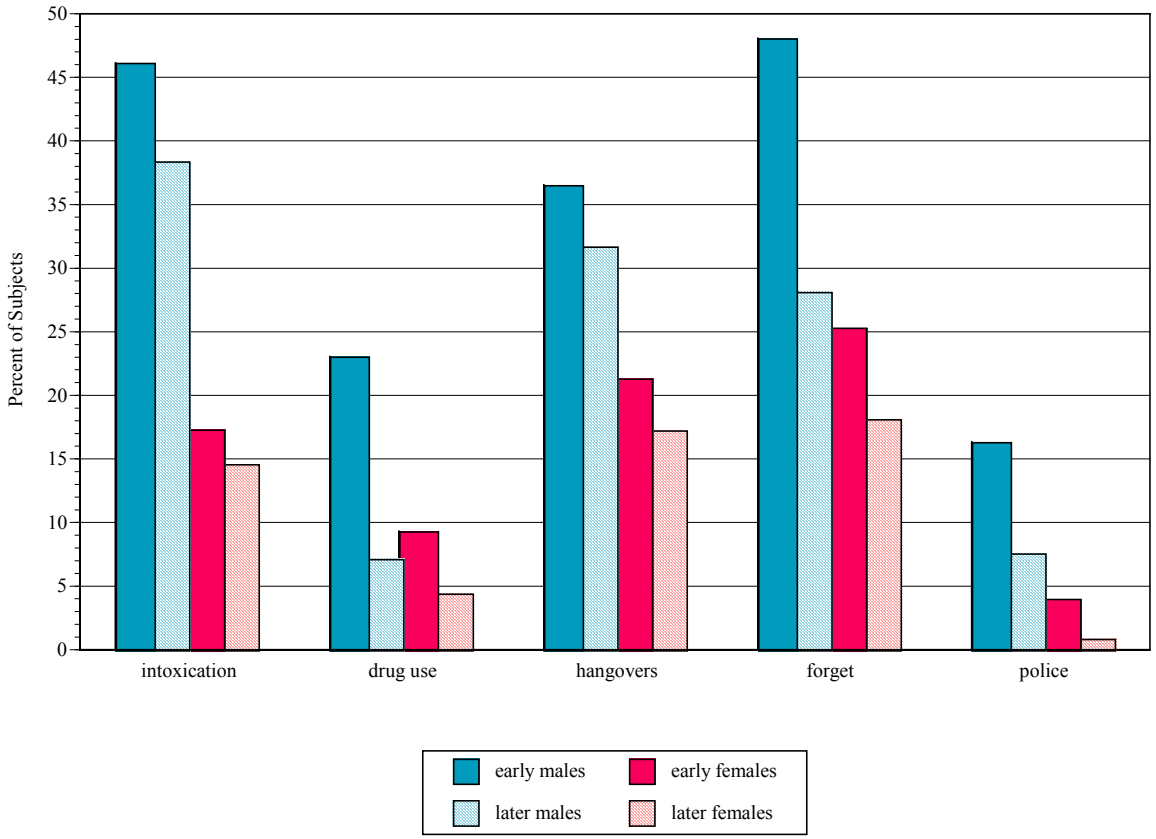


Figure 4–10: Young adult outcomes by gender and early onset status

Finally, with any structural equation modeling analysis, it is valuable to study the correlation matrix produced by the variables in the model. *Figure 4–11* displays the correlation matrix from the dataset imputed from EM parameters.

	early onset	delinquency	gender	fam his	age	drunk14	drunk15	drunk16	drunk17	drunk18	adlt drunk	adlt drugs	hangovers	blackouts	police
early onset	1.00														
delinquency	0.35	1.00													
gender	-0.08	-0.16	1.00												
family history	0.15	0.09	0.08	1.00											
age	-0.11	0.30	-0.03	0.01	1.00										
drunk at 14	0.58	0.43	-0.09	0.11	0.05	1.00									
drunk at 15	0.44	0.35	-0.14	0.15	0.05	0.60	1.00								
drunk at 16	0.32	0.26	-0.19	0.10	0.04	0.51	0.62	1.00							
drunk at 17	0.30	0.32	-0.25	0.03	0.11	0.44	0.53	0.69	1.00						
drunk at 18	0.18	0.36	-0.17	0.03	0.10	0.34	0.44	0.55	0.54	1.00					
adult intoxication	0.09	0.16	-0.32	-0.01	-0.13	0.19	0.24	0.33	0.33	0.38	1.00				
adult drug use	0.20	0.31	-0.21	0.01	-0.04	0.27	0.32	0.34	0.40	0.47	0.51	1.00			
hangovers	0.06	0.08	-0.26	0.02	-0.21	0.11	0.19	0.27	0.28	0.30	0.69	0.41	1.00		
blackouts	0.19	0.07	-0.13	0.06	-0.13	0.17	0.21	0.14	0.21	0.19	0.42	0.32	0.51	1.00	
police	0.13	0.02	-0.15	0.03	0.00	0.16	0.15	0.13	0.21	0.25	0.09	0.14	0.11	0.42	1.00

Figure 4–11: Correlation matrix of all variables

The simple means and frequencies reported thus far allow for a better understanding of the relationship between adolescent drinking over time, the covariates, and the distal outcomes; however, they do not imply whether these differences are statistically or practically significant. Next, analyses will be presented that allow for these determinations to be made.

Question 1: What is the impact of early onset intoxication on drinking behavior during adolescence (ages 14-18)?

A latent growth model of intoxication from age 14 to 18

To begin testing the hypotheses, a latent growth model was specified to describe the change in frequency of intoxication during adolescence. First, a linear latent growth model was explored. *Figure 4–12* depicts the model tested and reports on the fit indices of the model. The latent growth curve specified utilized an intercept (centered at age 17 as this age represents the student's senior year in high school) and a slope. This centering point was chosen for this and subsequent analyses because of the occasion it represents. That is, it represents the final year in high-school. The next assessment, measured at age 18, represents the first year after graduation. As such, by centering at age 17 the intercept represents the frequency of drinking reported in the student's senior year in high school, a salient representation.

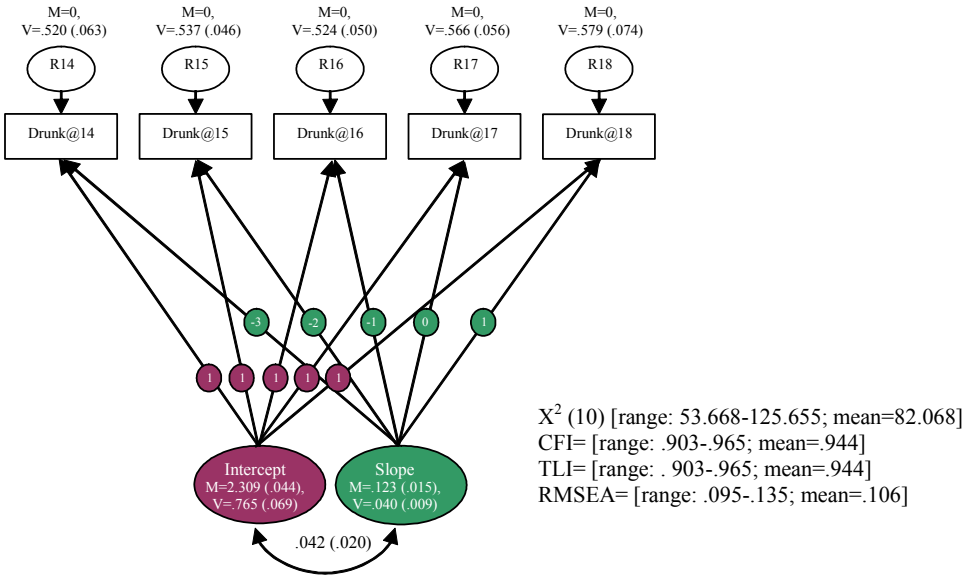


Figure 4–12: Linear latent growth model of drunkenness from age 14-18

A second LGM was specified which added a quadratic term to the growth model. *Figure 4–13* presents the model, estimates, and fit indices. Based on the X^2 value and the practical fit indices, the quadratic model was determined to provide a better (and in fact quite good) fit to the data.

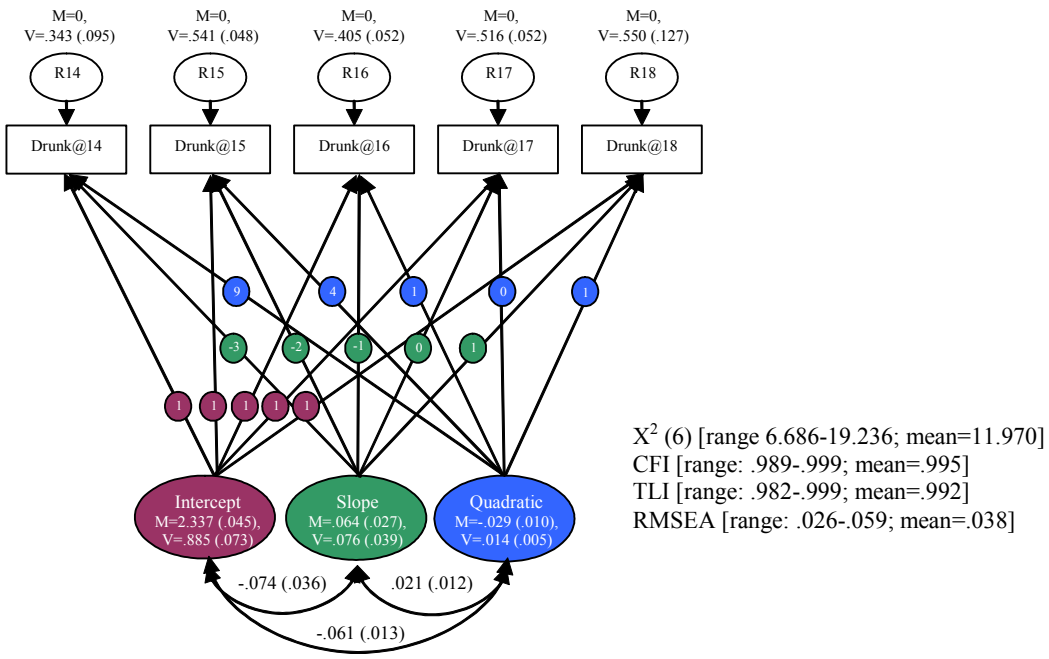


Figure 4–13: Quadratic latent growth model of drunkenness from age 14-18

The quadratic model describes the mean change in frequency of intoxication for the entire sample, as well as providing estimates of the variation due to individual differences. *Figure 4–14* depicts the mean curve estimated by the quadratic LGM. The model specifies the intercept to represent the mean frequency of intoxication at age 17, at the beginning of the students' senior year in high school. In the sample, this mean frequency equates to a value of 2.337. Recall that the variable is coded such that a value of 2.00 represents a frequency of a few times per year, while a value of 3.00 represents drinking to intoxication about once per month. A significant amount of variance was observed around the mean (Est.=.885, S.E.=.073, T=12.09), suggesting that the subjects

were drinking at significantly different levels at age 17. The positive slope and negative quadratic term indicate that a general upward trend was observed with a faster acceleration at the earlier ages and leveling off towards the end of adolescence.

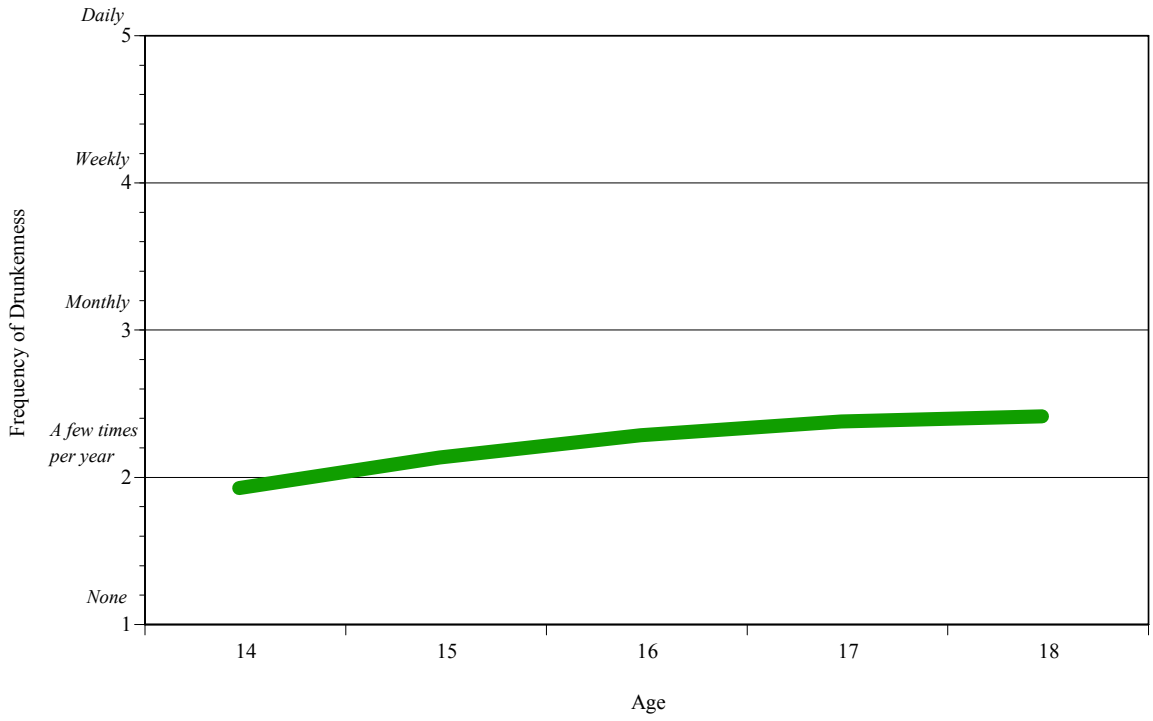


Figure 4–14: Mean trajectory of drunkenness observed for the sample

Next, the growth factors were regressed on early onset drinking and the covariates (gender and family history of AOD problems) to identify the impact of having experienced first intoxication by age 13 on subsequent drunkenness throughout adolescence. A growth model was first specified which utilized drunkenness at age 14 as the intercept. The model provided a good fit to the data [X^2 (12) ranged from 9.551-29.437, .003<p<.655; .989≤CFI≤1.000; .977≤TLI≤1.000, .000≤RMSEA≤.026].

Table 4–1 displays the coefficients associated with the model. Early onset drunkenness was a significant predictor of the intercept, indicating that individuals who had experienced their first intoxication by age 13 drank to intoxication more frequently at age 14. Early onset intoxication was also predictive of a milder instantaneous slope. This finding is likely due to a ceiling effect, that is, those who were already drinking had less room to increase as compared to those who had not begun drinking. No effect was noted for the regression of the quadratic term on early onset intoxication.

Gender was a significant predictor in the model. Males exhibited a steeper instantaneous slope of drinking, while the significant coefficient associating gender with the quadratic term suggests that as the students grew older the females demonstrated more accelerated (or less decelerated) increase in drinking as compared to the males.

Family history of AOD problems did not produce a significant impact on any of the growth parameters. Indicating that family history of AOD, while being an important predictor of early onset intoxication, did not predict the shape of the curve describing frequency of intoxication during adolescence.

The impact of the independent variables on drunkenness at each of the subsequent ages was evaluated by varying the centering point of the LGC. Early onset drinking remained a significant predictor of subsequent intoxication at ages 15, 16, 17, and 18. The relationship between gender and the quadratic term is further described by examining the changing relationship between gender and the slope over time. That is, as the subjects grew older the effect of male gender on a steeper instantaneous slope diminished, and was not significant by age 17.

Table 4–1: Effect of the covariates on drinking at ages 14-18

	Dep. Var.	Indep. Var.	Estimate	Std. Err.	T-ratio	DF	P-value
Centered at age 14	Intercept	early onset	1.405	0.087	16.09	635	0.0000
		gender	-0.088	0.078	-1.12	863	0.2623
		family history	0.024	0.090	0.26	728	0.7918
	Slope	early onset	-0.350	0.102	-3.44	118	0.0008
		gender	-0.247	0.077	-3.22	1163	0.0013
		family history	0.118	0.099	1.19	193	0.2343
	Quadratic	early onset	0.031	0.026	1.17	80	0.2458
		gender	0.045	0.019	2.36	478	0.0187
		family history	-0.036	0.025	-1.45	127	0.1498
Centered at age 15	Intercept	early onset	1.085	0.090	12.10	286	0.0000
		gender	-0.290	0.077	-3.79	727	0.0002
		family history	0.106	0.091	1.16	367	0.2471
	Slope	early onset	-0.289	0.054	-5.32	195	0.0000
		gender	-0.158	0.043	-3.67	2112	0.0003
		family history	0.046	0.054	0.85	310	0.3936
	Quadratic	early onset	0.031	0.026	1.17	80	0.2458
		gender	0.045	0.019	2.36	478	0.0187
		family history	-0.036	0.025	-1.45	127	0.1498
Centered at age 16	Intercept	early onset	0.827	0.103	8.06	259	0.0000
		gender	-0.403	0.085	-4.75	1286	0.0000
		family history	0.116	0.104	1.11	344	0.2658
	Slope	early onset	-0.228	0.031	-7.33	164	0.0000
		gender	-0.068	0.026	-2.56	306	0.0108
		family history	-0.026	0.031	-0.84	238	0.4043
	Quadratic	early onset	0.031	0.026	1.17	80	0.2458
		gender	0.045	0.019	2.36	478	0.0187
		family history	-0.036	0.025	-1.45	127	0.1498
Centered at age 17	Intercept	early onset	0.629	0.095	6.59	452	0.0000
		gender	-0.426	0.082	-5.22	1801	0.0000
		family history	0.054	0.099	0.55	496	0.5837
	Slope	early onset	-0.167	0.067	-2.51	66	0.0147
		gender	0.022	0.049	0.44	202	0.6598
		family history	-0.098	0.063	-1.56	99	0.1225
	Quadratic	early onset	0.031	0.026	1.17	80	0.2458
		gender	0.045	0.019	2.36	478	0.0187
		family history	-0.036	0.025	-1.45	127	0.1498
Centered at age 18	Intercept	early onset	0.493	0.119	4.13	137	0.0001
		gender	-0.359	0.097	-3.69	385	0.0003
		family history	-0.080	0.118	-0.67	197	0.5007
	Slope	early onset	-0.106	0.116	-0.92	67	0.3627
		gender	0.112	0.084	1.32	263	0.1863
		family history	-0.170	0.109	-1.56	103	0.1221
	Quadratic	early onset	0.031	0.026	1.17	80	0.2458
		gender	0.045	0.019	2.36	478	0.0187
		family history	-0.036	0.025	-1.45	127	0.1498

Figure 4–15 displays the standardized coefficients of the independent variables on drunkenness from age 14 to 18. The coefficients were taken from the standardized solution from a single dataset imputed from EM parameters. At each age, the figure demonstrates the unique effect of each independent variable. Positive coefficients are associated with more frequent intoxication and negative coefficients correspond to less frequent intoxication. As demonstrated by the figure, early onset drinking clearly became a less important predictor over time. Being female emerged as a protective factor at ages 15 through 18. Family history was not a significant predictor at any of the ages.

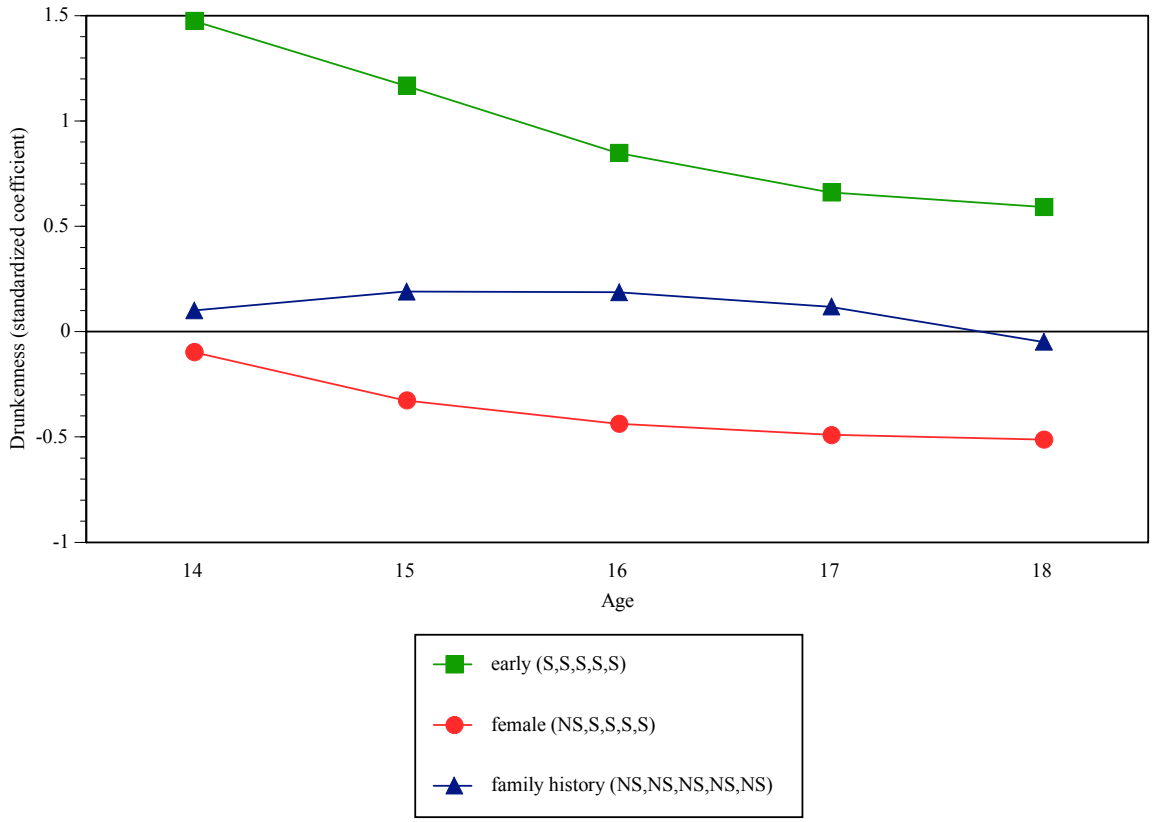


Figure 4–15: The changing impact of the covariates on drinking over time

Question 2: What is the impact of early onset intoxication on alcohol-related behavior in young adulthood; including frequency of intoxication, use of other substances, and negative consequences due to drinking?

The effect of early onset drunkenness on young adult outcomes

After exploring the impact of early onset drunkenness and the other covariates on the trajectory of alcohol use during adolescence, a model was next specified to assess the impact of early onset drunkenness on the young adult outcomes (drunkenness, illicit drug use, and three alcohol-related consequences). Recall that these young adult measurements were collected when the subjects were between 22 and 24 years old. As such, age at survey one was added as a covariate to this and all subsequent models. A simple path model was utilized to test the hypothesis.

In order to assess the independent effect of early onset drunkenness on the five distal outcomes, a path model was tested in which early onset intoxication, gender, family history of AOD problems, and age were specified to predict the young adult substance use variables. *Table 4–2* displays the results of the model. Early onset intoxication was positively associated with more drug use and forgetting where one was or what one did due to alcohol abuse. All five young adult outcomes were negatively associated with gender (females reported less drinking, drug use, and alcohol-related consequences). No relationship existed between the adult outcomes and family history of AOD problems. Finally, the younger subjects reported more frequent intoxication, hangovers, and incidence of forgetting where he/she was or what he/she did as a result of alcohol abuse

Table 4–2: Effect of the covariates on young adult outcomes

Parameter	Estimate	Std. Err.	T-ratio	DF	P-value
Adult drunkenness					
early onset	0.177	0.112	1.58	210	0.1152
gender	-0.642	0.095	-6.77	437	0.0000
family history	-0.029	0.112	-0.25	277	0.7994
age	-0.144	0.062	-2.33	266	0.0208
Adult drug use					
early onset	0.439	0.119	3.69	197	0.0003
gender	-0.387	0.112	-3.45	142	0.0007
family history	0.012	0.13	0.09	133	0.9250
age	-0.016	0.063	-0.26	394	0.7984
Frequency of Hangovers					
early onset	0.144	0.191	0.75	109	0.4533
gender	-0.759	0.16	-4.75	183	0.0000
family history	0.044	0.185	0.23	166	0.8147
age	-0.387	0.104	-3.74	144	0.0003
Frequency of Forgetting					
early onset	0.266	0.112	2.37	93	0.0199
gender	-0.281	0.077	-3.64	6432	0.0003
family history	0.148	0.103	1.43	199	0.1533
age	-0.117	0.058	-2.03	167	0.0437
Frequency of Trouble with Police					
early onset	0.086	0.051	1.68	92	0.0966
gender	-0.123	0.037	-3.32	899	0.0009
family history	0.028	0.045	0.62	377	0.5349
age	0.001	0.023	0.05	918	0.9577

Note: The degrees of freedom vary due to differences in missing information for each parameter.

Question 3: Does early onset intoxication affect the trajectory of drinking from ages 14-18?

Specification of an unconditional LCGM

The growth models specified thus far have assumed that the subjects exhibited a similar population trajectory of growth. That is, that all of the subjects belong to the

same population (Muthén, 2001). Recall that LGC modeling estimates the mean trajectory for the whole population (fixed effect) and captures individual variation around the grand mean as observed by the variance of the growth factors (random effects); however, it is certainly conceivable that the subjects belong to several different types of classes with regards to their change in alcohol use throughout adolescence and that each of the latent classes adhere to a different mean trajectory. While LGC modeling is an extremely useful evaluation tool for assessing change over time, it "cannot capture heterogeneity that corresponds to qualitatively different development" (Muthén, 2001, p. 296). Therefore, in order to explore the growth heterogeneity in adolescent alcohol intoxication, latent class growth modeling (LCGM) was utilized. An unconditional LCGM was first specified for the entire sample (presented in *Figure 4–16*). As required by LCGM, the variance of the growth factors was fixed to zero, allowing no within group variation. Also, the covariance of the growth factors was restricted to zero. This follows from the variance restriction and is necessary to estimate distinct trajectories. As mentioned and justified previously, intoxication at age 17 was selected to represent the intercept.

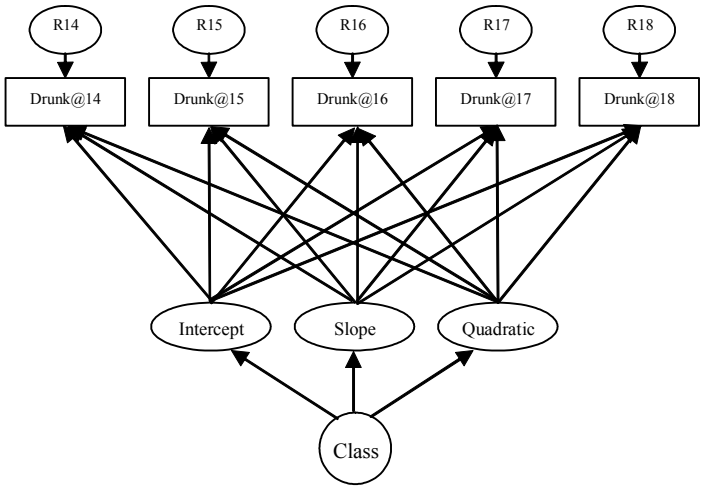


Figure 4–16: Unconditional LCGM

In order to determine the number of trajectory classes that best describe the data, a series of LCGMs were specified in which each successive model added one additional class. The model testing began with a single class model and continued until the addition of a new class resulted in non-convergence. As a result, up to six classes were evaluated. *Figure 4–17* displays the BIC values for each model. A low BIC value indicates a better fitting model. In the present application, a six-class model appeared to be the best.

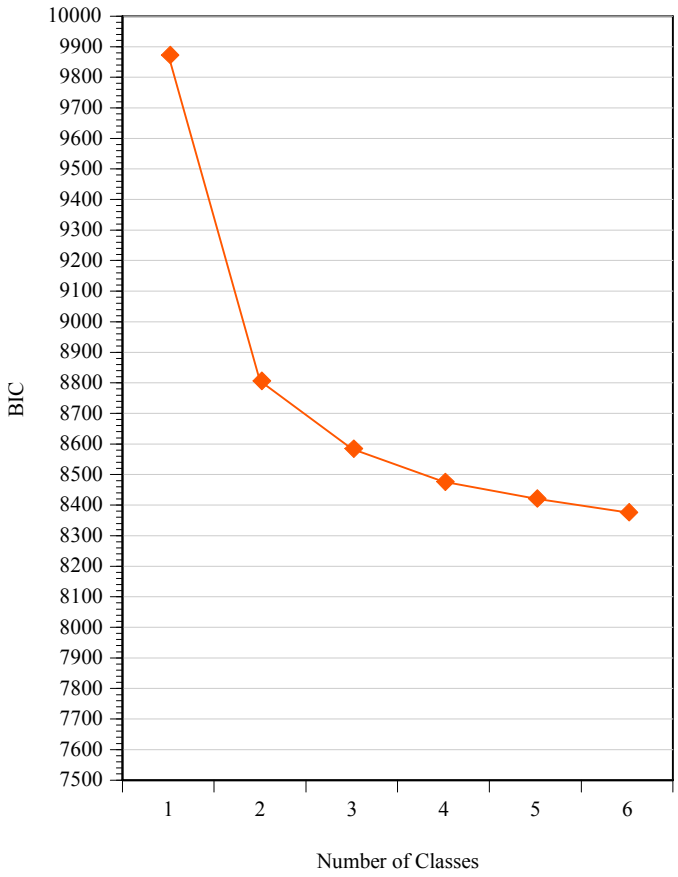


Figure 4–17: BIC values for the unconditional LCGM

In addition to having the lowest BIC the six-class solution also demonstrated reasonably good average posterior probabilities (reported in *Table 4–3*). In LCGM, each subject is assigned a posterior probability for each class. The probability describes the likelihood that the individual belongs to a given class. As such, a well fitting model is one in which subjects have a high likelihood of belonging to one class, and a low likelihood of belonging to the other classes. Finally, and perhaps most importantly, the

six-class solution resulted in classes that made both theoretical and practical sense (see *Figure 4-17*). The estimated trajectories of the 1, 2, 3, 4, and 5-class solutions can be found in Appendix A.

Table 4–3: Posterior probabilities for the unconditional six-class LCGM

Class	1	2	3	4	5	6
1	**0.889**	0.107	0.003	0.002	0.000	0.000
2	0.047	**0.855**	0.040	0.033	0.024	0.000
3	0.001	0.064	**0.813**	0.000	0.121	0.000
4	0.001	0.081	0.001	**0.854**	0.039	0.024
5	0.000	0.017	0.064	0.011	**0.811**	0.098
6	0.000	0.000	0.000	0.004	0.061	**0.935**

Note: The probabilites were averaged across the 20 datasets.

The estimated trajectories for the six class solution are depicted in *Figure 4–18* and reported in *Table 4–4*. *Table 4–5* indicates the estimated number of subjects belonging to each class as calculated by the posterior probabilities.

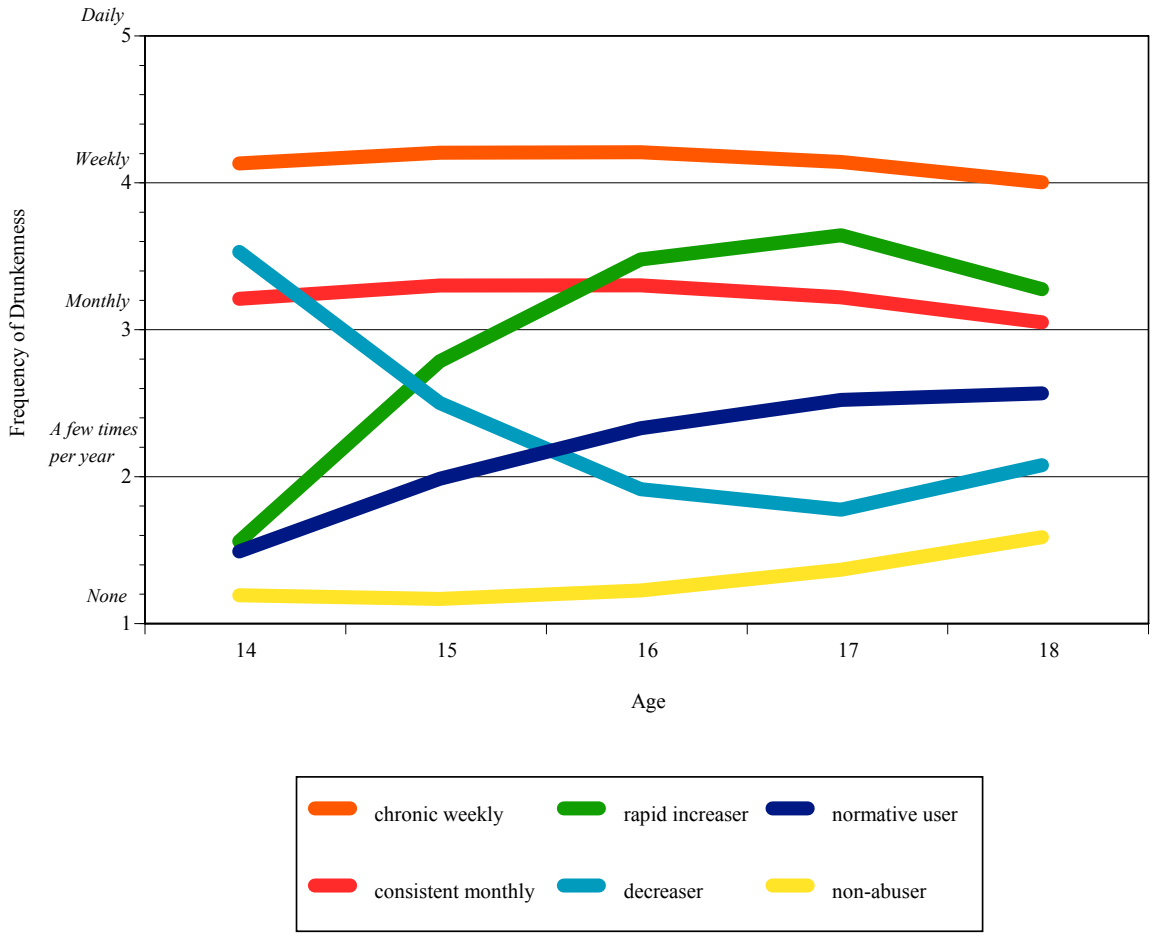


Figure 4–18: Estimated mean trajectories for the unconditional six-class LCGM

Table 4–4: Estimates for the unconditional six-class LCGM

Class	Parameter	Estimate	Std. Err.	T-ratio	DF	P-value
Class 1: chronic weekly	intercept	4.099	0.354	11.58	254	0.0000
	slope	-0.102	0.135	-0.76	156	0.4508
	quadratic	-0.035	0.053	-0.65	198	0.5149
Class 2: consistent monthly	intercept	3.178	0.248	12.81	87	0.0000
	slope	-0.126	0.109	-1.15	85	0.2529
	quadratic	-0.043	0.062	-0.69	145	0.4907
Class 3: rapid increasers	intercept	3.600	0.199	18.08	216	0.0000
	slope	-0.101	0.152	-0.67	139	0.5070
	quadratic	-0.265	0.057	-4.65	155	0.0000
Class 4: decreasers	intercept	1.733	0.355	4.88	193	0.0000
	slope	0.081	0.193	0.42	101	0.6741
	quadratic	0.222	0.098	2.27	160	0.0248
Class 5: normative user	intercept	2.481	0.144	17.21	162	0.0000
	slope	0.119	0.082	1.44	233	0.1510
	quadratic	-0.075	0.034	-2.23	154	0.0274
Class 6: non-abusers	intercept	1.324	0.054	24.68	271	0.0000
	slope	0.181	0.042	4.36	166	0.0000
	quadratic	0.041	0.013	3.11	163	0.0022

Note: The degrees of freedom vary due to differences in missing information for each parameter.

Table 4–5: Final class counts and proportion for the unconditional six-class LCGM

Class	Mean	Min	Max	%
1	34.35	18	59	5.45%
2	104.65	73	117	16.61%
3	63.60	40	88	10.10%
4	34.15	18	52	5.42%
5	163.50	139	183	25.95%
6	228.75	210	244	36.31%

Note: Minimum and maximum represent the range of class counts across the datasets. The mean is the average count.

For demonstration purposes, each subject was assigned to belong to their most likely class. The estimated trajectory (calculated using a single dataset imputed from EM parameters) for the members in each of the classes is presented in *Figure 4–19*. The figure allows the adequacy of the classes to be visually observed. Recall, however, that

in a LCGM each person is not truly assigned to a single class. Rather the posterior probabilities determine how much each subject contributes to a certain class. In this analysis, however, the probabilities for each particular class were quite high and likely provide a good representation of the individual trajectories in each class.

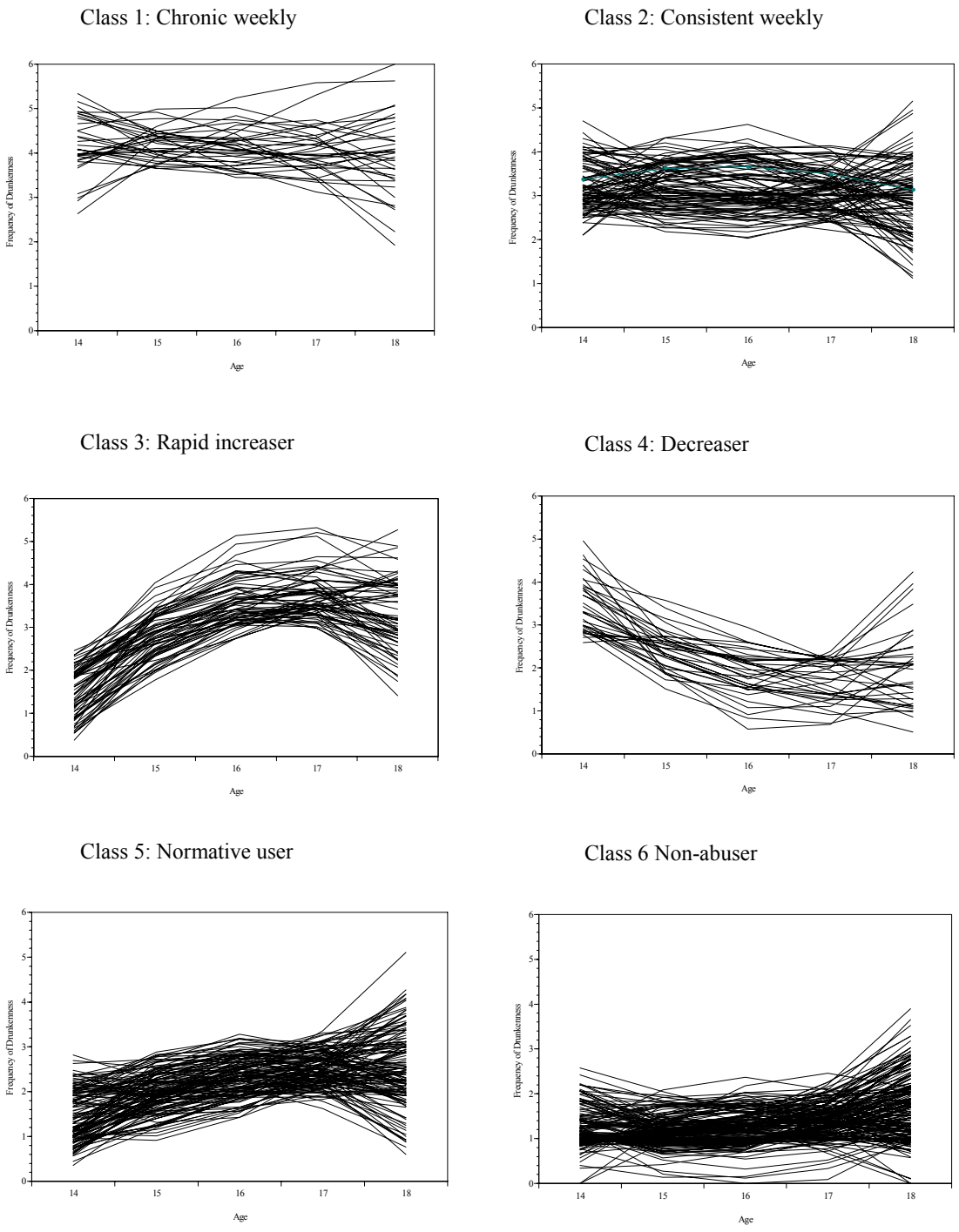


Figure 4–19: Estimated trajectories for members in each class

Class 1 represented a group of subjects who consistently reported frequent intoxication from age 14 to age 18. On average the members reported being drunk on a weekly basis at each of the five survey waves.

The second class consisted of subjects who also reported regular intoxication across the five measurement occasions; however, Class 2 students engaged in heavy drinking at a lower frequency than Class 1. The average Class 2 subject reported intoxication on a monthly basis from age 14 to age 18. Class 2 represented the third largest class.

A rapidly increasing trajectory described the pattern of adolescent alcohol use for a third class of subjects. At age 14, these students were never or rarely abusing alcohol; however, by 15 they reported an average of monthly intoxication. The increasing trend continued through the next year, with the average Class 3 member reporting between monthly and weekly intoxication. A slight upward trend continued through the end of high school (age 17) and then appeared to decline slightly.

Class 4 represented the smallest class. Its members were characterized by a distinctive downward trend. At age 14 the subjects reported regular intoxication (on average a frequency of monthly to weekly); however, a steady decline of use was observed through age 16. By middle adolescence the students leveled out, reporting an average frequency of drunkenness of a few times per year through age 18.

The fifth class was defined here as the normative user class, as their use of alcohol over time mimicked that exhibited by the majority of adolescents who experiment with alcohol (Udry, 1998). For example, based on the public use dataset from the first wave

of the Add Health study, 54.87% of students who were 17 years of age reported never having been drunk in their lifetime. Another 20.08% reported having been drunk just once or twice in their lifetime and 8.35% reported getting drunk once a month or less. A remaining 16.70% reported drinking to intoxication several times per month or more. As such, it seems that the majority of students who were 17 years of age did not drink to intoxication, while about 25% got drunk once per month or less, and 17% of 17-year-old students got drunk often. The students can be thought of as belonging to one of three groups based on their frequency of drinking to intoxication: 1.) students who never get drunk; 2.) students who get drunk once per month or less, and 3.) students who get drunk several times per month or more often. The Add Health data suggest that the number of students in the mid-level range (getting drunk once per month or less often) increases slowly as students grow older. That is, 17% of students 14 years of age fell into this mid-level range, 23% of students 15 years of age, and 24% of students 16 years of age. Comparatively, 9%, 10%, and 16% of students 14, 15, and 16 years of age respectively were getting drunk several times per month or more often. As such, it appears that the majority of students who do drink to intoxication do so at a moderate level. Based on this observation, the members of Class 5 in the study presented in this thesis likely represent the normative course of alcohol use. These members demonstrated low to no use of alcohol at age 14, with a mild increase over time. By age 17 the mean frequency of intoxication fell between a few times per year and monthly and remained steady through age 18.

The sixth and final class boasted the largest group membership. Class 6 members exhibited very low to no use from age 14 through age 17. A very mild upward trend was observed between ages 17 and 18. However, the average Class 6 member never exceeded a frequency of intoxication above a few times per year through age 18.

Specification of a conditional latent class growth model

The creation of distinct classes allows for the exploration of class membership predictors. These background variables help to predict and correctly classify members into classes. As such, an additional covariate, delinquency at age 13, was included. As reported earlier, delinquency at age 13 should not be used as a control variable in the same sense of the other covariates in the model as this would be considered added variable bias (Clogg & Haritou, 1998). However, due to its ability to discriminate class membership it was included in the LCGMs specified for these analyses.

To begin the exploration, the class variable was regressed on early onset drunkenness (*Figure 4–20)*. This analysis represents a multinomial logistic regression in that each class is compared to the reference class. In the present analysis, the reference class is defined as Class 6, the non-abusers. As such, the parameter estimates represent the increased or decreased likelihood of belonging to a given class as compared to belonging to the non-abusing class.

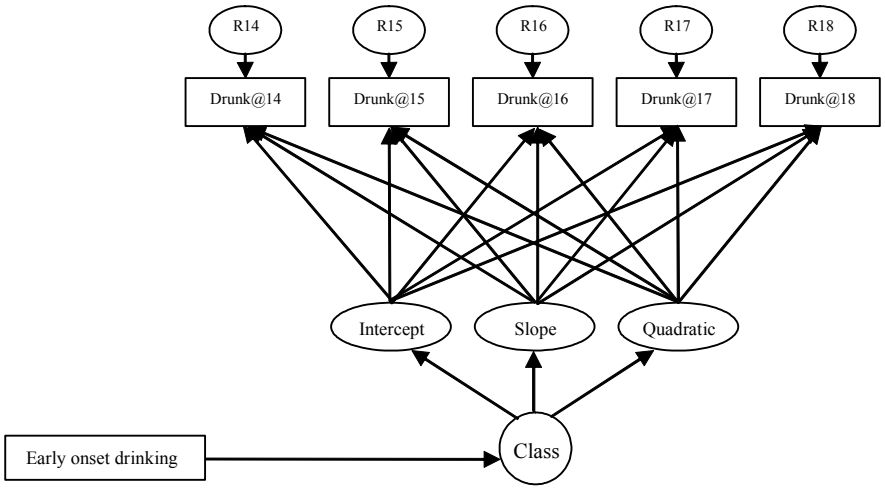


Figure 4–20: Six-class LCGM regressed on early onset drunkenness

The results suggest that individuals in Class 1 (β (901)=4.218, S.E.=.904, T=4.66, p= .0000), Class 2 (β (111)=3.100, S.E.=.704, T=4.40, p= .0000), and Class 4 (β (647)=3.513, S.E.=.991, T=3.54, p= .0004) were significantly more likely to have experienced their first intoxication by age 13 than members of Class 6, while individuals in Class 3 and Class 5 were no more likely. That is, the individuals demonstrating an adolescent drinking trajectory classified as chronic high, consistent monthly, or decreasing were more likely to have been drunk by age 13 than adolescents who exhibited a non-abusing trajectory from age 14 to age 18. However, individuals classified as rapid increasers or normative users were no more likely than the non-abusers to have experienced their first intoxication by age 13.

Next, the likelihood of class membership as a function of delinquency at age 13 was assessed. The members of Class 1 (β (160)=1.165, S.E.=. 224, T=5.20, p= .0000),

Class 3 (β (88)=.474, S.E.=. 199, T=2.39, p= .0191), and Class 4 (β (157)=.653, S.E.=. 245, T=2.67, p= .0084) were more likely to exhibit delinquent behavior at age 13 than the non-abusing group. Although not statistically significant, a strong trend was observed for members of Class 2 (β (66)=.680, S.E.=. 353, T=1.92, p= .0586) and Class 5 (β (61)=.377, S.E.=.193, T=1.95, p= .0552) to demonstrate higher levels of early delinquent behavior than members of Class 6.

Class membership was next regressed on gender. Members of Class 1 (β (488)= -1.825, S.E.=. 691, T=-2.64, p= .0085), Class 2 (β (1665)=-.827, S.E.=. 387, T=-2.13, p= .0330) and Class 3 (β (1956)=-.946, S.E.=. 444, T=-2.13, p= .0332) were more likely to be male, while members of Class 4 and Class 5 were no more likely than the non-abusing class to be male. However, a trend was noted for Class 5 (β (706)=-.554, S.E.=. 296, T=-1.87, p= .0612).

Finally, class membership was regressed on family history of AOD problems. The results suggested that none of the classes were more likely than the non-abusing class to have members with a family history of AOD problems.

Next, early onset and the three covariates of interest (delinquent behavior at age 13, gender, and family history of AOD problems) were evaluated in a single LCGM. In addition to these variables, age at survey one was also included because the distal young adult variables that were added in subsequent models vary by age. As a result, it was necessary to include a direct effect between the distal outcomes and age.

With all of the covariates in the model, the adequacy of the six-class model was re-evaluated, as recommended by Li, Duncan, and Duncan (2001). The six class model

continued to provide the best fit to the data as described in *Figure 4–23*. The addition of the covariates improved the fit of the model as well as the posterior probabilities (reported in *Table 4–6*). The class counts (reported in *Table 4–7*) and overall trajectories (depicted in *Figure 4–22* and reported in *Table 4–11)* remained similar to the unconditional LCGM.

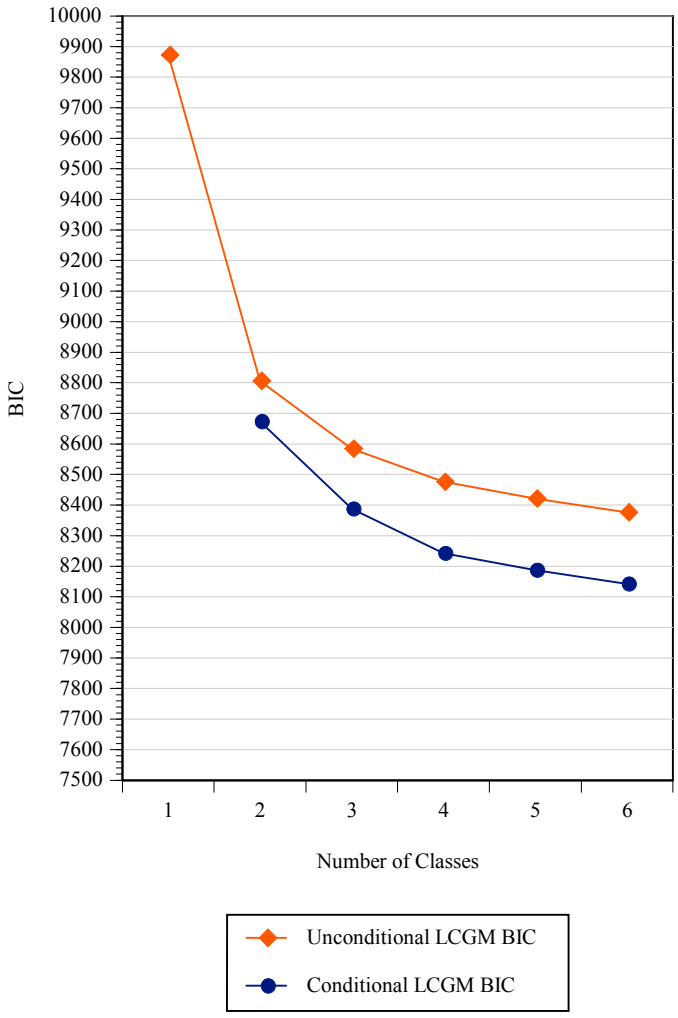


Figure 4–21: BIC values for the conditional LCGM

Table 4–6: Posterior probabilities for the conditional six-class LCGM

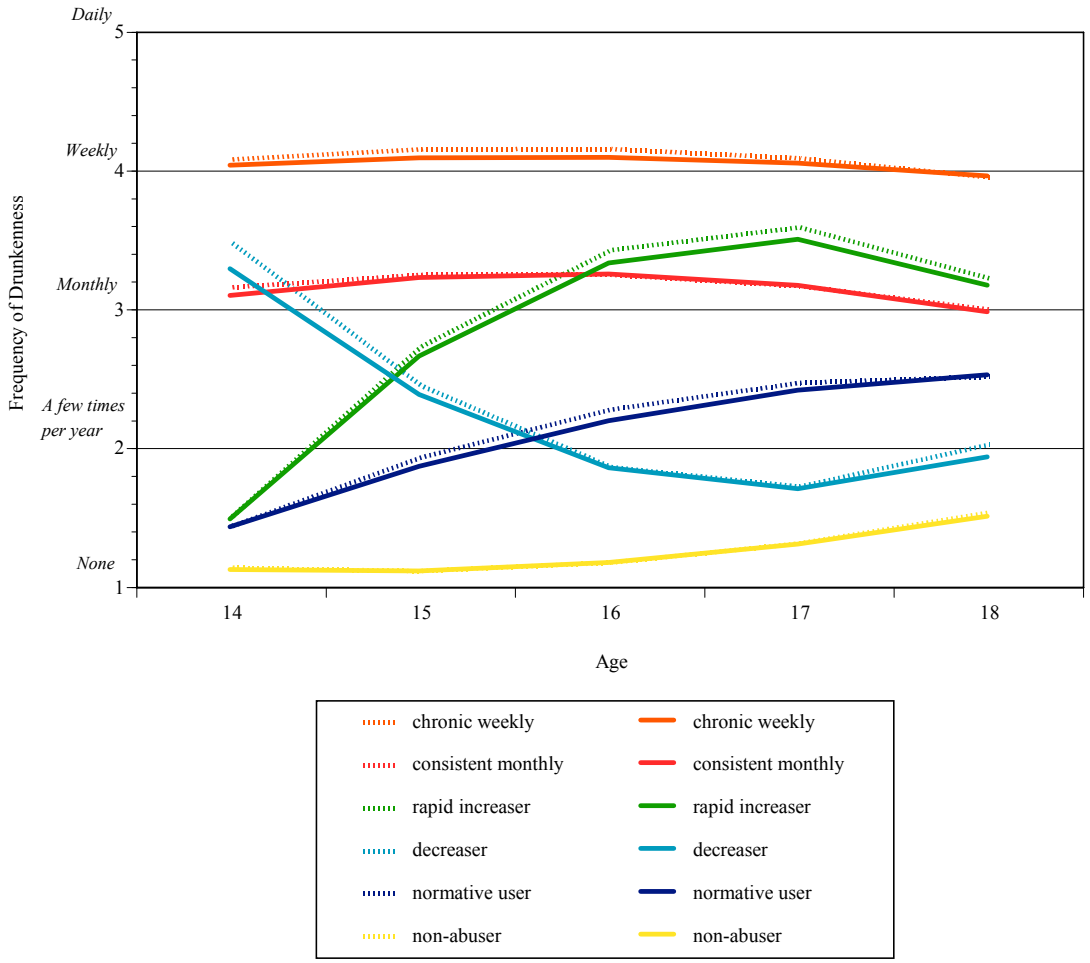
Class	1	2	3	4	5	6
1	**0.909**	0.085	0.001	0.005	0.000	0.000
2	0.042	**0.865**	0.042	0.029	0.022	0.000
3	0.002	0.054	**0.831**	0.002	0.112	0.000
4	0.004	0.063	0.004	**0.884**	0.030	0.016
5	0.000	0.015	0.066	0.013	**0.812**	0.095
6	0.000	0.000	0.000	0.004	0.062	**0.934**

Note: The probabilites were averaged across the 20 datasets.

Table 4–7: Final class counts and proportions for the conditional six-class LCGM

Class	Mean	Min	Max	%
1	40.95	19	86	6.50%
2	105.55	87	120	16.75%
3	70.00	50	106	11.11%
4	37.30	27	62	5.92%
5	159.25	139	176	25.28%
6	215.95	192	232	34.28%

Note: Minimum and maximum represent the range of class counts across the datasets. The mean is the average count.



Note: Dotted lines denote the estimated trajectory without covariates and solid lines represent the trajectories estimated with covariates in the model.

Figure 4–22: Estimated mean trajectories for the conditional six-class LCGM

Table 4–8: Estimates for the conditional six-class LCGM

Class	Parameter	Estimate	Std. Err.	T-ratio	DF	P-value
Class 1: chronic weekly	intercept	4.045	0.339	11.93	74	0.0000
	slope	-0.067	0.128	-0.52	210	0.6024
	quadratic	-0.024	0.054	-0.45	369	0.6564
Class 2: consistent monthly	intercept	3.164	0.352	9.00	393	0.0000
	slope	-0.135	0.150	-0.90	447	0.3699
	quadratic	-0.053	0.084	-0.63	456	0.5264
Class 3: rapid increasers	intercept	3.498	0.363	9.64	1057	0.0000
	slope	-0.081	0.175	-0.46	118	0.6452
	quadratic	-0.251	0.092	-2.74	901	0.0063
Class 4: decreasers	intercept	1.701	0.554	3.07	1502	0.0022
	slope	0.039	0.233	0.17	358	0.8665
	quadratic	0.189	0.129	1.47	628	0.1417
Class 5: normative user	intercept	2.409	0.210	11.47	154	0.0000
	slope	0.166	0.140	1.18	481	0.2374
	quadratic	-0.054	0.050	-1.08	273	0.2832
Class 6: non-abusers	intercept	1.301	0.059	22.22	268	0.0000
	slope	0.166	0.053	3.13	140	0.0021
	quadratic	0.035	0.016	2.19	208	0.0295

Note: The degrees of freedom vary due to differences in missing information for each parameter.

As can be seen in *Table 4–9,* early onset drunkenness continued to distinguish Classes 1 (chronic weekly), 2 (consistent monthly), and 4 (decreasers) from Class 6 (non-abusers). Delinquency emerged as a significant partial discriminator in predicting membership in Classes 1 and 2, the chronic high and consistent monthly drinkers.

Table 4–9: Regression of class membership on the covariates

Comparison	Parameter	Estimate	Std. Err.	T-ratio	DF	P-value
Class 1 to Class 6	early onset	3.652	1.018	3.59	423	0.0004
	delinquency	0.981	0.276	3.55	150	0.0005
	gender	-1.508	0.854	-1.76	555	0.0782
	family history	-0.012	0.680	-0.02	372	0.9864
	age	0.039	0.466	0.08	291	0.9332
Class 2 to Class 6	early onset	3.114	0.830	3.75	287	0.0002
	delinquency	0.529	0.219	2.42	170	0.0167
	gender	-0.713	0.587	-1.21	1187	0.2246
	family history	-0.177	0.483	-0.37	904	0.7143
	age	0.413	0.325	1.27	398	0.2050
Class 3 to Class 6	early onset	0.267	1.515	0.18	105	0.8606
	delinquency	0.337	0.256	1.32	125	0.1908
	gender	-1.007	0.674	-1.50	1738	0.1349
	family history	0.604	0.607	0.99	214	0.3210
	age	0.505	0.314	1.61	259	0.1090
Class 4 to Class 6	early onset	3.490	1.033	3.38	1460	0.0008
	delinquency	0.473	0.414	1.14	423	0.2532
	gender	0.632	1.385	0.46	2473	0.6483
	family history	0.101	0.890	0.11	1355	0.9100
	age	0.470	0.526	0.89	390	0.3725
Class 5 to Class 6	early onset	0.721	0.705	1.02	362	0.3071
	delinquency	0.430	0.262	1.64	90	0.1043
	gender	-0.512	0.402	-1.27	754	0.2031
	family history	-0.412	0.637	-0.65	1174	0.5184
	age	-0.248	0.360	-0.69	251	0.4912

Note: The degrees of freedom vary due to differences in missing information for each parameter.

Question 4: Are certain drinking trajectories more likely to be associated with young adult substance-use behavior and alcohol-related consequences?

The addition of distal young adult outcomes to the conditional LCGM

The conditional LCGM represents the final determination of class membership. The hypotheses considered here require that class membership be determined only by

factors that existed during adolescence. Therefore, the growth and covariate portion of all proceeding models were constrained to be equal to the parameters reported in *Table 4-8* and *4-9*. In addition, the time specific variances and intercepts for classes one through five were restricted to be equal to the parameters obtained in the conditional LCGM.

The next step in assessing the proposed research questions was to evaluate the differences in adult substance use and related consequences across the six trajectory classes. Five separate models were tested, one for each young adult outcome.

An initial model was specified for each of the distal outcomes that specified the direct effect between age and the distal only. When the distal outcome is continuous, the parameter estimate obtained represents the intercept. As with any intercept, it is by definition the value of Y when all of its direct effects are 0. As such, it is important to center the covariates at a meaningful value.

As a result of estimating the single direct effect between age and the distal these initial models allow the mean of the young adult outcome to be observed without adjusting for the covariates of interest (early onset, gender, and family history of AOD problems). The estimates are reported in *Table 4–10.*

Before the distal outcomes can be further compared as a function of class membership, the direct effect between the covariates and the distal outcomes must be assessed.

Table 4–10: Means of young adult outcomes by class membership

Class	Parameter	Estimate	Std. Err.	T-ratio	DF	P-value
Class 1: chronic weekly	Intoxication	3.765	0.233	16.15	126	0.0000
	Drug Use	3.551	0.337	10.55	188	0.0000
	Hangover	3.357	0.592	5.67	81	0.0000
	Forget	2.668	0.508	5.26	777	0.0000
	Police	1.488	0.232	6.43	1149	0.0000
Class 2: consistent monthly	Intoxication	3.313	0.127	26.04	210	0.0000
	Drug Use	2.084	0.150	13.94	227	0.0000
	Hangover	3.186	0.256	12.45	259	0.0000
	Forget	1.535	0.159	9.65	151	0.0000
	Police	1.080	0.040	27.22	98	0.0000
Class 3: rapid increasers	Intoxication	3.548	0.178	19.92	168	0.0000
	Drug Use	2.538	0.283	8.97	292	0.0000
	Hangover	3.410	0.341	10.00	172	0.0000
	Forget	1.646	0.177	9.30	179	0.0000
	Police	1.209	0.139	8.71	734	0.0000
Class 4: decreasers	Intoxication	2.592	0.182	14.27	221	0.0000
	Drug Use	1.572	0.178	8.85	162	0.0000
	Hangover	1.884	0.235	8.01	107	0.0000
	Forget	1.258	0.116	10.80	77	0.0000
	Police	1.034	0.069	15.01	100	0.0000
Class 5: normative user	Intoxication	3.174	0.113	28.22	417	0.0000
	Drug Use	1.777	0.113	15.77	188	0.0000
	Hangover	2.731	0.208	13.15	188	0.0000
	Forget	1.454	0.096	15.12	339	0.0000
	Police	1.059	0.049	21.77	338	0.0000
Class 6: non-abusers	Intoxication	2.403	0.086	27.82	270	0.0000
	Drug Use	1.376	0.071	19.47	136	0.0000
	Hangover	1.875	0.104	18.05	310	0.0000
	Forget	1.251	0.051	24.31	392	0.0000
	Police	1.020	0.013	80.65	171	0.0000

Note: The degrees of freedom vary due to differences in missing information for each parameter.

Question 5: Does early onset intoxication have an independent effect on young adult outcomes beyond the effect explained by trajectory class? To what extent does trajectory class mediate the relationship between early onset intoxication and adult substance abuse and related consequences?

The partial direct and mediated effect of the covariates on adult outcomes

The models tested for Research Question 4 assumed that the covariates of the model had no direct effect on the distal outcomes. That is, that the distal outcomes depended on the covariates only through class membership. In order to test the plausibility of this assumption, the direct effects between the covariates (all except delinquency) and the distals were estimated. A significant direct effect suggests that additional variance in the distal outcomes could be explained directly through the covariate being considered. In addition to testing the significance of the effect, the improvement in Log Likelihood was also considered.

Neither early onset nor family history of AOD problems had a direct effect on any of the young adult outcomes. Likewise, the improvement in Log Likelihood was not significant. Gender had a significant direct effect on frequency of intoxication (β (344)=- .465, S.E.=.094, T=-4.96, p=.0000), hangovers (β (153)=-.516, S.E.=.157, T=-3.28, p=.0013), forgetting where one was or what one did as a result of alcohol abuse (β (593)=-.164, S.E.=.079, T=-2.09, p=.0375), and alcohol-induced trouble with police (β (735)=-.086, S.E.=.033, T=-2.64, p=.0085). That is, females were less likely to experience these events. An improvement in Log Likelihood with the addition of the direct effect of gender was noted for frequency of intoxication (LL difference ranged

from 11.223-22.571, mean of 16.187 with 1 degree of freedom) and hangovers (LL difference ranged from 3.323-13.678, mean of 8.013 with 1 degree of freedom).

In addition to testing the covariates of substantive interest, the direct effect of age was also evaluated. Age had a significant direct effect on frequency of intoxication (β (346)=-.216, S.E.=.058, T=-3.74, p=.0002), hangovers (β (159)=-.493., S.E.=.099, T=-5.00, p=.0000) and forgetting where one was or what one did as a result of alcohol abuse (β (257)=-.145, S.E.=.058, T=-2.49, p=.0133). Likewise a significant improvement in Log Likelihood was observed (intoxication LL difference ranged from 3.87-13.648, hangovers ranged from 8.805-21.732, and forgetting where one was ranged from 2.122-10.348 [4 imputations resulted in a non-significant difference, the mean across the 20 imputed sets was 5.488]. In all cases, the effect was negative – a younger age was associated with more frequent substance use and related consequences.

As recommended by Li et al. (2001), the significant direct effects were retested, allowing them to differ across classes. This model allowed the covariates to have a different effect on the distal outcomes in each class. None of the models produced a significant difference in Log Likelihood between the model that allowed the direct effects to vary by class and the model that constrained them to be equal. However, the effect of gender on trouble with police had trouble converging. As reported earlier, only 1.5% of all females reported having trouble with police. Furthermore, only a small number of males had reported the event (approximately 12%), and the majority of those reporting the event experienced the event just once. Therefore, it was decided to estimate this distal outcome as a dichotomous variable (never as compared to one or more times) for

males only. This was achieved by allowing gender to be coded as a 1 for females and a 0 for males. As such, the intercept obtained for the distal variable represents the value of the distal when gender is 0 (male).

A final model was next specified for each distal outcome, which included the direct effect of gender and age for young adult intoxication, hangovers, and alcohol-induced forgetfulness. Based on the non-significant Log Likelihood differences, these effects were specified to be invariant across classes. As mentioned earlier, the estimated value of the distal when direct effects are included is an intercept and therefore the 0 value of the direct covariates must be meaningful. In the models that specify a direct effect for gender, the gender variable was centered. When a dichotomous variable is centered it represents the proportion of individuals reporting category 1 as compared to category 2 and therefore adjusts for the difference in proportions of the categories.

The test of significant young adult substance use differences as a function of trajectory class membership

The specification of the final model, a model in which all significant direct and indirect paths were specified, allows one to test if the means of the young adult outcomes were significantly different across classes. To achieve this task, planned comparisons were utilized. Class 5 (normative users) and Class 6 (non-abusers) together represent the vast majority of subjects in the sample. While these two groups did not significantly differ on the covariates, their young adult outcomes did appear to differ (see *Table 4-10*). To test for differences between Classes 5 and 6, the intercept of each of the young adult

outcomes was constrained to be equal. This model was compared to a model in which the young adult measures were freely estimated in each class. The nested models resulted in a significant Log Likelihood ratio test (distributed as X^2 with 1 degree of freedom) for young adult intoxication, drug use, and hangovers. That is, the members of the normative user class were more likely to drink to intoxication, use illicit drugs, and experience more hangovers than the non-abusing class. No significant difference was found between the normative user and non-abusing class for forgetting where one was or what one did as a result of alcohol abuse, or alcohol-induced trouble with the police (for males only). The Log Likelihood differences are reported in *Table 4–11*.

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Table 4–11: Differences in model fit for constrained distal outcomes

Comparison	df	Min	Max	Mean	Notes
Monthly Intoxication					
Class 5 to Class 6	1	8.981	22.289	14.325	
Class 4 to Low-Use Group	1	0.003	0.869	0.259	
Class 3 to Low-Use Group	1	6.996	21.622	14.609	
Class 2 to Low-Use Group	1	6.722	15.480	9.982	
Class 1 to Low-Use Group	1	4.071	15.986	10.594	
Omnibus (Class 1, 2, and 3)	2	0.175	4.416	1.996	
Monthly Illicit Drug Use					
Class 5 to Class 6	1	2.716	9.414	5.446	5 imputations produced a NS difference
Class 4 to Low-Use Group	1	0.000	0.826	0.164	
Class 3 to Low-Use Group	1	7.346	26.202	17.941	
Class 2 to Low-Use Group	1	4.934	13.658	8.796	
Class 1 to Low-Use Group	1	29.737	60.644	46.515	
Omnibus (Class 1, 2, and 3)	2	9.646	28.819	19.586	
Class 1 to Class 2	1	9.477	28.817	18.843	
Class 1 to Class 3	1	4.291	20.112	10.352	
Class 2 to Class 3	1	0.047	6.032	2.206	
Hangovers					
Class 5 to Class 6	1	2.222	12.035	7.161	1 imputations produced a NS difference
Class 4 to Low-Use Group	1	0.007	0.844	0.286	
Class 3 to Low-Use Group	1	6.061	20.141	11.602	
Class 2 to Low-Use Group	1	6.419	16.236	10.572	
Class 1 to Low-Use Group	1	0.601	15.566	4.566	11 imputations produced a NS difference
Omnibus (Class 1, 2, and 3)	2	0.050	4.346	1.079	
Forget					
Class 5 to Class 6	1	0.356	3.596	1.396	
Class 4 to Low-Use Group	1	0.000	0.450	0.124	
Class 3 to Low-Use Group	1	0.587	8.727	2.687	17 imputations produced a NS difference
Class 2 to Low-Use Group	1	0.004	3.889	1.569	1 imputations produced a NS difference
Class 1 to Low-Use Group	1	8.443	31.756	18.461	
Omnibus (Class 1, 2, and 3)	2	2.906	21.960	11.048	1 imputations produced a NS difference
Class 1 to Class 2	1	2.889	21.375	9.421	1 imputations produced a NS difference
Class 1 to Class 3	1	1.030	15.976	9.277	2 imputations produced a NS difference
Class 2 to Class 3	1	0.008	2.485	0.478	
Trouble with Police for Males					
Class 5 to Class 6	1	0.000	5.050	0.872	19 imputations produced a NS difference
Class 4 to Low-Use Group	1	†			
Class 3 to Low-Use Group	1	0.261	6.527	3.233	13 imputations produced a NS difference
Class 2 to Low-Use Group	1	0.000	7.281	2.544	17 imputations produced a NS difference
Class 1 to Low-Use Group	1	1.273	15.000	5.746	8 imputations produced a NS difference
Omnibus (Class 1, 2, and 3)	2	0.001	5.271	1.347	

† The distal outcome for Class 4 was constrained to be equal to a probability of 0.

Note: NS=not significant

Although these two groups exhibited some differences in adulthood, both classes demonstrated low-use adolescent alcohol use trajectories. Epidemiological data collected over the past several decades (see Johnston et al. 2001) describes the types of adolescent alcohol use demonstrated by the subjects in Classes 5 and 6 as normative development. One could compare the remaining classes to the teetotalers of Class 6 and surely stark differences in young adult substance misuse patterns would be illuminated. While the non-abusing class' abstemious behavior should be considered the gold standard of healthy adolescent development, it is impractical to believe that complete abstinence is achievable among adolescent populations. Practically speaking, it is more meaningful to compare the remaining classes to all lower use students, rather than only individuals who demonstrated meritorious behavior unlikely to be achieved by the majority of adolescents. Therefore, the non-abusing and normative user classes were combined into a low-use group. As such, the aggregated low-use group represents the individuals who demonstrated the lowest overall levels of alcohol use throughout adolescence.

The remaining four classes were compared to the low-use group. A series of models were tested in which the intercepts of the adult outcome variables in Classes 5 and 6 were constrained to be equal (referred to as the baseline model). Heretofore this aggregate group will be referred to as the low-use group, based on their low drinking trajectory throughout adolescence.

The results of the comparisons are reported in *Figure 4–23 and Table 4-11,* which display the difference in the mean Log Likelihood value between the fixed and free models.

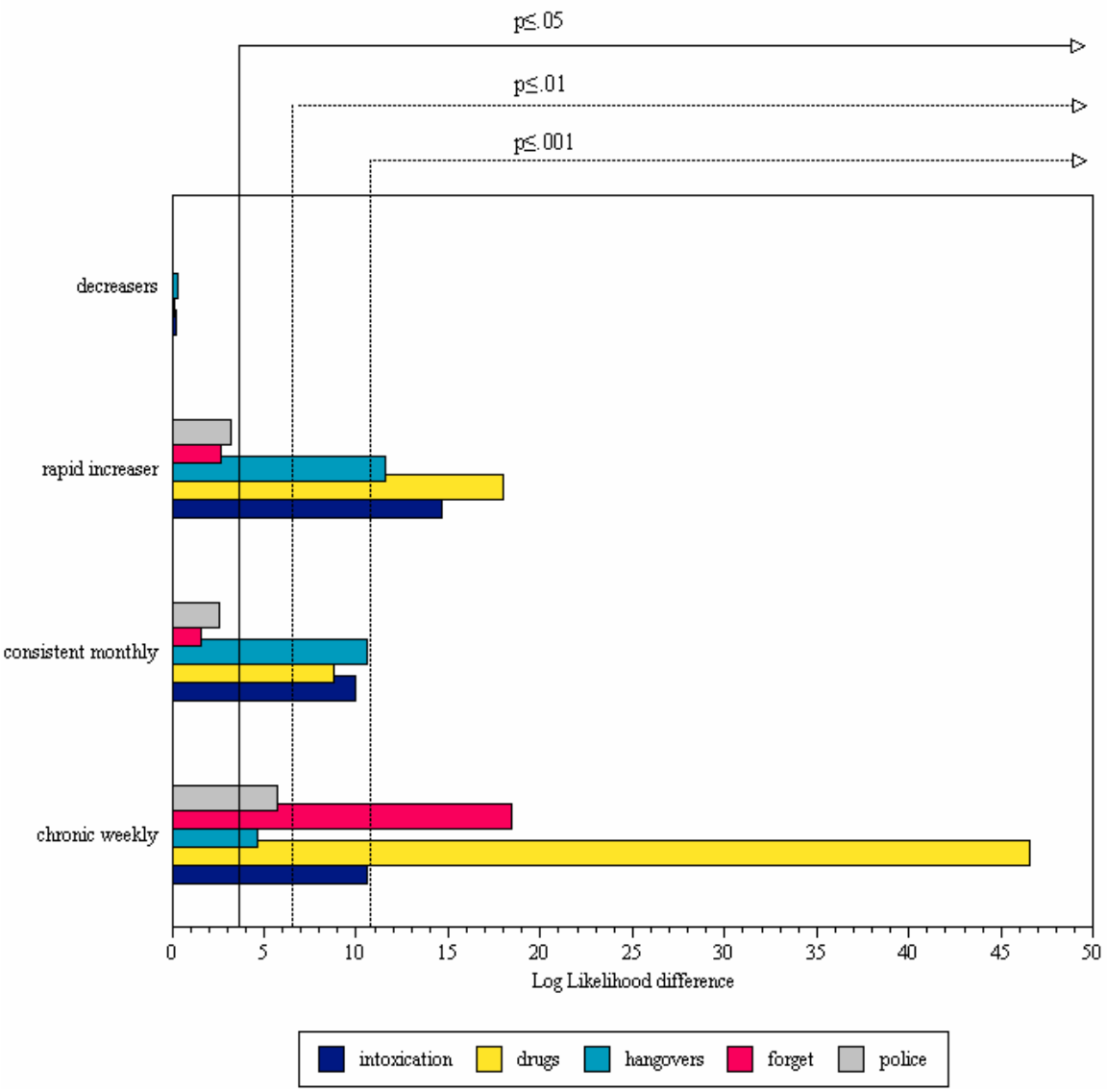

Figure 4–23: Difference in Log Likelihood for fixed as compared to free models comparing each class to the low-use group

The decreasers did not differ from the low-use group on any of the distal outcomes. That is, members of the decreasing class were no more or less likely to experience the distal outcomes than the members of the low-use group. None of the

members of Class 4 that were observed (not imputed) reported having trouble with police. When allowed to be estimated the trouble with police distal variable for Class 4 was set to the threshold extreme for the majority of the imputations, and would not converge for other imputations. Therefore, the probability of experiencing trouble with the police for members of Class 4 was restricted to a probability of 0. The members of the rapid increasing class demonstrated a higher frequency of problematic young adult outcomes for intoxication, drug use, and hangovers. Consistent monthly members also drank to intoxication, used drugs, and experienced hangovers more frequently than the low-use group. Finally, the chronic high members were more likely to experience all five young adult outcomes (although the difference in frequency of hangovers was marginal).

The comparisons thus far have allowed each of the classes to be compared to the low-use group (Classes 5 and Classes 6). These comparisons do not allow differences between Classes 1, 2 and 3 to be observed. Based on these results, a decision was made to conduct additional tests to compare Classes 1, 2, and 3 on all of the distal outcomes to one another. The models were specified such that the distal outcomes of Classes 1, 2, and 3 were constrained to be equal. This model was compared to a model in which all of the distal outcomes were freely estimated. The nested models differed by two degrees of freedom.

No significant difference was observed among the three classes for frequency of intoxication, hangovers, or alcohol-induced trouble with the police (the Log Likelihood differences are reported in *Table 4-11*). A significant difference was observed for drug

use and forgetting where one was or what one did as a result of alcohol abuse. Post-hoc tests suggest that members of Class 1 were significantly more likely to use drugs and forget where he/she was or what he/she did than members of Class 2 and Class 3. No significant difference was found between the members of Class 2 and 3 for either outcome.

Although evaluation of the mean for each distal as a function of class membership is valuable, it is does not enable one to see the percentage of subjects in a certain class who demonstrated problematic levels of the distal outcome. By dichotomizing the distal outcomes, one can observe the likelihood of experiencing a certain event conditional on class membership. Therefore, the distal variables were again observed in the LCGM in a dichotomous form. The probabilities were obtained using the EM imputed dataset.

Figure 4–24 presents the probability of weekly intoxication as a function of class membership after controlling for gender and age. The chronic high members were the most likely to have reported getting drunk on a weekly basis, followed by the rapid increasers. As expected, the non-abusers were the least likely to report weekly intoxication.

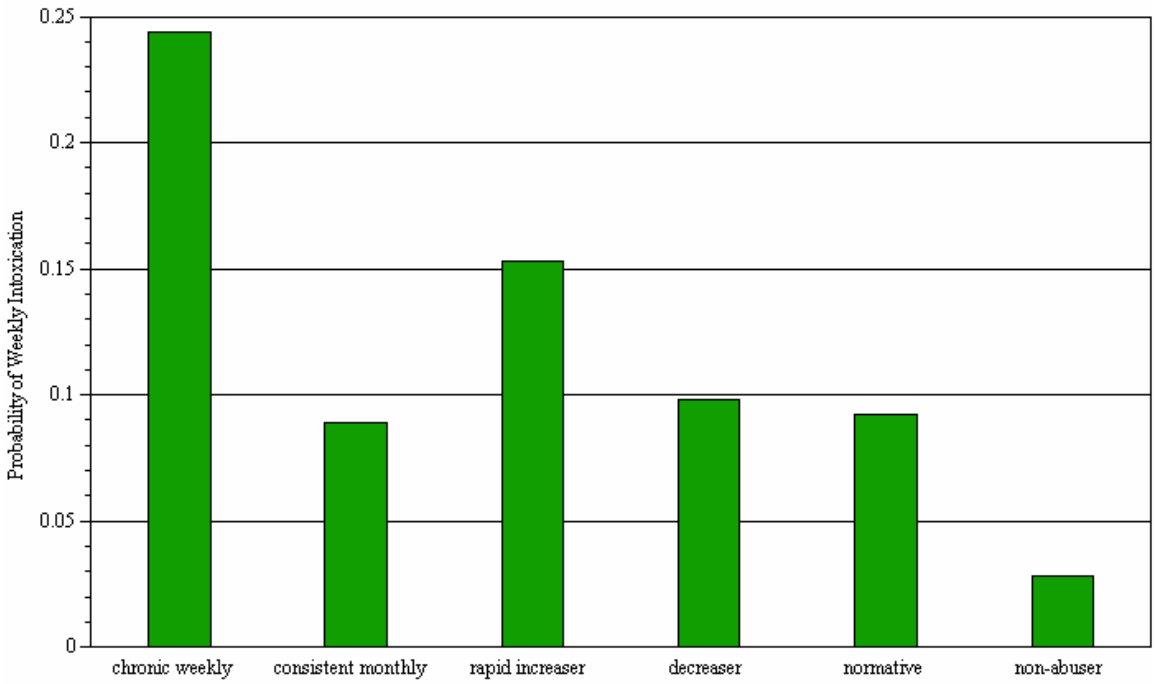

Figure 4–24: Probability of weekly intoxication by class membership

Figure 4–25 presents the probability of monthly use of illicit substances by class membership. Recall that neither gender nor age were significant predictors of young adult illicit drug use after considering trajectory class membership. Less than 5% of the decreasers, normative users, and non-abusing class members reported monthly use of illicit drugs; however, over 50% of the chronic weekly members reported use of illicit drugs on at least a monthly basis.

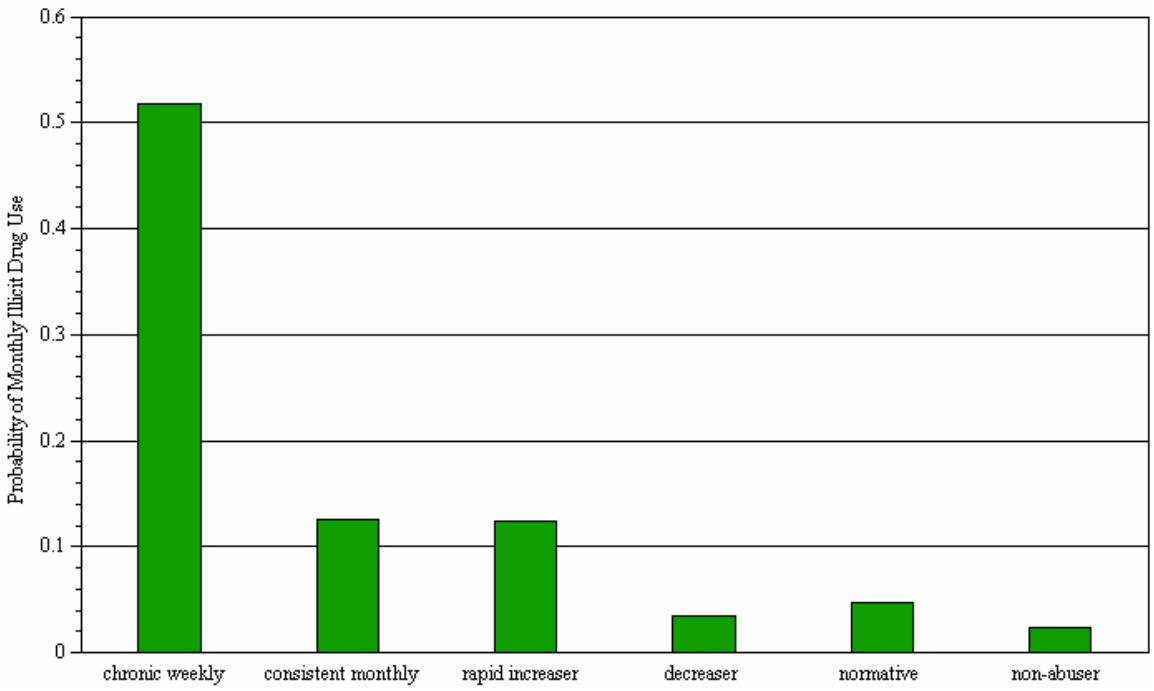

Figure 4–25: Probability of monthly use of illicit drugs by class membership

Figure 4–26 presents the probability of experiencing six or more hangovers in the past year by class membership after controlling for gender and age.

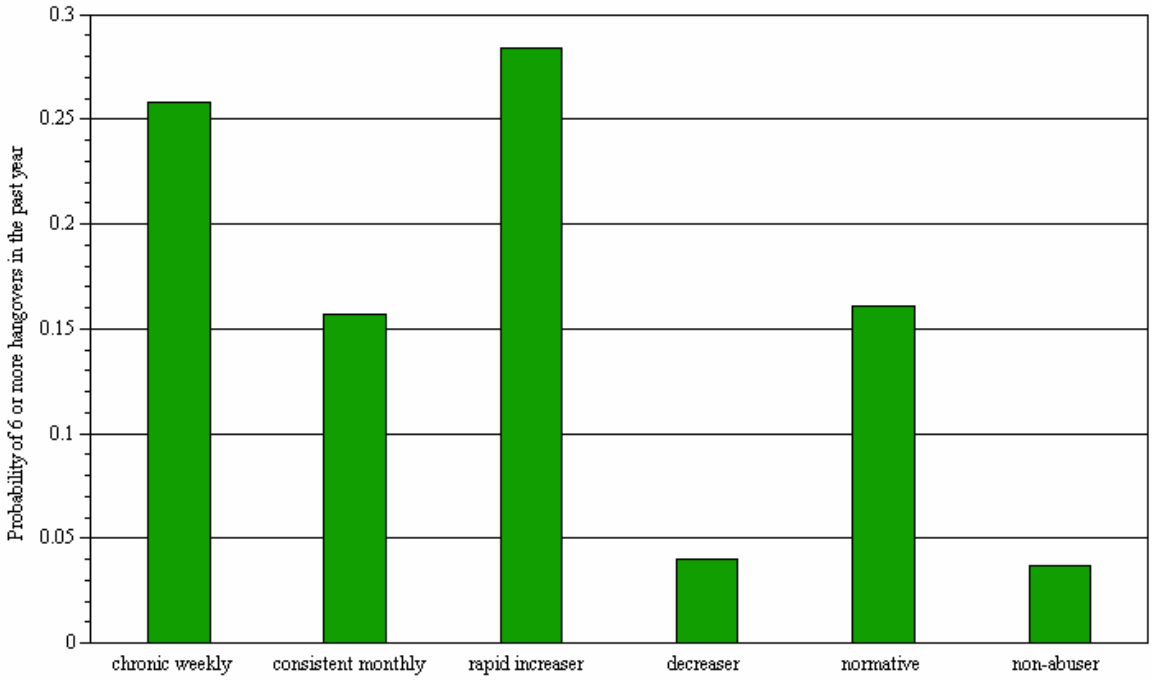

Figure 4–26: Probability of experiencing six or more hangovers in the past year.

Figure 4–27 presents the probability of forgetting where one was or what one did as a result of alcohol abuse two or more times in the past year by class membership. A direct effect between both gender and age and the distal outcome was observed and as such the estimate represents the probability of the outcome after adjusting for these variables.

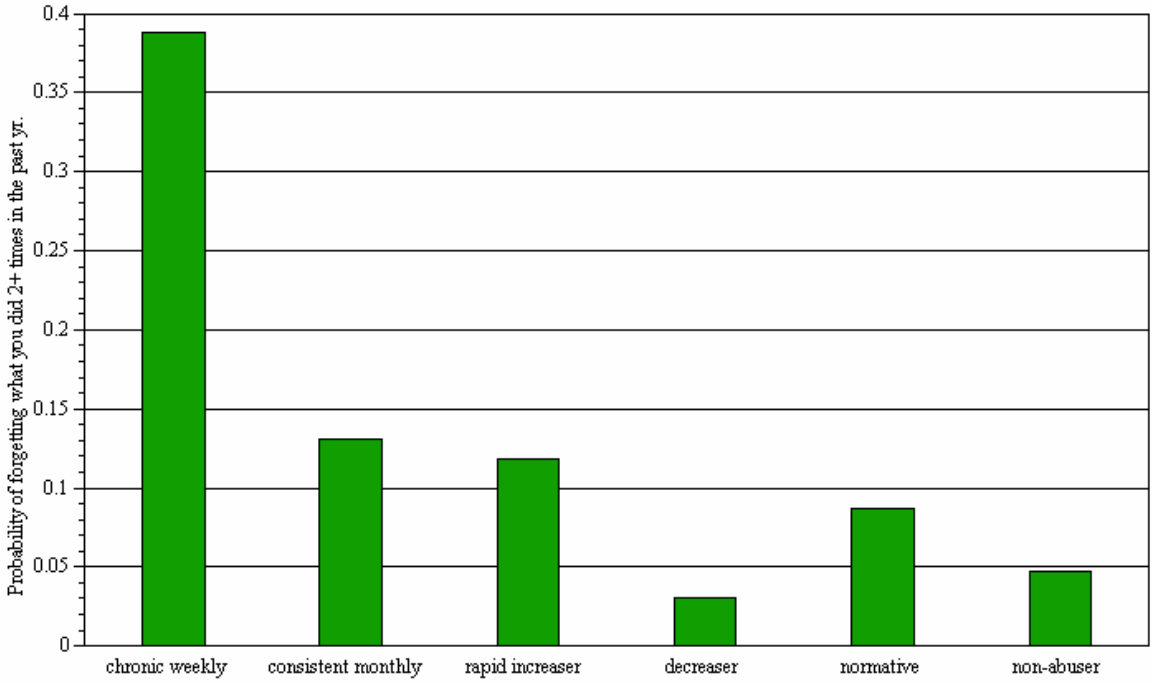

Figure 4–27: Probability of forgetting where one was or what one did as a result of alcohol abuse two or more times in the past year

Finally, *Figure 4–28* presents the probability of getting into trouble with the police as a result of alcohol abuse one or more times in the past year. A direct effect between gender and the distal outcome was observed. That is, males were more likely to have experienced the event than females. Furthermore, it was estimated that only 1.5% of the females as a whole had experienced the event. As such, the probability of the distal was estimated for males only.

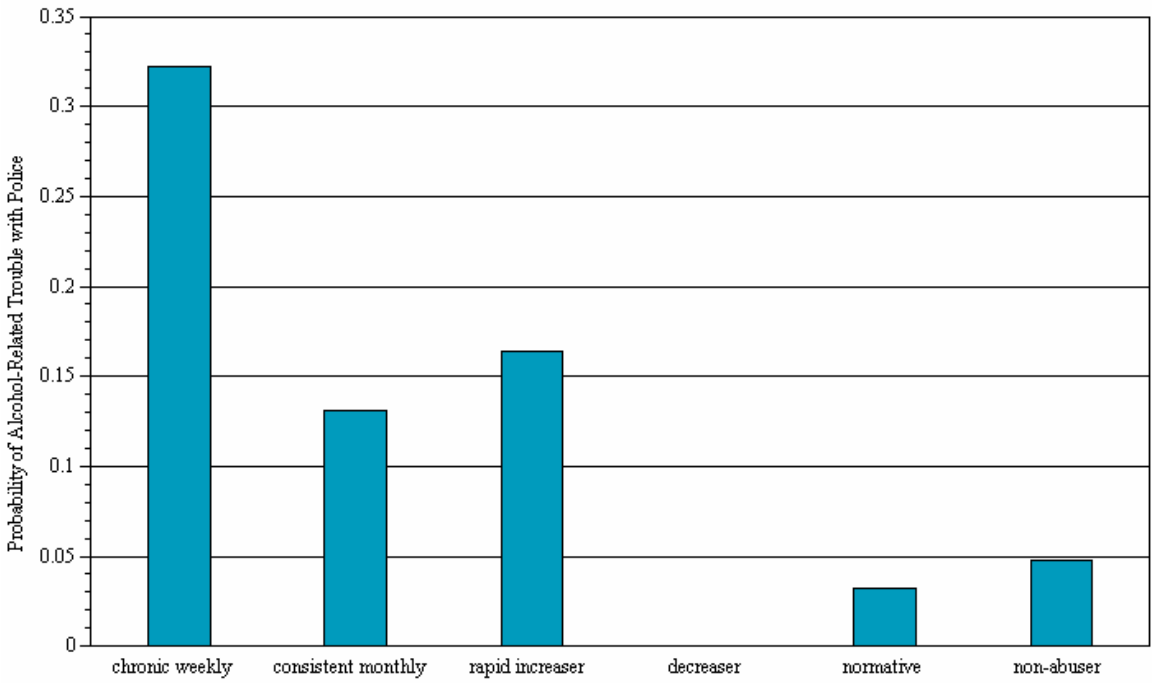

Figure 4–28: Probability of getting into trouble with the police as a result of alcohol abuse one or more times in the past year for males

Summary of findings

As discussed in Chapter 1, several prominent researchers (Guo et al. 2000 & Zucker et al., 1995) have discussed the importance of mapping out the developmental pathways for different types of drinkers, including a better understanding of time-specific variation of adolescent alcohol use and the impact of discontinuation of use during adolescence on lowering risk of adult abuse. The findings reported in this thesis offer a better understanding of the pathways to problematic substance use among rural young adults. Specifically, this thesis produced the following notable findings:

- Males were more likely to engage in delinquent acts at age 13, but no more likely to have experienced their first intoxication by age 13 than females. Males were less likely to have reported a family history of AOD problems.
- Male and female adolescents who experienced their first intoxication by age 13 were more likely to have a family member with an AOD problem. In addition, males with a family member with an AOD problem were more likely to engage in frequent delinquent behavior at age 13.
- Adolescents who experienced their first intoxication by age 13 were more likely to drink to intoxication throughout adolescence.
- Adolescents who experienced their first intoxication by age 13 were more likely to use illicit drugs and forget where they were or what they did due to alcohol abuse in young adulthood. Early onset intoxication did not have a direct effect on young adult intoxication, frequent hangovers, nor getting into trouble with police due to alcohol abuse.

- A six-class LCGM described the patterns of drinking to intoxication from age 14 to age 18 in the sample. The following classes emerged: chronic high, consistent monthly, rapid increaser, decreaser, normative user, and non-abuser.
- No significant differences between the non-abusers and normative users were observed with respect to the covariates (early onset intoxication, delinquency at age 13, gender, and family history of AOD).
- Members of the chronic high, consistent monthly, and the decreasing classes were more likely to have experienced their first intoxication by age 13 than the members of the non-abusing class.
- Members of the chronic high, rapid increasing, and decreasing classes reported more delinquent acts at age 13 than members of the non-abusing class.
- Members of the chronic high, consistent monthly, and the rapid increasing classes were more likely to be male than the members of the non-abusing class.
- Gender had a direct effect on the young adult outcomes (intoxication, forgetting where one was or what one did as a result of alcohol abuse, and alcohol-induced trouble with the police) after controlling for the adolescent alcohol use trajectory.
- The normative user class members were more likely to drink to intoxication, use drugs, and experience hangovers in young adulthood than members of the non-abusing class.
- Members of the consistent monthly and rapid increasing classes were more likely to drink to intoxication, use illicit drugs, and experience hangovers than members of the low-use group (aggregate of the normative user and non-abusing classes).

- Members of the chronic high class were more likely to experience all five of the negative young adult outcomes (drink to intoxication, use illicit drugs, experience hangovers, forget where he/she was or what he/she did as a result of alcohol abuse, and experience alcohol induced trouble with the police) than members of the low-use group.
- Students who were abusing alcohol at ages 13 and 14, but proceeded to cease use in later adolescence were no more likely than the low-use group to abuse substances in young adulthood.

Chapter 5

DISCUSSION

The fifth and final chapter of this thesis interprets the results from the current investigation and offers some possible explanations for the findings. The findings are compared and contrasted to other studies that have considered similar hypotheses. In addition, the limitations to the study are discussed as well as the practical implications and future directions.

Summary of findings

The results reported in Chapter 4 suggest that early adolescent drinking patterns play an important role in the likelihood of subsequent substance abuse. As hypothesized, those students who had experienced their first intoxication by age 13 reported a higher frequency of intoxication throughout adolescence. These results are in agreement with those reported by Rachel et al. (1982), Barnes and Welte (1986), Fergusson et al. (1994), Donnermeyer and Park (1995), Gruber et al. (1996), Thomas et al. (2000), Lo (2000), and Chassin et al. (2002) who reported that early onset drinkers were more likely to misuse alcohol during adolescence. These results are also in accordance with the Kandel and colleagues' (Kandel & Faust, 1975; Kandel, Kessler & Margulies, 1978) gateway hypothesis. That is, an early onset of alcohol use appears to act as a steppingstone to subsequent and more intense use.

The parameter estimate associating early onset intoxication and subsequent adolescent drinking became smaller over time, indicating that the effect of early onset drunkenness became less important as the students progressed in age. For example, at age 14, the parameter estimate for the regression of frequency of drunkenness on early onset was 1.405. As such, the early onset adolescents were drinking to intoxication an average of 1.4 units more than the non-early onset adolescents. The intercept for the model was 1.812; therefore, non-early onset adolescents were drinking to intoxication at age 14 at a frequency of 1.8 (between never and a few times per year), while early onset adolescents were drinking to intoxication at a frequency of 3.2 (nearly on a monthly basis). Now consider frequency of drunkenness at age 18. The regression coefficient was .493. With an intercept of 2.347, one can see that the non-early onset adolescents were getting drunk with a frequency of 2.3, while the early onset adolescents were getting drunk with a frequency of 2.8. Clearly, the difference in drunkenness as a function of onset status narrowed between age 14 and age18. Furthermore, by young adulthood, the effect of early onset drunkenness on frequency of intoxication was no longer statistically significant. Although Muthén and Muthén (2000a) evaluated the impact of onset status among an older population, they reported similar results. Their findings also supported the idea that early onset status demonstrates a less important effect on subsequent alcohol abuse as individuals grow older. Labouvie et al. (1997) reported similar results.

Previous research has documented the elevated use of substances common among individuals in their early twenties (SAMHSA, 2000). As such, the level of drinking exhibited by the subjects in the study during the young adult years may be normative.

One might surmise that the effect of early onset drunkenness is not likely to be observed with normative behaviors (frequent intoxication during one's young adulthood). Perhaps the impact of early onset drunkenness is more visible for more serious behaviors such as illicit drug use and frequent experience of alcohol-related consequences. This notion suggests that assessing frequency of intoxication at a later date, after frequent heavy drinking becomes less socially acceptable (or less normative), may allow the impact of early onset drinking to become more apparent. This hypothesis is supported by the observation that early onset young adults in the sample under investigation here did report significantly more frequent use of illicit drugs and more alcohol-related consequences.

In addition to considering the intercept, the slope and acceleration of intoxication over time were also evaluated. Adolescents reporting an early intoxication were more likely to demonstrate a lower slope. As discussed in Chapter 4, this is likely due to a ceiling effect. No significant effect was found for the regression of the quadratic term on early onset drunkenness. As such, it appears that early onset drunkenness affected subsequent adolescent drinking by increasing the frequency with which the subjects drank to intoxication. As the sample became older, and drinking became a more normative behavior, the effect of early onset drunkenness became less apparent.

The association between early onset and delinquency is quite high. This finding is in accordance with problem behavior theorists (see Jessor and Jessor, 1977) who suggest that undesirable behaviors often co-exist. Based on longitudinal evidence, Kellam, Brow, and Fleming (1982) believe that delinquent behavior most often predates

drug use. Their postulation is supported by research reporting that disruptive behavior observed at age six significantly predicted having been drunk by age 14 (Dobkin et al., 1995). Similarly, Huba and Bentler (1984) reported that disobeying the law predicted increased drug use and deviance throughout adolescence; however, drug use influenced subsequent deviant behavior to a lesser extent. However, these findings are not in accordance with the data reported here. It appears that early drinking was more likely to lead to early delinquency than early delinquency leading to early drinking in the RAD sample. This conclusion was drawn based on the youngest cohort (those who began providing data at age 12). Two regression analyses were used to investigate the causal flow. First, frequency of intoxication at age 13 was regressed on frequency of intoxication at age 12 and delinquency at age 12. While intoxication at age 12 was a significant predictor of intoxication one year later (β=.587, S.E.=0.123, T=4.77, $p<.0001$), delinquency at age 12 did not provide unique prediction to the equation (β=.060, S.E.=0.069, T=.87, p=.3882). Next, delinquency at age 13 was regressed on intoxication and delinquency at age 12. While delinquency at age 12 significantly predicted delinquency at age 13 (β=.455, S.E.=.104, T=4.37, p=.0001), intoxication at age 12 also lent significant unique prediction to the model (β=.462, S.E.=.194, T=2.38, p=.0191). As such, delinquency at age 13 was not used as a covariate in the models. That is, it was not appropriate to control for delinquency at age 13 because it is likely that early drinking lead to higher levels of delinquency at age 13.

Gender emerged as a protective factor throughout adolescence and into young adulthood. The females reported less frequent intoxication from ages 15-18 and in young

adulthood. Furthermore, they also reported less use of illicit drugs and fewer alcohol-related consequences as young adults. *Figure 4-15* elucidates the findings by describing the changing impact of the covariates on drinking over time. It appears that early onset drunkenness progressively became a less important factor in drinking behavior, while early-adolescent delinquent behavior became more important. Gender appears to have played its most substantial role in mid-adolescence.

Although Chassin et al. (2002) found that adolescents who began drinking early and maintained a high level of heavy drinking throughout adolescence and into adulthood were more likely to be children of alcoholics, family history of AOD problems provided no predictive utility in the longitudinal models presented in this thesis. However, one quite important significant effect regarding family history did emerge. Adolescents reporting a family history were more likely to have experienced their first intoxication by age 13. Based on estimates from the EM imputed dataset, 24% of adolescents reporting no family history experienced their first intoxication by age 13, as compared to 40% of adolescents with a family history. This finding is in agreement with that reported by Dawson (2000). She investigated the role of family history of alcoholism to test whether early onset alcoholism results from early age at alcohol initiation, a more rapid trajectory of use toward dependence once drinking has begun, or both. She found that the percentage of alcoholic relatives was positively associated with early initiation of drinking. Those individuals with a family history of alcoholism were more likely to initiate use before the age of 15. The analysis also suggested that family alcoholism was more predictive of early age of initiation than a more rapid development of dependence.

Dawson attributes part of this finding to the potential role of the dopaminergic and serotoninergic systems in the genetics of alcoholism. Both of these biological processes have been associated with novelty seeking and impulsivity, which may lead to an earlier onset of drinking.

Dawson suggests, however, that the familial role in the early onset of drinking is likely to be more attributable to environmental factors (easier access to alcohol in the home, familial acceptance of alcohol, poor parental monitoring) than genetic factors. She points to Rose's (1998) twin study in which she concluded that 'the influence of genetic factors on initiation of drinking was negligible relative to environmental effects, but that after initiation of drinking, genetic influence played a significant role in drinking behavior" (p. 638). Taken together, the findings of Dawson and Rose may suggest that the family environment created by an alcoholic parent puts a child at risk for an early debut to alcohol. Ferguson et al. (1996) support this notion, stating that early age of onset may be an indicator of a family environment that possesses a permissive attitude toward their child's alcohol use. Similarly, Schinke, Botvin, and Orlandi (1991) consider family factors, including parental modeling of substance use and attitudes about substance use, to be the strongest factors associated with substance use by children and adolescents. Finally, it is important to note that family history of AOD problems is clearly causally prior to early onset intoxication as it is quite unlikely that an adolescent's early exposure to alcohol could cause one of their family members to begin abusing alcohol.

Many alcohol researchers, including Zucker (1995), Labouvie (2001), and Guo et al. (2001), have stressed the importance of examining multiple pathways to problematic alcohol use. In the present application this was accomplished by estimating latent growth classes to describe the differential trajectories of adolescent alcohol use present in the sample. A six trajectory class solution best described the pattern of drinking from age 14-18. The subjects' adolescent drinking was represented by six overall patterns: chronic weekly (6.50% of the sample), consistent monthly (16.75%), rapid increasers (11.11%), decreasers (5.92%), normative users (25.28%), and non-abusers (34.28%). Hill et al. (2000) also utilized a person-centered approach to examine adolescent drinking trajectories. Although their longitudinal measure represented frequency of monthly binge drinking (consuming 5+ drinks in a row) rather than frequency of intoxication and their sample was followed from age 10 to 18 years of age, some of the same trajectory classes were found. In their sample, an early-heavy class was identified, as was an increasing class, a late onsetter class, and a non-bingeing class. Chassin et al. (2002) also used semi-parametric group based modeling to model the subjects' binge drinking trajectories throughout adolescence and into young adulthood. The trajectories were described by four different classes: non-bingeing (39.5%), early-heavy (20.9%), late-moderate (30.0%), and infrequent (9.6%) [note that the infrequent group started binge-drinking in mid-adolescence but didn't escalate, and the late moderate group began binge drinking around age 18.].

The LCGM was made conditional on four variables of interest, early onset drunkenness, delinquent behavior at age 13, gender, and family history of AOD

problems. Some of these covariates were effective in discriminating among classes. The majority of the chronic weekly, consistent monthly, and decreasers in the present investigation had experienced their first intoxication by age 13. Even after controlling for the covariates, early onset drunkenness continued to distinguish these three classes from the non-abusing class. Chronic high, rapid increasers, and decreasing members engaged in more delinquent acts at age 13 than non-abusers; however, delinquent behavior became a non-significant predictor of membership in the rapid increasing and decreasing class when all four independent variables were included in the model. Furthermore, delinquency emerged as a significant descriminator of members of Class 2 in the full model. Similarly, Hill et al.'s (2000) and Chassin et al.'s (2002) early-heavy classes were characterized by higher levels of delinquency. In the present investigation, significantly fewer females were members of the chronic high, consistent monthly, and rapid increasing class as compared to the non-abusing class when each independent variable was assessed independently. In the full model, gender did not discriminate any of the classes from the non-abusing class. Hill et al. (2000) also reported a gender effect. In their sample, more males were in the increasing and late onset groups. Chassin et al. (2002) reported the highest percentage of males in the early-heavy and late-moderate groups. As mentioned earlier, family history of AOD problems did not discriminate between groups in the present study.

Just as relevant covariates had the capacity to discriminate trajectory class membership, trajectory class membership was able to lend predictive utility to young adult substance use behaviors. The non-abusing class was significantly less likely to

drink to intoxication, use drugs, and experience frequent hangovers than the normative user class. This finding suggests that adolescents who do not use alcohol or who experiment with alcohol only mildly (do not drink to intoxication) are significantly less likely to abuse alcohol in adulthood than even those who used alcohol at a level that is normative among adolescents. One might surmise that delaying first intoxication to as late an age as possible produces the best young adult outcomes. As such, it is not surprising that the non-abusing class demonstrated the most desirable substance use levels. Furthermore, it is clear that the comparison of the non-abusers to the remaining groups would illuminate the stark difference in young adult substance misuse patterns. While the non-abusing class's abstemious behavior might be considered the gold standard of healthy adolescent development, it is impractical to believe that complete abstinence is achievable among the adolescent population. Therefore, the non-abusing and normative user classes were combined into a low-use group. As such, the aggregated low-use group represented the individuals who demonstrated the lowest overall levels of alcohol use throughout adolescence.

Individuals in the chronic weekly class were most likely to demonstrate overall problematic substance abuse behaviors in young adulthood, followed by the rapid increaser and consistent monthly members. These results differ from those reported by Hill et al. (2000). While the increasers and the late onsetters in their sample were more likely than the non-bingers to be alcohol abusers at age 21, the early highs were no more likely. However, these results do compare favorably to those reported by Schulenberg, O'Malley, Bachman, Wadsworth, and Johnston (1996). In their sample, the chronic and

increasing binge drinkers demonstrated the most problematic outcomes; however, their investigation began following the subjects at a much later age (from age 18 to 22 years). The results presented here are also similar to those reported by Chassin et al. (2002). In their sample, the early-heavy members were most likely to demonstrate alcohol abuse or dependence symptoms in young adulthood.

The chronic high, consistent monthly, and rapid increasing members reported significantly more use of illicit drugs than the low use group. An astonishing 52% of individuals demonstrating a chronic high adolescent trajectory reported using illicit drugs on a monthly basis as young adults. Nearly 13% of rapid increasers were regularly using drugs in young adulthood. Comparatively, 12% of consistent monthly and less than 4% of the members in the remaining classes reported regular illicit drug use.

Alcohol-related consequences in young adulthood were measured to assess collateral effects of alcohol abuse. Members of the consistent monthly and rapid increasing class were more likely to experience hangovers. Members of the chronic high class were also more likely to experience hangovers. In addition, they were more likely to forget where they were or what they did as a result of alcohol abuse and have been in trouble with the police due to alcohol abuse within the past year.

In addition to comparing the adolescents belonging to higher-risk classes to those in lower-risk classes, it is interesting to consider the three classes that were most likely to have been drunk by age 13: the chronic highs, consistent monthly, and decreasers. While the individuals in all three classes might have been classified as at-risk at ages 13 and 14 due to their use of alcohol and engagement in other delinquent behaviors, their young

adult substance use behaviors were quite different. The individuals in the chronic high class demonstrated the most extreme negative young adult substance use behaviors, while the decreasers reported levels quite similar to the non-abusing class.

The consistent monthly users were more likely than the low-use comparison group drink to intoxication and experience negative alcohol-related consequences; however, it was to a considerably lower degree than the members of the chronic weekly class. The members of Class 1 (chronic high) were using drugs more frequently and drinking to the point where they forgot where he/she forgot where he/she was than the members of Class 2. The findings surrounding the characteristics of and differences between Classes 1 and 2 are in support of the developmental pathways to alcoholism theories put forth by Zucker (1994). He describes four different types of alcoholism. One of the most well documented types of alcoholism is called antisocial alcoholism. This type of alcoholism is characterized by adult antisociality, abuse of other substances, early onset of alcohol-related symptoms, family history of alcoholism, and childhood conduct problems. Zucker explains the unequivocal links between severe alcohol-related problems among youth and childhood antisociality. Supporting Zucker's findings, both Weber et al. (1989) and Donovan and Jessor (1985) documented the existence of multiple subtypes of adolescent drinkers. Namely, both papers discuss the importance of differentiating between adolescents who only abuse substances and those that both abuse substances and exhibit antisocial behavior.

Zucker (1994) also discusses a second type of alcoholism called developmentally limited alcoholism. Unlike those classified as antisocial alcoholics, those experiencing

developmentally limited alcoholism cease abusing alcohol as they progress into adulthood. These individuals are characterized by a lower risk load in adolescence than antisocial alcoholics. That is, developmentally limited alcoholics exhibit lower levels of abuse during adolescence and are less likely to possess known risk factors (poor family relationships, poor school performance, high impulsivity, and rebelliousness). Zucker (1994) summarizes his thoughts by stating "even when predicting problematic alcohol involvement in adolescence, the evidence suggests that risk load prior to adolescence is less for those where a developmentally limited path would be anticipated" (p. 273).

Zucker's subtypes of alcoholism can be used to help explain the differences among Classes 1, 2, and 4. First, consider Classes 1 (chronic highs) and 2 (consistent monthly). Members of Class exhibited a higher level of early delinquent behavior than the members of Class 2. These differential patterns are in agreement with antisocial alcoholism. According to Zucker, the members of Class 1 were more likely to continue their substance abuse as young adults because they were predisposed to delinquency more so than the members of Class 2.

The theories behind developmentally limited alcoholism may lend explanatory power to the differences exhibited by members in Class 1 (chronic highs) as compared to members of Class 4 (decreasers). In the analyses reported here, members of the decreasing class were likely to have initiated early drinking; however, for some reason they decreased their use of alcohol in mid-adolescence and remained rare users or abstainers throughout high school. As a result, the decreasing class members were no more likely to abuse substances in young adulthood than the low-risk class. In fact, their

mean levels of use were even below the normative user class and quite similar to the non-abusers. Previous investigations have found similar results (Labouvie and White, 2002, Yamaguchi & Kandel, 1985). That is, many individuals cease abusing alcohol and other substances before entering into young adulthood. In describing their gateway hypothesis, Kandel, Yamaguchi and Chen (1992) discussed the importance of recognizing that use at one stage does not unequivocally lead to use at the next stage. Rather, progression through one stage may be a necessary but not sufficient prerequisite for entry into the next stage. In the case of the decreasers described here, the members were able to avoid subsequent entry into continued and escalated use, and, in fact they demonstrated a decreased use of alcohol and other drugs over time.

One of the primary purposes of this investigation was to discover whether the effect of early onset intoxication had significant predictive power of young adult substance use after considering the trajectory of alcohol use throughout adolescence. That is, to determine if early onset intoxication has a direct effect, and indirect effect (through trajectory class), or no effect at all on young adult substance use and related behaviors. In the present investigation, early onset drunkenness did not predict a significant amount of variance of the young adult measures after controlling for trajectory class. That is, no direct effect between early onset drunkenness and the young adult measures was observed, suggesting that the effect of early onset intoxication on young adult substance use is mediated by trajectory class membership. This finding is in agreement with findings reported by White et al. (2001). In their sample, early onset drinking was most predictive when the consideration of subsequent alcohol use was

included in the model. The interaction of early drinking and subsequent high levels of drinking best predicted problematic young adult drinking outcomes.

Similarly, both York (1995) and Guo et al. (2000) reported that the course of alcohol use following initiation is an extremely important factor in the prediction of young adult alcohol abuse and related problems. Furthermore, Guo et al. (2000) stress the importance of recognizing that the progression from early adolescent alcohol abuse to subsequent alcohol abuse is "neither automatic nor irrevocable" (p. 806). Ayers et al. (1999) offer an explanation for these findings, stating that "for most youths, delinquent acts are rather minor and infrequent, and engagement in delinquency is of a fairly short duration" (p.278). Ayers and colleagues suggest that three important behavioral characteristics must be differentiated in order to understand the etiology of delinquent behavior: (a) initiation of the behavior, (b) change in the seriousness of the behavior, and (c) discontinuance of the behavior once initiated. Therefore, it is possible that the initiation of alcohol use alone is not predictive of adult abuse. Rather, early initiation followed by risky patterns of alcohol use throughout adolescence may interact to predict young adult substance abuse.

While it appears the early onset intoxication serves as a risk factor for exhibiting higher levels of intoxication throughout adolescence (as observed among members of Classes 1 and 2), the pattern exhibited by the rapid increasing class demonstrates the importance of considering multiple trajectories. That is, the members of Class 3 appeared to be low risk at ages 13 and 14; however, their alcohol abuse levels showed a steep incline. Furthermore, they were the second most likely class to be abusing

substances in young adulthood.

Gender provided the only significant direct effect. Less frequent intoxication and alcohol-related consequences were associated with being female. This finding supports the results reported by Hill and colleagues (2000). In their model, gender also maintained a significant direct effect on alcohol abuse/dependence at age 21. After considering the trajectory classes in the present analysis, early onset intoxication nor family history significantly predicted the young adult outcomes. Chassin et al. (2002) noted a similar effect in that early onset binge-drinking failed to provide a direct effect on young adult alcohol abuse and/or dependence after trajectory class membership was added to the model. However, being the child of an alcoholic and being male did maintain a direct effect in their investigation. That is, COAs and males were more likely to qualify for DSM-IV criteria for alcohol abuse or dependence even after considering trajectory class membership. It is important to note, however, that Chassin and colleagues allowed the measure of binge drinking at the final assessment to be included in the trajectory model. The final measurement of binge drinking in their growth model was measured at the same time that alcohol abuse and dependence were assessed.

In summary, the analyses reported here were successful in answering the five research question formulated for this thesis. With regards to the first and second research questions, it was found that early onset intoxication increased the likelihood of subsequent drinking throughout high school. Furthermore, early onset intoxication increased the likelihood of illicit drug use and alcohol-related consequences in young adulthood.

The third question was addressed through the specification of a LCGM. It was found that early onset intoxication, delinquent behavior at age 13, and gender worked together to predict a certain trajectory of drinking throughout adolescence. While family history of AOD problems did not appear to affect the trajectory of drinking over time, it did affect the likelihood of experiencing one's first intoxication by age 13. Perhaps family history of AOD affects the trajectory of drinking only through its effect on age of first use.

In analyzing the fourth question, it was found that the trajectory of alcohol use an adolescent follows lends a great deal of power to determining the level of substance abuse and related behaviors exhibited in young adulthood. Namely, adolescents classified as chronic high users, consistent monthly, and rapid increasers were most likely to demonstrate problematic young adult outcomes.

Finally, the fifth question illuminated the finding that early onset intoxication and family history of AOD did not have a direct effect on young adult substance use after trajectory class was considered. As such, it appears that the effect of early onset intoxication on young adult outcomes is mediated by trajectory class membership. This conclusion is in strong support of the findings and theories reported by Labouvie and White (2002) suggesting that the combination of age at onset and alcohol use intensity throughout adolescence is most predictive of problematic substance use in young adulthood. Gender emerged as the only covariate that had a direct effect on the young adult outcomes.

The results presented here also suggest that the course of drinking in adolescence and early adulthood among rural individuals is relatively similar to other populations. However, further investigations would be needed to test for differences and similarities.

Limitations

While the present study provided many valuable insights, it is important to recognize its limitations. First, while the sample is representative of many rural populations in the U.S., the subjects were all from a single rural school district. Therefore, the study suffers from the lack of random selection and the ability to generalize the findings may be compromised.

Second, all of the data were generated from self-report questionnaires. Self-report of alcohol use and other illegal behaviors among adolescents has been considered relatively reliable (Williams, Toomey, McGovern, Wagenaar & Perry, 1995; Huizinga & Elliot, 1986); however, the reliability of the subject's responses may be of question.

Third, while the family history of AOD problems served as a semi-adequate measure of the genetic and environmental risks associated with being exposed to an AOD abusing relative, it was not a desirable proxy. In order to truly assess the impact of this variable, much better measures would be needed. For example, it would be important to know which family members have or had an alcohol problem and to what degree the subject was exposed to them. Likewise, a clear definition of alcohol problem would need to be defined.

Fourth, due to the cohort sequential design, it was not possible to know if some of the students had experienced their first intoxication by age 13. As a result, intoxication by age 13 was imputed for those individuals who were left censored.

Practical implications

The conclusions drawn from the analyses presented here are in support of Zucker's (1994) theory of multiple pathways to alcohol abuse. The estimation of adolescent alcohol abuse trajectories illuminates the importance of recognizing that a single pathway to alcohol and other drug problems does not exist.

From an applied point of view, these findings support the need for more specifically targeted prevention and intervention initiatives. It is apparent that different types of scenarios lead to different long-term outcomes. As such, it is important to provide targeted intervention strategies that best meet the particular needs of an adolescent. For instance, consider the rapid increasing class. A prevention initiative designed to delay first use of alcohol may have had little impact as most of the members did not initiate use until after the age of 14. Rather, an intervention designed to prevent or decrease their use during later adolescence may have been more fruitful. This type of intervention may involve high school prevention programming and/or harm reduction tactics.

On the other hand, the chronic high and consistent monthly class members would likely have benefited from initiatives designed to both delay initiation and decrease use over time. It is important to recognize that both of these groups were characterized by

members who were engaging in other delinquent acts in addition to alcohol abuse. Dryfoos (1990) discusses the antecedents often present among individuals who exhibit multiple problem behaviors, including early age of initiation of problem behaviors, poor academic achievement, lack of parental support, parental modeling of high-risk behaviors, low resistance to peer influences, low SES, rebelliousness, noncomformity, and low religiosity. It is likely that these higher risk individuals needed more individual attention than that provided by a typical school-based ATOD prevention program. As risk for later delinquency is often identifiable early in childhood (Dyrfoos, 1990), these types of individuals may be targeted for more individualized, comprehensive, and multi-component interventions, such as those offered by Student Assistance Programs. Springer, Sale, and Sambrano (2002) reported on an investigation called the Center for Substance Abuse Prevention National Cross-site Evaluation of High Risk Youth Programs. The investigation was a five-year, multi-site evaluation of 48 substance abuse prevention programs for high-risk youth. The study sought to determine the most effective program characteristics. The most effective programs were those that offered strong life-skills development content, utilized team and interpersonal delivery methods, implemented introspective learning approaches focusing on self-reflection, were grounded in theory, and provided intense contact with youth. Future programming efforts for high-risk youth should use these empirically studied program components to help reach adolescents at risk for substance abuse. The Center for Substance Abuse Prevention (1999) has specifically identified eight model programs for high-risk youth: Across Ages, The Child Development Project, Creating Lasting Connections, Dare To Be

You, Greater Alliance of Prevention Systems, The Residential Student Assistance Program, Smart Leaders, and Family Advocacy Network. Each of these programs are effective in increasing the latency of first ATOD use, reducing ATOD use, or decreasing risk factors. These findings provide promise for reaching high-risk youth.

Although small, it is also of interest to consider the decreasing class. This group is notable because it represents individuals who were at great risk in early adolescence; however, they proceeded to reduce or cease alcohol use in mid-adolescence. The decreasing class continued to be characterized by very low substance abuse in young adulthood. These conclusions suggest optimistic outcomes for individuals who exhibit problematic behaviors in early adolescence, yet proceed to cease engagement in these acts as they progress in age. Further research is needed to better understand the reasons why this change took place and how to facilitate its happening.

Future directions

As is often noted by many researchers about their research findings, this investigation seemed to raise as many questions as it answered. It is likely that this phenomenon allows the field of study to progress and for innovative ideas to develop. As such, two types of future directions will be discussed. First, potential directions with regards to the sample utilized in this thesis will be considered, followed by discussion of future directions for the questions answered and raised by the present study.

The data currently available from the RAD/RYATS sample allow for many further interesting related possibilities. First, there would be great value in determining

the effect of the trajectory classes on other outcomes in both adolescence and young adulthood, including academic performance, high school graduation, use of other substance during adolescence, progression to more serious delinquent behaviors, participation in post-high school education, success in transitioning to adulthood, and adoption of adult roles. It would also be valuable to compare the three classes that were most likely to have begun drinking at an early age to determine why they had divergent trajectories. Likewise, the remaining three classes (non-abusers, normative users, and rapid increasers) could be investigated to better understand the time-varying factors that worked to determine the level of increase in alcohol use over time (i.e. parental monitoring, change in peer groups, etc.). Similarly, within class variability could be explored. It would be quite useful to examine the subjects within a certain class to determine potential resiliency factors. In other words, to discover under what circumstances a high-risk trajectory leads to less problematic outcomes or a low-risk trajectory leads to a malevolent result.

Further analyses to better understand the synergistic effect between drinking and other delinquent behavior would be worthwhile. In addition to studying the similarities and differences, differential effects by gender may also be explored.

In addition to considering analyses that are currently possible, it is also worthwhile to consider the possibility of impending data. The subjects in the RAD/RYATS sample completed their final survey assessment in young adulthood. At the time (1995), the subjects were between 22 and 24 years of age. This age is generally a time in life when many individuals are engaging in elevated risk behaviors, including

abuse of AOD (SAMHSA, 2000). As demonstrated by Muthén and Muthén (2000b), a decline in abuse takes place as young adults grow older and assume adult roles. As such, it is likely that many of the individuals who were abusing AOD in young adulthood desisted. In addition, it is possible that individuals who were not previously abusing initiated abuse. Therefore, it would be beneficial to follow-up the study with a ninth wave of data collection, allowing alcohol and other drug abuse to be assessed at later ages. In addition to the measures collected at survey 8, questions designed to diagnose DSM-IV (1994) criterion for AOD abuse could be used.

Several recommendations stem from the limitations of the current study. It is of course important to investigate these hypotheses among a more representative sample of rural adolescents. In addition, a study that began following the sample at an earlier age would have the opportunity to dissect the interrelationships of the covariates. For example, this would allow one to determine more conclusively if early drinking precedes delinquent behavior or if delinquent behavior leads to early drinking. In this way, a mediation model could be explored to investigate whether early onset drinking mediates the relationship between childhood risk factors and subsequent abuse problems.

As smoking and illicit drug abuse are salient considerations to adolescent alcohol abuse, it would be efficacious to explore multiple trajectory models. That is, to consider whether a demonstrated high-risk trajectory of multiple substances is more foretelling of future problems than abuse of a single substance.

In summary, recent advances in longitudinal modeling methodology are allowing researchers to investigate the etiology of substance use problems in innovative, exciting,

and informative ways. These types of investigations will allow public health professionals and research scientists alike to better understand the pathways to problematic outcomes and to develop interventions to help ensure that each child has the potential to develop into a healthy adult.

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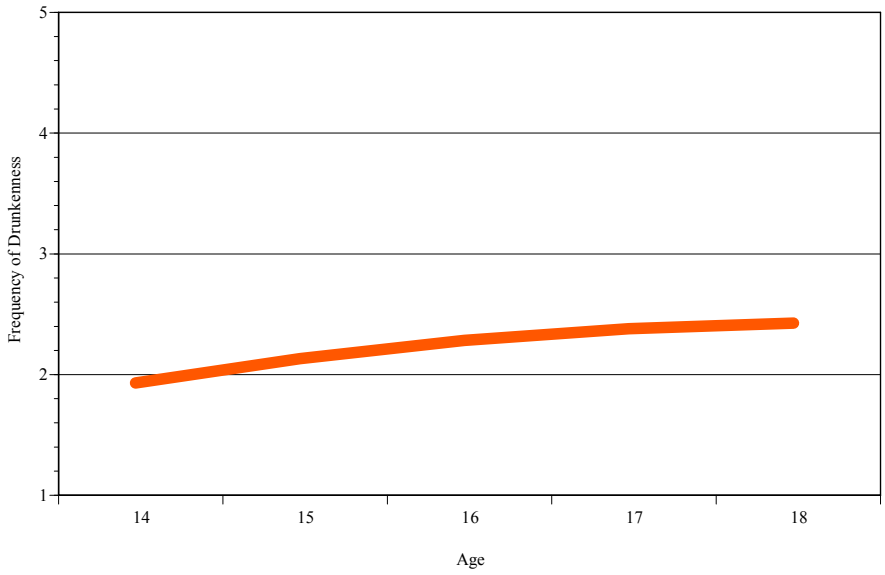
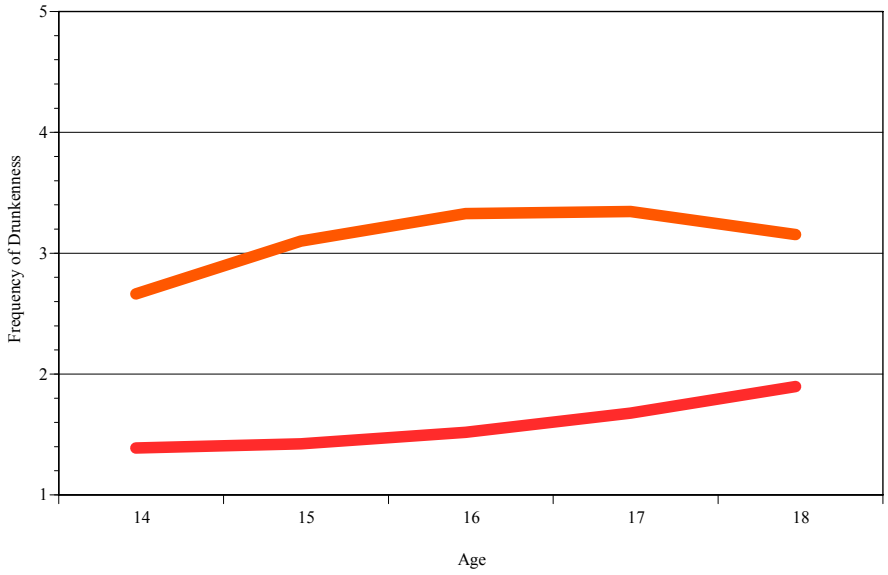
Appendix A

ESTIMATED TRAJECTORIES FOR ALTERNATE UNCONDITIONAL CLASS SOLUTIONS

1-Class Solution



2-Class Solution



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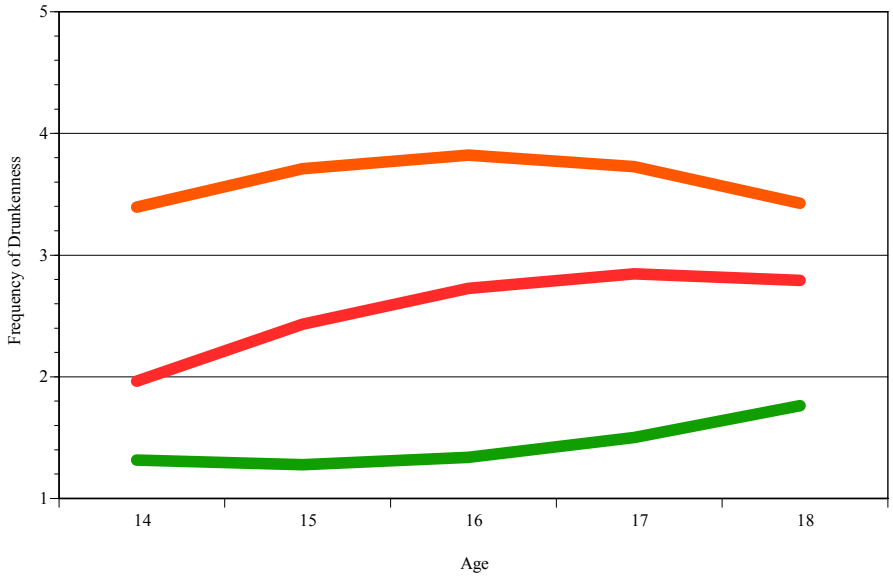
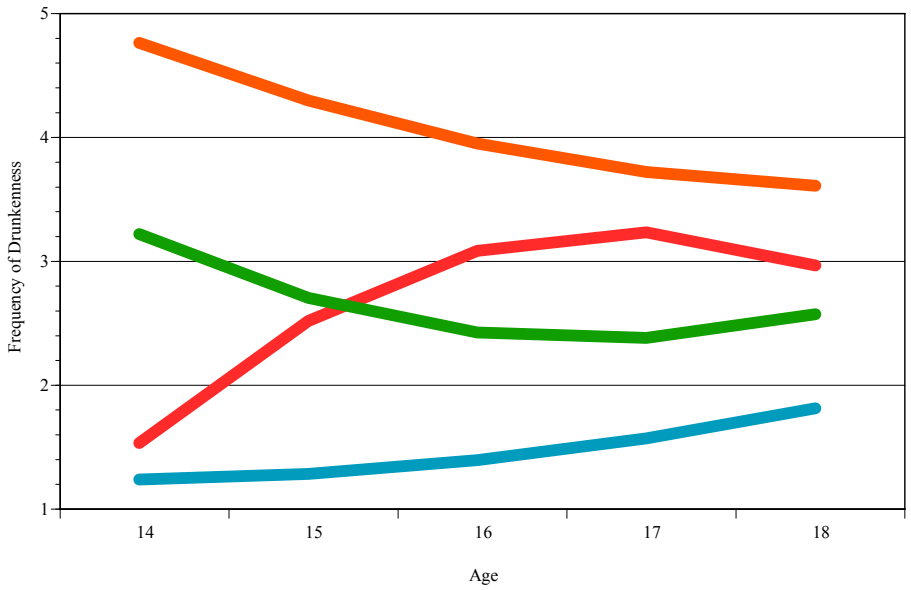
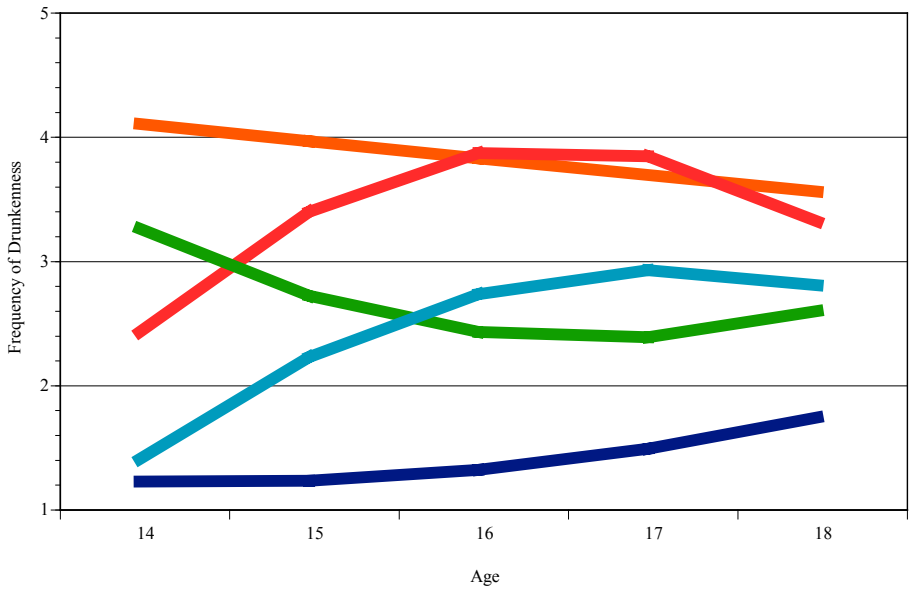


4-Class Solution



5-Class Solution



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