ABSTRACT

Longitudinal Trajectory Modeling of Alcohol Use Based on Early-Life, Time-Stable Covariates

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Alcohol and substance abuse (ASA), disorders, and addiction cause a great deal of damage to society through both health and social consequences. To understand and address these problems, it is imperative that we understand alcohol use patterns, including social and environmental factors that place individuals at risk for abuse or addiction across the life course, starting during childhood and adolescence. This study conducts a trajectory (latent class/profile) analysis to examine the trends and early origins of substance use patterns. To accomplish this goal, logistic maximum likelihood estimators are applied in a person-centered variable approach that separates individuals into distinct trajectory groups of alcohol use across adolescence and young adulthood. The optimized model for alcohol use, the primary dependent variable examined here, divides the sample into five distinct trajectory groups—high constant, increasing, mid peak, decreasing, and low constant. Logit group membership probabilities were determined to analyze which early-life factors are associated with relative probabilities of trajectory group membership. Overall trajectories were determined with n=4717 and independent variables had sample sizes ranging from n=3555 up to n=4717 based on variant refusal to answer questions on the part of the respondents. Key independent variables used in this portion of the analysis include: parental SES, quality/nature of familial interactions, family structure, social support networks, academics, stressful life events, early-life health, and psychological health.

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LONGITUDINAL TRAJECTORY MODELING OF ALCOHOL USE

BASED ON EARLY-LIFE, TIME-STABLE COVARIATES

A Thesis Submitted to the Faculty of

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CHAPTER ONE

Introduction

Alcohol Use and Abuse

Alcohol use and abuse can be destructive at both the individual and societal

levels. In addition to biological factors, social factors contribute to an individuals'

risk for developing problematic substance use patterns. Early-life factors are

particularly powerful in affecting individuals' tendencies and behaviors later in life,

but few analyses have gone beyond correlating a single early-life factor with later-

life substance use and abuse outcomes. The current study employs finite mixture

modeling and trajectory analysis techniques to investigate how a variety of early-life

factors—including parental SES, quality/nature of familial interactions, family

structure, social support networks, academics, stressful life events, early-life health,

and psychological health—shape trajectories of substance use across adolescence

and young adulthood.

The Societal Burden of Substance Abuse

The World Health Organization's (WHO) most recent Global Status Report on

Alcohol and Health details the societal health burdens of excessive alcohol

consumption. That report supplies the data presented in the following paragraphs

and Table 1. Alcohol's impact can be tricky to measure exactly[1]. In some cases, like with AUDs and fetal alcohol syndrome, it can be considered wholly culpable of any ensuing damages. However, in other cases, it is only partially culpable—pancreatitis and fatal accidents, for example. This second class has a lower Alcohol-attributable fraction (AAF) of health burden, meaning that other factors (diet, environmental stressors) are more likely to be in play. Even though alcohol is not wholly at fault for every associated disease, it has a large impact on global health. 3.3 million deaths, 5.9% of all deaths in 2012, were at least partially attributable to alcohol. Table 1 categorizes these Alcohol-attributable deaths (AADs), the largest proportion of which are related to chronic diseases like cardiovascular diseases and diabetes (CVD/D).

Table 1. Epidemiological Distribution of Alcohol-Attributable Disease[2]							
Type of AAD	Cancer	CVD/D	Neuro	GI	Infectious	Accidents	Intentional Injuries
% of AAD's	12.5%	33.4%	4.00%	16.2%	8.00%	17.1%	8.70%

In addition to its widespread health burden, excessive alcohol consumption has severe economic costs. According to a CDC report, excessive alcohol consumption cost the US economy an estimated $223.5 billion in 2006 alone (www.cdc.gov). This cost is distributed among loss in workplace productivity, health care expenses, criminal justice costs, and motor vehicle crash-related expenses. The large damage to workplace productivity does not simply cause

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[1]As a further complication, some researchers address 'excess consumption, dependence, and addiction' separately

[2] "Global Status Report on Alcohol and Health 2014." World Health Organization. Web. 17 Jan. 2016.

lessened revenues, but can also restrict the development potential of both individuals and the institutions that they represent and support (Casswell, 2011).

NIH studies have shown that 8.5% of the US population 18 years or older had either an Alcohol Use Disorder (AUD) or Substance Use Disorder (SUD) in 2013 (www.samhsa.gov). When controlling for gender, 11.4% of adult males had an AUD or substance use disorder (SUD) in the last year, but only 5.8% of all females. In addition to the general population prevalence, the United States Substance Abuse and Mental Health Services Administration reports that 10.6% of all children in the United States were living with an alcohol-abusing parent in 2010 (media.samhsa.gov). This affects families and children, not just isolated addicts.

Perceptions of Substance Use, Abuse, and Addiction

The false dichotomy—disease or choice—is often manipulated, intentionally or unintentionally, by the society in which we live. Simply put, "the disease concept of addiction is routinely applied to wealthy addicts while the general public persists in thinking of poor addicts as morally depraved" (Dunnington, 34). Data from national studies have shown historically marginalized racial groups, like African Americans and Asians, to carry a heavier burden of stigma for their alcoholism (Smith et al. 2010). Gender and age differences have also been demonstrated to have a significant role in personal perception of stigma towards alcoholism (Gomberg, 1988). The United States Surgeon General places stigma as "the most formidable" barrier to mental health in the United States (U.S. Department of Health

and Human Services, 1999, p. 3). More quantifiably, researchers have found discrimination and alienation due to stigma associated with SUDs to be detrimental to both physical and mental health (Ahern et al. 2007; Barry et al. 2014). Hopefully, the present study can elucidate the difficult questions of how social conditions are associated with the risk of developing different alcohol usage patterns.

Research on the Influences on Substance Abuse and Addiction

The development of addiction and other substance abuse problems is highly multifactorial. Socioeconomic forces strongly impact health outcomes and the development of substance use disorders (Case et al. 2005; Hawkins et al. 1992; Poulton et al. 2002; Mereish and Bradford 2014). Parental SES determines many quality-of-life and health outcomes, but is also a significant factor in both AUD and SUD development (Veenstra 2000, Osler et al. 2006). Through behavioral modeling and simple exposure risks, parental drug use also increases the AUD/SUD lifetime risk, especially if it is the mother who has the SUD (Hoffman and Su 1998; Christofferson and Soothill 2003). In another study that also used trajectory modeling, parental alcoholism and peer drug use were found to be strong risk factors for AUD development (Chassin et al. 2002). Parental divorce and the quality of daily family interactions can have major implications on mental health and addiction risk profiles (Hoffman and Su 1998; Brook and Brook 1990; Brook et al. 1999). Familial incarceration, suicide attempts by family members, and intraparental abuse can have similarly detrimental effects (Anda et al. 2002). In the
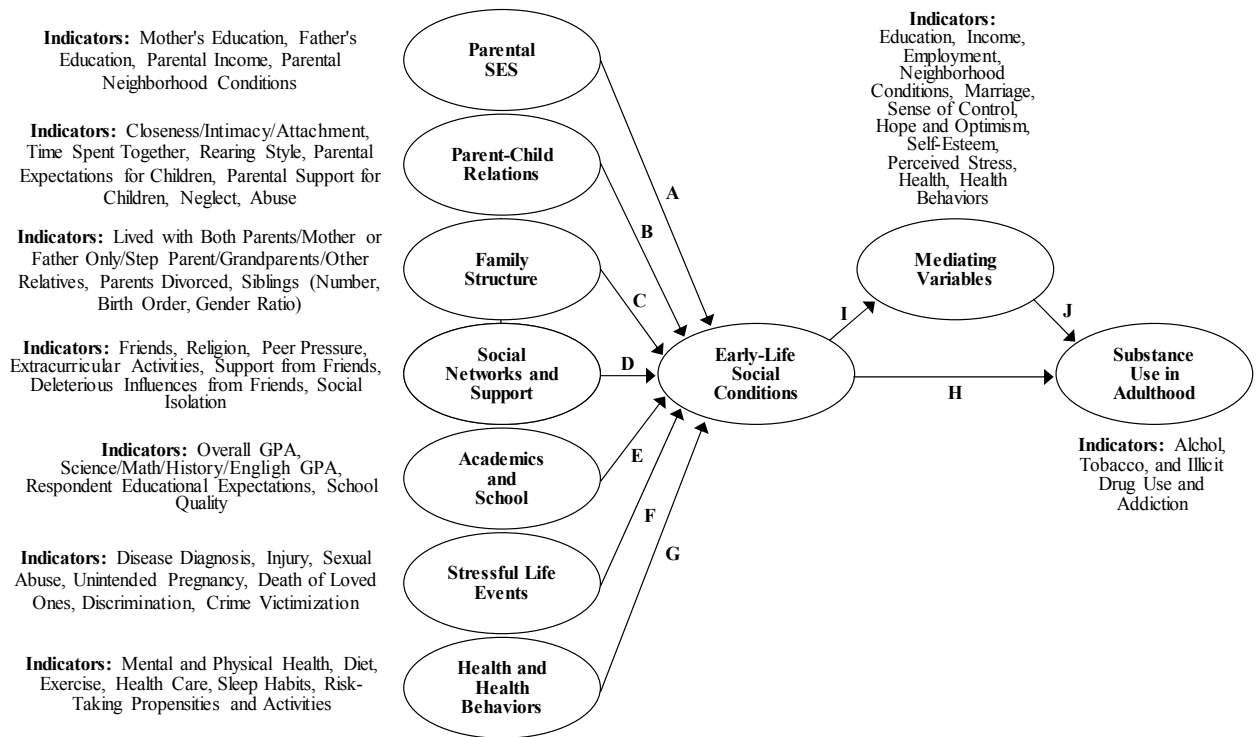
same way, strong parent-child attachment during childhood and adolescence was found to be protective against AUD/SUD development (Brook and Brook 1990).

Beyond the family, peer influences also take effect. Drug and alcohol abuse by close peers is a major risk factor for AUD/SUD development (Brook et al. 1999; Arteaga et al. 2010). In some studies, the number of friends consistently using drugs was considered the primary variable under analysis (Friedman and Glassman 2000). Delinquent peer group bonding is considered by some to be the most detrimental risk factor in terms of AUD/SUD development (iot et al. 1989).

Lastly, individual health and life circumstances also influence the chance of developing an ASA disorder. Being the victim of emotional abuse, physical abuse (familial or non), or sexual abuse puts one at greater risk of AUD/SUD development (Lansford et al. 2010, Anda et al. 2002; Sartor et al. 2013). Mood disorders and mental illnesses provide similar risks, especially when alcohol or drugs are used to relieve the symptoms (Bolton et al. 2009; Kilpatrick et al. 2000; Scheller-Gilkey et al. 2004). Early involvement in criminal activity, difficulty in adjusting to new school environments, and a tendency to bully other people and animals have also been associated with a higher risk of AUD/SUD development (Gordon et al. 2004). Similarly, poor school performance and disliking school attendance were indicative of likelihood to develop AUDs later in life (Osler et al. 2006). Interestingly, other authors have found the influences of poor maternal interactions and school performance to be more influential in females, while also noting that certain personality traits (temperament) beginning at 8 months of age were found to be positively associated with AUD development (Friedman et al. 1995). Other

personality traits with roots in genetic influences have similarly been found to be

predictive of addictive diseases including and beyond ASA disorders (Kreek et al.

2005).

With these diverse influences in mind, a conceptual model has been

developed (Figure 2) that, while not covering every detail, accounts for many of the

early-life factors that influence substance use patterns. This study will not attempt

to fully explore every one of these conceptual categories. It is meant to be an

exploratory analysis, a jumping-off point from which the more detailed analyses can

follow.

Indicators: Mother's Education, Father's Education, Parental Income, Parental Neighborhood Conditions

Indicators: Closeness/Intimacy/Attachment, Time Spent Together, Rearing Style, Parental Expectations for Children, Parental Support for Children, Neglect, Abuse

Indicators: Lived with Both Parents/Mother or Father Only/Step Parent/Grandparents/Other Relatives, Parents Divorced, Siblings (Number, Birth Order, Gender Ratio)

Indicators: Friends, Religion, Peer Pressure, Extracurricular Activities, Support from Friends, Deleterious Influences from Friends, Social Isolation

Indicators: Overall GPA, Science/Math/History/Engligh GPA, Respondent Educational Expectations, School Quality

Indicators: Disease Diagnosis, Injury, Sexual Abuse, Unintended Pregnancy, Death of Loved Ones, Discrimination, Crime Victimization

Indicators: Mental and Physical Health, Diet, Exercise, Health Care, Sleep Habits, Risk-Taking Propensities and Activities

Indicators: Education, Income, Employment, Neighborhood Conditions, Marriage, Sense of Control, Hope and Optimism, Self-Esteem, Perceived Stress, Health, Health Behaviors

Parental SES

Parent-Child Relations

Family Structure

Social Networks and Support

Academics and School

Stressful Life Events

Health and Health Behaviors

Early-Life Social Conditions

Mediating Variables

Substance Use in Adulthood

Indicators: Alchol, Tobacco, and Illicit Drug Use and Addiction

A B C D E F G H I J

Figure 1. Conceptual Model

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The Current Study's Contribution

The existing body research has provided an extensive list of risk factors. However, very few studies have taken into account the inherent heterogeneity of addictions. A lifelong alcoholic is not necessarily comparable to someone who becomes an alcoholic after a traumatic stress event. This study employs trajectory analysis more broadly than past studies (Xie et al. 2006, Grella and Lovinger 2011) by using a nationally representative sample instead of sampling a pre-effected population.

CHAPTER TWO

Methods

Data

This project will analyze data from Waves I, III, and IV of the National

Longitudinal Study of Adolescent to Adult Health (Add Health). This sample was

drawn from 80 high schools selected with probabilities proportional to size and an

additional 52 feeder middle schools. The overall response rate at baseline was 79

percent. More than 90,000 students completed in-school surveys during the 1994-

1995 academic year, and a sample of 20,745 adolescents (age 12-18 at Wave 1) in

grades 7-12 was interviewed in 1994-1995 (Wave I). A questionnaire was also

administered to a residential parent of each adolescent at that time. Subsequent

waves of data were collected in 1995-1996 (Wave II), 2001-2002 (Wave III), and

2007-2008 (Wave IV). Wave IV interviews took place when the respondents were

young adults in their late 20s to early 30s. Additional details about the data and

sampling techniques can be found at: http://www.cpc.unc.edu/projects/addhealth.

Dependent Variables

Alcohol use at each wave was measured with the following question: "During the past 12 months, on how many days did you drink alcohol?" Response categories ranged from: 0="never," 1="1 or 2 days in the past 12 months," 2="once a month or less (3-12 times in the past 12 months)," 3="2 or 3 days a month," 4="1 or 2 days a week," 5="3 to 5 days a week," and 6="every day or almost every day." The quotation marks denote words or sentences that are taken directly from the codebook.

Independent Variables

W1-4 Alcohol Use was determined by the respondents' answers to the question "During the past 12 months, on how many days did you drink alcohol?" with 0 for "never," 1 for "once or twice in the past 12 months," 2 for "once a month or less," 3 for "2 or 3 days a month," 4 for "1 or 2 days a week," 5 for "3 to 5 days a week," and 6 for "every day or almost every day."

Analytic Approach

This project will: (1) estimate trajectories of alcohol use across the three

waves of data (e.g., increasing, decreasing, stable, etc.); and (2) examine the

correlates of membership in each latent trajectory group. Many scholars would use

latent growth curve models to examine longitudinal trends in substance use. Latent

growth curve models are a class of structural equation models (SEMs) that use

repeated measures of an attribute (e.g., substance use or abuse) as observed

indicators of one or more latent variables (i.e., intercepts, or baseline effects; and

slopes, or rates of change) representing individuals over time (Bollen, 1989;

Zajacova & Burgard, 2010). However, growth mixture modeling, or trajectory

analysis[3], is also ideally suited to analyzing multi-wave longitudinal data (Nagin,

2005). Essentially, this technique identifies latent trajectory groups within the

sample using measured information on variables at multiple points in time (Muthén

& Muthén, 2000). Trajectory groups, or latent classes, are composed of individuals

who follow similar longitudinal pathways on variables such as alcohol use and

abuse.

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[3] Also referred to as latent class analysis, latent profile analysis, finite mixture modeling, and finite mixture
profile analysis (Pastor et al. 2007)

The latter approach will be used here because of the heterogeneous nature of substance use patterns in individual lives. As noted by Raudenbush, "it makes no sense to assume that everyone is increasing (or decreasing) in depression…many persons will never be high in depression, others will always be high, while others will become increasingly depressed" (Raudenbush 2001). In the same way, many individuals may have unique trajectories of substance use and abuse across time— some may consistently abstain from use, others may display chronic use, while others may change their behavior across time. Because of this, a population regression would not be very enlightening when investigating the influence of early-life factors on longitudinal patterns of substance use. The analyses conducted below will determine the number and form of different trajectories in the population, as well as conditions (i.e., early-life factors) that are associated with an increased probability of belonging in one trajectory group compared with the others.

This trajectory models estimated here draw heavily on Xie et al. (2006) and Nagin (2005). The general goal of trajectory modeling is to create a set of regressions that match latent trajectory groups within the sample as closely as possible. More formally, to estimate a set of parameters β for every trajectory group *j* so as to maximize the likelihood L of belonging to a specific group (*j*) given the individual's alcohol or substance abuse (ASA) outcomes y_{ASA}.

$$\beta_j = \{\, \beta_{0,j},\, \beta_{1,j},\, \ldots,\, \beta_{k(j),j} \,\}$$
$$\hat{\beta}_j = \mathsf{argmax}[\, \mathsf{L}(\beta_j \mid y_{ASA}) \,]$$

Once assigned to trajectory groups, further statistical analysis (logit group membership probability estimates) can be used to determine which early-life

factors, events, and characteristics are associated with higher-risk ASA trajectory groups. But, before this, the optimal number of groups (and the ideal number of regression parameters), as well as the functional form (e.g., intercept only, intercept and slope, quadratic, etc.) must be determined. The optimal number of groups and functional forms is determined through use of the Bayesian Information Criterion (BIC), calculated as:
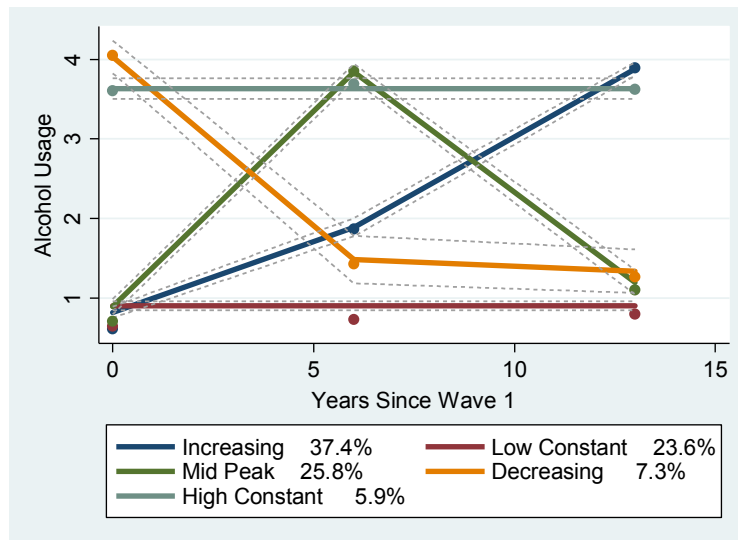
$$BIC = log(L) - 0.5 * log(n) * j$$

where L is the maximized likelihood of belonging to a trajectory group, *n* is the sample size, and *j* is the number of parameters in the model. The increase in model fit has to be greater than the penalty for increasing model complexity. In this way, it prevents over-fitting the data with too many trajectory groups. The STATA "traj" plugin was used to perform the mixture modeling analysis (Jones and Nagin, 2012). Due to the fact that only three waves of data are utilized, quadratic forms were the highest order functions considered for trajectory models.

Results

The model chosen to represent alcohol use is shown in Figure 3 below, with dotted 95% Confidence Intervals surrounding each trajectory group—all group memberships and trajectory parameters were statistically significant (p<0.0001; BIC=-26,744.35; n= 4717 (14151)). To better understand the trajectory plots, it is useful to know that at t=0 on the following plots, the respondents are all between 12 and 21 years of age. At wave 3 (t=7), they are between 18 and 27 years of age. At wave 4 (t=13), they are between 25 and 34 years of age. Wave 2 data were not included in these analyses because of the fact that wave 1 and wave 2 were separated by less than two years.

Figure 2. Five Group Model for Alcohol Use (with 95% CI)

Each subject was classified into one of the five groups which were named according to the groups' trends in alcohol usage. The 'Low Constant' group (red line) is the group at the lowest risk of pathological alcohol usage and is thus considered the reference group for the following analyses. The Low Constant group makes up 23.6% of the population (95% CI [22.0-25.1%]). The 'Increasing' group shows a consistent upward trend in usage and makes up an estimated 37.4% of the population (95% CI [35.4-39.3]). The 'Mid Peak' group made up 25.8% of the population (95% CI [24.1-27.6%]) and demonstrated alcohol usage primarily at Wave 3, a time point at which the respondents ranged from 18-27 years of age. The 'Decreasing' group shows a consistent downward trend in usage and makes up approximately 7.32% of the population (95% CI [6.77-7.87%]). The 'High Constant' group is the smallest group, making up only 5.92% of the population (95% CI [5.38-6.46%]).

Risk parameters for group membership are evaluated in terms of the log-odds (logit) estimates of how certain risk factors affect the probability of group membership. This measure can be interpreted as an exponential change in probability surrounding the "neutral point" of zero. Positive logit values mean an increased likelihood and negative logit values mean a decreased likelihood of the given event, so the change in logodds (Δlogodds) can be interpreted analogously to a regression parameter. For example, let's say Δlogodds(EventX | InputY) = +0.15. In this situation a one-unit increase in the given independent variable (InputY) causes a change of +0.15 in the logodds of Event X occurring: an increase in probability. In the following tables, the same principle holds. The Δlogodds for a given event are in

reference to how an independent variable impacts the probability of belonging to that specific group compared to the probability of belonging to the Low Constant reference group. Every group *other* than the Low Constant group is considered a higher risk group. The following seven tables indicate the Δlogodds of belonging to a specific trajectory group compared to the probability of belonging to the Low Constant group for independent variables belonging to each of the 7 conceptual classes—Parental SES, Parent-Child Relations, Family Structure, Social Networks, Academics, Stressful Life Events, and Health. The trajectory group probabilities listed below are based on individual variable analyses. Only one independent variables is considered at a time in the follow tables.

Table 2. Parental SES Variables				
Independent Variable	**Δlogodds- Increasing**	**Δlogodds- Mid Peak**	**Δlogodds- Decreasing**	**Δlogodds- High Constant**
Parental Education n= 4717	-0.037	0.00842	-0.14554	-0.1237
Neighborhood Drug Use n= 3993	-0.4246	-0.1118	-0.314	-0.15512
Neighborhood Quality n= 4717	0.00173	-0.00825	-0.03337	0.01423
Parental Educational Expectations n= 4423	-0.03054	0.08735	0.03119	-0.01449
*= p<0.05, **=p<0.01, ***=p<0.001				

To our surprise, measures of parental SES did not have detectable influence on trajectory membership. A likely explanation for this is that the alcohol variable is measuring use, not misuse. Parental SES has been demonstrated to be influential in development of ASA, but may not be as influential on trajectories that simply represent usage (Veenstra 2000, Osler et al. 2006).

Table 3. Parent-Child Relations Variables				
Independent Variable	**Δlogodds- Increasing**	**Δlogodds- Mid Peak**	**Δlogodds- Decreasing**	**Δlogodds- High Constant**
Mother Relationship Quality n= 4708	0.00904	0.01345	-0.07427***	-0.11469***
Father Relationship Quality n= 4709	-0.06259	-0.02668	-0.31346**	-0.45415***
Controlling Parenting n= 4615	0.10991	0.20265	-0.4783	-0.41325
Time Spent with Family n= 4604	0.03627	-0.00427	-0.72012***	-0.46624***
Parental Alcohol Use n= 4051	-0.46882*	-0.09654	-1.16488	0.1949
Parent Smoker n= 4717	0.03021	-0.04564	0.27751*	0.21794
Feel that Their Parents Care n= 4710	0.03597	0.0408	-0.33887**	-0.39257***
Feel that Their Family Understands Them n= 4708	0.08705	0.036	-0.24389***	-0.35898***
Feel that Their Family Is Attentive to Them n= 4703	0.04561	0.02305	-0.28997***	-0.29365***
			*= $p<0.05$, **=$p<0.01$, ***=$p<0.001$	

The Parent-Child Relations conceptual class contains the first set of
independent variables with significant influence. The quality of relationships with
one's parents and feeling that one's family is attentive and understanding seem to be
strong protective factors because they are associated with a lower likelihood of
belonging to a group other than the Low Constant group. In the same way, higher
amounts of time spent with family is associated with a lower likelihood of belonging
to the Decreasing or High Constant group. In this conceptual class, and in others to
come, this is a very common trend—a protective factor lowering the likelihood

belonging to the Decreasing or High Constant groups, but not necessarily having an influence on the likelihood of belonging to the Increasing or Mid Peak groups. A possible explanation for this lies in the fact that Decreasing and High Constant are the only two trajectory groups that have high usages at wave 1. Based on that, it may be that these protective factors are modifying the trajectory membership likelihoods primarily through that wave 1 usage. Either way, the closeness of a family has a clear effect.

The parental alcohol use variable had an interesting, apparently protective, effect on alcohol usage trajectories, given that it is associated with a lower likelihood of belonging to the Increasing group. It is possible that this effect is an artifact of the trend that individuals with parents who drink are less likely to have lower usage in the first place, a necessary condition for belonging to the Increasing group.

Table 4. Family Structure Variables				
Independent Variable	**Δlogodds- Increasing**	**Δlogodds- Mid Peak**	**Δlogodds- Decreasing**	**Δlogodds- High Constant**
Absent Mother n= 4717	-0.2154	-0.53121*	0.63033*	0.89855***
Absent Father n= 4717	0.0841	0.00012	0.18728	0.19599
Parental Divorce n= 4077	0.19312	0.15133	0.44183*	0.14844
*= p<0.05, **=p<0.01, ***=p<0.001				

The family structure variables showed mixed levels of influence. Lacking a present mother made one more likely to a group with higher initial usage and showed an especially strong association in regards to the largely increased

likelihood of belonging to the High Constant group. It was surprising that Paternal

Absenteeism is not be significantly associated with trajectory group membership in

higher or lower risk groups.

Table 5. Social Support and Networks Variables				
Independent Variable	**Δlogodds-Increasing**	**Δlogodds-Mid Peak**	**Δlogodds-Decreasing**	**Δlogodds-High Constant**
Peer Delinquency n= 4717	-0.00112	0.03376	0.75426***	0.74647***
Feeling Lonely n= 4714	-0.06667	0.01914	0.28577**	0.35085***
Feeling Socially Accepted n= 4714	-0.02727	0.00566	0.04656	-0.03725
Feel Adults Care n= 4701	0.03475	0.01111	-0.3128***	-0.34286***
Feel Friends Care n= 4708	-0.03152	-0.01933	-0.05064	-0.09965
Parental Religious Attendance n= 4064	-0.03087	0.0252	-0.36329***	-0.173
Parental Prayer Frequency n= 4058	-0.01192	-0.02252	-0.25926*	-0.10921
Nonreligious n= 4638	0.03903	0.12424	0.64965**	0.33288
Attend Religious Services by Choice n= 4709	0.0526	0.06211	-0.35654***	-0.19907**
Personal Importance of Religion n= 4711	0.03247	0.00668	-0.34972***	-0.21772**
Personal Prayer Frequency n= 4711	-0.02152	-0.16370	-0.15406	-0.31845***
				*= $p<0.05$, **=$p<0.01$, ***=$p<0.001$

The variables pertaining to Social Networks revealed some important risk

and protective factors. It was anticipated that higher levels of Peer Delinquency and

that feelings of isolation (Feeling Lonely) would be associated with higher usage

trajectories, but it came as a surprise when being nonreligious appeared to be a risk

factor. The beneficial psychological effects of in-group membership may mediate the

trend seen in the Nonreligious variable, but more detailed inquiry is necessary to

determine exactly why that trajectory membership trend exists.

Table 6. Academics and School Variables				
Independent Variable	**Δlogodds-Increasing**	**Δlogodds-Mid Peak**	**Δlogodds-Decreasing**	**Δlogodds-High Constant**
GPA n= 3555	-0.08286	-0.05738	-0.81725***	-0.43192**
Expulsion n= 4717	0.01626	-0.37028	1.33549***	0.77112*
Feel Unsafe at School n= 4617	0.0362	0.02705	0.00303	0.11825
College Aspirations n=4717	0.0535	0.00895	-0.28134***	-0.17995*
*= p<0.05, **=p<0.01, ***=p<0.001				

In the Academics and School section, GPA and College Aspirations were

considered significantly protective. In order to ensure that these were not being

confounded by parental education, all three (parental education, GPA, and college

aspirations) were analyzed together in a trajectory analysis analogous to a multiple

regression. This analysis showed no significant influence of parental education as

both GPA and college aspirations maintained similar logit parameters and

significance levels.

Table 7. Stressful Life Event Variables				
Independent Variable	**Δlogodds-Increasing**	**Δlogodds-Mid Peak**	**Δlogodds-Decreasing**	**Δlogodds-High Constant**
Attempted Suicide n= 4715	0.19142	0.2482	0.69609***	0.65357***
Friend Attempted Suicide n= 4688	-0.18495	-0.23775*	0.41491**	0.44728**
Family Suicide Attempt n= 4690	0.25877	0.28387	0.74908**	0.68716**
				*= p<0.05, **=p<0.01, ***=p<0.001

The Stressful Life Events section showed the strong trajectory risk associated with suicide or attempted suicide on the personal, familial, and social group levels. However, having a friend who attempted suicide was associated with a lower likelihood of belonging to the Mid Peak group.

Table 8. Health, Health Behaviors, and Psychological Health Variables				
Independent Variable	**Δlogodds-Increasing**	**Δlogodds-Mid Peak**	**Δlogodds-Decreasing**	**Δlogodds-High Constant**
General Health n= 4717	-0.06496	-0.09363	-0.13656	-0.31646***
Feel Fearful n= 4717	-0.1061	-0.04061	0.04653	0.22961
Overweight n= 4713	0.00149	0.04351	0.0285	0.04657
Everyday Health Problems n=4713	0.27834	-0.09532	0.67036**	0.48995
Parental Health n= 4071	-0.00372	-0.0009	0.09866	0.07846
Physical Disability n= 4716	0.45181	-0.47036	0.55635	0.77124
Early-Life Depression n= 4716	0.06547	0.07231	0.51719***	0.47105***
Hardworking n= 4717	-0.10544	-0.15036*	-0.20946	-0.2764*
Avoids their Problems n= 4717	-0.17303*	-0.15063*	-0.00931	-0.19913
Perceived Intelligence n= 4708	-0.01539	0.00684	-0.04952	-0.17237*
Hopeful n= 4708	-0.02499	0.02808	-0.1349	-0.13206
Self-Satisfaction n= 4715	-0.05601	-0.07247	-0.1721*	-0.18589*
Contemplated Suicide n= 4700	0.15713	0.18894	0.93829***	1.09654***
*= p<0.05, **=p<0.01, ***=p<0.001				

Lastly, the Health section showed both physical and psychological health attributes with mixed associations with alcohol use trajectories. A few personality variables (Hardworking, Avoidance of problems, self-confidence) were included in

this section because their relationship with psychological health made this the most

fitting conceptual class.

CHAPTER FOUR

Discussion

Alcohol

The alcohol use latent classes help visualize and quantify usage trends that are

typically well understood even without expertise in the field. There are people who

prefer not to drink (Low Constant), consistently heavy drinkers (High Constant), the

individuals who drank earlier on but moved away from alcohol use after that time

(Decreasing), those demonstrating a constantly upward usage trajectory

(Increasing), and those who only showed usage in the 18-27 year old range. With

this model, those stereotypes can be quantified and compared. The trajectory group

membership distributions are what contain some surprises. Before seeing these

results, the authors anticipated that a group resembling Low Constant or Mid Peak

would contain the largest proportion of the population. However, The Increasing

group is the largest group by a fairly wide margin. The fact that the Increasing and

Mid Peak groups had the highest membership proportions can be understood

through the fact that this alcohol use measure is not necessarily a measure of

addiction or pathological use; it is simply a usage measure. The Mid Peak group

showed the highest alcohol use behavior at Wave III, when the respondents were

between the ages of 18 and 27. This period of adolescence is a common time for

heavier drinking as the individuals are starting to leave the influence of their

parents and are more inclined to risk-taking behaviors like alcohol use (Larimer et al. 1997; Neve et al. 2009).

The group membership risk factors demonstrated many interesting associations. Specifically, social variables and variables pertaining to familial relationships had stronger associations than anticipated. The closeness, quality of time spent with family, and presence of a parent appeared a more prominent influence than even socioeconomic covariates, which had associations far weaker than expected. Suicide—be it personal attempts, attempts in primary groups, or even the consideration thereof—also seemed to be especially strongly associated with changes in trajectory group membership probabilities.

Implications

This study, in addition to demonstrating the utility of trajectory modeling with the field of addiction research, shows in a broad sense how the biopsychosocial environment associates with latent alcohol use outcomes. This information---the potential protective power of familial closeness in influencing alcohol use trajectories, for example—could potentially be used in the context of improving familial therapy techniques to help understand the best interventions to help keep kids and adolescents from following high usage paths in their lives. Further research will need to be done with a more detailed look at each of these variables, but this study lays down an exploratory framework upon which to build.

Conclusions regarding Trajectory Analysis

This study's use of trajectory parameterization for addictive substance outcomes is unique and it demonstrates interesting trends both in the trajectory plots themselves and in the analyses of which factors are associated with belonging to higher-risk groups. Between these conceptual classes, a whole host of different associations have been observed, but there is also a great deal more exploration to be done. Even just in the ADD Health dataset, there are thousands of questions in each of the conceptual classes that are still to be analyzed and countless other latent variables (dependent variables) that can be examined with this technique. In addition, the intra-class relationships between the independent variables are still to be considered, but this study demonstrates the potential capacity of a trajectory-based research model.

Limitations of the Study

At multiple stages of trajectory development and covariate relative risk estimation, the non-normality of our variables became a problem. The representative nature of the ADD Health sample is great for looking at how certain factors impact entire societies, but can be somewhat limiting when focusing in closely on how small groups within a relatively small portion of the population (the trajectory groups) are influenced by exterior factors. This is further complicated by the practical difficulty of predicting membership based on highly-skewed variables.

Appendix

Table 9. Descriptive statistics on the Parental SES Input Variables					
Variable	**Average**	**Standard Deviation**	**Observations**	**Range**	**Correlation with Wave 4 ASA**
Parental Education	1.322	0.892	6504	0-3	-0.0092
Neighbor Drug Use	0.494	0.658	5523	0-2	-0.0242
Neighborhood Quality	4.303	1.477	6504	0-6	-0.0203

For Parental Education, individuals were rated on a scale of 0-3 based on how far their most educated parent went in school—0 = less than high school, 1 = high school or some college, 2 = college graduate, 3 = graduate degree. Neighbor Drug Use was based on the question "In this neighborhood, how big a problem are drug dealers and drug users?" with the answer choices as follows—0 = no problem at all, 1 = a small problem, 2 = a big problem. Neighborhood quality was an additive score based on three questions answered by the workers that conducted the interviews. The first question reads "How well kept is the building in which the respondent lives?"; the second, "How well kept are most of the buildings on the street?"; and the third, "When you went to the respondent's home, did you feel concerned for your safety?" The first two were scored additively on a low (0) to high (2) scale and the third was scored as a (-2) if the interviewer responded "yes."

Table 10. Descriptive statistics on the Parent-Child Relationship Input Variables					
Variable	**Average**	**Standard Deviation**	**Observations**	**Range**	**Correlation with Wave 4 ASA**
Mom Educational Expectations	4.724	0.861	6095	1--5	0.01
Relationship with Mother	1.335	0.572	6481	0-2	-0.009
Relationship with Father	0.826	0.775	6489	0-2	-0.017
"Controlling" Parent	0.148	0.255	6362	0-1	0.014
Time Spent with Family	1.152	0.625	6350	0-1.75	0.017
Parental Alcohol Use	0.083	0.267	5605	0-2.5	-0.017
Parental Smoking	0.38	0.653	6504	0-1.5	0.009
Feel Parents Care	4.791	0.569	6474	1--5	-0.025
Feel Family Understands	3.612	1.011	6472	1--5	-0.004
Feel Family Is Attentive	3.93	0.937	6467	1--5	-0.002

Mom Educational Expectations was based on the question "On a scale of 1 to 5, where 1 is low and 5 is high, how disappointed would she be if you did not graduate from high school?" Relationship with Mother was an additive score based on the answers to seven questions. The questions were chosen to score both the closeness of the relationship and the level of positive independence the mother fostered— "Most of the time, your mother is warm and loving toward you," "Your mother encourages you to be independent," "When you do something wrong that is important, your mother talks about it with you and helps you understand why it is wrong," "You are satisfied with the way your mother and you communicate with

each other," "Overall, you are satisfied with your relationship with your mother,"

"How close do you feel to your mother/adoptive mother/stepmother/foster

mother", and "How much do you think she cares about you?" The Relationship with

Father variable was based on three similar questions—"Most of the time, your

father is warm and loving toward you," "You are satisfied with the way your father

and you communicate with each other," and "Overall, you are satisfied with your

relationship with your father." A respondent's parents were considered 'more

controlling' if the respondent answered "No" to the question "Do your parents let

you make your own decisions about the people you hang around with?" Time Spent

with Family was based on the respondents' answers to "On how many of the past 7

days was at least one of your parents in the room with you while you ate your

evening meal?" Parental Alcohol Use was based on the average parental response to

two questions "How often do you drink alcohol?" and "How often in the last month

have you had five or more drinks on one occasion?" with the answers ranged from

"never" (0) to "almost every day" or "five or more times" (5). Parental smoking was

based on the question "Do you smoke?" with answers of no (0) or yes (1.5). Feel

Parents Care was based on the respondent question "How much do you feel your

parents care about you?" with answers ranging from "not at all" at 0 to "very much"

at 5. Feel Family Understands was based on the respondent question "How much do

you feel that people in your family understand you?" with answers ranging from

"not at all" at 0 to "very much" at 5. Feel Family is Attentive is based on the question

"How much do you feel that your family pays attention to you?" with answers

ranging from "not at all" at 0 to "very much" at 5.

Table 11. Descriptive statistics on Family Structure Input Variables					
Variable	**Average**	**Standard Deviation**	**Observations**	**Range**	**Correlation with Wave 4 ASA**
Absentee Mother	0.057	0.232	6504	0-1	0.021
Absentee Father	0.3	0.458	6504	0-1	0.026
Parental Divorce	0.298	0.458	5644	0-1	0.023

Absentee Mother and Absentee Father were given a value of "1" if the respondent selected that there was no woman, or man, respectively, who functioned as the mother, or father, in the household. Parental divorce was given a value of "1" if the parent responded that their current marital status was "single, divorced, widowed, or separated."

Table 12. Descriptive statistics on Social Networks and Support Input Variables

Variable	Average	Standard Deviation	Observations	Range	Correlation with Wave 4 ASA
Peer Delinquency	1.901	2.083	6504	0-9	-0.001
Lonely	0.463	0.709	6485	0-3	-0.002
Socially Accepted	4.091	0.765	6479	1--5	0.004
Feel Adults Care	4.377	0.83	6463	1--5	-0.012
Feel Friends Care	4.244	0.798	6471	1--5	0.014
Parental Religious Attendance	1.091	0.793	5628	0-2	-0.008
Parental Prayer Frequency	1.543	0.694	5618	0-2	-0.026
Nonreligious Respondent	0.112	0.323	6365	0-1	0.03
Religious Service Attendance	1.75	1.206	6489	0-3	-0.023
Personal Religion Importance	2.043	1.073	6493	0-3	-0.02
Personal Prayer Frequency	1.7735	1.253	6493	0-3	-0.001

Peer delinquency is an additive score based on the summed answers to three questions—"Of your three best friends, how many drink alcohol at least once a month?", "Of your three best friends, how many use marijuana at least once a month?", and "In the past 12 months, how often did you take part in a fight where a group of your friends was against another group?" with "never"=0, "1 or 2 times"=1, "3 or 4 times" =2, and "5 or more times" =3. Lonely was based on the question "How often in the past week was the following true...You felt lonely" with "never or

rarely"=0, "sometimes"=1, "a lot of the time"=2, and "most of the time or all of the time"=3. Socially Accepted was based on the answer to the statement "You feel socially accepted" on a scale of 1 for "strongly disagree" up to 6 for "strongly agree." Feel Adults Care was based on the answer to the question "How much do you feel that adults care about you?" with 1 for "not at all" up to 5 for "very much." Feel Friends Care was based on the answer to the question "How much do you feel that your friends care about you?" with 1 for "not at all" up to 5 for "very much." Parental Religious Attendance was based on the parents' answer to the question "How often have you gone to religious services in the past year?" with 0 for "never", 0.5 for "less than once a month," 1 for "less than once a week, but at least once a month," and 2 for "once a week or more." Parental Prayer Frequency was based on the parents' answer to the question "How often do you pray?" with 0 for "never," 0.5 for "from time to time, but less than once a month" or "at least once a month," 1 for "at least once a week," and 2 for "at least once a day." Respondents received a 1 for Nonreligious if they responded "None" to the question "What is your religion?" and all other answer choices received a 0. Attend Religious Services was based on the respondents' answer to the question "In the past 12 months, how often did you attend religious services?" with 0 for "never," 1 for "less than once a month," 2 for "once a month or more, but less than once a week," and 3 for "once a week or more." Personal Religion Importance was based on the respondents' answer to the question "How important is religion to you?" with 0 for "not important at all," 1 for "fairly unimportant,' 2 for "fairly important," and 4 for "very important." Personal Prayer Frequency was based on the respondents' answer to the question "How often

do you pray?" with 0 for "never" or "less than once a month," 1 for "at least once a

month," 2 for " at least once a week," and 3 for "at least once a day."

Table 13. Descriptive Statistics on Academics and School Input Variables					
Variable	**Average**	**Standard Deviation**	**Observations**	**Range**	**Correlation with Wave 4 ASA**
Cumulative GPA	2.84	0.749	4899	1--4	-0.046
Expulsion	0.046	0.046	6504	0-1	0.016
Feel Unsafe at School	2.801	1.030	6367	0--4	-0.022
Desire to go to College	0.13	0.938	6504	0-3	-0.017

Cumulative GPA was an average of four separate variables. The respondents

were asked their grades in four classes—science, math, english, and history—and

received a 4 for "A," 3 for "B," 2 for "C," 1 for "D," and 0 for "F" or missing values.

Those four numbers were averaged to make the Cumulative GPA variable. This

variable has many missing values because of the fact that any respondents who had

dropped out or graduated high school were considered missing values and were

excluded from the analysis of this variable. Respondents received a 1 for Expulsion

if they answered "yes" to the question "Have you ever been expelled from school?"

Feel Unsafe at School was determined by the prompt "You feel safe in your school"

with 4 for "strongly agree" down through 0 for "strongly disagree." Desire to go to

College was determined by the question "how much do you want to go to college?"

with 0 as the lowest and 3 as the highest response.

Table 14. Descriptive Statistics on Stressful Life Event Input Variables					
Variable	**Average**	**Standard Deviation**	**Observations**	**Range**	**Correlation with Wave 4 ASA**
Been Jumped	0.137	0.412	6504	0-2	0.038
Attempted Suicide	0.06	0.362	6500	0-4	0.026
Friend Attempted Suicide	0.204	0.467	6422	0-2	-0.009
Familial Suicide Attempt	0.059	0.277	6425	0-2	0.007

Been Jumped was determined by the prompt "You were jumped" with 0 for "never," 1 for "once," and 2 for "more than once." Attempted Suicide was determined by the question "During the past 12 months, how many times did you actually attempt suicide?" with 0 for "0 times," 1 for "1 time," 2 for "2 or 3 times," 3 for "4 or 5 times," and 4 for "6 or more times." Friend Attempted Suicide was determined by the question "Have any of your friends tried to kill themselves during the past 12 months?" with 0 for "no" and 1 for "yes." Familial Suicide Attempt was determined by the question "Have any of your family tried to kill themselves during the past 12 months?" with 0 for "no" and 1 for "yes."

Table 15. Descriptive statistics on Health and Health Behavior Input Variables					
Variable	**Average**	**Standard Deviation**	**Observations**	**Range**	**Correlation with Wave 4 ASA**
General Health	3.899	0.9	6496	1--5	0.009
Overweight	0.352	0.549	6490	0-2	0.017
Health Impeding Activities	0.022	0.161	6488	0-2	0.001
Parental Health	1.308	0.516	5635	0-2	0.002
Physical Disability	0.022	0.146	6493	0-1	0.0284
Early Depression	0.512	0.752	6484	0-3	0.014
Fearfulness	0.266	0.366	6494	0-2	0

General Health was determined by the question "In general, how is your

health?" with 5 for "excellent" down through 1 for "poor." Overweight was defaulted

to 0, but was changed to 1 for respondents that self-identified as "slightly

overweight" and 2 for "very overweight." Health Impeding Activities was

determined by the question "In the last month, how often did a health or emotional

problem cause you to miss a social or recreational activity?" with 0 for "never" or

"just a few times," 1 for "about once a week" or "almost every day," and 2 for "every

day." Parental Health was determined by the parents' answer to the question "How

is your general physical health?" with 0 for "poor" up through 2 for "excellent."

Physical Disability was determined by the question "Do you have difficulty using

your hands, arms, legs, or feet because of a permanent physical condition?" with 0

for "no" and 1 for "yes." Early Depression was determined by how much the

respondents agreed with the prompt "during the last week you felt depressed" with

0 for "never" up through 3 for "most of the time or all of the time." Fearfulness was

determined by the question "how often have you felt fearfulness" with 0 for "never" up through 2 for "every day."

Table 16. Descriptive statistics on Personality Input Variables					
Variable	**Average**	**Standard Deviation**	**Observations**	**Range**	**Correlation with Wave 4 ASA**
Hard Worker	0.986	0.707	6504	0-2	0.029
Avoidant	0.505	0.661	6504	0-2	-0.009
Perceived Intelligence	2.876	1.097	6474	0-5	-0.026
Hopeful	1.845	0.986	6475	0-3	-0.008
Self-Satisfaction	4.021	0.944	6482	1--5	0.001
Contemplated Suicide	0.128	0.334	6435	0-1	0.032
Good Personality	3.589	0.849	6499	1--5	-0.011

Hard Worker was determined by agreeance to the prompt "When you get what you want, it's usually because you worked hard for it" with 0 as default, 1 for "agree," and 2 for "strongly." Avoidant was determined by agreeance to the prompt "You usually go out of your way to avoid having to deal with problems in your life" with 0 as default, 1 for "agree," and 2 for "strongly agree." Perceived Intelligence was determined by the question "compared with other people your age, how intelligent are you?" with 0 for "moderately below average" up through 6 for "extremely above average." Hopeful was determined by the respondents' answer to "In the last week you felt hopeful about the future" with 0 for "never or rarely" up through 3 for "most of the time or all of the time." Self-Satisfaction was determined by agreeance to "You like yourself just the way you are" with 0 for "strongly disagree" up through 5 for "strongly agree." Contemplated Suicide was determined by "During the past 12 months, did you ever seriously think about committing

suicide?" with 0 for "no" and 1 for "yes." Good Personality was determined by the

interviewers' response to the question "How attractive is the respondent's

personality?" with 1 for "very unattractive" up through 5 for "very attractive."

Table 17. Descriptive Statistics on Output Variables				
Variable	Average	Standard Deviation	Observations	Range
W1 Alcohol Use	1.075	1.472	4717	0-6
W3 Alcohol Use	2.188	1.757	4717	0-6
W4 Alcohol Use	2.234	1.811	4717	0-6

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