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Substance Use and Abuse Trajectories across Adolescence: A Latent Trajectory Analysis of a Community-Recruited Sample of Girls

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Abstract

We used data from a school-based study of 496 adolescent girls to identify qualitatively distinct substance use and substance abuse developmental trajectory groups and tested whether the problematic groups differed from the non-problematic groups on baseline and outcome validation variables. Results identified four substance use groups (late users, normative users, late-heavy users, early-heavy users) and four substance abuse groups (nonabusers, moderate escalating abusers, moderate decreasing abusers, adolescent-limited heavy abusers). Problematic substance use and abuse trajectory groups, relative to non-problematic groups, showed elevations in baseline validation variables (age 14 delinquency, depressive symptoms, negative affectivity, parental support deficits, body dissatisfaction) and outcome validation variables (age 20 delinquency, depressive symptoms, social impairment, legal problems, school dropout, and substance abuse diagnosis), providing partial validation of this trajectory model.

Keywords

adolescents; substance use; substance abuse; developmental trajectories

Adolescent substance abuse is a serious public health problem that increases risk for future morbidity, mortality, psychiatric comorbidity, interpersonal difficulties, and academic failure (Chassin, Ritter, Trim, & King, 2003). Thus, elucidating the developmental course of substance use and abuse is a key priority because it may suggest optimal periods for delivery

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of prevention programs. Prospective studies indicate that onset of alcohol use and substance use typically occurs between 13 and 15 years of age and that substance use typically peaks between 18 and 24 years of age (Johnston, O'Malley, & Bachman, 1999). Recently, researchers have used person-centered analyses to test whether there are qualitatively distinct developmental substance use trajectories (Jackson & Sher, 2005). Person-centered analyses determine whether there are qualitatively distinct subgroups of individuals who show particularly problematic substance use or abuse trajectories versus more benign trajectories, which is useful for more fully characterizing the development of these problems, identifying high-risk youth, and informing the timing of preventive interventions.

While there have been numerous studies in the past decade documenting developmental trajectories of substance use, these studies have typically examined patterns of substance use growth with a limited number of indexes of substance use. Studies examining the developmental course of substance use and abuse have primarily used two indexes as the basis of trajectories, use levels and binge behaviors. However alcohol dependence (Jackson & Sher, 2005), substance use disorders (Clark, Jones, Wood, & Cornelius, 2006), and negative consequences (Jackson & Sher, 2005) have also been examined in trajectory models. The measurement index used to model developmental trajectories impacts the characteristics of the groups identified in these models. Different measures from the same sample have demonstrated poor agreement across trajectory group classification schemes and predict different prevalence levels (Jackson & Sher, 2005). Thus, the index of substance use is an important consideration in evaluating developmental trajectories.

Use level, most commonly of alcohol, and to a lesser extent usage of other drugs, has been the most frequently modeled dependent variable in the extant literature on adolescent and early adulthood substance use trajectories. Bennette, McCrady, Johnson, and Pandina (1999) identified groups of stable low drinkers, stable moderate drinkers, youth-limited problem drinkers, and developmentally persistent problem drinkers among youth followed from age 12 to 30; by adulthood, persistent problem drinkers showed elevated externalizing behaviors relative to stable low drinkers. Flory, Lynam, Milich, Leukefeld, and Clayton (2004) found evidence of early onset, late onset, and non-user subgroups for both alcohol and marijuana among adolescents followed from age 11 to 21. Colder, Campbell, Ruel, Richardson, and Flay (2002) identified occasional light drinkers, moderate escalators, occasional heavy drinkers, rapid escalators, and heavy drinkers with declining frequency among adolescents followed from age 12 to 17. Ellickson, Martino, and Collins (2004) modeled adolescent marijuana use, finding evidence for four trajectory groups: early high users, stable light users, steady increasers, and occasional light users.

Binge drinking has been the focus of other studies. Chassin, Pitts, and Prost (2002) identified four binge-drinking trajectories from age 12 to 23: non-binger, infrequent, late-moderate, and early-heavy. Muthén and Shedden (1999) identified three binge-drinking trajectories from age 18 to 25: non-binger, increasers, and high binge drinkers. Jackson et al. (2005) identified four binge drinking trajectories in a large sample of women and men followed from age 18 to age 26: non-binge drinkers, developmentally limited binge drinkers, late onset binge drinkers, and chronic heavy binge drinkers. Tucker, Orlando, and Ellickson (2003) modeled binge drinking in adolescents between ages 13 to 23, finding evidence for

five groups: nonbingers, moderate stables who exhibited consistently low levels, steady increasers who increased exhibited a consistent escalation across adolescence, adolescent bingers who were initially high bingers but decreased to moderate levels, and early highs who decreased in the first year of the study to a consistent moderate level across adolescence.

The extant literature on substance use trajectories has typically identified stable light users, moderate escalators, occasional heavy users, heavy escalators, and youth limited heavy users (Bennett et al., 1999). Studies testing for binge-drinking trajectories have typically identified non-binge drinker, late onset binge drinker, developmentally limited binge drinker, and early escalating and chronic binge drinker groups (Jackson, Sher, & Schulenberg, 2005). Thus, studies that have tested for distinct substance use trajectories during adolescence have usually identify three to five substance use trajectories, with the most consistent observed trajectories involving chronic abstinent or light users, early escalators, and chronic high users. Studies following participants into young adulthood often found evidence of a developmentally limited group that showed reduced substance use during early adulthood and groups that show later escalations in use. While it is possible to generalize across studies that modeled use levels and binging, there is too little literature documenting trajectories of other measures, including dependence, substance use disorders, and negative consequences, to be able to generalize about the developmental course of these measures. Further, the literature has predominantly focused on alcohol, especially in the case of binging, although marijuana and tobacco have been examined.

The current study was entirely comprised of adolescent girls because the data were drawn from a study examining risk factors for eating disorders, which occur primarily in young women. In light of adult outcomes indicating higher levels of alcohol abuse, dependence, and abuse is higher in males than females (Nelson & Wittchen, 1998), studies in the etiology of substance use should regularly examine the possibility of sex differences in the prevalence of trajectory group membership. The majority of reports that compare sexes have focused on early adulthood and thus provide little information about the origins of substance use. Studies that have compared sex differences in adolescents report higher incidences of males in trajectory groups characterized by higher alcohol use. Males were more likely to be in early-heavy and late-moderate groups whereas females were more likely to be in infrequent and non-binger groups across ages 12 to 23 (Chassin et al., 2002). Windle, Mun, and Windle (2005) constructed separate models for male and female heavy drinking across ages 16 to 25, reporting higher proportions of males in the heavier drinking groups. Casswell, Pledger, and Pratap (2002) investigated trajectories of alcohol use for males and females separately in a sample ranging from age 18 to 26 and found a high degree of similarity across sexes, though females appeared to be concentrated in trajectories characterized by abstinence and low use levels with the exception of the heaviest use per occasion group in which there were comparable proportions of males and females. Thus, among studies that report sex differences, males are consistently more likely to be in trajectory groups characterized by heavier consumption. Examination of a female-specific sample provides insight into the origins of substance use in female adolescents and female-specific outcomes, both of which are largely obscured by heavy and problem substance use

groups that are predominantly comprised of males and therefore limit or knowledge of female-specific growth patterns and female-specific outcomes.

Although there is evidence that there are sex differences in alcohol trajectories, most studies have focused on participants 18 or older and no study has examined a female-only, early-adolescence model of substance abuse trajectories. As such, this study provides a unique contribution to the literature. In addition, due to the disproportionate numbers of males in problem use trajectories, the possibility of sex-specific effects is obscured. While we expect that negative consequences are associated with problematic substance use trajectories for both sexes, we sought to investigate the possibility that problem substance use trajectories are associated with outcomes, such as body dissatisfaction, that are primarily present in female populations. Thus, the current investigation provides insight into the origins of problem substance use as well as investigating the possibility of sex-specific outcomes.

The first aim of this study was to search for qualitatively distinct substance use and substance abuse trajectories during adolescence. In addition to constructing separate trajectory models for substance use and abuse, we constructed a dual trajectory model with the intent of identifying concordance between use and abuse. As it could be argued that it is most important to identify adolescents who show a problem substance abuse trajectory, even if it is not characterized by excessive substance use, an understanding of early adolescent trajectories of substance abuse fills a critical need in the literature. We modeled substance use as a combination of multiple substances (e.g., alcohol, marijuana, stimulants, and sedatives) that are commonly used by adolescents. By examining polysubstance use, we fill a gap in the literature, as the majority of investigations have focused on alcohol with some investigations of marijuana and tobacco. The existing focus on alcohol, marijuana, and tobacco is largely a result of the low prevalence of use of illicit substances, making specific investigations of low frequency substances difficult in prospective studies. Indeed, usage of substances other than alcohol, marijuana, and tobacco occurred too infrequently in our data to model trajectory patterns of individual substances. Thus, there is minimal understanding of heavy substance use that is characterized by both breath and quantity of substance use.

The second aim was to validate our grouping solution by testing whether trajectory groups differed on early adolescent factors. We investigated several factors that have been theorized to increase vulnerability to substance use and abuse, including delinquency, depressive symptoms, temperamental negative affectivity, deficits in parent and peer support, and body dissatisfaction. Delinquency has emerged as a predictor of future substance use and abuse in numerous studies (Ellickson & Hays, 1991; Stice, Barrera, & Chassin, 1998). Theoretically, a tendency towards delinquent behavior increases risk for underage use of alcohol and illicit substance use, potentially due to a heightened sensitivity to reward or difficulties anticipating negative consequences of motivated behavior (Loxton & Dawe, 2001). It has also been hypothesized that individuals with affective disturbances use psychoactive substances because they improve mood and provide distraction from adverse emotions. Deficits in parent and peer support have likewise been found to predict future increases in substance use and abuse (Wills et al., 1996). Low levels of parental support may result in a disruption in children's internalization of societal mores, which may increase risk for substance use or abuse. Deficits in peer support may lead adolescents to use substances in an

effort to gain social acceptance. Finally, body dissatisfaction may lead adolescent girls to use psychoactive substances to improve their affect or distract themselves from body image concerns or to lose weight (Camp, Klesges, & Relyea, 1993). It has also been theorized that body dissatisfaction increases risk for substance use among adolescent girls because it increases vulnerability to self-medication substance use and because many adolescent girls believe that stimulant medications assist in weight control (Camp et al., 1993).

The third aim was to further validate the grouping solution by testing whether the trajectory groups showed expected differences in young adulthood outcomes. Theoretically, psychoactive substance use increases risk for delinquent behavior because of the disinhibiting effects of some substances and increases risk for depression because of the sedating effects of other substances (Stice, Burton, & Shaw, 2004). In addition, heavy use putatively leads to impaired psychosocial functioning, including legal problems, school dropout, greater use of mental health services, and increased risk for substance abuse diagnosis (Chassin et al., 2003). Prior studies have found that adolescent substance use and abuse increases risk for each of these outcomes in early adulthood (Chassin et al., 2003; Stice et al., 2004).

Method

Participants

Participants were 496 adolescent girls from public and private middle schools in a large city in the United States (*M* age = 13.5 at Time 1; SD = 0.67). The sample included 2% Asian/Pacific Islanders, 7% African Americans, 68% Caucasians, 18% Hispanics, 1% Native Americans, and 4% who specified other/mixed racial heritage, which was representative of the schools from which we sampled. Average parental education, a proxy for socioeconomic status, was 29% high school graduate or less, 23% some college, 33% college graduate, and 15% graduate degree, which was representative of the city from which we sampled.

Procedures

The study was described as an investigation of adolescent mental and physical health. The average participation rate was 56%, which is similar to participation rates in other school-recruited samples that used active consent procedures and structured interviews (e.g., 61% for Lewinsohn, Hops, Roberts, Seeley, & Andrews, 1993). Girls completed a survey and participated in a structured interview at Time 1 (T1) and at seven follow-ups (T2, T3, T4, T5, T6, T7, and T8) that occurred at one year intervals. Participants were paid for completing each assessment. Interviews were conducted by female clinical assessors with at least a bachelor's degree in psychology who had attended 24 hours of training that included structured interview skills, diagnostic criteria for relevant DSM-IV disorders, differential diagnoses, simulated interviews, and role-played interviews. Assessors demonstrated acceptable inter-rater agreement ($\kappa > .80$) with supervisors using tape-recorded interviews before collecting data, ensuring that interviews were being conducted in a reliable manner. Assessors received ongoing supervision and consultation on diagnostic issues and participated in training workshops. Assessments typically took place at schools.

Measures

Substance use—Substance use was measured with 10 items from Johnson et al. (1999). Adolescents reported their frequency of consumption during the past year of beer/wine/wine coolers, and hard liquor, tobacco, marijuana, stimulants, downers, inhalants, and hallucinogens. Items used 6-point response scales ranging from 0 = *never* to 6 = *3-7 times a week*. Items were summed to form an overall substance use measure, which showed internal consistency (α =.90 at T1; α =.84 at T6), 1-year test-retest reliability (r = .53) and predictive validity for future increases in substance abuse (Stice et al., 1998). Self-reports of substance use appear to be the most valid measure of this construct (Winters, Stinchfield, Henly, & Schwartz, 1991).

Substance abuse symptoms—DSM-IV (American Psychiatric Association, 1994) symptoms of substance abuse were assessed with 8 items from Stice et al. (1998) that assessed negative consequences related to substance use in adolescents (e.g., negative consequences in the school and work environment). Items focused on obligation impairment, health problems, physically hazardous behavior, legal problems, and social difficulties resulting from substance use that occurred over the past year (e.g., got kicked out of school because of substance use). Items used a three-point response format (1 = *never*, 2 = *once*, 3 = *twice or more*) and were combined to form a substance abuse symptom composite. This scale showed internal consistency (α =.81 at T1; α =.85 at T6), 1-month test-retest reliability (r = .78), and predictive validity for future depression onset (Stice et al., 2004).

Substance abuse diagnosis—. Four items from the Schedule for Affective Disorders and Schizophrenia for School-Age Children (K-SADS; Puig-Antich & Chambers, 1983) assessed the four DSM-IV (APA, 1994) substance abuse diagnostic criteria at T4, T5, T6, T7, and T8, allowing us to derive substance abuse diagnoses at T6, T7, and T8. Questions inquired about negative consequences during the previous year resulting from use of alcohol or illicit substance use to minimize respondent burden and in recognition of the fact that most adolescents abuse multiple substances simultaneously (Brown, D'Amico, McCarthy, & Tapert, 2001). The K-SADS has shown test-retest reliability (κ = .63 – .90) and inter-rater reliability (κ = .64 – .89) for diagnoses (Grills & Ollendick, 2002). To assess the inter-rater reliability in our study, a randomly selected subset of participants (n = 149) were re-interviewed within a 3-day period by a second assessor who was blind to the first diagnosis, resulting in high inter-rater agreement for diagnoses (κ = .85). Another randomly selected subset of participants (n = 137) completed a second diagnostic interview with the same assessor one week later, producing high test-retest reliability for diagnoses (k = .81).

Delinquency—. Antisocial behaviors were assessed with 13 items from the Externalizing scale of the Child Behavior Checklist that inquired about delinquent behaviors in the past year (Achenbach & Edelbrock, 1983). The response scale was expanded to a five-point format, ranging from 1 = *never* to 5 = *always* to better capture the full range of variance in the underlying behaviors being measured. Ratings were averaged to form a composite. This scale showed internal consistency (α = .89 at T2; α = .82 at T6) and predictive validity for future increases in substance abuse symptoms (Stice et al., 1998).

Depression—An adapted version of the K-SADS (Puig-Antich & Chambers, 1983), a structured psychiatric interview, assessed diagnostic criteria for DSM-IV major depression. The 13 severity items for each symptom, which used ratings ranging from 1 = *not at all* to 6 = *extreme* to describe symptoms over the past 3 months, were averaged. This scale has shown internal consistency (α = .85 at T1; α = .78 at T6), 1-year test-retest reliability (*r* = .62), and predictive validity for bulimic pathology and substance abuse onset (Stice et al., 2004).

Negative affectivity—Buss and Plomin's (1984) Emotionality Scale assessed temperamental negative affectivity. Participants indicate their level of agreement with 12 statements regarding their tendency to become affectively distressed (sample item: *I frequently get distressed*) on 5-point response format ranging from 1 = *never true of me* to 5 = *always true of me*. Items were averaged. This scale showed internal consistency (α = .80 at T1) and predictive validity for onset of bulimic symptoms (Stice, Killen, et al., 1998).

Parental and peer support—Perceived social support was measured using 12 items from the Network of Relationships Inventory (Furman & Buhrmester, 1985) that assessed companionship, guidance, intimacy, affection, admiration, and reliable alliance from parents/parent surrogates and peers over the past six month period (sample items: How much can you count on mom to be there when you really need her no matter what?). Adolescents rated these items on 5-point scales ranging from 1 = *little or none* to 5 = *the most possible*. The 6 items assessing parental support were averaged to form a composite, as were the 6 items assessing peer support. These scales have shown internal consistency (α = .87 at T1 and α = .86 at T1 respectively), as well as predictive validity for future increases in substance use (Stice et al., 1998).

Body dissatisfaction—Participants rated their satisfaction with various body parts (e.g., waist, thighs) with 9 items from (Berscheid, Walster, & Bohrnstedt, 1973). Response options ranged from 1 = *extremely satisfied* to 5 = *extremely dissatisfied.* Items were averaged. This scale has shown internal consistency (α = .93 at T1) and predictive validity for future increases in dieting, negative affect, and bulimic symptoms (Stice, 2001).

Social impairment—Impairment in the family, peer group, romantic, and school spheres was measured with 17 items from the Social Adjustment Scale-Self Report for Youth (Weissman, Orvaschel, & Padian, 1980) (response options: 1 = *never* to 5 = *always*). Items were averaged. The 17-item version has shown internal consistency (α = .77), 1-week test-retest reliability (*r* = .83) and sensitivity to treatment effects (Stice, Marti, Spoor, Presnell, & Shaw, 2008).

Service utilization—One item assessed frequency of visits to health care providers (How often have you seen a doctor (physician) because of illness, injury, long-term health problems, or for regular check-ups in the last 6 months?) and another assessed frequency of visits to mental health providers (How often have you seen a psychologist, psychiatrist or other counselor/therapist because of mental health problems (depression, anxiety etc) in the last 6 months?). Responses were dichotomized to indicate whether participants had used

health services more than once and whether they used mental health services more than once. These items have shown 1-year test-retest reliability (r = .46 – .58) and sensitivity to detecting intervention effects (Stice, Shaw, Burton, & Wade, 2006).

Legal problems—An item assessing frequency of legal problems (How often have you had problems with the police/law in the last 6 months?) was included. Responses were used to classify participants into those who reported none versus one or more legal problems. In support of the validity of this item, those who reported legal problems were significantly more likely to show future increases in delinquency (semi partial r = .14, p = .003).

School dropout—: Participants were asked, “Have you dropped out of school in the past 12 months?” Responses were asked this question during at T4 through T8 of the study and were coded as school dropouts if they had reported dropping out at any assessment point that was prior to age 18.

Results

Onset Benchmark

We examined the frequency of alcohol use and marijuana use onset by age 17.5 to determine whether our sample was comparable to U.S. epidemiological statistics collected using the Youth Risk Behavior Surveillance System, a survey conducted by National Center for Chronic Disease Prevention and Health Promotion (2005). Our measure reflected onset during the study period, whereas the national benchmark was a measure of lifetime use. Nationally, 82% (95% CI = 6.5%) of females had consumed alcohol by 12th grade; 80% of the participants in the present study had consumed alcohol by 12th grade. Nationally, 43% (95% CI = ±5.8) of females had consumed marijuana by 12th grade; 46% of the participants in the present study had consumed marijuana by 12th grade. Thus, participants seem to be representative in terms of substance use onset rates.

Qualitatively Distinct Substance Use and Abuse Developmental Trajectory Groups

The first step of constructing developmental trajectory models for substance use and abuse was to determine the optimal number of latent groups in the sample. We used PROC TRAJ, a user-written SAS procedure (Jones, Nagin, & Roeder, 2001) to identify trajectory groups. Models were estimated with a censored normal distribution, a distribution in which there are clusters of data at the minimum or maximum of the distribution (Nagin, 2005). Given that the majority of observations were concentrated on the low end of the scale, this was an appropriate distributional assumption. Developmental trajectories are clusters of participants that share similar intercepts and slopes in regression equations in which the outcome is regressed on time. Modeling trajectories based on participant age resulted in missing data at the beginning and end of the study period because participants varied in age at each assessment (i.e., not all participants provided data for the early and later years of age). Thus, we omitted the earliest and latest ages from the analyses. PROC TRAJ uses maximum likelihood estimation and is thus able to make use of all available data. Age at measurement occasion was rounded to the nearest whole year. We required that the participants had at least five of the eight possible measurement points in order to be included in the model; this

resulted in the exclusion of 19 participants. Post hoc analysis indicated that there were no trajectory group differences in the number of observations that each case contributing to the substance use latent trajectory model (F (3,473) = .38, p = .77) or the substance abuse latent trajectory model (F (3,473) = 2.16, p = .09). Participants provided an average of 7.2 time points to the use and abuse trajectory models. The number of participants at each age for the substance use and substance abuse models respectively were as follows: 230 and 230 at age 13; 444 and 443 at age 14; 470 and 469 at age 15; 473 and 473 at age 16; 475 and 475 at age 17; 472 and 472 at age 18; 459 and 459 at age 19; and 414 and 415 at age 20.

A range of models that differed in (a) the number of developmental trajectory groups and (b) the number of linear and non-linear terms defining growth trajectories were considered. Because the polynomial complexity of the age trend or lack thereof determines the shape of the trajectory, we considered an intercept-only model, linear change, quadratic change, and cubic change. Several series of models were examined that compared models of comparable polynomial complexity with models that differed in the numbers of groups: in the first series, all combinations of intercept-only and linear terms were examined; in the second series, all combinations of linear and quadratic terms were examined; and in the third series, all combinations of linear and cubic terms were examined. This was done for models that ranged from one trajectory group to six trajectory groups. Bayesian Information Criterion (BIC), a measure used to compare models that differ in the number of parameters, was used to determine the optimal model in terms of number of developmental trajectory groups and the number of parameters representing time. We thus had a sequence of models for 1 to 6 groups where the sequences contained various combinations of time parameters. The best model for a group of a given size was determined by first identifying the largest BIC value. That model was examined to determine if all of the parameters representing time were significant. We examined the highest order term in polynomial equation. Models containing non-significant terms were rejected and a new best model was established within the set of models for a particular number of groups by identifying the next largest BIC-value. This was repeated until the largest BIC for a model of a particular number of groups was determined. As a final step, the BIC values for the best model for the 1 through 6 group models were compared and the model with the largest BIC value was selected.

The baseline substance use developmental trajectory group model was an intercept-only, single group model with a BIC of −8951.08. Models containing quadratic terms consistently had larger BIC values than did parallel cubic models. Following the a priori decision rules, a model containing four-groups (BIC = −8051.45), comprised of two linear groups and two quadratic groups, was selected. Figure 1 plots the levels of substance use for each developmental trajectory group. To assess the adequacy of the classification scheme, group probabilities were examined to determine how accurately participants were classified into developmental trajectory groups. Each participant is assigned a probability of group membership for each of the developmental trajectory groups in the model and is classified into the group with the largest probability value for that participant. The four substance use groups, normative users (M = .91), late users (M = .93), late-heavy users (M = .93), and early-heavy users (M = .97) all exhibited high average group probabilities. The sample was

comprised of 24% late users, 52% normative users, 16% late-heavy users, and 7% early-heavy users.

The decision rules described above were used to establish a trajectory group model for substance abuse. The baseline model, a single group, intercept-only model had a BIC of −1947.58. A four-group model (BIC = −1600.19) contained one linear group and three quadratic groups. Figure 2 plots the levels of substance abuse for each trajectory group. Average group probabilities within the four groups were as follows: non-abusers (M = .94), moderate escalating abusers (M = .81), moderate decreasing abusers (M = .84), and adolescent-limited heavy abusers (M = .90), indicating that individuals were largely classified without ambiguity. The sample was comprised of 66% non-abusers, 19% moderate escalating abusers, 10% moderate decreasing abusers, and 4% adolescent-limited heavy abusers.

Cross-Validating Substance Use and Substance Abuse Models

A dual trajectory model was constructed to evaluate the relation between the developmental courses of substance use and abuse. The dual trajectory model is an implementation of PROC TRAJ that extends the single trajectory models by assessing the joint probability of group membership in two developmental trajectory groups. The cross-classification of the two models showed that there was a high degree of overlap in groups across the substance use and substance abuse models. Of the 16 possible cross-classifications, 7 of the cross-classifications accounted for 92% of participants: 24% of participants were late users, non-abusers; 42% were normative users, non-abusers; 8% were normative users, moderate escalating abusers; 9% were late-heavy users, moderate escalating abusers; 3% were late-heavy users, moderate decreasing abusers; 4% were early-heavy users, moderate decreasing abusers, and 3% were early-heavy users, adolescent-limited heavy abusers. Table 1 presents the conditional probabilities of substance abuse given substance use and the conditional probabilities of substance use given substance abuse. Table 2 presents group means for substance use and abuse at each age in addition to usage of key substances.

Baseline Validation of Substance Use and Abuse Trajectory Groups

To partially validate the trajectory solution, we tested whether participants in the various groups differed on age 14 measures of delinquency, depressive symptoms, negative affectivity, peer support, parental support, and body dissatisfaction. One-way analysis of variance (ANOVA) examined differences across developmental trajectory groups (Table 3) wherein trajectory group membership served as the independent variable. We considered using age 14 substance use and abuse levels as controls, but ultimately did not due to the non-independence between these measures and the trajectory groups that were in part defined by these variables. In the event of a significant main effect of a trajectory group, we conducted two follow-up contrasts; the first contrasted problem groups with non-problem groups and the second contrasted problem groups. The first contrast was intended to establish that differences in validation variables were indeed a result of predicted differences between problematic trajectory groups and non-problematic and normative groups. The second contrasts investigated differences between problem groups to determine whether these low frequency groups were indeed distinct or were perhaps artifacts of the trajectory

solution that did not represent fundamentally different underlying behavioral and psychological characteristics. For the substance use model, the first contrast was early-heavy and late-heavy users with late and normative users and the second contrast was between early-heavy and late-heavy users. For the substance abuse model, the first contrast compared non-abusers with moderate escalating abusers, declining abusers, and adolescent-limited heavy abusers and the second contrasted moderate escalating abusers and moderate decreasing abusers with adolescent-limited heavy abusers. Follow-up contrasts are presented in Table 6.

Five of the six age 14 predictors exhibited significant differences between substance use trajectory groups: delinquency, ($F(3, 464) = 40.69$, $p < .001$, $\eta^2 = .21$) depressive symptoms, ($F(3, 466) = 9.91$, $p < .001$, $\eta^2 = .06$), temperamental negative affectivity ($F(3, 463) = 3.14$, $p < .05$, $\eta^2 = .02$), parental support ($F(3, 464) = 14.20$, $p < .001$, $\eta^2 = .08$), and body dissatisfaction ($F(3, 464) = 3.51$, $p < .05$, $\eta^2 = .02$).

The same five age 14 predictors discriminated between substance abuse trajectory groups: delinquency ($F(2, 464) = 40.45$, $p < .001$, $\eta^2 = .21$), depressive symptoms $F(2, 466) = 16.56$, $p < .001$, $\eta^2 = .09$), temperamental negative affectivity ($F(2, 463) = 8.02$, $p < .001$, $\eta^2 = .05$), parental support ($F(2, 467) = 8.54$, $p < .001$, $\eta^2 = .05$), and body dissatisfaction ($F(2, 464) = 5.36$, $p < .01$, $\eta^2 = .03$).

We examined the sensitivity and specificity of age 14 validation variables to predict membership in problem trajectory groups using discriminant function analysis (DFA). Models assumed unequal variances across trajectory groups and used prior probabilities that were proportional to the sample sizes of the groups. Age 14 substance use and abuse in addition to each of the age 14 predictors that was a significant predictor of group membership in the previously reported ANOVAs were included as independent variables in the DFA models. Two models were constructed for substance use and substance abuse classification: the first compared problem trajectories with non-problem trajectories and the second compared moderate problem trajectories with heavy problem trajectories. Sensitivity was assessed as the proportion of true positives of all positive cases in the sample and specificity was assessed as the proportion of true negatives of all negative cases in the sample. Sensitivity for identifying problem users was .45 and specificity was .94; sensitivity for distinguishing between early- and late-heavy users was .84 and specificity was .84. Sensitivity for identifying problem abusers was .41 and specificity was .93; sensitivity for distinguishing between moderate and heavy abusers was .62 and specificity was .82.

Outcome Validation of Substance Use and Abuse Trajectory Groups

We also conducted outcome validation analyses that compared differential levels on variables in young adulthood (see Tables 4 and 5). Outcome validation variables, which were drawn from the assessment closest to age 20, included: delinquency, depression, social impairment, health and mental health service utilization, legal problems, school dropout, and substance abuse diagnoses. Follow-up contrasts were conducted in an identical manner to age 14 baseline validation variables and are presented in Table 6.

Substance use trajectory groups differed on all three of the continuous outcomes: delinquency ($F(3, 445) = 23.40$, $p < .001$, $\eta^2 = .14$), depressive symptoms ($F(3, 448) = 4.80$, $p < .01$, $\eta^2 = .03$), and social impairment ($F(3, 446) = 4.62$, $p < .01$, $\eta^2 = .03$) at age 20. Binary outcomes were analyzed using a generalized estimating equation model. The Wald χ^2 was used to evaluate omnibus group differences; follow-up comparisons between non-problematic trajectory groups and the problematic trajectory groups were analyzed using logistic regression. Substance use trajectory groups differed on legal problems ($\chi^2(3, N = 446) = 10.00$, $p < .05$), school dropout ($\chi^2(3, N = 477) = 30.04$, $p < .001$), and substance abuse diagnosis ($\chi^2(3, N = 451) = 45.34$, $p < .001$), but did not differ on health or mental health service utilization.

Substance abuse trajectory groups also differed on delinquency ($F(3, 445) = 21.80$, $p < .001$, $\eta^2 = .13$), depressive symptoms $F(3, 448) = 6.61$, $p < .001$, $\eta^2 = .04$), and social impairment $F(3, 446) = 8.03$, $p < .001$, $\eta^2 = .05$), legal problems ($\chi^2(3, N = 446) = 12.45$, $p < .01$), school dropout ($\chi^2(3, N = 477) = 27.58$, $p < .001$), and substance abuse diagnosis ($\chi^2(3, N = 478) = 65.61$, $p < .001$), but did not differ on health or mental health service utilization.

Discussion

Qualitatively Distinct Substance Use and Abuse Developmental Trajectories

The first aim was to search for qualitatively distinct substance use and abuse trajectories in adolescent girls. Four substance use trajectory groups were identified: normative users, late users, late-heavy users, and early-heavy users. These results generally converge with past studies (Colder et al., 2002; Wills et al., 1996), suggesting that the patterns of substance use developmental trajectories in adolescent females is typical of adolescents in general. We identified four substance abuse trajectory groups: non-abusers, moderate escalating abusers, declining abusers, and adolescent-limited heavy abusers, which is similar to the trajectory groups identified by two previous studies that have examined substance abuse data (Bennett et al., 1999; Jackson & Sher, 2005). These latter studies, which included males, also identified a developmentally persistent substance abuse trajectory group, suggesting that perhaps females are less likely to populate such a developmentally persistent substance abuse trajectory. As an initial step in validating our trajectory solutions, we estimated a dual trajectory model that cross-classified respondents based on their trajectories for both substance use and abuse symptoms. The cross-classification of use and abuse models revealed that 7 of a possible 16 cross-classifications accounted for 92% of the participants. The results make two unique contributions to the literature: the substance use model supports the distinction between early- and late-heavy users in a female-only sample and the substance abuse model is the first such model for the adolescent period.

Qualitative Distinctions between Early- and Late-Heavy Substance Users

This study establishes support for a distinction between early- and late-heavy substance users in a female sample. Previous research has established that males are more likely to be in early-heavy and late-moderate groups (Chassin et al., 2002) trajectory groups than females. In light of such a disparity, there is a possibility that the distinction between early and late users is sex specific as these patterns could essentially be established to the high

propensity of early-heavy male users. However, in this female-only sample, early- and late-heavy substance users consistently differed in the validation measures as well as their correspondence with substance abuse classification. Indeed the patterns are similar to a retrospective study of adult males in which trajectory groups of substance use disorder symptoms for two groups that parallel the early- and late-heavy users in the current study (Clark et al., 2006). In addition, a three-group model of alcohol and marijuana use across ages 12 to 17 documents early and late onset groups in both models (Colder et al., 2002). There were two lines of evidence that we believe support qualitative differences between the two groups. First, there was strong concordance between these groups and their classification in the abuse trajectories in the dual trajectory model. In examining substance abuse group membership conditional on substance use group, 89% of the late-heavy users are moderate-escalating abuser, 66% of early-heavy users are moderate decreasing abusers, and 31% of the late-heavy users are adolescent-limited heavy abusers. The high degree of correspondence in distinct use and abuse trajectories supports qualitative differences between these trajectory groups. Second, the baseline validation measures demonstrated that the early-heavy groups exhibited elevated levels of problem behaviors relative to the late-heavy users. Contrasts between early- and late-heavy users and contrasts of moderate escalating abusers with moderate declining and adolescent-limited heavy abusers consistently demonstrated that the early-heavy substance users and moderate declining and adolescent-limited heavy abusers exhibited more problematic outcomes at age 14 but these differences disappeared relative to late-heavy and moderate declining and adolescent-limited heavy abusers respectively at age 20. This pattern of results supports the existence of an early-heavy user group and adolescent-limited heavy abuser groups by demonstrating that the early adolescent differences in females correspond with psychological and behavioral problems during the same age range.

Substance Abuse Trajectories

The analyses presented herein represent the first trajectory model of adolescent substance abuse of which we are aware. The most comparable model is Jackson and Sher's (2005) model of negative consequences associated with alcohol that reported four trajectory groups. It appears that our results converge with those from Jackson and Sher (2005): In their model of negative consequences, the majority of their participants (72%) were classified as not exhibiting alcohol dependence, most of the remaining were classified as developmentally limited, which consisted of elevated levels of alcohol consequences at age 18, followed by a decline. There were two groups that exhibited elevated levels of alcohol consequences consisting of only 6% of the sample. While there are differences in nomenclature, in the age groups studied, and our sample is female only, the pattern of abuse in the samples was similar: approximately two-thirds of the sample exhibits no appreciable negative consequences, approximately a quarter of the sample exhibits moderate levels of abuse, and approximately 5% of the sample exhibits heavy levels of abuse.

Although there was not a one-to-one correspondence between use and abuse groups, the limited number of combinations that accounted for most participants suggests that the use and abuse trajectories are related. The only previous study to examine the correspondence between use and abuse trajectory groups (Jackson & Sher, 2005) reported a modest

concordance between groups. In light of the distribution of trajectory groups in the current study, Jackson and Sher (2005), and previous studies that have examined correlations between use and abuse (Bailey & Rachal, 1993; Stice et al., 1998), it is not surprising that there is only moderate correspondence in the classification schemes given that the modal abuse trajectory is non-abuse and the modal use trajectory is moderate use. Despite only modest correspondence between use and abuse, it appears that there a limited number of cross-classifications that account for the majority of the sample; indeed, it was the case in the results presented herein that 7 of a possible 16 cross-classifications between use and abuse groups accounted for 92% of the sample. Thus, we conclude that while there may be low direct correspondence between substance use and substance abuse trajectory groups in female adolescents, they are not independent, and it is in fact the case that there is a logically limited set of cross-classifications across the two models.

Early and Late Adolescent Outcomes Associated with Substance Use and Abuse Trajectories

Our validation analyses for early adolescent and early adulthood outcomes consistently demonstrated that substance use and abuse groups consistently predicted outcomes. This pattern established that established relationships between substance use and abuse are consistently present in a female-only sample. Thus, the possibility that effects in mixed sex samples are primarily a result of males who are heavier substance users in unlikely as females exhibit the same negative outcomes that are associated with substance use and abuse as are established in extant literature. The observed relationship between use and abuse trajectories and body dissatisfaction provides evidence for an outcome that is potentially female-specific. The limited prior literature on the relationship between body satisfaction and substance use and abuse has focused on females (Camp et al., 1993), which is largely due to the prevalence of eating pathology which occurs at approximately 10 times the rate in females than males (Wilson, Becker, & Heffernan, 2003). Body dissatisfaction has previously been linked with increased dieting and bulimic symptoms (Stice, 2001), underscoring the risks in the combination of substance use and abuse problems with body dissatisfaction.

Effect sizes ranged from $\eta^2 = .02$ to $\eta^2 = .21$. Evaluated using Cohen's (1988) criteria that η^2 values of .01, .06, and .14 represent small, medium, and large effect sizes respectively, trajectory groups exhibit a range of impact in their ability to predict non-substance use/abuse constructs. Effects for temperamental negative affectivity and body dissatisfaction tended to be on the small end of the range at baseline, though temperamental negative affectivity approached a medium effect for abuse trajectories; depressive symptoms and parental support consistently exhibited medium effect sizes; and delinquency exhibited a large effect size. At age 20, depressive symptoms and social impairment exhibited small to medium effect sizes and delinquency exhibited a large effect size. When considering Cohen's guidelines for interpreting effect sizes, it is important to remember that small effect sizes are typical of non-experimental research where is not possible to remove extraneous noise in the data. Thus, the presences of medium and even large effect sizes are particularly impressive in a prospective study.

Clinical Implications

One implication of the present results is that it might be useful to deliver selected or indicated substance abuse prevention programs to adolescents who are likely to populate the moderate escalating abuser, moderated decreasing abuser, and adolescent-limited heavy abuser developmental trajectory groups. One assumption of the above implication is that adolescents who are likely to populate maladaptive substance abuse trajectory groups can be reliably identified in early adolescence. Sensitivity and specificity analyses confirmed that age 14 measures of substance use, substance abuse, and variables that were significant predictors of trajectory group membership reasonably predicted distinctions between problem and non-problem users and abusers and between problem use and abuse groups. Within this context it is important to note that although selected prevention programs often produce large effects, there is a risk of stigmatization (Stice & Shaw, 2004). In addition, selected and indicated programs are implemented after problematic risk factors and symptoms emerge. Thus, universal programs should also be considered as these programs have the potential to prevent adolescents from engaging in substance use through promotion of positive developmental pathways (Ferrer-Wreder, Stattin, Lorente, Tubman, & Adamson, 2004).

Limitations

It is important to consider the limitations of this study when interpreting the findings. First, this study relied on self-report data, which raises the possibility that reporter bias has artificially inflated some of the relations examined in this report. Second, we were only able to include a limited number of baseline and outcome validation variables, because of concerns about the assessment burden. Third, because this sample does not contain male adolescents, the results should not be generalized to this population. Fourth, the moderate participation rate suggests that care should be used in generalizing these findings to the broader population of adolescent females. We suspect that the moderate recruitment rate occurred because of the high-respondent burden in an 8-year prospective study involving diagnostic interviews and because we only offered participants a $15 gift certificate for completing assessments. Finally, participants primarily are of upper middle class backgrounds in the U.S. limiting the generalizability of the findings to lower socioeconomic groups and non-U.S. adolescents.

Conclusions

In sum, results provided additional evidence of qualitatively distinct substance use developmental trajectories in female adolescents and provide the first trajectory model of substance abuse across adolescent years. The models presented herein have two sources of validation: a limited number of use and abuse group combinations account for 92% of all participants, and the early- and late-heavy users, relative to their counterparts in non-problem trajectories, exhibited more problematic levels on the baseline and outcome validation variables. The substance use model and subsequent validation support the qualitative distinction between early- and late-heavy users. The substance abuse model is validated by a predictable correspondence with heavy substance use, consistently predicting detrimental psychological and behavioral antecedents of adolescent abuse trajectories, and

negative psychological, health, and social outcomes. It is possible that by offering selected or indicated substance abuse prevention programs to youth who are likely members of problematic developmental trajectories will increase the yield of prevention programs, and it is further possible that universal programs that precede the emergence of problematic substance use and abuse pathways have the potential to prevent problematic developmental trajectories through the promotion of positive development.

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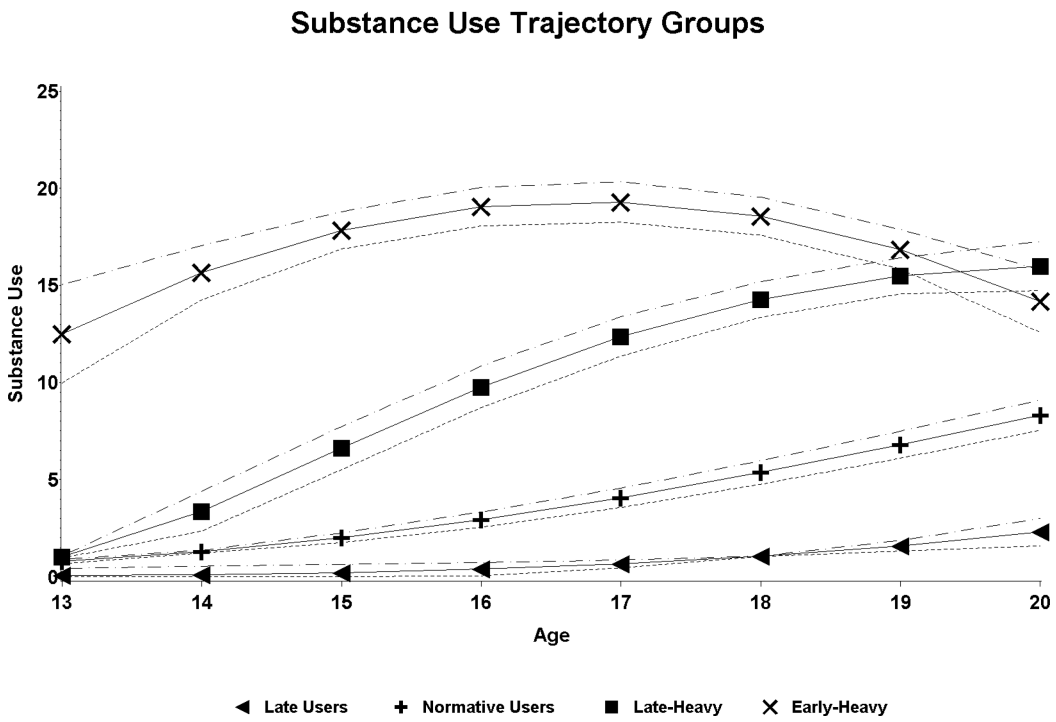

Figure 1.

Growth curves from age 13 to 20 for substance use with 95% confidence intervals. Solid lines represent estimated growth curves for developmental trajectory groups. Dashed lines represent the lower 95% confidence interval and dashed-dot lines represent the upper 95% confidence interval.

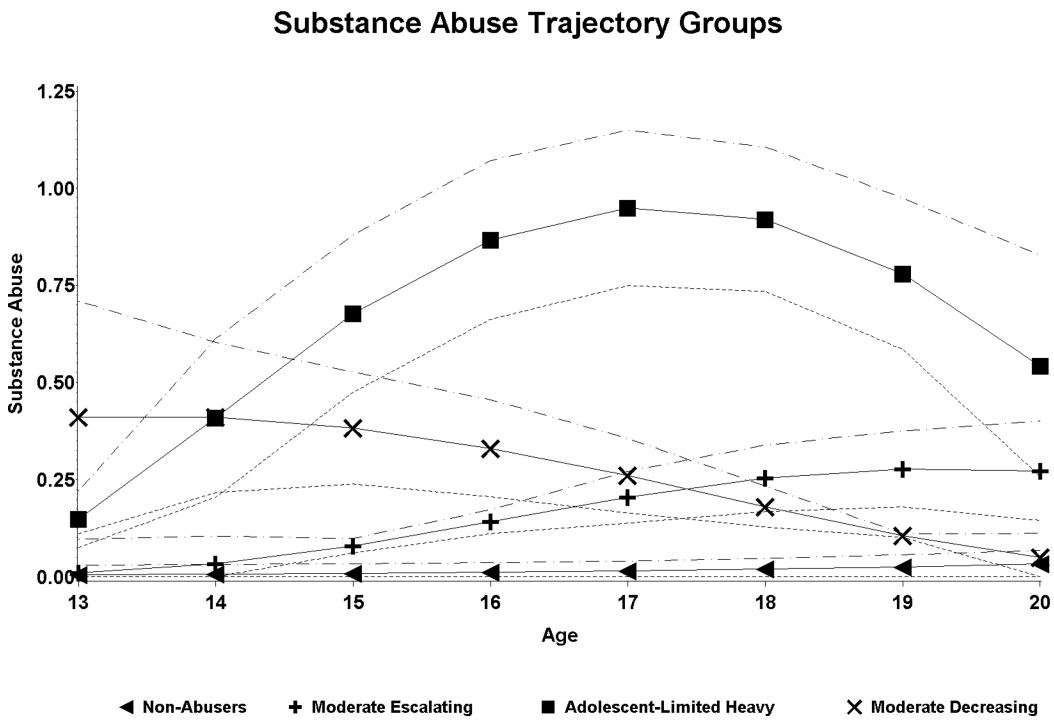

Figure 2.

Growth curves from age 13 to 20 for substance abuse with 95% confidence intervals. Solid lines represent estimated growth curves for developmental trajectory groups. Dashed lines represent the lower 95% confidence interval and dashed-dot lines represent the upper 95% confidence interval.

Table 1

Cross-classification of the Substance Use and Substance Abuse Trajectory Groups

Substance Use Probabilities Conditional on Substance Abuse

	Late onset	Normative	Late-heavy	Early-heavy
Non-abusers	.40	.60	.00	.00
Moderate escalating abusers	.00	.39	.60	.01
Moderate decreasing abusers	.00	. 00	.16	.84
Adolescent-limited heavy abusers	.00	.00	.31	.69

Substance Abuse Probabilities Conditional on Substance Use

	Non-abusers	Moderate escalating abusers	Moderate decreasing abusers	Adolescent-limited heavy abusers
Late onset	1.00	.00	.00	.00
Normative	.79	.21	.00	.01
Late-heavy	.00	.89	.05	.06
Early-heavy	.00	.03	.63	.33

Table 2

Means with Standard Deviations in Parentheses for Substance Use and Substance Abuse

		Age							
Measure	**Group**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Substance Use	Late onset	0.13 (0.5)	0.06 (0.3)	0.12 (0.3)	0.20 (0.5)	0.33 (1.3)	0.45 (0.8)	1.42 (2.2)	2.32 (2.6)
	Normative	0.55 (1.4)	1.19 (3.7)	1.79 (2.7)	2.89 (3.4)	3.47 (3.0)	4.88 (3.2)	7.05 (4.1)	8.08 (4.7)
	Late-heavy	1.47 (2.2)	2.84 (3.9)	6.16 (5.5)	9.82 (6.7)	13.11 (5.5)	14.62 (6.7)	15.06 (4.8)	16.18 (5.4)
	Early-heavy	10.47 (9.2)	16.09 (8.1)	19.43 (7.3)	18.84 (7.8)	19.57 (5.9)	16.73 (6.1)	17.23 (5.7)	14.74 (5.6)
	Total	1.25 (3.6)	2.27 (5.5)	3.36 (6.0)	4.49 (6.6)	5.40 (6.7)	6.23 (6.6)	7.71 (6.4)	8.43 (6.5)
Substance Abuse	Non-abusers	0.01 (0.1)	0.01 (0.1)	0.01 (<0.01)	0.01 (0.1)	0.01 (<0.01)	0.01 (0.1)	0.02 (0.1)	0.03 (0.1)
	Moderate escalating	0.00 (0.0)	0.03 (0.1)	0.08 (0.2)	0.16 (0.2)	0.21 (0.3)	0.23 (0.3)	0.30 (0.3)	0.31 (0.3)
	Moderate decreasing	0.26 (0.4)	0.39 (0.5)	0.72 (0.6)	0.91 (0.6)	0.97 (0.5)	0.91 (0.5)	0.78 (0.51)	0.48 (0.5)
	Adolescent-limited	0.38 (0.2)	0.37 (0.3)	0.47 (0.4)	0.38 (0.4)	0.25 (0.3)	0.10 (0.2)	0.07 (0.2)	0.06 (0.1)
	Total	0.05 (0.2)	0.06 (0.2)	0.10 (0.3)	0.12 (0.3)	0.11 (0.3)	0.10 (0.3)	0.11 (0.3)	0.11 (0.2)
Alcohol	Total	0.61 (1.5)	1.02 (2.0)	1.66 (2.4)	2.21 (2.6)	2.65 (2.8)	3.21 (2.8)	4.34 (3.0)	4.81 (3.0)
Tobacco	Total	0.28 (1.0)	0.51 (1.4)	0.68 (1.6)	0.88 (1.8)	1.20 (2.0)	1.38 (2.2)	1.63 (2.3)	1.72 (2.3)
Marijuana	Total	0.19 (0.8)	0.44 (1.3)	0.59 (1.4)	0.86 (1.6)	1.03 (1.7)	1.13 (1.9)	1.23 (1.9)	1.33 (2.0)
Other*	Total	0.17 (1.0)	0.31 (1.7)	0.43 (1.7)	0.54 (1.9)	0.52 (1.7)	0.51 (1.8)	0.53 (1.5)	0.59 (1.7)

Table 3

Means with Standard Deviations in Parentheses for Age 14 Predictors Across Trajectory Groups

Trajectory Group	Delinquency	Depressive symptoms	Negative affect	Peer support	Parental support	Body dissatisfaction
Substance use developmental trajectory groups						
Late	1.41 (0.36)	1.29 (0.38)	2.68 (0.64)	4.30 (0.77)	4.34 (0.76)	2.64 (0.99)
Normative	1.64 (0.54)	1.31 (0.34)	2.74 (0.66)	4.35 (0.70)	3.97 (0.84)	2.72 (0.97)
Late-heavy	1.85 (0.59)	1.43 (0.42)	2.80 (0.68)	4.28 (0.88)	3.76 (0.97)	2.88 (0.93)
Early-heavy	2.51 (0.74)	1.64 (0.44)	3.07 (0.60)	4.44 (0.66)	3.36 (1.01)	3.20 (0.91)
Substance abuse developmental trajectory groups						
Non-abusers	1.52 (0.45)	1.29 (0.34)	2.67 (0.64)	4.33 (0.70)	4.09 (0.84)	2.66 (0.98)
Moderate escalating	1.82 (0.64)	1.35 (0.35)	2.90 (0.68)	4.34 (0.87)	3.91 (0.89)	2.80 (0.91)
Adolescent-limited heavy	2.16 (0.79)	1.68 (0.38)	2.77 (0.57)	4.47 (0.56)	3.76 (0.92)	3.30 (0.83)
Moderate Decreasing	2.32 (0.65)	1.61 (0.49)	3.11 (0.60)	4.26 (0.88)	3.43 (1.05)	3.11 (0.97)
Total Sample						
Total	1.68 (0.59)	1.35 (0.38)	2.76 (0.66)	4.33 (0.74)	3.98 (0.89)	2.76 (0.97)

Table 4

Means with Standard Deviations in Parentheses for Age 20 Outcomes across Groups

Trajectory Group	Delinquency	Depressive symptoms	Social impairment
Substance use developmental trajectory groups			
Late	1.25 (0.2)	1.35 (0.4)	1.86 (0.4)
Normative	1.40 (0.4)	1.41 (0.4)	1.98 (0.5)
Late-heavy	1.72 (0.6)	1.55 (0.5)	2.14 (0.5)
Early-heavy	1.51 (0.3)	1.58 (0.5)	2.01 (0.5)
Substance abuse developmental trajectory groups			
Non-abusers	1.33 (0.3)	1.37 (0.4)	1.92 (0.5)
Moderate escalating	1.68 (0.6)	1.55 (0.5)	2.18 (0.6)
Adolescent-limited heavy	1.64 (0.4)	1.68 (0.6)	2.22 (0.5)
Moderate Decreasing	1.51 (0.4)	1.48 (0.4)	1.90 (0.5)
Total	1.42 (0.4)	1.43 (0.4)	1.98 (0.5)

Table 5

Percentages of Age 18 Outcomes Exhibiting Characteristic

	Health service	Mental health service	Legal problems	School dropout	Substance abuse diagnosis
Substance use developmental trajectory groups					
Late Users	70.3%	19.8%	1.8%	3.5%	0.9%
Normative Users	81.5%	19.4%	9.9%	3.6%	11.3%
Late Heavy	80.3%	28.2%	17.1%	9.3%	42.9%
Early Heavy	87.1%	20.6%	11.8%	31.4%	33.3%
Substance abuse developmental trajectory groups					
Non-abusers	75.9%	20.5%	6.3%	3.7%	5.2%
Moderate escalating	86.4%	21.0%	16.3%	4.8%	39.5%
Adolescent-limited heavy	88.9%	40.0%	25.0%	33.3%	57.9%
Moderate Decreasing	81.4%	15.9%	9.1%	16.7%	22.2%
Total	78.9%	21.0%	9.2%	6.5%	15.3%

Table 6

Effect Sizes for follow-up Contrasts

	Problematic Use	Problematic Abuse	Late-Heavy Users	Moderate Escalating
Age 14 Delinquency	$\eta^2 = .12^{***}$	$\eta^2 = .12^{***}$	$\eta^2 = .19^{***}$	$\eta^2 = .11^{***}$
Age 14 Depressive symptoms	$\eta^2 = .05^{**}$	$\eta^2 = .05^{***}$	$\eta^2 = .05^{*}$	$\eta^2 = .11^{***}$
Age 14 Negative affectivity	$\eta^2 = .01$	$\eta^2 = .04^{***}$	$\eta^2 = .04$	$\eta^2 = .01$
Age 14 Parental support deficits	$\eta^2 = .04^{*}$	$\eta^2 = .03^{***}$	$\eta^2 = .04^{*}$	$\eta^2 = .04^{*}$
Age 14 Body dissatisfaction	$\eta^2 = .02$	$\eta^2 = .02^{**}$	$\eta^2 = .03$	$\eta^2 = .04^{*}$
Age 20 Delinquency	$\eta^2 = .10^{***}$	$\eta^2 = .13^{***}$	$\eta^2 = .04$	$\eta^2 = .02$
Age 20 Depressive symptoms	$\eta^2 = .03^{**}$	$\eta^2 = .04^{***}$	$\eta^2 = .00$	$\eta^2 = .00$
Age 20 Social impairment	$\eta^2 = .02^{**}$	$\eta^2 = .03^{***}$	$\eta^2 = .01$	$\eta^2 = .03$
Age 20 Legal problems	$OR = 2.30^{*}$	$OR = 2.69^{**}$	OR = .64	OR = .84
Age 20 School dropout	$OR = 5.33^{***}$	$OR = 3.69^{***}$	$OR = 4.45^{**}$	$OR = 5.56^{**}$
Age 20 Substance abuse diagnosis	$OR = 7.56^{***}$	$OR = 10.44^{***}$	OR = .67	OR = .75

Note. Effect sizes represent four follow-up contrasts: (1) Problematic Use: Late and Normative Users v. Early- and Late Heavy Users, (2) Problematic Abuse: Non-Abusers v. All Others, (3) Late-Heavy Users: Early- v. Late Heavy Users, and (4) Moderate Escalating: Moderate Escalating v. Moderate-Decreasing and Adolescent-Limited Heavy Abusers. All effect sizes reflect effects in the predicted direction whereby trajectories with higher levels of use or abuse exhibited higher levels of the age 14 and age 20.

$^{*}p < .05$

$^{**}p < .01$

$^{***}p < .001$