

# **Substance Use among Serious Adolescent Offenders Following Different Patterns of Antisocial Activity**

Michelle Besana

*University of the Philippines Visayas*

Edward P. Mulvey, Ph. D.

*University of Pittsburgh School of Medicine*

The present study examines individual differences in the levels of substance use in a sample ( $n=1,067$ ) of male serious adolescent offenders following distinct trajectories of criminal offending over a three year period. The levels of substance use are compared for the different offender groups controlling the effects of age, ethnicity, and diagnosis of previous drug and alcohol abuse/dependence. The association between antisocial activity and the level of substance use was also examined and compared for the different groups after controlling the effect of institutional placement. The growth or decline in substance use was investigated and compared for the different groups above and beyond the effects of antisocial activity and institutional confinement.

After fitting a series of hierarchical generalized linear models for repeated measurements data, results revealed that significant differences in the level of substance use exist among the different offender groups in the sample. Antisocial activity is associated with the level of substance use over time after controlling the effect of institutional placement in all offender groups. Above and beyond the effect of antisocial activity and institutional placement, substance use is increasing over the data collection period in all groups, but the rate of growth is highest in the lowest offending group.

*Keywords: hierarchical generalized linear models, growth curve models, substance use, antisocial activity, delinquency, serious adolescent offenders*

## 1. Introduction

Substance use is a significant problem among the youth, especially those involved with the juvenile justice system (Prinz & Kern, 2003). Adolescents in the juvenile justice system have rates of substance use several times that seen in the general adolescent population (Deschenes & Greenwood, 1994). In addition, the rate of diagnosable substance use disorders is higher among the more serious youth offenders (Huizinga & Jakob-Chien, 1998) and is estimated to be approximately one-half of this group of adolescents (Grisso, 2004). The co-occurrence of substance use problems and delinquency (Teplin et al., 2002; Young et al., 2007) as well as the link (Winters, 1998; Dawkins, 1997; D'Amico et al., 2008; Hammersley et al, 2003; Chassin, 2008; Elliot et al, 1985) between the two behaviors among adolescent offenders has received significant attention in previous research studies. Researchers believe that the association between the two behaviors is reciprocal in nature (D'Amico et al., 2008; Sullivan & Hamilton, 2007) and that they are predicted by similar risk factors (Elliot et al, 1985; Mason & Windle, 2002).

The current study examines the relationship between substance use and antisocial activity or delinquent criminal behavior in a sample of male serious adolescent offenders over a three year period. The analyses presented here addresses the question of whether or not the link between the two behaviors holds in groups of adolescent offenders that follow distinct patterns of offending. The different patterns of offending used in the study are those reflecting different offending trajectories derived in previous research (Mulvey et al., 2010). The level of substance use as well as its growth or decline over time in each offender group will be examined. The impact of antisocial activity on substance use over time for each group will also be explored after controlling the effect of institutional placement. Institutional placement is included in the analysis because spending time in a controlled residential environment curtails the opportunities for substance use, significantly affects the trajectories of criminal offending, and affects the relation between these two behaviors in a sample of serious adolescent offenders (Piquero et al., 2001; Mauricio et al., 2009; Mulvey et al., 2010). The effects of subject level variables such as age, ethnicity, and diagnosis of previous drug or alcohol abuse/dependence on the level of substance use are also included in the analysis. Previous studies revealed that these variables are significant predictive factors for illicit drug use in adolescent population (Young et al., 2002; Ljubotina et al., 2004; Howard & Jenson, 1999; Steinberg, 2002; Hofler et al., 1999; von Sydow et al., 2002; Chassin et al., 1996; Kandel et al., 1986).

In studying the relationship between delinquent behavior and its associated problems such as substance use in a sample of chronic youth offenders, it is important to distinguish between different offender groups (Eklund & Klinteberg, 2009) because patterns of substance use in this sample of high risk individuals may also be different. The knowledge of the levels of substance use and the relationship between substance

use and criminal behavior in each offender group would allow policymakers to design early preventive programs and interventions that recognize the different needs of the individuals in the different groups.

## **2. Review of Literature**

### **2.1 The unilateral relationship between substance use and antisocial behavior**

Numerous studies support the link between substance use and antisocial behavior among adolescent offenders. On one hand, some studies assert that substance use predicts antisocial behavior among adolescent offenders; on the other hand, others support the reverse relationship. In a cross-sectional study of 293 highly delinquent offenders between 14 to 18 years old composed predominantly of males (81%), over a half of the group agreed that alcohol or drugs had been associated with getting upset or angry which had led eventually to offending (Hammersley et al., 2003). This study concludes that substance use predicted offending and that socially acceptable drugs (alcohol, tobacco, and cannabis) did so more than any other drugs. This same study, meanwhile, also found that almost half (44%) of the sample of highly delinquent adolescent offenders committed serious crimes to obtain money for drugs or alcohol (Hammersley et al., 2003), supporting the notion that substance use leads to offending.

Longitudinal studies on adolescent offenders have also examined this relationship over time. Studies confirm that previous substance use is a significant predictor of subsequent serious offending among adolescent offenders (D'Amico et al., 2008; Dembo et al., 2007) while other investigations indicate that conduct problems and aggression predict adolescent illicit substance use (Kellam et al., 1983) and that delinquent behavior predicts subsequent substance abuse and dependence (Chassin et al., 1999; Disney et al., 1999). Furthermore, studies also show that delinquent behavior among adolescent offenders eventually leads to accelerated levels of substance use over time (Hill et al., 2000; Hussong et al., 1998).

### **2.2 The link between substance use and antisocial behavior**

The literature provides substantial evidence of the prevalence of substance use and substance use disorder among adolescents particularly among adolescent offenders. It has been recognized that very early substance use is a significant problem among the youth especially those who end up in the juvenile justice system (Prinz & Kern, 2003). Since the mid-1990s, the use of marijuana, stimulants, cocaine, and LSD is rising among the adolescent population (Steinberg, 2002), and evidence shows that the youth involved in the juvenile justice system are several times more likely to use alcohol and other drugs than adolescents in general (Deschenes & Greenwood, 1994). The rates of substance use and diagnosable substance use disorder

are observed to be higher among more serious adolescent offenders (Huizinga & Jakob-Chien, 1998), and the proportion of adolescent offenders with diagnosable substance use disorder is approximately one-half (Grisso, 2004).

The comorbidity (co-occurrence) of substance use problems and delinquency among adolescent offenders is also supported in the literature. About half of the males and almost half of the females who had encounters with the juvenile justice system had substance use problems, with marijuana use disorder being the most common (Teplin et al., 2002). One study found that the prevalence of substance use disorders among adolescents aged 12-17 who had encounters with the juvenile justice system is almost three times that of the youth in the same age range who had never been jailed or detained (NSDUH Report, February 27, 2004). Another study indicates that adolescent offenders who continue to use drugs will more likely continue offending (Young et al., 2007).

The evidence of the link between antisocial behavior and substance use among adolescent offenders abound in the literature. On one hand, many adolescent conduct problems can result from alcohol and drug use; on the other hand, it is also possible that substance use may contribute to the maintenance of adolescent delinquency which may continue into adult antisocial behavior (Winters, 1998). Many studies support the link or positive association between substance use and delinquent criminal behavior among adolescents (Dawkins, 1997; D'Amico et al., 2008; Hammersley et al., 2003; Chassin, 2008; Elliot et al., 1985). Many researchers believe that this positive association is reciprocal in nature and that the relationship between the two behaviors is fairly stable over time (D'Amico et al., 2008; Sullivan & Hamilton, 2007), and that they are predicted by similar risk factors (Elliot et al., 1985; Mason & Windle, 2002).

## 2.3 The Pathways to Desistance Study

The Pathways to Desistance Study is a large-scale, two-site, prospective longitudinal study of a cohort of serious adolescent offenders. The rationale behind the study can be found in Mulvey et al. (2004). The study started in November, 2000, and enrollment of the subjects was completed in March, 2003. The project follows a sample  $N=1,354$  serious juvenile offenders from adolescence to young adulthood in two metropolitan cities: Philadelphia, Pennsylvania and Phoenix, Arizona. The primary aims of the study are: (a) to describe the patterns by which serious adolescent offenders stop engaging in illegal activities; (b) to describe the role of social context and developmental changes in promoting these positive changes; and, (c) to compare the effects of sanctions and interventions in promoting these changes. The participants in the study are adolescent offenders between the ages of 14 and 18 at the time of adjudication, who have been found guilty of a serious offense (almost exclusively felony offenses, with a few serious misdemeanor charges included, e.g. weapons offense, sexual assault). Assessments were done at baseline

and every six months thereafter for a period of three years and yearly assessments follow for a period of five years.

Table 1 shows the descriptive statistics of the enrolled participants in the Pathways to Desistance Study. The enrolled sample is 86% male and 14% female; it is 20% White, 41% African-American, 34% Hispanic, and 5% other. The average age of the participants at study index petition was 16.24 years old (S.D.= 1.10 years) with an average of approximately 2 prior petitions (S.D.= 2.14) at the time of adjudication. About 44% of the participants had been adjudicated of serious crimes against persons, 25% of property crime, 16% of drug offense, 10% of weapons offense, and 4% of other offenses (Schubert et al., 2004).

**Table 1 Descriptive Statistics of Enrolled Research Participants and the Sample Used**

Characteristic	Pathways sample		Sample used	
N	1354		1067	
Mean age at study index petition	16.24	(1.10)	16.21	(1.11)
Mean number of prior petitions <sup>a</sup>	1.92	(2.14)	2.03	(2.19)
Mean age at first prior petition	14.93	(1.64)	14.86	(1.64)
Race/Ethnicity				
Caucasian/White	20%		20%	
African American/Black	41%		43%	
Hispanic	34%		36%	
Other	5%		0%	
Most serious offense <sup>b</sup>				
Crime against person	44%		44%	
Property crime	25%		27%	
Drug offense	16%		14%	
Weapons offense	10%		10%	
Other	4%		4%	
Missing data	1%		1%	

Note. The values in parentheses are standard deviations

<sup>a</sup> Average count of all prior petitions available in the subject's court records excluding probation violations

<sup>b</sup> Most serious charge on study index petition

## 2.4 Selected findings from the Pathways study involving substance use and antisocial behavior

Several papers presented or published about the Pathways to Desistance Study have documented the relationship between substance use and antisocial behavior in this sample. One study found that the presence of a drug or alcohol disorder and level of substance use predict the level of self-reported offending and number of arrests (Losoya & Chassin, 2004). Moreover, the researchers found that baseline substance use and substance use disorders also predict continued delinquency

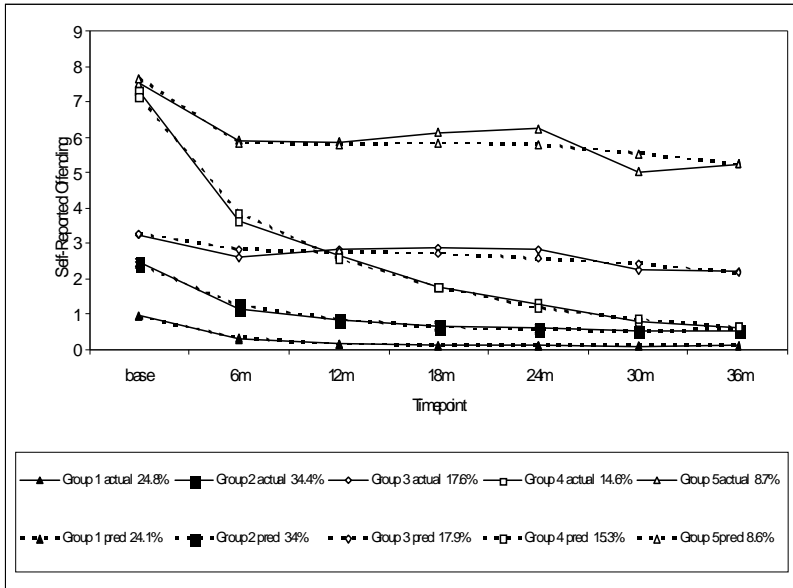
involvement (after controlling for baseline offending levels), and that the relationship between substance use and substance use disorder and self-reported offending is strongest for those who had spent the least time in an institution over the one year follow-up period. Another study on the association between the two behaviors indicates that substance use goes hand-in-hand with criminal offending in this group of adolescent offenders across multiple waves of interviews (Mulvey et al., 2010). The study on the effects of risk and protective factors on alcohol and marijuana use across time on a sample of male participants revealed that time in supervised facility was shown to alter alcohol and marijuana trajectories over time (Mauricio et al., 2009).

A subsample of the Pathways to Desistance Study consisting of only males who completed at least four interviews (n=1,119) in a period of three years (including baseline assessment) were considered in another set of analyses which focused on finding distinct developmental offending trajectories by which the subjects behave after court adjudication and the different factors that differentiate these patterns. The purpose of these analyses was to give a better picture of the different pathways of criminal behavior among these adolescent offenders and to eventually provide explanations why adolescents desist from doing further criminal offending and why others continue (Mulvey, et al., 2010). After incorporating the time at risk for offending in the community in the analysis, the study identified five (5) developmental offending trajectory groups (see Figure 1), including two low offending groups (constituting about 59% of the sample; Groups 1 and 2), a moderate offending group (17.6%; Group 3), a “desister” group (14.6%; Group 4), and a “persister” group (8.7%; Group 5). The results revealed that the five trajectory offending groups differ significantly (but not dramatically) in terms of age, ethnicity, antisocial history, deviant peers, a criminal father, substance use, and psychosocial maturity. These factors, however, did not significantly differentiate the persister from the desister group.

### **3. Objectives of the Study**

The general purpose of this paper is to study the nature of association between substance use and antisocial behavior across time among male serious adolescent offenders that follow distinct trajectories of offending after taking into account the effect of institutional placement. Specifically this paper aims to find out whether antisocial activity predicts substance use across time among the different groups of male serious adolescent offenders following distinct patterns of offending after controlling for institutional placement. The specific objectives of this paper are the following: (1) to compare the level of substance use among male serious adolescent offenders following different patterns of offending; (2) to determine the effect of age, ethnicity, previous drug or alcohol abuse/dependence problems, and institutional placement on the level of substance use; (3) to investigate the relationship between

**Figure 1 Five-group trajectory solution using the Zero Inflated Poisson Model**



antisocial activity and substance use across time among the different offender groups after controlling institutional placement; and, (4) to compare the rate of growth or decline in substance use among the different offender groups.

#### 4. Method

This study is a secondary data analysis on a subsample of the participants in the Pathways to Desistance Study. Table 1 shows the descriptive characteristics of the complete Pathways sample and the sample used for this study. The sample ( $n=1,067$ ) includes only the males who completed at least three follow-up interviews done approximately every six months over a period of three years who belong to three major ethnicity groups, namely: Caucasian/White, African American/Black, and Hispanic. The sample is composed of 20% White, 43% African American, and 36% Hispanic. The average age at study index petition of the subjects in the sample is 16.21 years old ( $S.D. = 1.11$ ). On the average, the subjects had 2.03 ( $S.D.=2.19$ ) prior petitions and the average age of the subjects at first prior petition is 14.86 years old ( $S.D.=1.64$ ). About 44% of the subjects in the sample had been convicted of serious crimes against persons, 27% of property crime, 14% of drug offense, 10% of weapons offense, and 4% of other offenses. In terms of the mean age at study index petition, mean number of prior petitions, mean age at first prior petition

as well as the most serious charge on study index petition, this sample does not significantly differ from the over-all Pathways sample.

The outcome variable in this study is the level of substance use across the 36-month period excluding baseline measurement, namely: assessments at the 6-month, 12-month, 18-month, 24-month, 30-month, and the 36-month follow-up interview. The potential level 1 predictors are measurement occasions, antisocial activity, and institutional placement. Both antisocial activity and institutional placement are treated as time-varying covariates. The potential level 2 predictors include age at baseline interview, ethnicity, previous drug or alcohol abuse/dependence problems, and membership in the different trajectory groups of offending.

Statistical analysis of the outcome variable and the various potential explanatory variables employs the hierarchical generalized linear models for repeated measurements data using the Negative Binomial distribution (Raudenbush & Bryk, 2002). The GLIMMIX procedure of SAS was used to derive the estimates of the different models considered in the model building procedure.

#### 4.1 Measures

In the context of this study, substance use is measured by items adapted from the Alcohol and Health Study at the University of Missouri (Chassin et al., 1991). This self-report measure considers the adolescent's use of illegal drugs and alcohol over the course of his/her lifetime and in the past six-months. Substance use in this study is measured by aggregating the frequency of use (for the past 6 months) for alcohol, marijuana/hashish, sedatives/tranquilizers, stimulants/amphetamines, cocaine, opiates, ecstasy, hallucinogens, inhalants, and amyl nitrate/odorizers. The scale used for each substance is the following: 0: (never), 1: (1-2 times in the last 6 months), 2: (3-5 times in the last 6 months), 3: (1 time per month), 4: (2-3 times per month), 5: (1 time per week), 6: (2-3 times per week), 7: (4-5 times per week), and 8: (every day).

Antisocial activity is measured by the modified version of the Self-Report of Offending (Elliot, 1990; Huizinga et al., 1991) scale which measures the adolescent's involvement in antisocial and illegal activities at each interview. The scale is composed of 22-items listing different illegal activities, and the subject indicates whether or not he has done any of these activities over the "last six months." A sum of the number of items endorsed ranging from 0 – 22 is calculated and is used as a measure of antisocial activity for the purpose of this study. This over-all variety score has been shown to be a reliable and valid measure of the adolescent's overall involvement in illegal activities (Osgood et al., 2002; Thornberry & Krohn, 2000). The 22 items included in the self-report of offense measure are the following: (a) destroyed property, (b) set fire, (c) broke into building, (d) stole from store, (e) bought something stolen, (f) used credit card illegally, (g) stole car/motorcycle, (h)

sold marijuana, (i) sold other illegal drugs, (j) carjacked someone, (k) drove while drunk/high, (l) was paid for sex, (m) forced someone for sex, (n) killed someone, (o) shot someone, (p) shot at someone (pulled trigger), (q) took something (with weapon), (r) took something (no weapon), (s) beat up someone, (t) was in a fight, (u) beat up someone (with a gang), and (v) carried a gun.

The measure for previous drug or alcohol abuse/dependence diagnosis is taken from the Composite International Diagnostic Interview (CIDI, 1990), a comprehensive, fully structured interview used to assess a variety of mental disorders including alcohol abuse, alcohol dependence, drug abuse, and drug dependence. An indicator variable for this measure was used in the study to indicate the presence (1) or the absence (0) of the diagnosis.

For the purpose of this study, institutional placement is taken as the proportion of time in the recall period of approximately six months that the subject spent in a psychiatric hospital, detox/drug treatment facility, secure facility, or a residential treatment facility. This is determined from the subject self report at each follow-up interview.

The variable GROUP in this study is a categorical variable that represents membership in one of the five different developmental offending trajectory groups identified in previous research (Mulvey et al., 2010) that reflects the subject’s pattern of criminal offending. Table 2 shows the number of subjects in the sample belonging to these five trajectories.

**Table 2** Number of Subjects in the Sample Belonging to the Different Trajectory Groups of Offending

Trajectory Group	Number
Group 1	265
Group 2	367
Group 3	189
Group 4	155
Group 5	91
Total Sample	1067

## 4.2 The proposed model

The study uses hierarchical generalized linear models to describe individual change over time. In the context of this study, it is used to model the relationship between the dependent variable (frequency of substance use) and a number of independent variables over time. We let the dependent variable  $Y_{it}$  represent the frequency of use for 10 substances measured at time  $t$  for subject  $i$ . The measurement

occasions include assessments of approximately every six months for a period of three years. If we let  $\mu_{it}$  represent the average frequency of substance use for subject  $i$  at time  $t$ , we suppose that  $Y_{it} | \mu_{it}$  follows a Negative Binomial distribution. The model assumes that the mean and variance of  $Y_{it}$  are not equal. The variance function for this model is given by  $\mu_{it} + k\mu_{it}^2$ , where  $k$  is taken as a scale parameter (Schabenberger, 2005).

We model  $\eta_{it}$  as the log average frequency of substance use for subject  $i$  at time  $t$ ; thus,  $\eta_{it} = \log \mu_{it}$ . The level 1 and level 2 hierarchical structures are shown below.

Level 1 (Repeated measurements over time  $t$  for subject  $i$ )

$$\eta_{it} = \pi_{0i} + \pi_{1i} \textit{Antisocial}_{it} + \pi_{2i} \textit{Lock}_{it} + \pi_{3i} \textit{Time}_{it} \quad (1)$$

Level 2 (Model for subject  $i$ )

$$\pi_{0i} = \beta_{00} + \beta_{01} \textit{Group}_i + \beta_{02} \textit{Age}_i + \beta_{03} \textit{Ethni}_i + \beta_{04} \textit{Diag}_i + r_{0i} \quad (2)$$

$$\pi_{1i} = \beta_{10} + \beta_{11} \textit{Group}_i + r_{1i} \quad (3)$$

$$\pi_{2i} = \beta_{20} + r_{2i} \quad (4)$$

$$\pi_{3i} = \beta_{30} + \beta_{31} \textit{Group}_i + r_{3i} \quad (5)$$

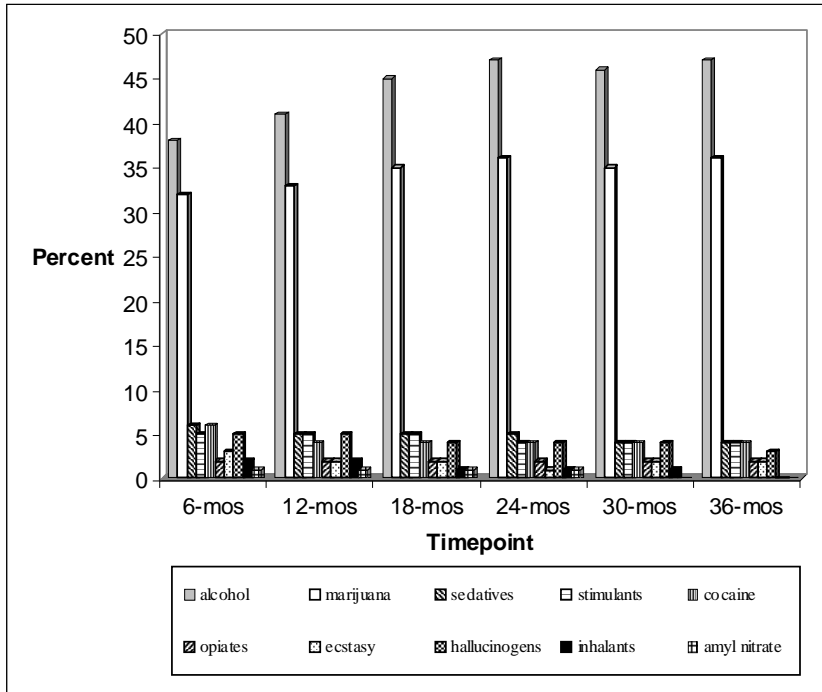
The predictors at level 1 are the level of antisocial activity (ANTISOCIAL), institutional placement (LOCK), and measurement occasions (TIME). For this study, antisocial activity and institutional placement are time-varying covariates and group mean centered. Measurement occasion is centered at the 18-month data collection period to facilitate easier and more meaningful interpretation of the growth parameters. At level 2, the predictors of the initial status ( $\pi_{0i}$ ) are trajectory group membership (GROUP), age centered at 14 (AGE), ethnicity (ETHNI), and diagnosis of previous drug or alcohol abuse/dependence problems (DIAG). The model also takes into account the effect of trajectory group membership on the slope of antisocial activity and the rate of growth. The error terms at level 2 ( $r_{0i}$ ,  $r_{1i}$ ,  $r_{2i}$ , and  $r_{3i}$ ) are assumed to follow a multivariate normal distribution with a zero mean vector and a 4x4 unstructured variance-covariance matrix.

## 5. Results

The percentages of the sample that had alcohol to drink over the recall period are increasing across time with the following percentages at each assessment: 38%, 41%, 45%, 47%, 46%, and 47%, respectively (see Figure 2). The percentages of the sample that smoked marijuana over the recall period are 32%, 33%, 35%, 36%, 35%, and 36% respectively; thus, the rate of increase is minimal over time. The percentages of the sample that used other substances across time are approximately the following: sedatives (5%), stimulants (5%), cocaine (4%), opiates (2%), ecstasy (2%), hallucinogen (4%), inhalants (1%), and amyl nitrate (< 1%). Thus, it is clear

that the level of use for these other substances is very low across time with the use of inhalants and amyl nitrate being the lowest.

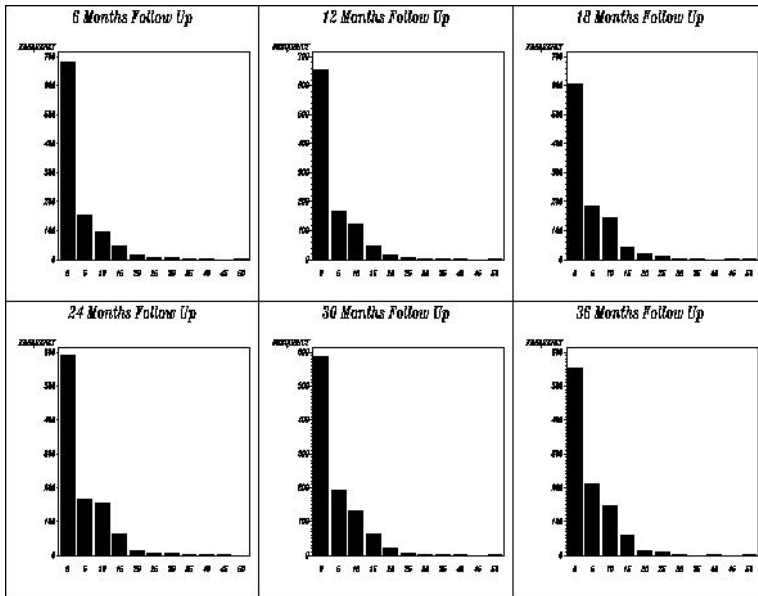
**Figure 2. Proportions of the sample using the different substances across time**



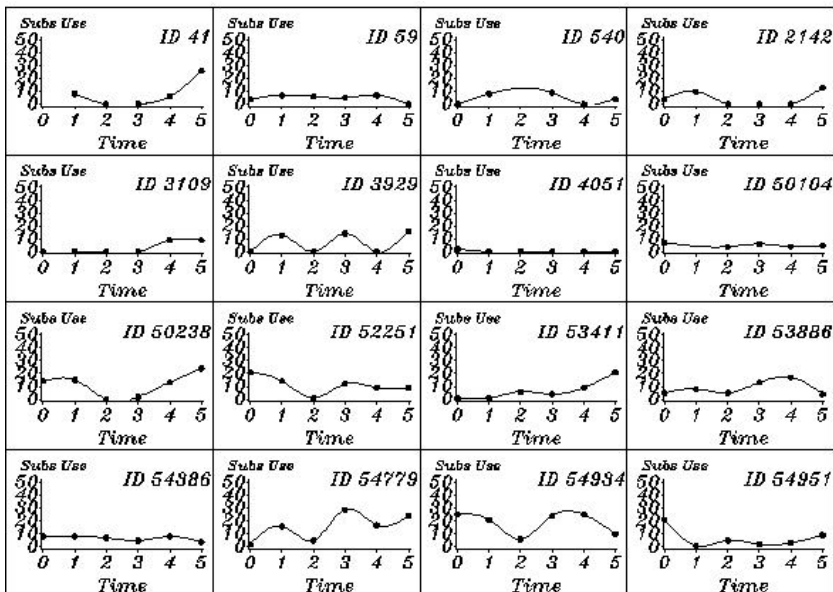
The frequency of use across the ten (10) substances over time (see Figure 3) does not only show the significantly large number of subjects that do not use any of these substances but also display a highly positively skewed distribution of the dependent variable over time.

Preliminary exploratory techniques using smooth non-parametric as well as the ordinary least squares summary of the individual change over time for selected subjects in the sample (see Figures 4 and 5) suggest differences in the level of substance use as well as in the rate of change over time. The graphs also suggest modeling individual change using linear or quadratic growth parameters. The smooth non-parametric and the ordinary least squares summary across all the subjects also reveal the same observation (see Figure 6). The graph suggests differences in the individual level of substance use and in the rate of change across time. Furthermore, the graph validates the use of models that are linear or quadratic in time to model individual change.

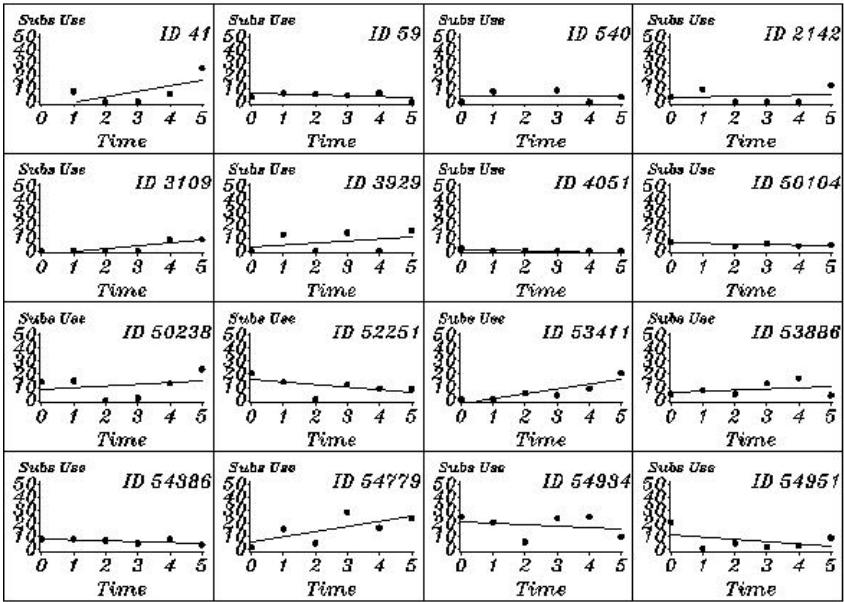
**Figure 3. The Frequency of Use across 10 Substances over a Three Year Period for all Subjects**



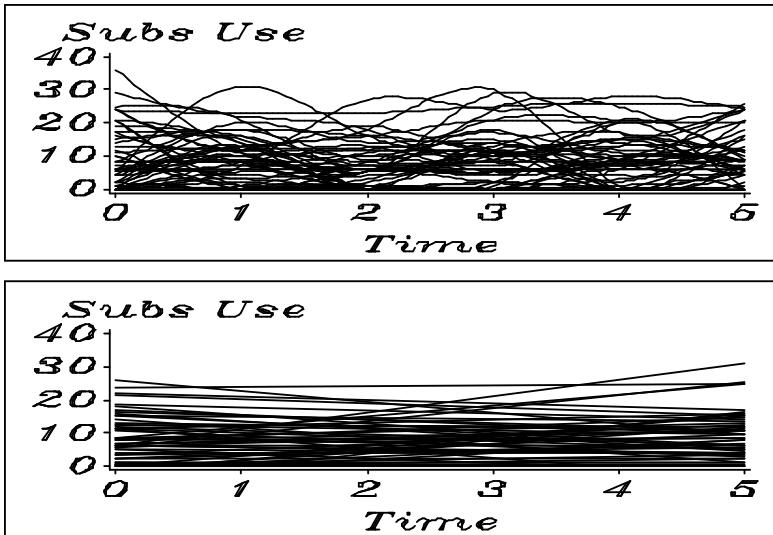
**Figure 4. Smooth non-parametric summaries of the individual change over time for selected subjects**



**Figure 5.** OLS summaries of the individual change over time for selected subjects



**Figure 6.** Smooth non-parametric and OLS trajectories of substance use over time for all subjects



Further graphical exploratory analysis using the OLS summaries of substance use across time for each trajectory offending group (see Figure 7) supports differences in the level of substance use as well as in the growth rate in substance use among the five offending groups. In addition, OLS summaries of substance use against the level of antisocial activity for each longitudinal offending group (see Figure 8) reveal differences in the strength of relationship between the two variables among the five developmental trajectories.

Exploratory techniques used to demonstrate the relationship between the dependent and the independent variables suggest that it is reasonable to use a hierarchical generalized model which is linear in the time variable. The link function used in the model was the log link function and the sampling model used at level 1 was the Negative Binomial distribution as opposed to the Poisson distribution since the data manifest overdispersion problems (Schabenberger, 2005). The model building procedure starts with the fully unconditional growth model and builds up by successively including all the potential level 1 and level 2 predictors in the proposed model until the final model is identified where all the model coefficients are significant and the fit statistics suggest a reasonable fit.

The result for fitting the fully unconditional growth model (model A) suggests that there is still unexplained variability in the dependent variable. We next fit a model (model B) using measurement occasions (TIME) as the sole level 1 predictor and the growth rate is constant while the level of substance use is random across the subjects. We then fit a model (model C) with measurement occasions, level of antisocial activity, and institutional placement as level 1 predictors and the growth rate and the slope of antisocial activity are constant across subjects but the slope of institutional confinement is random across subjects. In addition, we include the effect of membership to different trajectory offending groups (GROUP), age centered at 14 (AGE), ethnicity (ETHNI), and diagnosis of previous drug or alcohol abuse/dependence (DIAG) on the level of substance use ( $\pi_{0i}$ ). At the final stage of model fitting, we include the effect of membership to the different longitudinal offending groups (GROUP) on the growth rate and the slope of antisocial activity (ANTISOCIAL) to the previous model to form model D. The structural models for model D are as follows:

The Final Model (Model D)

Level 1

$$\eta_{ii} = \pi_{0i} + \pi_{1i} \textit{Antisocial}_{ii} + \pi_{2i} \textit{Lock}_{ii} + \pi_{3i} \textit{Time}_{ii} \tag{6}$$

Level 2

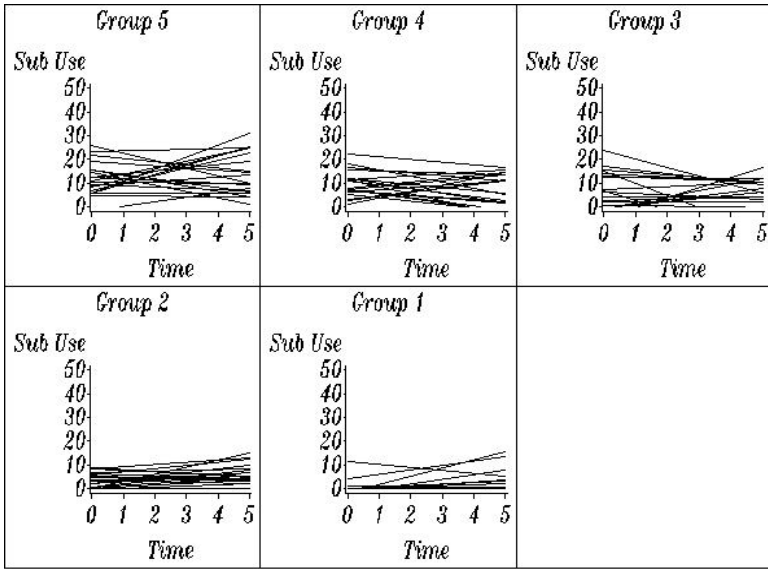
$$\pi_{0i} = \beta_{00} + \beta_{01} \textit{Group}_i + \beta_{02} \textit{Age}_i + \beta_{03} \textit{Ethni}_i + \beta_{04} \textit{Diag}_i + r_{0i} \tag{7}$$

$$\pi_{1i} = \beta_{10} + \beta_{11} \textit{Group}_i \tag{8}$$

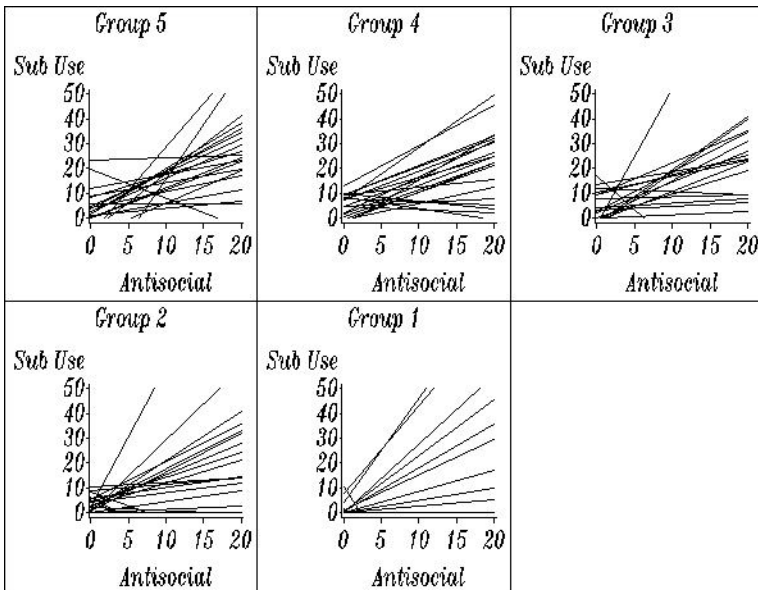
$$\pi_{2i} = \beta_{20} + r_{2i} \tag{9}$$

$$\pi_{3i} = \beta_{30} + \beta_{31} \textit{Group}_i \tag{10}$$

**Figure 7. OLS summaries of substance use over time for each group for selected subjects**



**Figure 8. OLS summaries of substance use against the level of antisocial activity for each group for selected**



The scale parameter for model D is highly significant which means that the use of the Negative Binomial distribution as a sampling model at level 1 is appropriate. Also, the ratio of the value of the generalized chi-square to the over-all degrees of freedom (DF) is 1.08 indicating no serious problems of overdispersion and that the model fits the data since this fit-statistic should ideally be around 1. This further supports the appropriateness of the use of Negative Binomial distribution at level 1. In addition, measurement occasions (TIME) was centered at the different assessment periods to check whether the model holds across the data collection period. The result indicates that model D fits the data appropriately and that the model indeed holds across the data collection period. Thus, model D is the final model selected and its result is shown in Table 3 together with the results from fitting the other models.

**Table 3 Summary of Model Fitting Using Negative Binomial Distribution**

	Model A	Model B	Model C	Model D
Fixed Effect				
Model for $\pi_{0i}$				
Intercept	1.38**	1.36**	1.26**	1.22**
Group 5			1.77**	1.85**
Group 4			1.16**	1.27**
Group 3			1.51**	1.59**
Group 2			0.90**	0.94**
Age14			0.15**	0.15**
Hispanic			-0.28**	-0.29**
Black			-0.56**	-0.58**
Diagnosis			0.25**	0.25**
Model for Antisocial Slope, $\pi_{1i}$				
Intercept			0.17**	0.36**
Group 5				-0.26*
Group 4				-0.21 <sup>ns</sup>
Group 3				-0.17 <sup>ns</sup>
Group 2				-0.04
Model for Inst Placement Slope, $\pi_{2i}$				
Intercept			-1.28**	-1.31**
Model for Ind Level Growth Rate, $\pi_{3i}$				
Intercept		0.04**	0.07**	0.17**
Group 5				-0.12**
Group 4				-0.16**
Group 3				-0.12**
Group 2				-0.07*
Random Effect				
Intercept	0.84**	0.84**	0.54**	0.52**
Institutional Time			0.30**	0.34**
Scale	1.28**	1.31**	1.54**	1.54**
Fit Statistics				
Gener. Chi-sq/DF	1.00	1.00	1.06	1.08

\*  $0.01 < p < 0.05$ , \*\*  $p < 0.01$ , <sup>ns</sup> not significant

The result of the final model indicates that substance use for typical subjects in groups 5, 4, 3, and 2 is significantly higher than those in group 1 after controlling for the effect of age, ethnicity, and diagnosis of previous drug or alcohol abuse/dependence problems. Age has a strong significant positive effect on substance use for a typical subject after controlling for the effect of trajectory group membership, ethnicity, and diagnosis of previous substance abuse/dependence. Substance use for a typical Hispanic or African American subject is significantly lower than his White counterpart after controlling for the effect of trajectory group membership, age, and diagnosis of previous drug or alcohol abuse/dependence. Substance use for a typical subject who had previous drug or alcohol abuse/dependence problems is significantly higher than his counterpart with no previous drug or alcohol abuse/dependence problems after controlling for the effect of trajectory group membership, age, and ethnicity.

On the average, the level of antisocial activity has a strong significant positive relation with substance use for all offender groups. The estimated slope of antisocial activity in group 5 is significantly lower than those in the other trajectory offending groups (Groups 1, 2, 3, and 4) after controlling for the effect of institutional placement and assessment period. There is no significant difference in the estimated slope of antisocial activity among groups 1, 2, 3 and 4 holding constant the effect of institutional placement and assessment period. Institutional placement has a strong significant negative effect on substance use after controlling for the effect of the level of antisocial activity and assessment period. The estimated growth rates in substance use for groups 5, 4, 3 and 2 are significantly lower than group 1 after controlling for the effect of the level of antisocial activity and institutional placement.

## **6. Discussion**

This paper models the differences in the individual level of substance use over a three year period of male adolescent offenders convicted of the most serious crimes taking into account the effect of the level of antisocial activity, institutional placement, age, ethnicity, the presence of previous drug or alcohol abuse/dependence problems, and membership in different trajectories of offending. The levels as well as the rates of growth in substance use over time are compared for the different offender groups in the sample. The paper further explores the nature and the degree of relationship that may exist between substance use and antisocial activity for the different groups.

The result from the final model reveals that, across time, substance use for typical subjects belonging to four of the longitudinal offending groups is significantly higher than those belonging to the lowest offending group (Group 1) whenever age, ethnicity, and diagnosis of previous drug or alcohol abuse/dependence are held constant. This indicates that above and beyond the effect of age, ethnicity, and diagnosis of previous drug or alcohol abuse/dependence, the average levels of

substance use across time for typical (those with average levels of antisocial activity and institutional placement) subjects belonging to groups 2,3,4, and 5 are significantly higher than that in group 1. This finding is consistent with the result of a previous study of highly delinquent youth offenders with substance use involvement which supports that drug use was found to be highest among the most frequent offenders, lower in the medium offenders, and lowest in the less frequent offenders (Hammersley et al., 2003).

For a typical subject, age has a strong significant positive effect on substance use whenever the other subject level variables are held constant. This indicates that above and beyond the effect of ethnicity, presence of previous drug and alcohol abuse/dependence problems, and trajectory group membership, typical (those with average levels of antisocial activity and institutional placement) subjects who are older have significantly higher levels of substance use. This result supports findings of previous research that age (older adolescents) is a significant predictor of cannabis use or overall level of drug use among young people (Young et al., 2002; Ljubotina et al., 2004; Howard & Jenson, 1999).

Substance use for typical Hispanic or African American subjects is significantly lower than typical White subjects whenever the other subject level variables are held constant. This implies that above and beyond the effect of age, trajectory group membership, and diagnosis of previous drug or alcohol abuse/dependence problems, the level of substance use for White subjects (those with average levels of antisocial activity and institutional placement) is significantly higher than both African American and Hispanic subjects. This result replicated previous research findings that there exist ethnic differences in substance use and abuse (Steinberg, 2002), and that rate of substance use disorder is highest among White incarcerated or detained adolescent offenders and lowest among African American subjects (Teplin et al., 2006).

Substance use for a typical subject who had previous drug or alcohol abuse/dependence problems is significantly higher than a typical subject with no previous drug or alcohol abuse/dependence problems whenever the other subject level variables are held constant. This means that whenever age, ethnicity, and trajectory group membership are held fixed, the level of substance use for typical (those with average levels of antisocial activity and institutional placement) subjects with previous drug or alcohol abuse/dependence problems is significantly higher than his counterpart with no diagnosis of previous drug or alcohol abuse/dependence. This finding is consistent with the result of previous studies. Previous research findings indicate that early onset of substance use is a key predictor of illicit drug use among young people (Hofler et al., 1999; von Sydow et al., 2002; Howard & Jenson, 1999). Previous studies contend that diagnosis of substance use disorder is

a strong predictor of adolescent's future alcohol and drug use which may even continue until adulthood (Chassin et al., 1996; Kandel et al., 1986).

On the average, the level of antisocial activity has a strong significant positive relation with substance use for all offender groups whenever the level of institutional placement and assessment period are held constant. The effect is significantly weaker among subjects belonging to the highest offending group (Group 5) compared to all other groups (Groups 1, 2, 3, and 4); in addition, there is no significant difference in the slope of antisocial activity over time among the four groups. It is worth noting that, in the marginal analysis (ignoring the effect of institutional placement) the correlation between substance use and antisocial activity across time is, on the average, observed to be highest in the persister group (Group 5) and lowest in the lowest offending group (Group 1). However, after controlling the effect of institutional placement, the reverse situation occurs. Although this may seem odd, this scenario occurs because institutional placement affects the level of offending in samples of active offenders (Piquero et al., 2001). Furthermore, the effect of institutional placement is different in different groups of adolescent offenders following different behavioral patterns (Mulvey et al., 2010). This finding is also supported by another result in this study that, on the average, institutional placement significantly lowers substance use whenever the level of antisocial activity and assessment period are controlled. According to the model, each additional delinquent act committed in the future is associated with an estimated increase in the average frequency of substance use by about 2.29 for group 1 and only 1.26 for group 5, for fixed levels of institutional placement and assessment period. Thus, above and beyond the effect of institutional confinement and assessment period, the level of antisocial activity, on the average, is associated with the level of substance use in different groups of adolescent offenders with different offending patterns. This result supports previous research findings that delinquent behavior predicts substance use among chronic young offenders (Kellam et al., 1983; Hill et al., 2000; Chassin et al., 1999; Disney et al., 1999). This study does not only confirm the strong link between delinquency and substance use among serious adolescent offenders (Dawkins, 1997; D'Amico et al., 2008; Mulvey et al., 2010; Chassin, 2008; Hammersley et al., 2003) but this also reveals that this strong link exists in different groups of serious adolescent offenders having different offending patterns across time even after the effect of institutional placement has been controlled.

Institutional placement has a strong significant negative effect on the level of substance use whenever the level of antisocial activity and assessment period are held constant. This research finding suggests that institutional placement, on the average, lowers the level of substance use across time above and beyond the effect of antisocial activity. For fixed levels of antisocial activity, longer periods of institutional confinement are associated with lower levels of substance use across

time. This result is consistent with the findings of previous research that residence in a supervised setting suppressed age-related growth in alcohol and marijuana use (Mauricio et al., 2009). The result of the present study also confirms the significant effect of controlled residential environments on the trajectories of substance use and criminal offending of serious youth offenders (Piquero et al., 2001; Mauricio et al., 2009; Mulvey et al., 2010).

On the average, substance use is increasing over the data collection period but the rates of growth in substance use among subjects belonging to the four trajectory groups (Groups 5, 4, 3, and 2) of offending are, on the average, significantly lower than that in the lowest offending group (Group 1), whenever the level of antisocial activity and institutional placement are held constant. This implies that above and beyond the effect of antisocial activity and institutional placement, the rates of increase in substance use in the four offending groups are, on the average, significantly lower than that in the lowest offending group. The rate of increase in substance use in group 5 is mainly due to the increasing consumption of alcohol and marijuana while it is the increasing consumption of alcohol in group 1 which drives the increase in substance use. This finding reiterates previous results (Mauricio et al., 2009) on another subsample from the same Pathways to Desistance Study which supports that higher levels of initial substance use were associated with slower rate of growth in substance use and lower levels of initial use corresponds to higher growth rate. It is not known how much of these effects might be attributable to ceiling and floor effects on substance use.

In summary, the study supports that, across the three year data collection period, high levels of substance use in the sample are associated with subjects who are older, White, with previous substance abuse/dependence problems, and belong to longitudinal offending groups other than the lowest offending group (Group 1). Longer periods of institutional confinement are associated with lower levels of substance use. High levels of antisocial activity or delinquent behavior are associated with high levels of substance use. Furthermore, antisocial activity is still associated with the level of substance use over time, even after controlling the effect of institutional confinement, for all offender groups. And finally, above and beyond the effect of antisocial activity and institutional confinement, substance use is increasing over the data collection period in all trajectory offending groups, with the highest rate of increase in the lowest offending group.

The paper recognizes the importance of distinguishing between different offender groups when examining the relationship between delinquent behavior and associated problems (such as substance use in this case; Eklund & Klinteberg, 2009). The main contribution of this paper is its simultaneous analysis of the individual differences in substance use across time in a group of male serious youth offenders that follow different offending patterns. In addition, the levels of substance use are compared

for different offender groups controlling the effects of other subject level variables and the association of antisocial activity with the level of substance use was examined and compared for the different groups after controlling for the different effects of institutional confinement. Finally, the growth in substance use was also investigated and compared for the different groups after controlling for the different effects of antisocial activity and institutional placement. The knowledge of the levels of substance use and the relationship between substance use and offending in each offender group suggests that preventive programs and interventions that recognize the different needs of the individuals in each group would be useful.

It is important to note that the sample used in this study was a purposive sample of serious adolescent offenders; these are males belonging to three major ethnicity groups, with female youth offenders and other ethnicity groups not represented in the analysis. The interpretation of the results may only work for the kind of population where the sample came from and may not reflect the actual situation in the general population of adolescent offenders. The self-report data on antisocial activity and substance use should also be interpreted with caution since juvenile offenders, particularly African Americans, may under-report their involvement in criminal activity and illegal substances and self-reports on substance use involvement may be more appropriate only for past use rather than the current use (McClelland et al., 2004).

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