## Title

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## Journal

Journal of Substance Abuse Treatment, 45(5)

## ISSN

0740-5472

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## Publication Date

2013-11-01

## DOI

10.1016/j.jsat.2013.05.011

Peer reviewed

Published in final edited form as:
*J Subst Abuse Treat*. 2013 ; 45(5): 426–432. doi:10.1016/j.jsat.2013.05.011.

# Concurrent Life-course Trajectories of Employment and Marijuana-use: Exploring Interdependence of Longitudinal Outcomes

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## Abstract

This study analyzes data on 7,661 individuals who participated in the 1979 National Longitudinal Survey of Youth (NLSY79) to estimate trajectories of employment and marijuana-use over a 17-year period. Bivariate random intercept and slope modeling is applied to examine concurrently the cross-correlation between the two concurrent longitudinal trajectories from age 23 to 39. Parameter estimates indicate baseline level (at age 23) of employment to be negatively correlated with marijuana, suggesting marijuana-use is associated with lower workforce productivity at age 23. The longitudinal employment slope is positively correlated with employment intercept for both males and females, indicating that survey participants with higher levels of employment at age 23 are more likely to have a positive impact on employment trajectory over time. For males, however, the employment slope is also significantly correlated with marijuana intercept ($r = -0.07$), indicating marijuana-use in early adulthood may uniquely lower workforce productivity over age.

### Keywords

employment; marijuana-use; gender differences; life-course; multivariate longitudinal outcomes

## 1 Introduction

The adverse consequences of illicit drug use on users' physical (Mokdad et al., 2004) and psychological health (Brook et al., 2002) have been examined extensively. Substance abuse has been found to be associated with reduced cognitive abilities (Pope & Yurgelun-Todd,

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**Author Disclosures**
This study is supported in part by the UCLA Center for Advancing Longitudinal Drug Abuse Research (P30DA016383 from the National Institute on Drug Abuse or NIDA) (PI: Hser). David Y.C. Huang is also supported by a grant (R03HD064619) from the National Institute of Child Health and Human Development. Yih-Ing Hser is also supported by a Senior Scientist award from NIDA (K05DA017648). All authors declare that they have no conflict of interest.

1996; Solowij, 1998; Block et al., 1990), educational attainment (Bray et al., 2000; Ellickson et al., 1998; Yamada et al., 1996; Ellickson & Bell, 1990), as well as undesirable labor market outcomes such as unemployment (French et al., 2001; MacDonald & Pudney, 2000; Bryant et al., 1996; van Ours, 2006; Fergusson & Boden, 2008), employment mobility (Kaestner, 1994a) and lower wages (Bryant et al., 2000; French et al., 1998; Fergusson & Boden, 2008; Griffin et al., 2011). Studies that specifically focus on marijuana-use and labor market outcomes have yielded similar findings (DeSimone, 2002; Kaestner, 1994a; Register & Williams, 1992), where regular cannabis use is associated with poor school performance, higher dropout rates (Lynskey et al., 2003), and lower levels of educational attainment - an important factor that facilitates subsequent labor market outcomes including occupational status and income (King et al., 2006).

Despite the growing number of studies investigating the relationship between substance abuse and labor market outcomes, however, a closer examination of the empirical evidence reveals a surprising lack of concurrence among their findings. Using data from both the 1980 and 1984 waves of the National Longitudinal Survey of Youth (NLSY), Gill & Michaels (1992), examine the effects of substance abuse on wages. After accounting for what they refer to as “self-selection” effects, the authors conclude that users of illicit drugs receive higher wages than their non-drug using counterparts. The findings by Register & Williams (1992), who use the 1984 wave of the NLSY, concur in that general marijuana-use (e.g., long-term or on-the-job use) to have a positive effect on wages. These results, in conjunction with less extreme conclusions by Kaestner (1994a) and Burgess & Propper (1998), who conclude that illicit drug use does not have a significant adverse impact on employment, reveal how the widely accepted perceptions on the effect of illicit drug use on labor market outcomes is, in fact, far from conclusive.

One factor contributing to this apparent heterogeneity among study findings may be the widespread presumption that substance abuse is strictly an exogenous factor (i.e., an independent covariate) predicting labor market outcomes. Rather than treating both as bivariate markers of a complex change process over time (Beckett et al., 2004; Fieuws & Verbeke, 2006, 2004), prior studies have often been quick to designate elicit drug use as a predictor for labor market outcomes, without sufficient justification to rule out the possible need to consider the effect in the opposite direction (MacDonald & Pudney, 2000; French et al., 1998; Kaestner, 1994a). Indeed, despite the recognition for the need to statistically model the fully dynamic and reciprocal nature of these multivariate longitudinal outcomes (DeSimone, 2002; Ringel et al., 2006; French et al., 1998; Buchmueller & Zuvekas, 1998; Gill & Michaels, 1992; White et al., 1988; Fergusson & Boden, 2008), attempts to implement such analyses is a relatively recent development (D’Amico et al., 2008). Needless to say, failing to account for the simultaneity between the bivariate responses of repeated measures data may impact the conclusions reached in comparison to a joint model that concurrently analyze both outcomes within a single analytic framework (Weiss, 2005; Sitholea & Jones, 2007).

To simultaneously analyze the joint processes between the two markers of change - developmental pathway of marijuana-use and employment - the bivariate random intercept and slope model (BRISM, see Weiss, 2005) is applied in the present study. Building on the multilevel modeling framework (Laird & Ware, 1982; Blomqvist, 1977) to study the relationship between change and initial value in a linear growth curve setting, the main advantage of BRISM lies in its ability to utilize the inherent cross-correlated structure of truly multivariate repeated measures outcomes. The approach allows for the assessment of the association between one growth curve coefficient and another (e.g., the slope and intercept for a selected response variable, or the two slopes for two different response variables) after adjusting for key covariates for all of the response variables, as well as

estimation of cross-correlations between two, or more, slopes and intercepts (Zucker et al., 1995; Shah et al., 1997; Schluchter, 1990).

In addition to accounting for the potential confounding influence of reverse causality (i.e., that labor market outcomes may impact substance use), joint modeling of multivariate longitudinal outcomes also encapsulates the upshot issue that the life-course trajectory of illicit drug use as well as employment is dynamic (Buchmueller & Zuvekas, 1998). Levels of illicit drug use and labor market outcomes tend to vary over ages especially during the transition period from adolescence to young adulthood. Substance abuse behaviors may undergo dramatic changes as adolescents mature physically and mentally, develop better decision-making skills, and take on new roles and responsibilities as they transition into adulthood (Vaillant, 1988; Schottenfeld et al., 1992; Zanis et al., 1994; Leukefeld et al., 2004; Brownab & Montoya, 2009). Concurrently, levels of employment may fluctuate substantially during this transitional period as these individuals complete their education, begin initiating into the workforce, and enter into marriage and parenthood (Fergusson & Boden, 2008; King et al., 2006; Lynskey et al., 2003; Fergusson et al., 2003). With the magnitudes and direction of correlation between longitudinal illicit drug use and labor market outcomes presumably varying at each life stage, it is essential to treat an individual's drug use trajectory (Hser et al., 2007) as an interdependent outcome measure.

The present study contributes to the literature by examining the bidirectional longitudinal effects of substance use and employment outcomes while properly accounting for dynamic interdependencies between two concurrent repeated-measures outcomes and important covariates such as gender. Previous studies have found that males and females differ considerably in terms of their illicit drug use patterns as well as in labor market outcomes (Kaestner, 1994b; Mullahy & Sindelar, 1991). French et al. (1998), for example, found that when the "ever in lifetime" drug use measure was decomposed into marijuana-use and other drug use, females who used marijuana in their lifetime (whether exclusively or in addition to other types of drugs) were more likely to be absent during the past year than female employees who had never used drugs. Buchmueller & Zuvekas (1998) concur with strong evidence that problematic drug use is negatively related to income, particularly for prime-age males. Application of bivariate random intercept and slope modeling (BRISM) framework (Weiss, 2005) allows for cross-correlation (i.e., correlations between two longitudinal outcomes) among the initial status and longitudinal trajectories of the two outcomes to be quantified, while simultaneously accounting for unobserved person-specific variation across multiple time-points. The central purpose of the study is to construct estimates of the impact of drug use on the employment status for men and women, as well as assesses (1) whether longitudinal employment trajectory is systematically related to marijuana-use trajectory, and (2) to what extent the interdependence between the two longitudinal outcomes is confounded by gender.

## 2 Methods

### 2.1 Sample

The data used in the analysis come from the National Longitudinal Survey of Youth (NLSY79), which is a longitudinal survey of a nationally representative sample ($n$ = 12, 686) of young men and women who were between 14 and 22 years old at the time of the first survey in 1979. Annual follow-up surveys were conducted from 1979 through 1994, and biennially since 1996. These surveys collect extensive information on labor market behavior, educational experiences, and training investments over time, as well as detailed demographic information on participants' military experience, income and assets, health conditions, attitudes and aspirations, geographic residence, family background, household composition, marital and fertility histories, child care, criminal behavior, and alcohol and

drug use. For the present study, a total of 7,661 subjects (3,677 males and 3,984 females) who completed the follow-up in 2004 were included for the analysis (see Table 1 for composition of demographic/background characteristics by gender).

## 2.2 Measures

**2.2.1 Employment—**At each wave of the survey, respondents provided detailed information on their workforce participation in the past calendar year, including occupations of the jobs, number of weeks worked, hours usually worked per week, weeks out of the labor force, as well as start and end dates for each position held. The main outcome variable used for the analysis is percent of weeks worked per year, which was computed as the number of weeks worked during a year divided by number of weeks in the year, and ranges from 0 to 100%. To create a comprehensive picture of participants' developmental trajectory of employment from the initiation of their formal career, this study examined employment status over a 17-year period starting at age 23, thereby excluding periods when many survey participants were full-time students and/or part-time workers. The latter cut-off of age 39 is due, in part, to the excessive missing data beyond this point.

**2.2.2 Illicit drug use—**While some information on survey participants' illicit drug use has been collected since the first survey in 1979 (i.e., asking them to recall number of months with marijuana-use per year), more detailed data collection on substance use activities began with the 1984 survey. Among the fields included in the revised instrument were the types of drug used (e.g., marijuana, cocaine, heroin, amphetamine, and other drugs), age of first drug use (see Table 1), frequency of drug use within a participant's lifetime, time period of most recent drug use, number of times drugs had been used in the past 30 days, whether the participant used drugs at work, and if so, the frequency of drug use at work. Table 2 provides a descriptive overview of when illicit drug use begins for both genders, illustrating the gender-gap in substance abuse persistent across drug types. Adopting the life-course perspective drug use trajectory framework (Hser et al., 2007), the analysis for the present study focuses on marijuana-use from age 23 to 39, as one of the two longitudinal outcome variables.

## 2.3 Analytic approach

Using employment ($Y_{it}$) and marijuana-use ($W_{it}$) for participant $i$ at time $t$ as the two repeated measures outcomes, the present study fits a BRISM that can be expressed as

$$\begin{cases} Y_{it}=\alpha_{iY}+\beta_{iY}*(\text{time})_{it}+\varepsilon_{itY} \\ W_{it}=\alpha_{iW}+\beta_{iW}*(\text{time})_{it}+\varepsilon_{itW} \end{cases} \quad (1)$$

where $(\text{time})_{it}$ variable denotes the age of participant $i$ at time $t$. Each longitudinal outcome is modeled by its own growth model, where $\alpha_{iY}$ and $\alpha_{iW}$ denote the respective initial status for employment and marijuana-use, while $\beta_{iY}$ and $\beta_{iW}$ correspond to their longitudinal trajectories. All four parameters are modeled as random effects with bivariate normal distribution

$$\beta_i=\begin{pmatrix} \alpha_{iY} \\ \beta_{iY} \\ \alpha_{iW} \\ \beta_{iW} \end{pmatrix} \sim N_4\ (\mathbf{0}, \boldsymbol{D}) \quad (2)$$

where $\boldsymbol{D}$ is the variance-covariance matrix that allows for the possibility of cross-correlations between the two repeated measures

$$\boldsymbol{D}=\begin{pmatrix} D_{\alpha Y \alpha Y} & & & \\ D_{\beta Y\, \alpha Y} & D_{\beta Y\, \beta Y} & & \\ D_{\alpha W \alpha Y} & D_{\alpha W\, \beta Y} & D_{\alpha W \alpha W} & \\ D_{\beta W\, \alpha Y} & D_{\beta W\, \beta Y} & D_{\beta W\, \alpha W} & D_{\beta W\, \beta W} \end{pmatrix}. \quad (3)$$

The covariance $D_{\alpha W \alpha Y} = D_{\alpha Y \alpha W}$, for example, captures the interdependence of the two intercepts ($\alpha_{iY}$ and $\alpha_{iW}$), while $D_{\beta W \beta Y} = D_{\beta Y\, \beta W}$ captures the interdependence of the two slopes ($\beta_{iY}$ and $\beta_{iW}$).

Measurement errors for the two outcomes are assumed to have a bivariate normal distribution

$$\begin{pmatrix} \varepsilon_{itY} \\ \varepsilon_{itW} \end{pmatrix} \sim N_2 \left( \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_Y^2 & \sigma_{YW} \\ \sigma_{WY} & \sigma_W^2 \end{pmatrix} \right) \quad (4)$$

thereby allowing the residuals to correlate: a distinction with conventional parallel process growth models in which the residuals are presumed to be uncorrelated.

## 3 Results

As summarized in Table 1, the average age of the 7,661 subjects at intake (year 1979) was 17.5 for males and 17.6 for females, and the majority were not and had never been married at intake (94.9% for males and 85.3% for females). Ethnicity composition was similar between males and females with about 50% non-Hispanic Caucasians, 31% African American, and 19% Hispanic. Average years of education at intake were 10 years for both genders. Notably, one area where males and females significantly differ is in the age when they first used two of the illicit drugs: Marijuana and Cocaine. The difference is particularly pronounced for marijuana, where the average age of first-time use is 15.32 for males and 16.12 for females.

Figure 1 shows the empirical mean employment (i.e., percentage of weeks of worked within a year) for male and female survey participants respectively, and contrasts the longitudinal trajectories for each gender by those who had ever used marijuana (82% for males and 69% for females) to those who had never used. While an upward trend in employment is evident in both genders, a closer comparison of the longitudinal trajectories reveals that the male employment trajectories (for both marijuana users and non-users) are persistently higher than those of females, reflecting the distinctly gendered patterns of employment - for men, full-time workforce participation is often initiated in early adulthood and remains relatively uninterrupted throughout the prime income earning years (Huang et al., 2011; Hynes & Clarkberg, 2005).

Meanwhile, Figure 2 depicts the concurrent marijuana-use rate for each gender, with a gradual decline in usage in both groups as participants fully transition into adulthood (Leukefeld et al., 2004; Zanis et al., 1994; Schottenfeld et al., 1992; Brownab & Montoya, 2009). The empirical usage rate is consistently higher for males over females during the age range specified for the present study (from age 23 to 39), indicating that the higher rate of marijuana consumption observed among adolescent males (c.f., Tu et al., 2008) persist well into adulthood.

Table 3 summarizes the parameter estimates for the variance covariance matrix ***D*** - corresponding to Equation (3) - for both males and females from fitting the bivariate random intercept and slope model (BRISM), while Table 4 expresses the same interdependence between the two repeated measures outcomes as a correlation matrix. Meanwhile, Table 5 provides residual variance-covariance matrix - corresponding to Equation (4) - for both males and females.

The covariance between the slope and intercept for the employment trajectories ($D_{\beta Y \alpha Y}$) are substantial for both genders, with significant correlation for males ($r = 0.20$, $p < 0.01$) as well as for females ($r = 0.23$, $p < 0.01$) - see Table 4. The positive correlation coefficient estimates indicate that participants with a higher number of weeks worked at age 23 are more likely to maintain their productive employment status over subsequent years. However, the same cannot be said about their longitudinal marijuana-use trajectory. The slope-intercept covariance parameter estimate ($D_{\beta W \alpha W}$) for the repeated measures outcome is almost non-existent, with non-significant negative correlation for both male ($r = -0.01$, $p > 0.05$) and female ($r = -0.04$, $p > 0.05$) participants. In other words, unlike the employment trajectories, a person's marijuana-use status at age 23 is uncorrelated with marijuana-use trajectory during early adulthood.

In addition to slope-intercept covariance specific to each of the two outcomes, BRISM estimates the cross-correlations among the four longitudinal growth parameters. As summarized in Table 3, the covariance between the two intercepts ($D_{\alpha W \alpha Y}$) is significant for both genders. The negative correlation between the two random effects (male: $r = -0.05$, $p < 0.05$; female: $r = -0.06$, $p < 0.01$), indicates that survey participants with higher marijuana-use at age 23 tend to be less participatory in the workforce at that time. The covariance between the slope of marijuana-use and the employment intercept ($D_{\beta W \alpha Y}$) is also negative for the two groups (male: $r = -0.06$, $p < 0.05$; female: $r = -0.07$, $p < 0.05$), suggesting that those who were less participatory in the workforce at age 23 are increasingly likely to develop an illicit drug use habit in later years.

The BRISM also points out where the genders diverge in their bivariate outcomes. While the covariance estimate between the intercept for marijuana-use and the employment slope are negative for both groups, the correlation is statistically significant for males ($r = -0.07$, $p < 0.05$) but non-significant for females ($r = -0.04$, $p > 0.05$). While higher marijuana-use at age 23 is correlated with lower workforce productivity in later life for males, this relationship is not significant for their female counterparts.

The genders also diverge in terms of their residual covariance between the two longitudinal outcomes (See Table 5). While the correlation is negative and statistically significant for males ($r = -0.03$, $p < 0.01$), it is non-significant for females ($r = -0.001$, $p > 0.05$). In other words, males with higher level of workforce participation are less likely to engage in marijuana-use, while this pattern does not hold for females.

## 4 Discussion

This study examined the association of marijuana-use and percent of weeks worked per year over time, and contributes to the growing body of literature by incorporating methodological analytic strategies that examine long-term patterns of employment in relation to drug-use trajectory. Adoption of a life-course perspective for the analysis of longitudinal substance abuse patterns (Hser et al., 2007) facilitates a comprehensive examination of changes in workforce participation and drug use as cross-correlated repeated measures over age that more closely align with the multifaceted and dynamic nature of substance abuse in early adulthood.

The key findings of the study can be summarized as follows: first, a negative correlation of marijuana-use with level of employment was initially observed (age 23) for both genders. Concurring with the pool of empirical evidence from cross-sectional analyses (c.f., MacDonald & Pudney, 2000; Kandel et al., 1995), the present study suggests how current marijuana-use is negatively associated with contemporaneous measures of employment.

Second, the parameter estimates from the BRISM revealed that employment at early adulthood (age 23 at intake) was negatively associated with slope of marijuana-use trajectory. In other words, workforce participation at age 23 is associated with lower marijuana-use rate over subsequent years for both males and females. This finding supports key concepts from the life-course theory (Laub & Sampson, 1993) which emphasizes salient life events such as employment or marriage to explain both continuity in childhood deviant behavior and changes during the life-course, and highlights the need for integrated drug programs that provide substance abuse treatment in conjunction with occupational trainings.

Third, marijuana-use during the initial observation period was negatively correlated with slope of employment trajectory for males, indicating that marijuana-use is associated with decreased levels of workforce participation and has an adverse consequence on subsequent career growth. Clearly, the implication is that the harm of marijuana-use on users' socioeconomic aspects of life is long term and chronic. One possible explanation for why this is uniquely found for males may lie in the dissimilarity of level of workforce participation and level of marijuana consumption. As illustrated in Figure 1, on average, females appear to be employed less time (e.g., work fewer hours) than males and tend to engage in marijuana-use to a lesser degree. Kaestner (1998) calls to attention the importance of including demographic contexts such as educational achievement, marital status and number of dependent children in examining the association of marijuana-use and employment. These demographic factors have been reported as important determinants of work participation and also show influences on level of marijuana consumption (Fergus et al., 2007). Therefore, further studies that simultaneously examine the association of employment with drug use as well as the demographic contexts are recommended.

Finally, slope of employment trajectory is not significantly correlated with slope of marijuana-use trajectory for either gender, indicating that the association between changes in marijuana-use and work participation over age are not systematic. The lack of consistency in the association between the two longitudinal trajectories suggests that the magnitude and direction of relationship between employment and drug use are not consistent over age, and that the direction of causality is complicated and uncertain. Again, this is consistent with other longitudinal studies (c.f., Kaestner, 1994a; Bryant et al., 1996), and it highlights the need for sophisticated causal inference approaches (Rubin, 1974; Holland, 1986; Rosenbaum & Rubin, 1983) in future studies, especially given the limitations of empirical analyses on providing credible evidence for causal relationships.

Despite significant findings, the present study has several limitations. The sample used for the analysis was a subset of the National Longitudinal Survey of Youth 1979 (NLSY79) cohort who completed the 2004 follow-up survey. While utmost care was taken in examining participants' demographic characteristics for any possible systematic missing patterns of subjects, the generalizability of the findings from this study sample to the entire NLSY79 cohort may be limited. Furthermore, the measures used in NLSY to record substance use are relatively coarse. A dichotomous measure of marijuana-use are relative crude and may differ drastically from person to person when identifying patterns of marijuana-use that affect employment.

The current approach to estimating a BRISM is also limited in its ability to incorporate time-varying covariates (e.g., years of educational attainment, annual income), as these would need to be treated as additional longitudinal trajectories within a multivariate random intercept and slope model. In addition, inclusion of quadratic, or higher order terms, within the bivariate longitudinal model resulted in a lack of model convergence. Work is currently ongoing to develop methods that allows for the incorporation of time-varying covariates. One possible solution to be explored in future studies include taking a Bayesian approach (c.f., Lee, 2004; Bernardo & Smith, 2000; Gelman et al., 2003; Carlin & Louis, 2000) to fitting the model with informative prior distributions that are derived from empirical studies (Spiegelhalter et al., 2004; Pollard, 1986; Mayer, 2008; Kass & Greenhouse, 1989; Spiegelhalter et al., 1994).

In sum, our results highlight the cross-correlational longitudinal effects of substance use and employment outcomes for young adults, while properly accounting for dynamic interdependencies between two concurrent repeated-measures outcomes. Additional research is encouraged to determine whether the findings endure with other data sets, different types of drugs and different employment variables. In particular, future research should closely examine how these two concurrent longitudinal outcomes may differ by race/ethnicity groups through assessment of their interaction effect with the inter-dependent trajectories.

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## Appendix

An Example of SAS Script for Fitting a BRISM

```
proc mixed data=bivar method=REML covtest;
  class id type nhage;
  model response=type age*type /noint s;
  random type age*type /type=un subject=id g gcorr;
  repeated /type=un subject=nhage(id) r rcorr;
  run;
  quit;
```

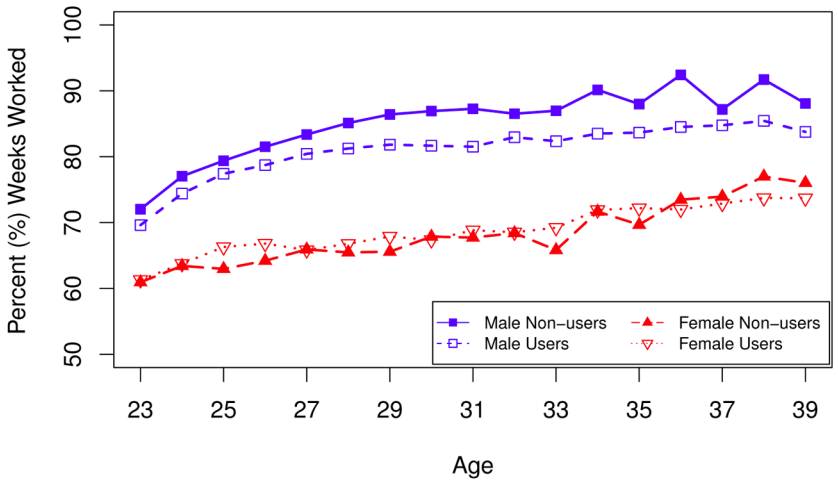


**Figure 1.**
Empirical mean employment (% weeks worked) over age by gender and by marijuana-use.

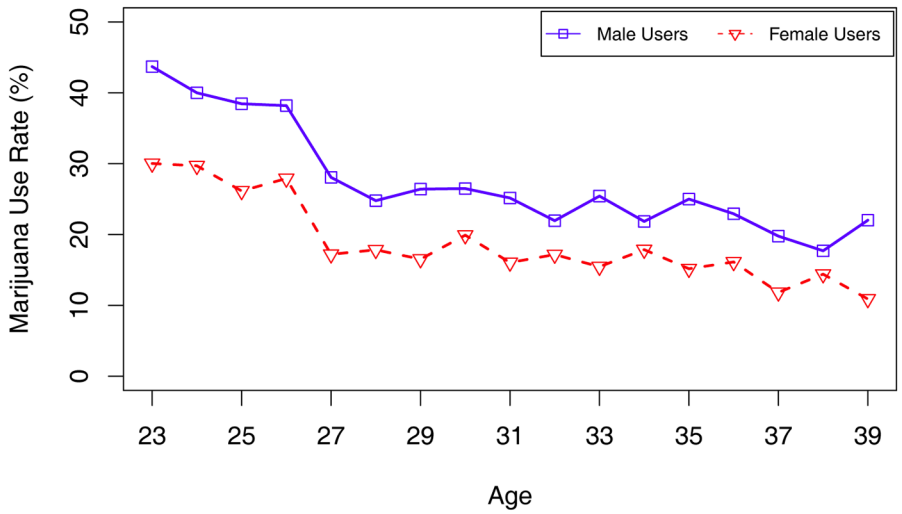


**Figure 2.**
Empirical mean marijuana-use rate by gender.

## Table 1

Background Characteristics and Initial Drug Use Age by Gender

| | Male | Female |
|---|---|---|
| Race/Ethnicity [*n* (%)] | | |
| Hispanic | 699 (19.01) | 765 (19.20) |
| African Amerian | 1,115 (30.32) | 1,230 (30.87) |
| Non-Hispanic/ Non-African American | 1,863 (50.67) | 1,989 (49.92) |
| Highest Year of Education Obtained between 1979–2004 [*M*(*SD*)] | 13.12 (2.55) | 13.37 (2.51) |
| Age of First Time Use [*M*(*SD*)] | | |
| Marijuana | 15.32 (2.84) | 16.12 (3.20) ** |
| Cocaine | 19.52 (3.79) | 19.90 (3.86) ** |
| Amphetamine | 17.64 (2.51) | 17.90 (2.67) |
| Crack | 24.47 (5.82) | 24.15 (5.17) |
| Heroin | 17.89 (2.96) | 17.79 (2.59) |

* $p < 0.05$;

** $p < 0.01$

**Table 2**

Illicit Drug Use [*n* (%)] by Gender

| | Before Age 15 | | Before Age 18 | | Before Age 23 | | Lifetime | |
|---|---|---|---|---|---|---|---|---|
| **Drug Type [*n* (%)]** | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** |
| Marijuana | | | | | | | | |
| Used | 1,039 (28.26) | 731 (18.35) ** | 2,440 (66.36) | 1,994 (50.05) ** | 2,944 (80.07) | 2,624 (65.86) ** | 3,016 (82.02) | 2,766 (69.43) ** |
| Not Used | 2,638 (71.74) | 3,253 (81.65) | 1,237 (33.64) | 1,990 (49.95) | 733 (19.93) | 1,360 (34.14) | 661 (17.98) | 1,218 (30.57) |
| Cocaine | | | | | | | | |
| Used | 73 (1.99) | 42 (1.05) ** | 429 (11.67) | 293 (7.35) ** | 1,381 (37.56) | 916 (22.99) ** | 1,717 (46.70) | 1,196 (30.02) ** |
| Not Used | 3,604 (98.01) | 3,942 (98.95) | 3,248 (88.33) | 3,691 (92.65) | 2,296 (62.44) | 3,068 (77.01) | 1,960 (53.30) | 2,788 (69.98) |
| Amphetamine | | | | | | | | |
| Used | 68 (1.85) | 56 (1.41) * | 337 (9.17) | 303 (7.61) * | 686 (18.66) | 603 (15.14) ** | 724 (19.69) | 657 (16.49) ** |
| Not Used | 3,609 (98.15) | 3,928 (98.59) | 3,340 (90.83) | 3,681 (92.39) | 2,991 (81.34) | 3,381 (84.86) | 2,953 (80.31) | 3,327 (83.51) |
| Crack | | | | | | | | |
| Used | 14 (0.38) | 6 (0.15) * | 40 (1.09) | 24 (0.60) * | 182 (4.95) | 106 (2.66) ** | 534 (14.52) | 321 (8.06) ** |
| Not Used | 3,663 (99.62) | 3,978 (99.85) | 3,637 (98.91) | 3,960 (99.40) | 3495 (95.05) | 3878 (97.34) | 3,143 (85.48) | 3,663 (91.94) |
| Heroin | | | | | | | | |
| Used | 20 (0.54) | 10 (0.25) * | 87 (2.37) | 58 (1.46) * | 178 (4.84) | 114 (2.86) ** | 337 (9.17) | 194 (4.87) ** |
| Not Used | 3,657 (99.46) | 3,974 (99.75) | 3,590 (97.63) | 3,926 (98.54) | 3,499 (95.16) | 3,870 (97.14) | 3,340 (90.83) | 3,790 (95.13) |

* $p < 0.05$;

** $p < 0.01$

*J Subst Abuse Treat*. Author manuscript; available in PMC 2014 November 01.

**Table 3**

Variance-covariance Matrix (***D***) Parameter Estimates by Gender

| | Male | Female |
|---|---|---|
| **Covariance Matrix Parameter** | **Est. (SE)** | **Est. (SE)** |
| Employment Intercept Variance ($D_{\alpha Y \alpha Y}$) | 575.95 (16.13) ** | 855.82 (24.69) ** |
| Employment Slope Variance ($D_{\beta Y \beta Y}$) | 4.41 (0.16) ** | 7.93 (0.27) ** |
| Employment Slope-Intercept Covariance ($D_{\beta Y \alpha Y}$) | 9.97 (1.16) ** | 19.23 (1.91) ** |
| Marijuana-use Intercept Variance ($D_{\alpha W \alpha W}$) | 791.54 (28.87) ** | 520.87 (21.48) ** |
| Marijuana-use Slope Variance ($D_{\beta W \beta W}$) | 7.29 (0.43) ** | 6.45 (0.39) ** |
| Marijuana-use Slope-Intercept Covariance ($D_{\beta W \alpha W}$) | −0.82 (2.61) | −2.19 (2.14) |
| Marijuana-use Intercept - Employment Intercept Covariance ($D_{\alpha W \alpha Y}$) | −34.03 (15.08) * | −43.12 (16.08) ** |
| Marijuana-use Intercept - Employment Slope Covariance ($D_{\alpha W \beta Y}$) | −4.17 (1.48) ** | −2.81 (1.68) |
| Marijuana-use Slope - Employment Intercept Covariance ($D_{\beta W \alpha Y}$) | −3.85 (1.88) * | −5.03 (2.22) * |
| Marijuana-use Slope - Employment Slope Covariance ($D_{\beta W \beta Y}$) | 0.18 (0.19) | 0.30 (0.23) |

* $p < 0.05$;

** $p < 0.01$

## Table 4

Random Effects Correlation Matrix by Gender

| | | Employment | Marijuana-use | |
|---|---|---|---|---|
| **Gender** | **Random Effects** | **Slope ($\beta_{iY}$)** | **Intercept ($\alpha_{iW}$)** | **Slope ($\beta_{iW}$)** |
| Male | Employment Intercept ($\alpha_{iY}$) | 0.20** | −0.05* | −0.06* |
| | Employment Slope ($\beta_{iY}$) | - | −0.07* | 0.03 |
| | Marijuana-use Intercept ($\alpha_{iW}$) | - | - | −0.01 |
| Female | Employment Intercept ($\alpha_{iY}$) | 0.23** | −0.06** | −0.07* |
| | Employment Slope ($\beta_{iY}$) | - | −0.04 | 0.04 |
| | Marijuana-use Intercept ($\alpha_{iW}$) | - | - | −0.04 |

* $p < 0.05$;

** $p < 0.01$

**Table 5**

Residual Covariance Matrix Parameter Estimates by Gender

| | Male | Female |
|---|---|---|
| **Residual Covariance Matrix Parameter** | **Est. (SE)** | **Est. (SE)** |
| Employment Residual Variance ($\sigma^2_Y$) | 460.76 (3.54)** | 651.86 (5.13)** |
| Marijuana-use Residual Variance ($\sigma^2_W$) | 980.54 (14.31)** | 846.62 (12.65)** |
| Employment - Marijuana-use Residual Covariance ($\sigma_{WY}$) | −16.54 (6.38)** | −0.78 (7.32) |

*$p < 0.05$;

**$p < 0.01$