# Trajectories of Substance Use Disorder in Youth After Detention: A 12-Year Longitudinal Study

Leah J. Welty, PhD, Jennifer A. Hershfield, PhD, Karen M. Abram, PhD, Hongyun Han, PhD, Gayle R. Byck, PhD, Linda A. Teplin, PhD

**Objective:** To identify trajectories of substance use disorders (SUDs) in youth during the 12 years after detention and how gender, race/ethnicity, and age at baseline predict trajectories.

**Method:** As part of the Northwestern Juvenile Project, a longitudinal study of 1,829 youth randomly sampled from detention in Chicago, Illinois from 1995 through 1998, participants were reinterviewed in the community or correctional facilities up to 9 times over 12 years. Independent interviewers assessed SUDs using the Diagnostic Interview Schedule for Children 2.3 (baseline) and the Diagnostic Interview Schedule IV (follow-ups). Primary outcome was a mutually exclusive 5-category typology of disorder: no SUD, alcohol alone, marijuana alone, comorbid alcohol and marijuana, or "other" illicit ("hard") drug. Trajectories were estimated using growth mixture models with a 3-category ordinal variable derived from the typology.

**Results:** During the 12-year follow-up, 19.6% of youth did not have an SUD. The remaining 81.4% were in 3 trajectory classes. Class 1 (24.5%), a bell-shaped trajectory, peaked 5 years after baseline when 42.7% had an SUD and 12.5% had comorbid or "other" illicit drug disorders. Class 2 (41.3%) had a higher prevalence of SUD at baseline, 73.8%. Although prevalence decreased over time, 23.5% had an SUD 12 years later. Class 3 (14.6%), the most serious and persistent trajectory, had the highest prevalence of comorbid or "other" illicit drug disorders—52.1% at baseline and 17.4% 12 years later. Males, Hispanics, non-Hispanic whites, and youth who were older at baseline (detention) had the worst outcomes.

**Conclusion:** Gender, race/ethnicity, and age at detention predict trajectories of SUDs in delinquent youth. Findings provide an empirical basis for child psychiatry to address health disparities and improve prevention.

**Key words:** substance use disorders, trajectories, high-risk youth, delinquents, longitudinal

**J Am Acad Child Adolesc Psychiatry 2017;56(2):140–148.**

Substance abuse is common and persistent in delinquent youth. Among youth in the juvenile justice system, more than 90% report using illicit drugs[1] and as many as three-fourths of males and females[2-4] have a substance use disorder (SUD). Prevalence remains high as youth age: 5 years after detention, more than 30% of males and 20% of females have an SUD.[5] By the median age of 28 years, 91.3% of males and 78.5% of females have ever had an SUD.[6] Substance abuse in adolescence can have lifelong consequences.[7] It predicts substance abuse later in life and among delinquent youth is associated with recidivism,[8,9] sexually transmitted diseases,[10] psychiatric comorbidity, and early violent death.[11-13]

Although informative, most longitudinal studies provide few data about patterns of substance abuse over time. For example, a study might find that 30% of participants have marijuana use disorder at time 1 and at time 2, but are these the same people? For some youth, substance abuse is limited to adolescence; for others, it can begin in adulthood.

Trajectory analysis addresses this limitation by identifying subgroups of people who share similar patterns (trajectories) of substance abuse over time. Trajectory analysis identifies the most common patterns of substance abuse as youth age and variables—such as gender and race/ethnicity—that predict trajectories. Thus, trajectory analysis addresses critical questions: Are there subgroups whose substance abuse increases over time (escalation)? Whose substance abuse decreases (desistance)? Do gender and race/ethnicity predict escalation and desistance?

Many studies of general population youth have examined trajectories of marijuana use and heavy drinking.[14-22] Among studies of marijuana use, a common trajectory is "abstainers" (approximately 45% of youth).[17,18,20] "Occasional" marijuana users constitute approximately 30% of youth,[17,20] and several studies identified 2% to 12% of youth as "early" marijuana users.[16-18,20,22] Among studies of heavy or binge drinking, a common trajectory is "abstainers" or "infrequent" users (approximately 30%–50% of youth).[14,20,21] Several studies identified groups (8%–15% of youth)[14,20,21] whose heavy drinking peaked in their teens and early 20s, and 10% to 15% of youth[14,20] were classified as "increasers."

However, findings are not generalizable to youth in the juvenile justice system for two reasons. First, the demographic characteristics of youth in detention differ from those in the general population.[23] Youth in detention are disproportionately poor, and racial/ethnic minorities are overrepresented.[23-27] Second, delinquent youth are

Supplemental material cited in this article is available online.

systematically underrepresented in general population studies, which typically sample from schools or use household surveys. Even studies of "high-risk" youth (e.g., children of alcoholics[28,29] or those living in high-crime neighborhoods[30]) provide little information about delinquent youth. Although these studies would have included delinquent youth, none distinguished these youth from those without histories of delinquency. (Summary tables of these studies are available on request.)

To our knowledge, only 1 study of delinquent youth (Pathways to Desistance) examined trajectories of substance abuse.[31] This investigation, sampling only serious juvenile offenders, found that substance use had initiated by 15 years of age and that frequency of alcohol and marijuana use increased from 15 to 20 years of age.[31] However, the trajectory analysis had several limitations: participants were followed up for only 3 years; serious offenders constituted a small fraction of youth processed through the juvenile justice system; the analysis excluded females who constitute an increasing proportion of youth in the juvenile justice system; and the study focused only on substance use, not disorder. Definitions of substance use vary widely, might not differentiate experimentation from problematic use, and are difficult to compare across studies.

In sum, no comprehensive study has examined trajectories of SUD in delinquent youth. This omission is critical for two reasons. First, because juvenile detainees have a median length of stay of 15 days,[32] delinquent youth with SUDs become a community public health problem when they are released. Second, data on gender and racial/ethnic differences are needed to address health disparities and improve prevention and treatment. More than any other racial/ethnic group, African Americans are disproportionately incarcerated,[23] constituting approximately 14% of the general population[33] but approximately 40% of youth and young adults in corrections.[34,35] Females constitute a growing proportion of youth in the juvenile justice system,[23] composing 27.9% of youth processed in juvenile court[34] and 13.6% of incarcerated youth.[34]

We present data from the Northwestern Juvenile Project, the first large-scale study of psychiatric disorders in youth after they leave detention. The sample is large (N = 1,829), is racially/ethnically diverse, and includes males and females. This is the first paper to examine trajectories of SUDs. The goals were to identify trajectories of SUDs during the 12 years after detention (median age 28 years) and to examine how age at detention, gender, and race/ethnicity predict trajectories of SUDs.

# METHOD

We summarize the information from the Northwestern Juvenile Project most relevant to this study. Additional information is available in Supplement 1 (available online) and is published elsewhere.[2,5,6]

## Sample and Procedures

We recruited a stratified random sample of 1,829 youth at intake to the Cook County Juvenile Temporary Detention Center (CCJTDC) in Chicago, Illinois from November 20, 1995 through June 14, 1998 who were awaiting the adjudication or disposition of their case. The CCJTDC is used for pretrial detention and for offenders sentenced for fewer than 30 days. To ensure adequate representation of key subgroups, we stratified our sample by gender, race/ethnicity (African American, non-Hispanic white, Hispanic, other), age (10–13 or ≥14 years), and legal status (processed in juvenile or adult court). Face-to-face structured interviews were conducted at the detention center in a private area, most within 2 days of intake (baseline interview).

We conducted follow-up interviews at 3, 4.5, 6, 8, and 12 years after baseline for the entire sample; at 3.5 and 4 years after baseline for a random subsample of 997 participants (600 males and 397 females); and at 10 and 11 years after baseline for the last 800 participants enrolled at baseline (460 males and 340 females). Participants were interviewed whether they lived in the community or in correctional facilities.

Participants signed an assent form (if they were <18 years old) or a consent form (if they were ≥18 years old). The institutional review boards approved all study procedures and waived parental consent for persons younger than 18 years, consistent with federal regulations regarding research with minimal risk.[36]

## Measurements and Variables

*Typology of SUDs.* To assess SUDs at baseline, we administered the Diagnostic Interview Schedule for Children version 2.3 (DISC 2.3),[37,38] based on the *DSM-III-R,* the most recent version available at the time. The DISC 2.3 generates diagnoses for alcohol, marijuana, and "other" illicit drug use disorders (e.g., "hard drugs" such as cocaine, opiates, hallucinogens, or PCP) for the past 6 months. At follow-up interviews, we administered the Diagnostic Interview Schedule version IV (DIS-IV),[39,40] based on the *DSM-IV,* because the DISC was not sufficiently comprehensive to cover the substance use behaviors of aging delinquent youth. The DIS-IV assesses SUDs in the year before the interview. Consistent with prior studies, such as the National Comorbidity Survey Replication,[41] (1) participants who met diagnostic criteria for an SUD with "partial recovery" were scored as having the disorder,[41] and (2) SUD was defined as a diagnosis of abuse or dependence.[41-43] Among participants with any SUD, approximately two-thirds met the criteria for dependence (see Supplement 1, available online, for additional estimates). As detailed in Supplement 1, prior analyses demonstrated that changes in the prevalence of drug and alcohol use disorders (abuse or dependence combined) from baseline to later time points did not appear to be due to changes in measurement.[5] However, the proportion of diagnoses attributable to dependence might have decreased over time because the *DSM* criteria changed (see Supplement 1, available online, for details).

We used a mutually exclusive 5-category typology, validated in our prior work,[1] to score participants' SUD at each follow-up: none, alcohol alone, marijuana alone, comorbid alcohol and marijuana, and any "hard" drug (those other than marijuana, such as cocaine or hallucinogens). For example, a participant with alcohol and cocaine use disorders would be in the last category. For convenience, we refer to the last category as "other" illicit drug.

## Data Analysis

*Prevalence of Disorder at Specific Time Points.* Prevalence was calculated using commercial software (STATA 12[44]) with its survey routines. To generate prevalence estimates that reflect the population of the CCJTDC, each participant was assigned a sampling weight augmented with a nonresponse adjustment to account for missing data.[45] Taylor series linearization was used to estimate standard errors.[46,47]

As in our prior work,[5,6] because some participants were interviewed more often than others, we summarize prevalence at 6 time points for the entire sample: baseline (time 0) and time 1 through time 5, corresponding to approximately 3, 5, 6, 8, and 12 years after baseline. Table 1 presents a summary of the sample demographics and retention; 83% of participants had a time 5 interview (retention for time 1 to time 4 was 91%, 85%, 77%, and 73%, respectively).

*Trajectories of SUDs Over Time.* We determined trajectories of SUDs using growth mixture models estimated with Mplus 6.[48] Figure S1, available online, illustrates our model. SUDs were measured at baseline and at up to 9 additional time points in the subsequent 12 years (a total of 12,511 interviews from 1,825 participants). We hypothesized that there were "c" distinct trajectory classes of SUD. Within each trajectory class, the shape of the trajectory was determined by 3 parameters: intercept (i), slope (s), and a quadratic term (q); variances were estimated freely. This model allowed the shapes of trajectories to vary across classes. We treated SUD as an ordinal outcome. We used demographic characteristics—gender, race/ethnicity (African American, Hispanic, and non-Hispanic white), and age at detention—to predict trajectory class membership within the growth mixture model. There was no evidence that demographic characteristics were significantly associated with intercept and slope within class. We excluded 4 participants who self-identified as "other" race/ethnicity and estimated all models with sampling weights to account for study design.

**TABLE 1** Demographic Characteristics of the Sample at the Baseline Interview and 12 Years Later

| | Baseline (n = 1,829) | | Time 5, 12 y later[a] (n = 1,519) | |
|---|---|---|---|---|
| **Characteristic** | **n** | **%** | **n** | **%** |
| Race/ethnicity | | | | |
| African American | 1,005 | 55 | 879 | 58 |
| Non-Hispanic white | 296 | 16 | 228 | 15 |
| Hispanic | 524 | 29 | 410 | 27 |
| Other | 4 | 0 | 2 | 0 |
| Gender | | | | |
| Males | 1,172 | 64 | 943 | 62 |
| Females | 657 | 36 | 576 | 38 |
| Legal status at detention | | | | |
| Processed in adult court | 275 | 15 | 230 | 15 |
| Processed in juvenile court | 1,554 | 85 | 1,289 | 85 |
| Age (y) | | | | |
| Mean (SD) | 14.9 | 1.4 | 27.6 | 1.4 |
| Median | 15 | | 28 | |
| Range | 10–18 | | 22–32 | |
| Nonresponse | | | | |
| Died | — | | 97 | |
| Refused | — | | 69 | |
| Skipped interview[b] | — | | 135 | |
| Interview out of range[c] | — | | 9 | |

*Note: SD = standard deviation.*
[a]*At time 5, 83.1% (n = 1,519) of the sample was retained.*
[b]*Participant was not located in time to be interviewed.*
[c]*The participant was interviewed more than 1.5 years after the interview due date.*

Because incarceration can restrict access to substances, the time incarcerated before the follow-up interview was treated as a time-varying exogenous factor. To match the measurement period for SUDs, we used incarceration information from the year preceding each follow-up interview. Depending on time point, 36.0% to 48.8% of the sample had been incarcerated in the year before the interview; their median time incarcerated ranged from 177 to 237 days. From 9.3% to 15.7% of the sample had been incarcerated the entire year before the interview.

We estimated models with 1, 2, 3, and 4 classes using maximum likelihood with numerical integration. We evaluated models using the following metrics: sample size-adjusted Bayesian information criterion (BIC),[49,50] with lower values indicating better models; average posterior probabilities of trajectory membership, with higher values indicating better classification of individuals; entropy, with higher values indicating better classification of individuals; and ease of interpretation—that is, trajectories distinguished differences that were clinically meaningful.

*Missing Data.* Although attrition was modest (Table 1), and we augmented sampling weights with nonresponse adjustments, we used multiple imputations by chained equations to examine the sensitivity of our findings to unplanned missing data. We imputed data under the assumption that participants who dropped out had up to twice the odds of the disorder compared with participants who remained in the study. Because there were no substantive differences in trajectories (tables and figures available from the authors), we present results using the original data.

## RESULTS

### Prevalence

Figures 1 and 2 present prevalence estimates for any SUD and its mutually exclusive subcategories (defined earlier) during the 12 years after detention for males and females, respectively. Prevalence of marijuana alone and comorbid alcohol and marijuana generally decreased, whereas alcohol alone increased slightly. Up through 8 years after baseline, alcohol alone was less prevalent than marijuana alone. Throughout the follow-up period, approximately 5% of females and fewer than 5% of males had an "other" illicit

**FIGURE 1** Prevalence of substance use disorders during the 12 years after detention in Cook County (Chicago): males (n = 1,142). Note: Prevalence estimates are shown for any substance use disorder and its mutually exclusive subcategories.

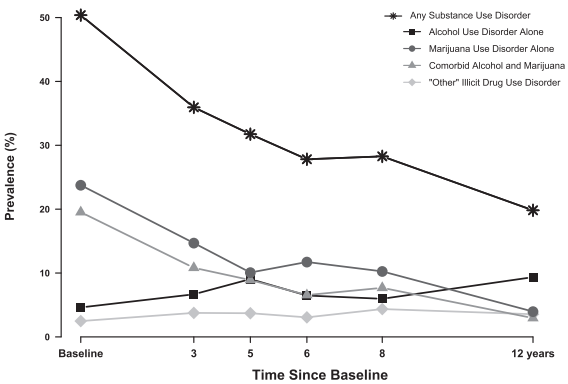
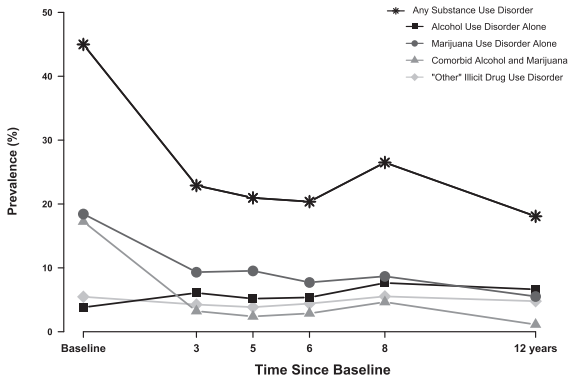


**FIGURE 2** Prevalence of substance use disorders during the 12 years after detention in Cook County (Chicago): females (n = 631). Note: Prevalence estimates are shown for any substance use disorder and its mutually exclusive subcategories.




drug use disorder, such as cocaine or hallucinogen disorders. Table S1, available online, presents the specific prevalence estimates shown in the figures. Gender and racial/ethnic differences in the prevalence of disorders of specific drugs are published elsewhere.[6]

## Trajectories of SUDs

Because prevalence of alcohol alone and "other" illicit drug use disorder was low at baseline and throughout much of the follow-up, to estimate trajectories, we collapsed the 5-category typology of SUD into a 3-category ordinal variable: no disorder, alcohol or marijuana alone, and comorbid alcohol and marijuana or "other" illicit drug (any "hard" drug). Hereafter, we refer to the latter category as comorbid/"other" illicit. Prevalence estimates are presented in Table S2, available online.

Because our goal was to model trajectories of disorder, we omitted from the analysis participants who did not have an SUD at any interview (19.6% of youth). This approach is common in trajectory analysis.[20,28,51] Compared with males, females were more likely to have no SUD (30.4% versus 18.7%; adjusted odds ratio [AOR] 2.0; 95% CI 1.5–2.6). African Americans were more likely to have no SUDs than non-Hispanic whites (20.6% versus 11.7%; AOR 2.1; 95% CI 1.3–3.3).

## Model Selection

We estimated models with 2, 3, and 4 trajectory classes. We present the 3-class model because it offered the best combination of fit and parsimony (sample size-adjusted Bayesian information criterion 14,573.6 for 3-class model versus 14,924.1 and 14,848.5 for 2- and 4-class models, respectively). Average posterior probabilities for the 3-class solution were acceptable (0.71, 0.77, and 0.78). Although the 4-class model classified participants better than the 3-class model (entropy of 0.65 versus 0.46), too few participants (n = 4) were assigned to the fourth class to interpret the trajectory. Entropy was decreased using sampling weights (e.g., 3-class unweighted entropy of 0.61 versus 0.46 weighted). We present the weighted 3-class model because it offered the best combination of fit and parsimony (see Supplement 1, available online, for details).

## Trajectory Classes

Figure 3 depicts the prevalence of any SUD and its subcategories (alcohol or marijuana alone; comorbid/"other" illicit) for each of the 3 trajectory classes. Table S3, available online, lists the corresponding prevalence estimates. We discuss classes in order of increasing severity.

*Class 1 (24.5% of Youth).* Participants in this class exhibited bell-shaped trajectories. Prevalence increased in the first 5 years after baseline and then decreased substantially. Alcohol or marijuana alone was more common than comorbid/"other" illicit drug use disorders. Twelve years after baseline, 17.9% of participants in this class had an SUD.

*Class 2 (41.3% of Youth).* Compared with class 1, class 2 had a higher prevalence of SUDs at baseline. Then, prevalence decreased sharply in the first 6 years after detention. Similar to class 1, alcohol or marijuana alone was more common than comorbid/"other" illicit drug disorder. Twelve years after baseline, 23.5% of youth had an SUD.

*Class 3 (14.6% of Youth).* This class, representing the most serious and persistent trajectory, had the highest prevalence of any SUD and its subcategory, comorbid/"other" illicit. Like class 2, prevalence decreased over time. However, unlike classes 1 and 2, comorbid/"other" illicit drug disorder was more prevalent than alcohol or marijuana alone at many time points. However, 12 years after baseline, 35.3% of participants had an SUD, 17.9% had alcohol or marijuana disorder alone, and 17.4% had comorbid/"other" illicit drug disorder.

## Trajectory Classes: Gender, Racial/Ethnic, and Age Differences

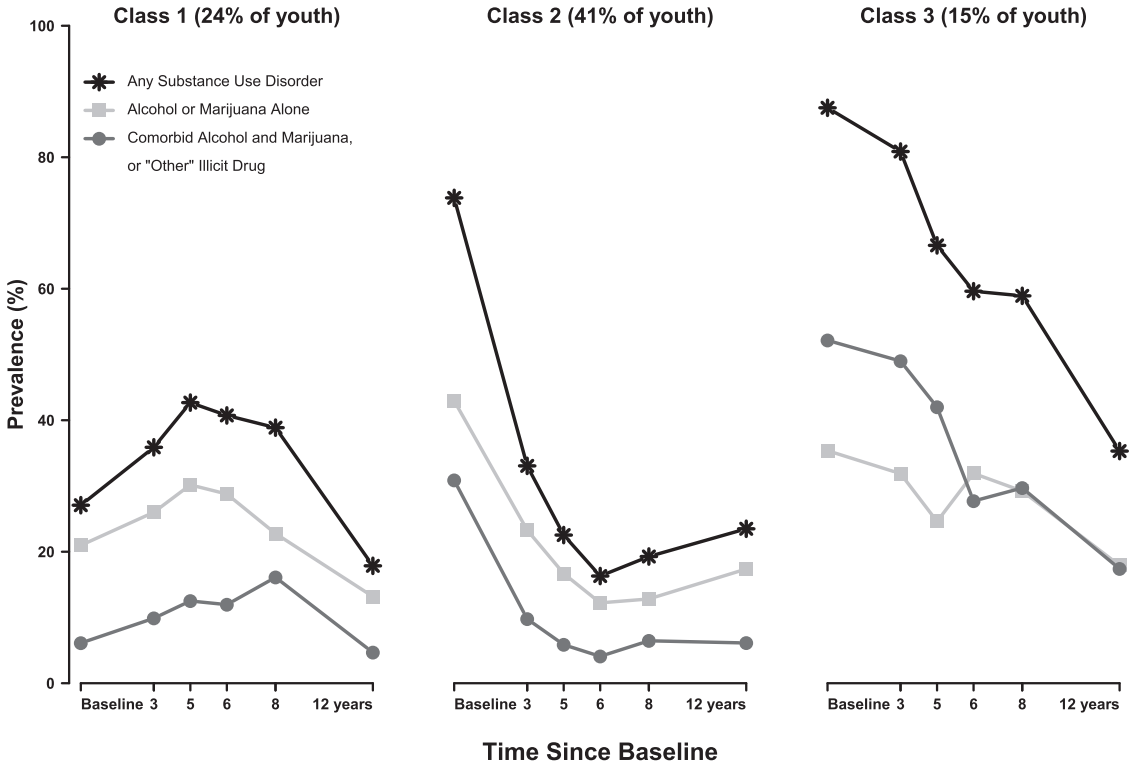
Gender, race/ethnicity, and age at baseline were significant predictors of trajectory class. Table 2 lists ORs for demographic differences. Table 2 also presents demographic differences between the no-SUD group (discussed earlier) and participants included in the trajectory analyses.

*Gender Differences.* More than half the females were in class 2 compared with 40.3% of males. Only 6.3% of females were in class 3 compared with 15.2% of males. Compared with females, males had more than 3 times the odds of being in class 3 than in class 2 (AOR 3.6; 95% CI 2.0–6.7).

*Racial/Ethnic Differences.* Nearly one-third of Hispanics and nearly half of non-Hispanic whites were in class 3. In contrast, only 9.1% of African Americans were in class 3. Compared with African Americans, Hispanics had 3.8 times the odds—and non-Hispanic whites had 6.0 times the odds—of being in class 3 than in class 2 (95% CI 1.6–9.2 and 2.9–12.4, respectively). In addition, compared with African Americans, non-Hispanic whites were more likely to be in class 3 than in class 1 (AOR 4.7; 95% CI 1.8–12.2).

*Age Differences.* More than half the participants who were 10 to 13 years of age at baseline were in class 1 compared

**FIGURE 3** Trajectories of substance use disorder in juvenile delinquents during the 12 years after detention (N = 1,822). Note: Prevalence of any substance use disorder and its subcategories (alcohol or marijuana alone, comorbid/"other" illicit) for each of the three trajectory classes is shown. The 19.6% of youth who never had a substance use disorder at any follow-up interview are not shown. Subcategories of any substance use disorder are mutually exclusive.




with 10.6% of those at least 17 years old. In contrast, nearly half the participants at least 17 years old at baseline were in class 2 compared with only 11.9% of 10- to 13-year-olds. Similarly, only 3.6% of the 10- to 13-year-olds were in class 3 compared with 17.9% of participants at least 17 years old. Being older at baseline was significantly associated with being in class 2 or 3 compared with class 1 (AOR 2.2 per year; 95% CI 1.1–4.2; AOR 2.1 per year; 95% CI 1.4–3.3, respectively).

## DISCUSSION

Delinquent youth follow markedly different trajectories of SUD as they age. Nearly 1 in 6 youth were in the most serious and persistent trajectory (class 3). At all time points, this group had the highest prevalence of SUD: nearly 90% at the baseline interview and more than one-third 12 years later. Comorbid SUDs and illicit drug use disorders—such as cocaine or hallucinogen—were far more common in this trajectory than in others. Youth who were older at baseline were more likely to be in this group; younger participants might not have had enough time to develop more serious or multiple SUDs.

Trajectory classes 1 and 2—24% and 41% of youth, respectively—were similar to the "adolescent-limited" trajectories of substance abuse found among general population youth.[20,52] Class 2 contained disproportionately older detainees who might have been closer to the "maturing out" phase when sampled at baseline.[53] More than half the youth who were 10 to 13 years old at detention were in class 1. These youth might be the most amenable to preventive interventions because they have yet to develop SUDs. Moreover, they are more likely to receive services than older detainees.[54]

There were substantial gender differences. Consistent with studies of general population and other at-risk youth,[15,17,28,29,55] females had twice the odds of being in the no-SUD group compared with males. Compared with females, males had 3.6 times the odds of being in the most serious and persistent trajectory (class 3). What accounts for these dramatic gender differences? Females might be more likely than males to desist as childcare demands evolve.[56-58] Moreover, females benefit from the greater provision of mental health services provided to them while they are incarcerated and when they return to their communities.[5,59]

Although the war on drugs has disproportionately affected African Americans,[60-62] fewer than 10% of African Americans were in the most serious and persistent trajectory (class 3) compared with nearly 45% of non-Hispanic whites. Hispanics had trajectories more similar to non-Hispanic whites than to African Americans. Our findings add new information to the equivocal and often conflicting literature on racial/ethnic differences in trajectories of substance abuse. However, it is difficult to compare our findings with the findings of prior studies because most investigated only

**TABLE 2** Predicting Trajectory Class Membership Using Gender, Race/Ethnicity, and Age at Baseline (N = 1,822)[a]

| | Percentage in Each Group | | | | Odds Ratio (95% CI) Predicting Class Membership[b] | | | |
|---|---|---|---|---|---|---|---|---|
| | No SUD | Class 1 | Class 2 | Class 3 | No SUD vs. All Classes | Class 3 vs. 1 | Class 3 vs. 2 | Class 2 vs. 1 |
| Overall | 19.6 | 24.5 | 41.3 | 14.6 | | | | |
| Gender | | | | | | | | |
| Females | 30.4 | 8.6 | 54.7 | 6.3 | reference[c] | reference[c] | reference[c] | reference[c] |
| Males | 18.7 | 25.8 | 40.3 | 15.2 | **0.5 (0.4–0.7)** | 1.1 (0.4–3.3) | **3.6 (2.0–6.7)** | 0.3 (0.1–1.1) |
| Race/ethnicity | | | | | | | | |
| African American | 20.6 | 25.5 | 44.8 | 9.1 | reference[d] | reference[d] | reference[d] | reference[d] |
| Hispanic | 17.2 | 22.1 | 29.8 | 30.9 | 0.8 (0.5–1.2) | 2.5 (0.9–6.5) | **3.8 (1.6–9.2)** | 0.6 (0.2–1.9) |
| Non-Hispanic white | 11.7 | 18.4 | 26.3 | 43.5 | **0.5 (0.3–0.8)** | **4.7 (1.8–12.2)** | **6.0 (2.9–12.4)** | 0.8 (0.3–2.0) |
| Age at baseline[e] | | | | | 1.0 (0.9–1.2) | **2.1 (1.4–3.3)** | 1.0 (0.6–1.5) | **2.2 (1.1–4.2)** |
| 10–13 y | 31.0 | 53.6 | 11.9 | 3.6 | | | | |
| 14–16 y | 14.2 | 34.3 | 38.5 | 13.0 | | | | |
| ≥17 y | 22.3 | 10.6 | 49.2 | 17.9 | | | | |

*Note: Odds ratios in boldface type are significantly different from 1.0 with p < .05. SUD = substance use disorder.*

[a] *Prevalence estimates and odds ratios are weighted to adjust for sampling design and to reflect the demographic characteristics of the Cook County Juvenile Temporary Detention Center. Four participants who identified as "other" race/ethnicity and 3 participants who never completed the Diagnostic Interview Schedule for Children (baseline interview) or the Diagnostic Interview Schedule (follow-up interviews) are excluded from the table.*

[b] *Odds ratios comparing classes 1, 2, and 3 were estimated within our growth mixture model to account for uncertainty in assigning participants to the latent classes. Odds ratios comparing the no-SUD group with all classes were estimated using logistic regression outside the growth mixture model framework.*

[c] *The reference group is females.*

[d] *The reference group is African Americans. Odds ratios (95% CI) for Hispanics compared with non-Hispanic whites are 1.9 (0.7–5.1) for class 3 versus 1, 1.6 (0.7–3.5) for class 3 versus 2, 1.2 (0.3–4.4) for class 2 versus 1, and 1.6 (0.9–2.6) for no SUD versus all other classes.*

[e] *Odds ratios (95% CI) are given per every year. For example, the odds ratio of 2.1 means that compared with a participant who is 14 years old at baseline, a participant who is 15 years old at baseline has 2.1 times the odds of being in class 3 compared with class 1.*

use (not disorder), excluded Hispanics, or had too few racial/ethnic minorities to analyze differences.[17,20,55,63-66]

This study has several limitations. The sample included participants from 1 jurisdiction; findings might not be generalizable to other regions. Our data also are subject to the limitations of self-report. Although participants were reinterviewed up to 9 times, some might have had SUDs outside the recall period. As in prior studies,[41-43] we defined SUDs as including abuse or dependence disorders. This approach does not account for the severity of disorder as measured by symptom counts. Estimating trajectories necessitated combining less common substances. Although the sample was large, we could not identify more than 3 trajectories or include predictors beyond demographic characteristics. To reflect the population of youth entering the juvenile justice system (10–18 years of age), we sampled a wide range of ages at baseline.[2] Trajectories might have been different had we focused on a specific age at baseline. We did not model trajectories based on a participant's age at each wave because of age cohort effects: participants sampled during early adolescence have different outcomes as they age compared with participants sampled during late adolescence.

Despite these limitations, our findings have implications for future research, mental health policy, and clinical services. Recommendations for future research are listed below.

1. Incorporate trajectory analysis into longitudinal studies of psychiatric disorders in youth. Trajectory analysis provides unique information about the course of psychiatric disorders, complementing information provided by studies of prevalence. Investigations of high-risk populations—youth in the child welfare system and homeless and runaway youth—are especially needed.
2. Use trajectories to predict distal outcomes. Trajectory analysis provides a comprehensive view of psychiatric disorder as youth age, not just at 1 point in time. Thus, trajectory analysis is a powerful tool to predict how the burden of disorder during adolescence affects outcomes in adulthood, such as educational achievement, employment, and responsible parenting.
3. Examine multiple substances. Most trajectory analyses focus on use (not disorder) and examine only 1 substance, such as alcohol or marijuana.[18,20-22,30,67] Few examine other illicit drugs, how the choice of substances changes with age, and the sequences of multiple SUDs. Thus, we have the fewest data on the most serious patterns of abuse.

We note the following implications for clinicians.

1. Design interventions for Hispanics. Like non-Hispanic whites, Hispanics were more likely than African Americans to be in the most serious and persistent trajectory. However, few substance use prevention or treatment programs have been designed for Hispanic youth. This omission is critical: Hispanics are now the largest minority in the United States[68] and are disproportionately incarcerated in many states.[24,69,70]
2. Provide gender-specific interventions. The past decade has seen needed improvements in programs for delinquent females who have been historically underserved in the justice system. However, males continue to be overrepresented in juvenile justice and to fare worse than

females; we found that 15.2% of males were in the most serious and persistent trajectory compared with 6.3% of females. Moreover, males have poorer outcomes after substance use treatment than females.[71-73] Interventions designed for males must focus on their unique service needs and risk factors for relapse.[71-73]

3. Design preventive interventions for younger detainees. Interventions that work with older adolescents might not be successful with younger adolescents. Our finding that more than half the youngest participants had yet to develop SUDs indicates that interventions during early adolescence could provide the best return on treatment dollars.[74]

Many youth become involved in the juvenile justice system as a consequence of substance abuse.[75] A substantial proportion will resume abusing drugs after they are released from detention.[76] The challenge for child psychiatry is to slow the revolving door between the detention center and the community. The Patient Protection and Affordable Care Act (PPACA) provides reason for optimism because treatment for SUD is considered an "essential health benefit" that must be provided by Medicaid and the insurance exchanges to youth in the community.[77] (The PPACA does not pertain to services provided to prisoners.[78]) Nevertheless, challenges remain. Child psychiatrists and other mental health specialists must collaborate with the police, courts, and detention centers to ensure that youth accused of minor offenses are diverted from juvenile justice to receive needed services, more effective treatments are developed for incarcerated youth, and the systems that serve released detainees when they return are improved. &

Accepted November 29, 2016.

Drs. Welty, Hershfield, Abram, Han, Byck, and Teplin are with Health Disparities and Public Policy, Northwestern University Feinberg School of Medicine, Chicago. Dr. Hershfield also is with Children's Hospital Los Angeles, University of Southern California Center for Excellence in Developmental Disabilities, Los Angeles.

This work was supported by National Institute on Drug Abuse grants R01DA019380, R01DA022953, and R01DA028763; National Institute of Mental Health grants R01MH54197 and R01MH59463 (Division of Services and Intervention Research and Center for Mental Health Research on AIDS); and grants 1999-JE-FX-1001, 2005-JL-FX-0288, and 2008-JF-FX-0068 from the Office of Juvenile Justice and Delinquency Prevention. Major funding also was provided by the National Institute on Alcohol Abuse and Alcoholism, the National Institutes of Health (NIH) Office of Behavioral and Social Sciences Research, the Substance Abuse and Mental Health Services Administration (Center for Mental Health Services, Center for Substance Abuse Prevention, Center for Substance Abuse Treatment), the NIH Center on Minority Health and Health Disparities, the Centers for Disease Control and Prevention (National Center for Injury Prevention and Control and National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention), the NIH Office of Research on Women's Health, the NIH Office of Rare Diseases, Department of Labor, Department of Housing and Urban Development, the William T. Grant Foundation, and the Robert Wood Johnson Foundation. Additional funds were provided by the John D. and Catherine T. MacArthur Foundation, the Open Society Institute, and the Chicago Community Trust.

Drs. Welty and Han served as the statistical experts for this research.

The authors thank their participants for their time and willingness to participate and the Circuit Court of Cook County including the Cook County Juvenile Temporary Detention Center, the Juvenile Justice and Child Protection Department, the Juvenile Probation and Court Services Department, the Social Service Department, Adult Probation, and Forensic Clinical Services; the Cook County Department of Corrections; the Illinois Department of Juvenile Justice; and the Illinois Department of Corrections.

Disclosure: Dr. Welty has received an honorarium to cover travel costs as an invited speaker from the Association for Clinical and Translational Science. Dr. Abram has received travel reimbursements and an honorarium from the American Institutes for Research, Neglected or Delinquent Technical Assistance Center for the Education of Children/Youth Who Are Neglected or At-Risk (NDTAC). Dr. Teplin has received payment from Indivior.com (McCann Complete Medical Inc.) to take part in a survey. Drs. Hershfield, Han, and Byck report no biomedical financial interests or potential conflicts of interest.

Correspondence to Linda A. Teplin, PhD, Department of Psychiatry and Behavioral Sciences, Northwestern University, Feinberg School of Medicine, 710 N. Lakeshore Drive, Suite 900, Chicago, IL 60611; e-mail: healthdisparities@northwestern.edu

0890-8567/$36.00/©2016 American Academy of Child and Adolescent Psychiatry

http://dx.doi.org/10.1016/j.jaac.2016.10.018

## REFERENCES

1. McClelland GM, Elkington KS, Teplin LA, Abram KM. Multiple substance use disorders in juvenile detainees. J Am Acad Child Adolesc Psychiatry. 2004;43:1215-1224.
2. Teplin LA, Abram KM, McClelland GM, Dulcan MK, Mericle AA. Psychiatric disorders in youth in juvenile detention. Arch Gen Psychiatry. 2002;59:1133-1143.
3. Harzke AJ, Baillargeon J, Baillargeon G, *et al*. Prevalence of psychiatric disorders in the Texas juvenile correctional system. J Correct Health Care. 2012;18:143-157.
4. Lederman CS, Dakof GA, Larrea MA, Li H. Characteristics of adolescent females in juvenile detention. Int J Law Psychiatry. 2004;27:321-337.
5. Teplin LA, Welty LJ, Abram KM, Dulcan MK, Washburn JJ. Prevalence and persistence of psychiatric disorders in youth after detention: a prospective longitudinal study. Arch Gen Psychiatry. 2012;69:1031-1043.
6. Welty LJ, Harrison AJ, Abram KM, *et al*. Health disparities in drug- and alcohol-use disorders: a 12-year longitudinal study of youths after detention. Am J Public Health. 2016;106:872-880.
7. Copeland WE, Shanahan L, Costello J, Angold A. Childhood and adolescent psychiatric disorders as predictors of young adult disorders. Arch Gen Psychiatry. 2009;66:764-772.
8. Cottle CC, Lee RJ, Heilbrun K. The prediction of criminal recidivism in juveniles—a meta-analysis. Crim Justice Behav. 2001;28:367-394.
9. Stoolmiller M, Blechman EA. Substance use is a robust predictor of adolescent recidivism. Crim Justice Behav. 2005;32:302-328.
10. Kingree JB, Betz H. Risky sexual behavior in relation to marijuana and alcohol use among African-American, male adolescent detainees and their female partners. Drug Alcohol Depend. 2003;72:197-203.
11. Laub JH, Vaillant GE. Delinquency and mortality: A 50-year follow-up study of 1,000 delinquent and nondelinquent boys. Am J Psychiatry. 2000;157:96-102.
12. Abram KM, Teplin LA, McClelland GM, Dulcan MK. Comorbid psychiatric disorders in youth in juvenile detention. Arch Gen Psychiatry. 2003;60:1097-1108.
13. Randall J, Henggeler SW, Pickrel SG, Brondino MJ. Psychiatric comorbidity and the 16-month trajectory of substance-abusing and substance-dependent juvenile offenders. J Am Acad Child Adolesc Psychiatry. 1999;38:1118-1124.
14. Schulenberg J, O'Malley PM, Bachman JG, Wadsworth KN, Johnston LD. Getting drunk and growing up: trajectories of frequent binge drinking during the transition to young adulthood. J Stud Alcohol. 1996;57:289-304.
15. Brook DW, Brook JS, Rubenstone E, Zhang C, Saar NS. Developmental associations between externalizing behaviors, peer delinquency, drug use, perceived neighborhood crime, and violent behavior in urban communities. Aggress Behav. 2011;37:349-361.
16. Brown TL, Flory K, Lynam DR, Leukefeld C, Clayton RR. Comparing the developmental trajectories of marijuana use of African American and Caucasian adolescents: patterns, antecedents, and consequences. Exp Clin Psychopharmacol. 2004;12:47-56.

17. Ellickson PL, Martino S, Collins RL. Marijuana use from adolescence to young adulthood: Multiple developmental trajectories and their associated outcomes. Health Psychol. 2004;23:299-307.
18. Flory K, Lynam D, Milich R, Leukefeld C, Clayton R. Early adolescent through young adult alcohol and marijuana use trajectories: early predictors, young adult outcomes, and predictive utility. Dev Psychopathol. 2004;16:193-213.
19. Marti CN, Stice E, Springer DW. Substance use and abuse trajectories across adolescence: a latent trajectory analysis of a community-recruited sample of girls. J Adolesc. 2010;33:449-461.
20. Tucker JS, Ellickson PL, Orlando M, Martino SC, Klein DJ. Substance use trajectories from early adolescence to emerging adulthood: a comparison of smoking, binge drinking, and marijuana use. J Drug Issues. 2005;35:307-332.
21. Windle M, Mun EY, Windle RC. Adolescent-to-young adulthood heavy drinking trajectories and their prospective predictors. J Stud Alcohol. 2005;66:313-322.
22. Windle M, Wiesner M. Trajectories of marijuana use from adolescence to young adulthood: predictors and outcomes. Dev Psychopathol. 2004;16:1007-1027.
23. Sedlak AJ, McPherson KS. Youth's Needs and Services: Findings from the Survey of Youth in Residential Placement. Washington, DC: US Department of Justice, Office of Juvenile Justice and Delinquency Prevention; 2010.
24. Hsia H, Bridges G, McHale R. Disproportionate Minority Confinement 2002 Update. Washington, DC: US Department of Justice, Office of Justice Programs, Partnerships for Safer Communities; 2004.
25. Huizinga D, Thornberry TP, Knight K, *et al*. Disproportionate Minority Contact in the Juvenile Justice System: A Study of Differential Minority Arrest/Referral to Court in Three Cities. Washington, DC: Office of Juvenile Justice and Delinquency Prevention; 2007.
26. Schiraldi V, Ziedenberg J. Cellblocks or Classrooms?: The Funding of Higher Education and Corrections and Its Impact on African American Men. Washington, DC: Justice Policy Institute; 2002.
27. Armour J, Hammond S. Minority youth in the juvenile justice system: disproportionate minority contact. Paper presented at: National Conference of State Legislatures; 2009; Washington, DC.
28. Chassin L, Flora DB, King KM. Trajectories of alcohol and drug use and dependence from adolescence to adulthood: the effects of familial alcoholism and personality. J Abnorm Psychol. 2004;113:483-498.
29. Jackson KM, Sher KJ, Wood PK. Trajectories of concurrent substance use disorders: a developmental, typological approach to comorbidity. Alcohol Clin Exp Res. 2000;24:902-913.
30. Hill KG, White HR, Chung IJ, Hawkins JD, Catalano RF. Early adult outcomes of adolescent binge drinking: Person- and variable-centered analyses of binge drinking trajectories. Alcohol Clin Exp Res. 2000;24:892-901.
31. Mauricio AM, Little M, Chassin L, *et al*. Juvenile offenders' alcohol and marijuana trajectories: risk and protective factor effects in the context of time in a supervised facility. J Youth Adolesc. 2009;38:440-453.
32. Hockenberry S. Juveniles in Residential Placement, 2011. Rockville, MD: US Department of Justice, Office of Justice Programs, Office of Juvenile Justice and Delinquency Prevention; 2014.
33. Rastogi S, Census USBot. The Black Population: 2010. Washington, DC: US Department of Commerce, Economics and Statistics Administration, US Census Bureau; 2011.
34. Sickmund M, Sladky T, Kang W, Puzzanchera C. Easy access to the census of juveniles in residential placement. https://www.ojjdp.gov/ojstatbb/ezacjrp/. Published 2011. Accessed February 14, 2013.
35. Guerino P, Harrison PM, Sabol WJ. Prisoners in 2010. Washington, DC: Bureau of Justice Statistics; 2011.
36. Federal policy for the protection of human subjects: notices and rules. Part 2 (56 FR 28002). Fed Reg. 1991;56(117):28002-28032.
37. Fisher PW, Shaffer D, Piacentini J, *et al*. Sensitivity of the Diagnostic Interview Schedule for Children, 2nd edition (DISC-2.1) for specific diagnoses of children and adolescents. J Am Acad Child Adolesc Psychiatry. 1993;32:666-673.
38. Shaffer D, Fisher PW, Dulcan MK, Davies M. The NIMH Diagnostic Interview Schedule for Children Version 2.3 (DISC-2.3): description, acceptability, prevalence rates, and performance in the MECA study. J Am Acad Child Adolesc Psychiatry. 1996;35:865-877.
39. Compton WM, Cottler LB. The Diagnostic Interview Schedule (DIS). In: Hilsenroth M, Segal DL, eds. Comprehensive Handbook of Psychological Assessment, Vol 2. Hoboken, NJ: John Wiley and Sons; 2004:153-162.
40. Robins LN, Cottler LB, Bucholz KK, Compton WM. Diagnostic Interview Schedule for DSM-IV (DIS-IV). St Louis, MO: Washington University; 1995.
41. Kessler RC, McGonagle KA, Zhao S, *et al*. Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States: results from the National Comorbidity Survey. Arch Gen Psychiatry. 1994;51:8-19.
42. Hedden SL. Behavioral Health Trends in the United States: Results From the 2014 National Survey on Drug Use and Health. Rockville, MD: SAMHSA; 2015.
43. National Institute on Alcohol Abuse and Alcoholism. National Epidemiologic Survey on Alcohol and Related Conditions—III (NESARC-III). https://www.niaaa.nih.gov/research/nesarc-iii. Published 2014. Accessed November 3, 2016.
44. Stata Statistical Software: Release 12 [computer program]. College Station, TX: StataCorp LP; 2011.
45. Korn E, Graubard B. Analysis of Health Surveys. New York: John Wiley and Sons; 1999.
46. Cochran WG. Sampling Techniques. New York: John Wiley and Sons; 1977.
47. Levy PS, Lemeshow S. Sampling of Populations: Methods and Applications. New York: John Wiley and Sons; 1999.
48. Muthen LK, Muthen BO. Mplus User's Guide. 6th ed. Los Angeles: Muthen and Muthen; 1998-2011.
49. D'Unger AV, Land KC, McCall PL, Nagin DS. How many latent classes of delinquent/criminal careers? Results from mixed Poisson regression analyses. Am J Sociol. 1998;103:1593-1630.
50. Keribin C. Consistent estimation of the order of mixture models. Indian J Stat. 2000;62:49-66.
51. Chassin L, Pitts SC, Prost J. Binge drinking trajectories from adolescence to emerging adulthood in a high-risk sample: predictors and substance abuse outcomes. J Consult Clin Psychol. 2002;70:67-78.
52. White HR, Pandina RJ, Chen PH. Developmental trajectories of cigarette use from early adolescence into young adulthood. Drug Alcohol Depend. 2002;65:167-178.
53. Vergés A, Haeny AM, Jackson KM, *et al*. Refining the notion of maturing out: results from the National Epidemiologic Survey on Alcohol and Related Conditions. Am J Public Health. 2013;103:e67-e73.
54. Teplin LA, Abram KM, McClelland GM, Washburn JJ, Pikus AK. Detecting mental disorder in juvenile detainees: who receives services. Am J Public Health. 2005;95:1773-1780.
55. Schulenberg JE, Merline AC, Johnston LD, O'Malley PM, Bachman JG, Laetz VB. Trajectories of marijuana use during the transition to adulthood: the big picture based on national panel data. J Drug Issues. 2005;35:255-279.
56. Staff J, Schulenberg JE, Maslowsky J, *et al*. Substance use changes and social role transitions: proximal developmental effects on ongoing trajectories from late adolescence through early adulthood. Dev Psychopathol. 2010;22:917-932.
57. Merline AC, O'Malley PM, Schulenberg JE, Bachman JG, Johnston LD. Substance use among adults 35 years of age: prevalence, adulthood predictors, and impact of adolescent substance use. Am J Public Health. 2004;94:96-102.
58. Fergusson DM, Boden JM, Horwood LJ. Transition to parenthood and substance use disorders: findings from a 30-year longitudinal study. Drug Alcohol Depend. 2012;125:295-300.
59. Belenko S, Houser KA. Gender differences in prison-based drug treatment participation. Int J Offender Ther Comp Criminol. 2012;56:790-810.
60. Dumont DM, Brockmann B, Dickman S, Alexander N, Rich JD. Public health and the epidemic of incarceration. Annu Rev Public Health. 2012;33:325.
61. Dumont DM, Allen SA, Brockmann BW, Alexander NE, Rich JD. Incarceration, community health, and racial disparities. J Health Care Poor Underserved. 2013;24:78-88.
62. Moore LD, Elkavich A. Who's using and who's doing time: incarceration, the war on drugs, and public health. Am J Public Health. 2008;98(suppl 1):S176.
63. Chen P, Jacobson KC. Developmental trajectories of substance use from early adolescence to young adulthood: gender and racial/ethnic differences. J Adolesc Health. 2012;60:154-163.
64. Finlay AK, White HR, Mun EY, Cronley CC, Lee C. Racial differences in trajectories of heavy drinking and regular marijuana use from ages 13 to 24 among African-American and White males. Drug Alcohol Depend. 2012;121:118-123.

65. Dembo R, Wareham J, Schmeidler J. Drug use and delinquent behavior—a growth model of parallel processes among high-risk youths. Crim Justice Behav. 2007;34:680-696.
66. O'Malley PM, Johnston LD. Epidemiology of alcohol and other drug use among American college students. J Stud Alcohol Suppl. 2002;14:23-39.
67. Brook JS, Whiteman M, Finch SJ, Morojele NK, Cohen P. Individual latent growth curves in the development of marijuana use from childhood to young adulthood. J Behav Med. 2000;23:451-464.
68. Brown A, Lopez MH. Mapping the Latino Population, by State, County, and City. Washington, DC: Pew Research Center's Hispanic Trends Project; 2013.
69. Bishop DM. The role of race and ethnicity in juvenile justice processing. In: Hawkins DF, Kempf-Leonard K, eds. Our Children, Their Children: Confronting Racial and Ethnic Differences in American Juvenile Justice. Chicago: University of Chicago Press; 2005:23-82.
70. Kempf-Leonard K. Minority youths and juvenile justice: disproportionate minority contact after nearly 20 years of reform efforts. Youth Violence Juv Justice. 2007;5:71-86.
71. Marsh JC, Cao D, D'Aunno T. Gender differences in the impact of comprehensive services in substance abuse treatment. J Subst Abuse Treat. 2004;27:289-300.
72. Green CA. Gender and use of substance abuse treatment services. Alcohol Res Health. 2006;29:55.
73. Grella CE, Scott CK, Foss MA, Dennis ML. Gender similarities and differences in the treatment, relapse, and recovery cycle. Eval Rev. 2008;32:113-137.
74. Bukstein OG. Substance use disorders and addictions. In: Dulcan MK, ed. Dulcan's Textbook of Child and Adolescent Psychiatry. Arlington, VA: American Psychiatry Publishing; 2016:219-244.
75. Belenko S, Sprott JB, Petersen C. Drug and alcohol involvement among minority and female juvenile offenders: treatment and policy issues. Crim Justice Policy Rev. 2004;5:3-34.
76. Vandam L. Patterns of drug use before, during and after detention: a review of epidemiological literature. In: Cools M, De Kimpe S, De Ruyver B, *et al.*, eds. Contemporary Issues in the Empirical Study of Crime. Governance of Security (GofS) Research Paper Series, Vol 1. Antwerp: Maklu; 2009:227-255.
77. Services USCfMM. Mental health and substance abuse coverage. https://www.healthcare.gov/coverage/mental-health-substance-abuse-coverage/. Published 2013. Accessed January 12, 2016.
78. Services USCfMM. Incarcerated people. https://www.healthcare.gov/incarcerated-people/. Published 2013. Accessed January 12, 2016.