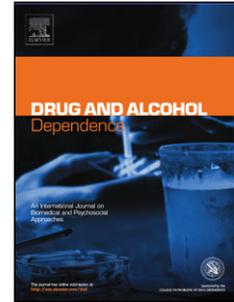


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Marijuana use trajectories among drug-using youth presenting to an urban emergency department: Violence and social influences

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Highlights

- Five marijuana use trajectory groups were identified among drug-using youth.
- Aggression and male gender were baseline markers of more severe use trajectories.
- Peer influences distinguished marijuana use trajectories over time.

Abstract

Aims: This paper examined longitudinal marijuana use trajectories among drug-using youth presenting to the ED to inform intervention development. **Methods:** Given interest in substance use and violence, this study oversampled those presenting with assault injuries. Assault-injured youth (ages 14-24) endorsing past 6-month drug use (n=349), and a sex and age proportionally-sampled comparison group (n=250) endorsing drug use, completed a baseline assessment and follow-ups at 6, 12, 18, and 24 months. Latent class trajectory analyses examined days of marijuana use over 2 years. Multinomial regression analyses examined baseline, 12-month and 24-month factors associated with substance use trajectory groups. **Results:** Trajectory analyses identified 5 groups: Low (Low; 28.2%; n=169); Intermittent (INT; 16.2%; n=97); Moderate Decline (MD; 12.0%; n=72); High decline (HD, 13.2%; n=79) and Chronic (C; 30.4%; n=182). At baseline, as compared to the Low group, the other trajectory groups were more likely to be male and have greater levels of physical aggression. At 12- and 24-months, negative and positive peer influences, incarceration and community violence were additional characteristics associated with the greater marijuana use trajectories (as compared to the Low group). **Conclusions:** Interventions for drug-using youth presenting to the urban ED should address peer influences, physical aggression and community violence exposure, given the association between these characteristics and greater marijuana use trajectories.

Keywords: marijuana use; youth; violence; latent class trajectory analysis; peer influence

1.0 Introduction

There is a critical need to understand marijuana use trajectories among youth residing in socio-economically disadvantaged communities. Marijuana is the most commonly used illicit drug used during adolescence (Substance Abuse and Mental Health Service Administration, 2014b), with use adversely affecting neuromaturation of the vulnerable adolescent brain (Gruber et al., 2012; Lopez-Larson et al., 2011; Schepis et al., 2011). Marijuana use during adolescence places youth at increased risk for motor vehicle crash (Maxwell, 2012; Naimi et al., 2003; Quinlan et al., 2005; Wilhelmi and Cohen, 2012), and other drug use (Center for Disease Control and Prevention, 2012; Center for Lawful Access and Abuse Deterrence, 2011; Schillie et al., 2009; Substance Abuse and Mental Health Service Administration, 2013; White et al., 2013a). The emergency department (ED) provides a useful setting to identify at-risk youth and initiate substance use interventions (Cunningham et al., 2009).

Based on social ecological and resiliency theories (Bronfenbrenner, 1998; Garnezy, 1991; Rutter, 1987; Stokols et al., 1996), marijuana use during adolescence and emerging adulthood is associated with evolving interactions between individual and social risk and promotive factors that can decrease or accelerate problem trajectories (Abadi et al., 2011; Bernstein et al., 2011; Brown et al., 2008; Cadoret et al., 1995; Cleveland and Wiebe, 2008; Fowler et al., 2007; Henry and Thornberry, 2010; Hussong et al., 2008; Mrug et al., 2010; Wagner, 2008; Windle et al., 2008; Zucker et al., 2000; Zucker et al., 2008). For example, violence is associated with substance use, particularly among those residing in socio-economically disadvantaged communities (Goldstick et al., 2015; Goldstick et al., 2016; Walton et al., 2009; White et al., 2009), likely due to shared risk and promotive factors for some substances (e.g., marijuana), and/or acute pharmacological effects of substances (e.g., alcohol)

(Chermack and Giancola, 1997; White et al., 2009). Although parental influences are important during younger ages, peers are the most robust influence for substance use during the transition to adulthood (Abadi et al., 2011; Allen et al., 2012; Brechwald and Prinstein, 2011; Burk et al., 2012; Chein et al., 2011; Dziak et al., 2014; Simons-Morton and Farhat, 2010; Wolfe et al., 2012), increasing exposure to deviant social contexts and distancing youth from protective influences.

Latent trajectory analysis is a useful approach to identifying heterogeneity in trajectories of substance use (Nagin and Tremblay, 2005; Skardhamar, 2010), with groupings providing an opportunity to examine characteristics that can inform interventions (Brame et al., 2012). Prior research examining marijuana use trajectories are relatively rare. For example, a longitudinal study of youth from a socio-economically disadvantaged community (Brook et al., 2011) found four groups of marijuana users (low users, decreasing, increasing, and chronic), whereas Schulenberg and colleagues (2005) used Monitoring the Future (MTF) data to identify six marijuana use trajectory groups (i.e., chronic, decreased, increased, fling, rare, and abstain). Chronic users are more likely to be male, with the greatest constellation of risk factors including externalizing (e.g., delinquency, impulsivity, and substance use) and internalizing problems (Brook et al., 2011; Chassin et al., 2004; Jackson et al., 2008; Meier et al., 2013). Baseline factors that distinguish chronic users from decreasing or late onset users are less evident, with one study finding greater negative affect among the late onset group (Brook et al., 2011; Meier et al., 2013). Other researchers find that decreasing users are initially similar to chronic users, but over time had less substance use, delinquency and peers who used marijuana (Schulenberg et al., 2005); in contrast, increasing users are most likely to use other substances, use marijuana to cope, have drug-using friends, and report delinquency (Schulenberg et al., 2005). Although

aggression is related to alcohol use during adolescence (White et al., 2013b; White et al., 2009), few studies have examined marijuana use in relation to violence, with one study finding that increasing users show more persistent physical aggression (Schulenberg et al., 2005). It is unclear how these findings generalize to youth presenting to urban EDs, with generally much lower socio-economic status and greater minority representation.

The current study examined longitudinal marijuana use trajectories among youth presenting for care at an urban ED. The ED is an important contact point for medical care for youth at high risk for substance use and violence, especially the underinsured and uninsured, with ED patients over-representing socially disadvantaged minority groups (Albert and McCaig, 2014). Further, the ED provides a location to access adolescents, who are often missed in school-based studies because of poor attendance (Grove et al., 2000; Ramirez et al., 2012; Wilson and Klein, 2000). Most patients (>90%) seeking ED care are treated and released (Albert and McCaig, 2014), which is consistent with studies demonstrating the receptivity of patients to ED-based interventions (Walton et al., 2012; Cunningham et al., 2015).

The purpose of this study was to examine factors associated with greater marijuana use trajectories to inform intervention development for drug-using youth presenting to urban EDs, with this study enrolling patients with past 6 month drug use, oversampling those presenting with assault injuries (Bohnert et al., 2015). Prior papers showed that assault-injured youth had increased rates of ED visits for violent injury, which was related to having a drug use disorder (Cunningham et al., 2015). First, this paper presents findings from latent trajectory analysis to identify subgroups of marijuana users two-years post-ED visit. Second, we characterize risk and promotive factors associated with these groupings at baseline, and at 12- and 24-months to inform interventions. For example, if the relationship between time-varying factors is consistent

over time, then baseline screening could indicate the need for initiating interventions in the ED, with extended interventions addressing influences over time. In contrast, if the factors associated with trajectories varied over time, then adaptive interventions may be indicated to address these changing factors (Lei et al., 2012; Rich et al., 2014). Hypothesized factors associated with greater marijuana use trajectories included: male gender and older age; greater involvement with violence (assault injury, physical aggression, physical victimization, community violence) and negative peer influences; less involvement with positive peers, substance use treatment, and the criminal justice system. Also, we hypothesized that greater marijuana use trajectories would be: consistently related to peer influences over time, reflecting their importance during adolescence and emerging adulthood, and community violence, reflecting the urban setting in which youth likely remain; less strongly associated with interpersonal violence (aggression and victimization) over time, reflecting developmental trends for decreased involvement with violence during the transition to emerging adulthood; and, inconsistently related to incarceration and drug treatment over time, particularly given expected low rates of receipt of treatment services.

2.0 Material and Methods

2.1 Design

Data were collected for the Flint Youth Injury Study (Bohnert et al., 2015; Cunningham et al., 2015; Cunningham et al., 2014), which is a longitudinal study with assessments during the ED visit and over 24-months. Flint, Michigan has similar crime rates to other urban centers (Federal Bureau of Investigation, 2011). Youth presenting for an assault injury were oversampled (n=349), and proportionally balanced by age (ages 14-17; 18-20; 21-24) and sex with youth presenting for other reasons (n=250). The study was approved by university and hospital IRBs; a NIH Certificate of Confidentiality was obtained.

2.2 Setting and Sample

Following written assent/consent (parental consent if age <18 years), patients (ages 14-24) presenting to the ED for an assault injury, and a proportionally sampled group presenting for other reasons self-administered a computerized survey (assault patients admitted to the hospital were recruited if they stabilized within 72 hours). Exclusions were presentation for acute sexual assault, child maltreatment, suicidal ideation/attempt, or inability to provide consent (e.g., altered mental status).

2.3 Procedures

Youth reporting past six-month drug use on the Alcohol, Smoking, and Substance use Involvement Screening Test [ASSIST; marijuana, other illicit drugs (i.e., cocaine, inhalants, Street opioids, other) or non-medical use of prescription drugs (i.e., opioids, sedative, stimulants)](Humenuik et al., 2008; National Institute on Drug Abuse, 2010; WHO ASSIST Working Group, 2002) were eligible for the study. Alcohol and tobacco use were not inclusion criteria. Eligible youth provided assent/consent (parental consent if age <18 years), and completed a ~90-minute baseline assessment (\$20 remuneration, plus \$5 for urine sample for drug testing). In-person follow-up assessments were conducted at 6-, 12-, 18-, and 24-months [remuneration: \$35, \$40, \$40, and \$50 respectively, including urine samples).

2.4 Measures

2.4.1 Demographics. Age, sex, race, education, marital status, school drop-out (past 6-month not in school or complete high school) and past 6-month self/family receipt of public assistance were collected (Cunningham et al., 2014).

2.4.2 Substance Use. Substance use was assessed using the Time Line Follow Back (TLFB) (Chermack et al., 2010; Epstein-Ngo et al., 2013; Hjorthoj et al., 2012; Sobell et al.,

1988) for the past 30 days at baseline and for the past 90 days at follow-ups. For latent trajectory analyses, the number of days of marijuana use was summed for each assessment.

2.4.3 Violence. Past 6-month violence was assessed using a modified version of the physical assault scale of the Conflict Tactics Scale 2 (Straus et al., 1996), assessing: a) frequency of moderate and severe physical victimization (someone did to you); and, b) physical aggression (you did to someone else). Aggression and victimization were assessed separately for dating partners (e.g., girlfriend/boyfriend, husband/wife) and peers (e.g., non-partners: friend, stranger, acquaintance, etc.); responses ranged from 0 (never) to 6 (20 times or more). Peer and dating items were summed for a total score (physical aggression $\alpha = .0.90$; physical victimization $\alpha = .0.93$). Community violence exposure in the past 6 months included five items assessing frequency of witnessed neighborhood behaviors (e.g., heard gun shots, saw drug deals, had their homes broken into, saw gangs in the neighborhood, saw someone getting stabbed or shot) (Richters and Martinez, 1992), ranging from “never” (0) to “many times” (3) (range 0 -15; $\alpha = .0.73$).

2.4.4 Drug Treatment, Criminal Justice Involvement. Participants were asked the number of days they were incarcerated in the past 6 months (McLellan et al., 1992). Similarly, past 6-month substance use treatment was assessed with a single item (McLellan et al., 1992).

2.4.5 Other Risk and Promotive Factors. Negative peer influences assessed how many of their friends were currently involved in negative activities (e.g., use substances, sell drugs, fight, carry weapons, shoplifting/busted for burglary/robbery) (Ostaszewski and Zimmerman, 2006) (range 7-35; $\alpha = 0.81$). Positive peer influences assessed how many of their friends were currently involved in positive activities (e.g., good grades, attend church, school clubs or community activities, plans to go to college; range 4-20; $\alpha = 0.75$).

2.5 Data Analyses

Data were analyzed with R version 3.2.3. Using the R package flexmix (Grun and Leisch, 2008; Leisch, 2004), we modeled marijuana use days across the five time points using latent trajectory analysis. Because the outcome variable is a count, we specified a Poisson distribution for the outcome; an offset for the log of the number of days in the substance use calendar was used, to account for different follow-back periods at baseline (past 30 days) vs. follow-ups (past 90 days at each assessment); thus, the fitted model is effectively equivalent to modeling the % of use days (i.e., number of use days per days assessed). A cubic polynomial was used to model the time-varying rate on the log scale. This specification is capable of capturing most plausible patterns of change over five time points, and uses fewer parameters than estimating separate coefficients for each time point. Following convention (Nylund et al., 2007), we used the Bayesian information criterion (BIC), in conjunction with considerations of parsimony and interpretability, to select the number of groups. To ensure a parsimonious solution that does not over fit the data, as well as ensuring large enough groups to make between-group comparisons, we imposed the constraint that each group must have a prior probability of at least 0.10 (corresponding to 60 individuals); this constraint operated within the fitting process so that, for a given number of input classes, the fitted model is that which maximizes the likelihood subject to the aforementioned constraint; in some cases the optimal solution may have fewer than the nominal number of input classes. To guard against model convergence to local maximums, the model was re-fit from 200 random starting values for each number of input classes and the model corresponding to the maximum converged likelihood was saved. To evaluate class separation, we calculated the relative entropy of the posterior probability distribution, with a value of 0.8 indicating acceptable separation between classes (Ram and Grimm, 2009). After

assigning participants to the group in which they had the greatest posterior probability of membership, we compared the model-estimated rates with the empirical rates in each group to verify acceptable within-group fit.

We used regression analyses to examine the associations between trajectory membership and factors assessed at baseline, 12, and 24 months, with descriptive data also provided to aid with interpretation of regression models. We included time invariant measures of age, sex, and assault injury in regression analyses; we included all other time-varying variables in regression analyses except physical victimization (which was highly correlated with physical aggression at baseline; $r=0.66$), prioritizing variables that would inform interventions in terms of sample (i.e., assault injury) and content (i.e., physical aggression, community violence). The outcome, predicted trajectory class, is not changing across the baseline, 12- and 24-month analyses; however, time-invariant associations (e.g., age, male) vary across the models due to differences in the time-varying factors and participants that are simultaneously included (i.e., $n=599$ at baseline; $n=502$ at 12-months; $n=512$ at 24-months). While we have ascribed labels to the groups identified, we want to emphasize latent trajectory analysis as a model-based tool for detecting, and describing, heterogeneity in trajectories of marijuana use over the study period, rather than as an immutable typology of individuals (Nagin and Tremblay, 2005; Skardhamar, 2010). This descriptive, rather than endogenous, interpretation of the groupings partially justifies our examination of 12- and 24-month correlates of trajectory groups, which may inform interventions aims at disrupting a deleterious trajectory (Brame et al., 2012).

3.0 Results

3.1 Descriptive Characteristics

At baseline, 58.8% were male, the mean age was 20.1 (standard deviation=2.4), 28% were living with a partner, 40% had at least one child, most received public assistance (73.0%), and were African-American (58.3%; 32.5% Caucasian, 9.3% other); 5.8% reported Hispanic ethnicity. Follow-up rates were: 85.3% (6-months), 83.7% (12-months), 84.2% (18-months) and 85.3% (24-months).

3.2 Marijuana Use Trajectory Groups

Examination of the BIC scores resulted in strong evidence in support of a five-group model [1 group BIC= 111537.30; 2 group= 63993.41; 3 group= 54853.51; 4 group=47800.53; 5 group= 43637.72]: Low (Low; 28.2%; n=169); Moderate decline (MD; 12.0%; n=72); Intermittent (INT; 16.2%; n=97); High decline (HD, 13.2%; n=79) and Chronic (C; 30.4%; n=182). Based on 200 replications from random starting values, the maximum likelihood estimator for the (at most) 6-class model, subject to the group size constraint, had 5-classes in 100% of replications; thus no admissible 6-class model was found, in light of our constraint. The relative entropy for the 5-class solution was 0.94, indicating very good separation between classes. The very close agreement between the model-estimated rates shown in Figure 1 and the observed proportion of substance use days for each group and time point shown in Table 1 indicate good within-group model fit.

3.3 Characteristics of Trajectory Groups

Table 2 shows descriptive characteristics based on marijuana use trajectory group. Age and assault injury appeared similar across the groups, whereas females appeared to be most likely in Low group. Physical aggression and victimization decreased over time. Rates of drug treatment were generally low across the groups. Rates of incarceration were higher at baseline

for all groups. The Low group had the lowest negative peer influences and community violence, and the greatest positive peer influences.

3.3.1 Baseline

At baseline (Table 3), males were more likely to be in the INT, MD, HD, and Chronic groups than in the Low group. Physical aggression was greater among those in the INT, MD, HD, and Chronic groups than in the Low group. In contrast, community violence was greater among those in the HD group than the Low group. Finally, the Chronic group reported less positive peer influences than the Low group.

3.3.2 12-months

At 12-months (Table 3), males were more likely to be assigned to the MD, HD, and Chronic groups than in the Low group. The Low and INT groups did not differ on any variables examined. The MD group was significantly more likely to be incarcerated than the Low group. The HD reported greater physical aggression and community violence than the Low group. Finally, the Chronic group reported more physical aggression, negative peer influences and community violence, and less positive peer influences than the Low group.

3.3.3 24-months

At 24-months (Table 3), the INT group was younger than the Low group. Males were more likely to be in the MD, HD, and Chronic groups than in the Low group. The INT group reported greater negative peer influences and community violence than the Low group. With the exception of sex, the MD group did not differ from the Low group. The HD had less positive friend influences than the Low group. As compared to the Low group, the Chronic group was less likely to be incarcerated and have positive peer influences, and had more negative peer influences and community violence.

4.0 Discussion

This study presents novel data regarding marijuana use trajectories among youth from socioeconomically disadvantaged communities who present to the ED for care. Specifically, 30.4% of youth were chronic users, reporting almost daily use of marijuana over time. Conversely, 28.2% of youth showed low rates of marijuana use at baseline, with almost no days of use two years later. Similar to increasing or late onset groups in other studies, 16.2% were intermittent users, with marijuana use increasing at 24-months. The moderate and high decline groups comprised 25.2% of the sample, showing decreases in marijuana use. Note that the trajectory groups identified represent statistical probabilities of group membership, as opposed to definitive individual outcomes (Nagin and Tremblay, 2005; Skardhamar, 2010); nonetheless, this grouping is useful for understanding characteristics associated with greater marijuana use to inform ED-based intervention efforts (Brame et al., 2012).

Consistent with prior studies, males were more likely than females to be in the greater marijuana use groups (Brook et al., 2011; Schulenberg et al., 2005). Overall, age did not distinguish trajectory groups; however, the limited numbers of adolescents could have precluded detection of effects found in other studies (White et al., 2013b; White et al., 2009). For example, it could be that the moderate declining group may mature into the high declining group. Although prior analysis from the screening sample of this study among drug-users and non-drug users showed that youth presenting with assault injuries had higher rates of substance use than those presenting for other reasons (Cunningham et al., 2014), when examining drug using youth, assault injury (as compared to other reason) was not related to substance use trajectory groups. These findings support the notion of universal screening and initiation of substance use interventions in the ED regardless of chief presenting complaint. The baseline factor consistently

associated with greater marijuana use trajectories was physical aggression, which is consistent with findings for externalizing behaviors (Brook et al., 2011; Chassin et al., 2004; Jackson et al., 2008; Schulenberg et al., 2005), likely due to shared risk and promotive factors (e.g., peer influences) and/or exposure to situations that increase aggression (e.g., community violence). The relationship between greater marijuana use and aggression was also observed at 12-months post-ED visit, but dissipated by 24 months, likely reflecting developmental maturation of the sample.

Together, these findings suggest that ED-based interventions should address both substance use and violence, among youth reporting these multiple risk behaviors. Prior studies examining brief interventions for marijuana use are sparse, with a handful of studies showing positive outcomes among youth (D'Amico et al., 2008; Walton et al., 2013; Walton et al., 2014; Woolard et al., 2013), whereas adult studies show null findings (Blow et al., under review; Bogenschutz et al., 2014; Roy-Byrne et al., 2014; Saitz et al., 2014; Woodruff et al., 2014). These interventions, however, have not addressed violence. Similarly, although violence interventions have shown promise among assault injured youth (Becker et al., 2004; Cheng et al., 2008a; Cheng et al., 2008b; Cooper et al., 2006; De Vos et al., 1996; Dicker, 2005; Fein et al., 2013; Karraker et al., 2011; Zun et al., 2006; Zun et al., 2003), these approaches do not typically address substance use. Given that a motivational interviewing (Miller and Rollnick, 2002; Miller and Rollnick, 2012) based brief intervention addressing alcohol and violence showed sustained though modest effects (Cunningham et al., 2012; Walton et al., 2010), interventions may need to be extended, adapting to address increasing and decreasing risk and promotive factors for marijuana use over time (Lei et al., 2012; Rich et al., 2014).

Findings from this study suggest that such adaptive substance use interventions approaches consider also addressing negative peer influences and community violence, which were associated with greater marijuana use trajectories over time. For example, the chronic group showed less positive peer influences at all time points, and more negative peer influences and community violence at 12- and 24-months than the low group. Corresponding to increasing rates of marijuana use, the intermittent group reported greater negative peer influences and community violence at 24-months. Caution is required, however, when making causal conclusions, as the direction of this relationship can't be fully ascertained in this study; in fact, it is likely that these relationships are reciprocal. For example, greater exposure to community violence could lead to greater marijuana use to cope with negative affect, and/or greater marijuana use could lead to greater exposure to situations where violence is likely (e.g., buying and selling drugs). In this regard, multi-level interventions may be beneficial, including individual approaches that facilitate connections with pro-social peers, activities, and services potentially using technology (e.g., text messaging, remote therapy) to reduce barriers, in concert with community-level approaches (Hawkins et al., 2012).

Participation in substance use treatment was not related to marijuana use trajectories, likely because access to treatment services is generally low for youth, particularly in resource poor environments (Center for Behavioral Health Statistics and Quality, 2015), which is reflected in low rates of treatment utilization in this sample despite nearly daily use of marijuana in the chronic group. Next, incarceration was not a useful correlate of marijuana use trajectories, with the exception that the moderate decline group was more likely (at 12 months) to be incarcerated and the chronic group was less likely (at 24 months) to be incarcerated than the low group. Given data showing disproportionate rates of incarceration among African-American youth, with

substance use being a salient risk factor for incarceration, early interventions are needed to reduce these health disparities (Mukku et al., 2012; Substance Abuse and Mental Health Service Administration, 2014a).

4.1. Limitations

Although data collected from youth residing in socio-economically disadvantaged communities is an important contribution to the literature, data from a single emergency department setting may not generalize to other samples (e.g., Hispanics). Given findings that self-reported community violence exposure was related to greater marijuana use trajectories, future studies are needed examining geospatial influences on substance use and violence. Our study examined trajectories following an event, namely an ED visit, as opposed to focusing on developmental trajectories among a specific age group, which is why our sample contained a wide age range (14-24 years) of youth with recent drug use. It is likely findings for classes would have differed if non-drug using youth presenting to ED had been included (e.g., abstainers, early initiators, later initiators). Replication of study findings among ED studies taking an age-specific sampling approach would provide further evidence for characteristics associated with marijuana use trajectories across the key developmental transition from adolescence to young adulthood.

5.0 Conclusions

Findings underscore the need for interventions to interrupt marijuana use trajectories among youth residing in urban communities, with a third of youth likely remaining chronic users of marijuana. Interventions for marijuana-using youth should be initiated at the point of the ED visit, particularly among those involved with physical aggression and/or exposed to community violence, which are associated with greater marijuana use. Peer influences are particularly important in distinguishing marijuana use trajectory groups over time, suggesting that

interventions are needed to help young people increase involvement with positive peers, activities, and services, adapting to evolving needs over time.

Conflict of Interest: The authors do not have any conflicts of interest to declare.

Contributors: The final manuscript has been reviewed and approved by all authors. Dr. Cunningham was the principal investigator on the grant that funded this work. Drs. Walton, Cunningham, and Epstein-Ngo initiated the development of this paper. Dr. Walton wrote an initial draft of the manuscript, with writing assistance from Drs. Epstein-Ngo, Cunningham and Carter. Drs. Walton, Zimmerman, and Blow were co-investigators on the grant that funded this work; they designed the study including measurements, and with Dr. Buu, provided critical feedback on the focus of this manuscript. Dr. Goldstick assisted with analyses and refinement of the results section and tables. All authors reviewed/edited the manuscript multiple times, approving this final version of the manuscript.

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References

- Abadi, M.H., Shamblen, S.R., Thompson, K., Collins, D.A., Johnson, K., 2011. Influence of risk and protective factors on substance use outcomes across developmental periods: A comparison of youth and young adults. *Subst. Use Misuse* 46, 1604-1612.
- Albert, M., McCaig, L.F., 2014. Injury-related emergency department visits by children and adolescents: United States, 2009-2010. NCHS data brief. National Center for Health Statistics, Hyattsville, MD.
- Allen, J.P., Chango, J., Szvedo, D., Schad, M., Marston, E., 2012. Predictors of susceptibility to peer influence regarding substance use in adolescence. *Child Dev.* 83, 337-350.
- Becker, M.G., Hall, J.S., Ursic, C.M., Jain, S., Calhoun, D., 2004. Caught in the Crossfire: the effects of a peer-based intervention program for violently injured youth. *J. Adolesc. Health* 34, 177-183.
- Bernstein, J., Graczyk, A., Lawrence, D., Bernstein, E., Strunin, L., 2011. Determinants of drinking trajectories among minority youth and young adults the interaction of risk and resilience. *Youth Soc.* 43, 1199-1219.
- Blow, F.C., Walton, M.A., Bohnert, A.S.B., Ignacio, R.V., Chermack, S., Cunningham, R.M., Booth, B.M., Ilgen, M., Barry, K.L., under review. Brief interventions for drug use among adults in an inner city emergency department: A randomized controlled trial. *JAMA*.
- Bogenschutz, M.P., Donovan, D.M., Mandler, R.N., Perl, H.I., Forcehimes, A.A., Crandall, C., Lindblad, R., Oden, N.L., Sharma, G., Metsch, L., Lyons, M.S., McCormack, R., Konstantopoulos, W.M., Douaihy, A., 2014. Brief intervention for patients with problematic drug use presenting in emergency departments: A randomized clinical trial. *JAMA Intern. Med.* 174, 1736-1745.

- Bohnert, K.M., Walton, M.A., Ranney, M., Bonar, E.E., Blow, F.C., Zimmerman, M.A., Booth, B.M., Cunningham, R.M., 2015. Understanding the service needs of assault-injured, drug-using youth presenting for care in an urban emergency department. *Addict. Behav.* 41, 97-105.
- Brame, R., Paternoster, R., Piquero, A.R., 2012. Thoughts on the analysis of group-based developmental trajectories in criminology. *Justice Q.* 29, 469-490.
- Brechwald, W.A., Prinstein, M.J., 2011. Beyond homophily: A decade of advances in understanding peer influence processes. *J. Res. Adolesc.* 21, 166-179.
- Bronfenbrenner, U., 1998. The ecology of developmental processes. In: Damon, W., Lerner, R.M. (Eds.), *Handbook of Child Psychology; Vol 1: Theoretical models of human development*. John Wiley and Sons, Inc., New York. pp. 993-1023.
- Brook, J.S., Lee, J.Y., Brown, E.N., Finch, S.J., Brook, D.W., 2011. Developmental trajectories of marijuana use from adolescence to adulthood: Personality and social role outcomes. *Psychol. Rep.* 108, 339-357.
- Brown, S.A., McGue, M., Maggs, J., Schulenberg, J., Hingson, R., Swartzwelder, S., Martin, C., Chung, T., Tapert, S.F., Sher, K., Winters, K.C., Lowman, C., Murphy, S., 2008. A developmental perspective on alcohol and youths 16 to 20 years of age. *Pediatrics* 121, S290-S310.
- Burk, W.J., Van der Vorst, H., Kerr, M., Stattin, H., 2012. Alcohol use and friendship dynamics: Selection and socialization in early-, middle-, and late-adolescent peer networks. *J. Stud. Alcohol Drugs* 73, 89-98.
- Cadoret, R.J., Yates, W.R., Troughton, E., Woodworth, G., Stewart, M.A., 1995. Adoption study demonstrating two genetic pathways to drug abuse. *Arch. Gen. Psychiatry* 52, 42-52.

- Center for Behavioral Health Statistics and Quality, 2015. Behavioral health trends in the United States: Results from the 2014 National Survey on Drug Use and Health.
- Center for Disease Control and Prevention, 2012. Youth Risk Behavior Surveillance - United States, 2011. Morbidity & Mortality Weekly Report 61.
- Center for Lawful Access and Abuse Deterrence, 2011. The National Prescription Drug Abuse Prevention Strategy: 2011-2012 Update. Arlington.
- Chassin, L., Fora, D.B., King, K.M., 2004. Trajectories of alcohol and drug use and dependence from adolescence to adulthood: The effects of familial alcoholism and personality. *J. Abnorm. Psychol.* 113, 483-498.
- Chein, J., Albert, D., O'Brien, L., Uckert, K., Steinberg, L., 2011. Peers increase adolescent risk taking by enhancing activity in the brain's reward circuitry. *Dev. Sci.* 14.
- Cheng, T.L., Haynie, D., Brenner, R., Wright, J.L., Chung, S.E., Simons-Morton, B., 2008a. Effectiveness of a mentor-implemented, violence prevention intervention for assault-injured youths presenting to the emergency department: Results of a randomized trial. *Pediatrics* 122, 938-946.
- Cheng, T.L., Wright, J.L., Markakis, D., Copeland-Linder, N., Menvielle, E., 2008b. Randomized trial of a case management program for assault-injured youth: Impact on service utilization and risk for reinjury. *Pediatr. Emerg. Care* 24, 130-136.
- Chermack, S.T., Giancola, P.R., 1997. The relation between alcohol and aggression: An integrated biopsychosocial conceptualization. *Clin. Psychol. Rev.* 17, 621-649.
- Chermack, S.T., Grogan-Kaylor, A., Perron, B.E., Murray, R.L., De Chavez, P., Walton, M.A., 2010. Violence among men and women in substance use disorder treatment: A multi-level event-based analysis. *Drug Alcohol Depend.* 112, 194-200.

- Cleveland, H.H., Wiebe, R.P., 2008. Understanding the association between adolescent marijuana use and later serious drug use: Gateway effect or developmental trajectory? *Dev. Psychopathol.* 20, 615-632.
- Cooper, C., Eslinger, D.M., Stolley, P.D., 2006. Hospital-based violence intervention programs work. *J. Trauma* 61, 534-537; discussion 537-540.
- Cunningham, R.M., Bernstein, S.L., Walton, M.A., Broderick, K., Vaca, F., Woolard, B., Bernstein, E., Blow, F.C., D'Onofrio, G., 2009. Alcohol, tobacco, and other drugs: Future directions for screening and intervention in the emergency department. *Acad. Emerg. Med.* 16, 1078-1088.
- Cunningham, R.M., Carter, P.M., Ranney, M., Zimmerman, M.A., Blow, F.C., Booth, B.M., Goldstick, J., Walton, M.A., 2015. Violent reinjury and mortality among youth seeking emergency department care for assault-related injury: a 2-year prospective cohort study. *JAMA Pediatr* 169, 63-70.
- Cunningham, R.M., Chermack, S.T., Zimmerman, M.A., Shope, J.T., Bingham, C.R., Blow, F.C., Walton, M.A., 2012. Brief motivational interviewing intervention for peer violence and alcohol use in teens: One-year follow-up. *Pediatrics* 129, 1083-1090.
- Cunningham, R.M., Ranney, M., Newton, M., Woodhull, W., Zimmerman, M., Walton, M.A., 2014. Characteristics of youth seeking emergency care for assault injuries. *Pediatrics* 133, e96-e105.
- D'Amico, E.J., Miles, J.N., Stern, S.A., Meredith, L.S., 2008. Brief motivational interviewing for teens at risk of substance use consequences: A randomized pilot study in a primary care clinic. *J. Subst. Abuse Treat.* 35, 53-61.

- De Vos, E., Stone, D.A., Goetz, M.A., Dahlberg, L.L., 1996. Evaluation of a hospital-based youth violence intervention. *Am. J. Prev. Med.* 12, 101-108.
- Dicker, R., 2005. Violence prevention for trauma centers: A feasible start [Poster 2901]. *Injury and Violence In America*, Denver, CO.
- Dziak, J.J., Li, R., Zimmerman, M.A., Buu, A., 2014. Time- varying effect models for ordinal responses with applications in substance abuse research. *Stat. Med.* 33, 5126-5137.
- Epstein-Ngo, Q.M., Cunningham, R.M., Whiteside, L.K., Chermack, S.T., Booth, B.M., Zimmerman, M.A., Walton, M.A., 2013. A daily calendar analysis of substance use and dating violence among high risk urban youth. *Drug Alcohol Depend.* 1, 1-3.
- Federal Bureau of Investigation, 2011. Preliminary Annual Uniform Crime Report, January - December, 2010. Federal Bureau of Investigation, Washington, DC.
- Fein, J.A., Mollen, C.J., Greene, M.B., 2013. The assault-injured youth and the emergency medical system: What can we do? . *Clin. Pediatr. Emerg. Med.* 14, 47-55.
- Fowler, T., Lifford, K., Shelton, K., Rice, F., Thapar, A., Neale, M.C., McBride, A., Van den Bree, M.B., 2007. Exploring the relationship between genetic and environmental influence on initiation and progression of substance use. *Addiction* 101, 413-422.
- Garnezy, N., 1991. Resilience in children's adaptation to negative life events and stressed environments. *Pediatr. Ann.* 20, 459-460, 463-456.
- Goldstick, J.E., Lipton, R.I., Carter, P., Stoddard, S.A., Newton, M.F., Reischl, T., Walton, M., Zimmerman, M.A., Cunningham, R.M., 2015. The effect of neighborhood context on the relationship between substance misuse and weapons aggression in urban adolescents seeking ED care. *Subst. Use Misuse* 50, 674-684.

- Goldstick, J.E., Stoddard, S.A., Carter, P.M., Zimmerman, M.A., Walton, M.A., Cunningham, R.M., 2016. Characteristic substance misuse profiles among youth entering an urban emergency department: neighborhood correlates and behavioral comorbidities. *Am. J. Drug Alcohol Abuse*, 1-11.
- Grove, D.D., Lazebnik, R., Petrack, E.M., 2000. Urban emergency department utilization by adolescents. *Clin. Pediatr. (Phila.)* 39, 479-483.
- Gruber, S.A., Dahlgren, M.K., Sagar, K.A., Gönenc, A., Killgore, W.D.S., 2012. Age of onset of marijuana use impacts inhibitory processing. *Neurosci. Lett.* 511, 89-94.
- Grun, B., Leisch, F., 2008. FlexMix version 2: Finite mixtures with concomitant variables and varying and constant parameters. *J. Stat. Softw.* 28, 1-35.
- Hawkins, J.D., Oesterle, S., Brown, E.C., Monahan, K.C., Abbott, R.D., Arthur, M.W., Catalano, R.F., 2012. Sustained decreases in risk exposure and youth problem behaviors after installation of the Communities That Care prevention system in a randomized trial. *Arch. Pediatr. Adolesc. Med.* 166, 141-148.
- Henry, K.L., Thornberry, T.P., 2010. Truancy and escalation of substance use during adolescence. *J. Stud. Alcohol Drugs* 71, 115-124.
- Hjorthoj, C.R., Hjorthoj, A.R., Nordentoft, M., 2012. Validity of Timeline Follow-Back for self-reported use of cannabis and other illicit substances--systematic review and meta-analysis. *Addict. Behav.* 37, 225-233.
- Humeniuk, R., Ali, R., Babor, T.F., Farrell, M., Formigoni, M.L., Jittiwutikarn, J., de Lacerda, R.B., Ling, W., Marsden, J., Monteiro, M., Nhiwatiwa, S., Pal, H., Poznyak, V., Simon, S., 2008. Validation of the Alcohol, Smoking And Substance Involvement Screening Test (ASSIST). *Addiction* 103, 1039-1047.

- Hussong, A., Bauer, D., Chassin, L., 2008. Telescoped trajectories from alcohol initiation to disorder in children of alcoholic parents. *J. Abnorm. Psychol.* 117, 63-78.
- Jackson, K.M., Sher, K.J., Schulenberg, J.E., 2008. Conjoint developmental trajectories of young adult substance use. *Alcohol Clin. Exp. Res.* 23, 723-737.
- Karraker, N., Cunningham, R.M., Becker, M.G., Fein, J.A., Knox, L.M., 2011. Violence is Preventable: A Best Practices Guide for Launching & Sustaining a Hospital-based Program to Break the Cycle of Violence. <http://www.ncdsv.org/images/NNHVIP-YouthAlive_ViolenceIsPreventable_2011.pdf>.
- Lei, H., Nahum-Shani, I., Lynch, K., Oslin, D., Murphy, S.A., 2012. A "SMART" design for building individualized treatment sequences. *Annu. Rev. Clin. Psychol.* 8, 21-48.
- Leisch, F., 2004. Flexmix: A general framework for finite mixture models and latent class regression in R. *J. Stat. Softw.* 11, 1-18.
- Lopez-Larson, M.P., Bogorodzki, P., Rogowska, J., McGlade, E., King, J.B., Terry, J., Yurgelun-Todd, D., 2011. Altered prefrontal and insular cortical thickness in adolescent marijuana users. *Behav. Brain Res.* 220, 164-172.
- Maxwell, J.C., 2012. Drunk versus drugged: How different are the drivers? *Drug Alcohol Depend.* 121, 68-72.
- McLellan, A.T., Kushner, H., Metzger, D., Peters, R., Smith, I., Grissom, G., Pettinati, H., Argeriou, M., 1992. The fifth edition of the addiction severity index. *J. Subst. Abuse Treat.* 9, 199-213.
- Meier, M.H., Caspi, A., Houts, R., Slutske, W.S., Harrington, H., Jackson, K.M., Belsky, D.W., Poulton, R., Moffitt, T.E., 2013. Prospective developmental subtypes of alcohol dependence

- from age 18 to 32 years: Implications for nosology, etiology, and intervention. *Dev. Psychopathol.* 25, 785-800.
- Miller, W.R., Rollnick, S., 2002. *Motivational Interviewing: Preparing People for Change*. The Guilford Press, New York, NY.
- Miller, W.R., Rollnick, S., 2012. *Motivational Interviewing: Helping People Change*. The Guilford Press, New York.
- Mrug, S., Gaines, J., Su, W., Windle, M., 2010. School-level substance use: Effects on early adolescents' alcohol, tobacco, and marijuana use. *J. Stud. Alcohol Drugs* 71, 488-495.
- Mukku, V.K., Benson, T.G., Alam, F., Richie, W.D., Bailey, R.K., 2012. Overview of substance use disorders and incarceration of African American males. *Front. Psychiatry* 3.
- Nagin, D.S., Tremblay, R.E., 2005. Developmental trajectory groups: Fact or a useful statistical fiction? *Criminology* 43, 873-904.
- Naimi, T.S., Brewer, R.D., Mokdad, A., Denny, C., Serdula, M.K., Marks, J.S., 2003. Binge drinking among US adults. *JAMA* 289, 70-75.
- National Institute on Drug Abuse, 2010. NIDA-Modified ASSIST-Prescreen V1.0. <http://www.drugabuse.gov/nidamed/screening/nmassist.pdf>. Accessed on July 20, 2010.
- Nylund, K.L., Asparouhov, T., Muthén, B.O., 2007. Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Struct. Equ. Modeling* 14, 535-569.
- Ostaszewski, K., Zimmerman, M.A., 2006. The effects of cumulative risks and promotive factors on urban adolescent alcohol and other drug use: A longitudinal study of resiliency. *Am. J. Community Psychol.* 38, 237-249.

- Quinlan, K.P., Brewer, R.D., Siegel, P., Sleet, D.A., Mokdad, A.H., Shults, R.A., Flowers, N., 2005. Alcohol-impaired driving among U.S. adults, 1993-2002. *Am. J. Prev. Med.* 28, 346-350.
- Ram, N., Grimm, K.J., 2009. Methods and measures: Growth mixture modeling: A method for identifying differences in longitudinal change among unobserved groups. *Int. J. Behav. Dev.* 33, 565-576.
- Ramirez, M., Wu, Y., Kataoka, S., Wong, M., Yang, J., Peek-Asa, C., Stein, B., 2012. Youth violence across multiple dimensions: A study of violence, absenteeism, and suspensions among middle school children. *J. Pediatr.* 161, 542-546. e542.
- Rich, B., Moodie, E.E., Stephens, D.A., 2014. Simulating sequential multiple assignment randomized trials to generate optimal personalized warfarin dosing strategies. *Clin. Trials* 11, 435-444.
- Richters, J.E., Martinez, P., 1992. Things I Have Seen and Heard: A structured interview for assessing young children's violence exposure. In: National Institute of Mental Health (Ed.), Rockville, MD.
- Roy-Byrne, P., Bumgardner, K., Krupski, A., Dunn, C., Ries, R., Donovan, D., West, II, Maynard, C., Atkins, D.C., Graves, M.C., Joesch, J.M., Zarkin, G.A., 2014. Brief intervention for problem drug use in safety-net primary care settings: a randomized clinical trial. *JAMA* 312, 492-501.
- Rutter, M., 1987. Psychosocial resilience and protective mechanisms. *Am. J. Orthopsychiatry* 57, 316-331.

- Saitz, R., Palfai, T.P., Cheng, D.M., Alford, D.P., Bernstein, J.A., Lloyd-Travaglini, C.A., Meli, S.M., Chaisson, C.E., Samet, J.H., 2014. Screening and brief intervention for drug use in primary care: the ASPIRE randomized clinical trial. *JAMA* 312, 502-513.
- Schepis, T.S., Desai, R.A., Cavallo, D.A., Smith, A.E., McFetridge, A., Liss, T.B., Potenza, M.N., Krishnan-Sarin, S., 2011. Gender differences in adolescent marijuana use and associated psychosocial characteristics. *J. Addict. Med.* 5, 65-73.
- Schillie, S.F., Shehab, N., Thomas, K.E., Budnitz, D.S., 2009. Medication overdoses leading to emergency department visits among children. *Am. J. Prev. Med.* 37, 181-187.
- Schulenberg, J.E., Merline, A.C., Johnston, L.D., O'Malley, P.M., Bachman, J.G., Laetz, V.B., 2005. Trajectories of marijuana use during the transition to adulthood: The big picture based on national panel data. *J. Drug Issues* 35, 255-280.
- Simons-Morton, B., Farhat, T., 2010. Recent findings on peer group influences on adolescent smoking. *J. Prim. Prev.* 31, 191-208.
- Skardhamar, T., 2010. Distinguishing facts and artifacts in group- based modeling. *Criminology* 48, 295-320.
- Sobell, L.C., Sobell, M.B., Leo, G.I., Cancilla, A., 1988. Reliability of a timeline method: assessing normal drinkers' reports of recent drinking and a comparative evaluation across several populations. *Br. J. Addict.* 83, 393-402.
- Stokols, D., Allen, J., Bellingham, L., 1996. The social ecology for health promotion: Implications for research and practice. *Am. J. Health Promot.* 10, 247-251.
- Straus, M.A., Hamby, S.L., Boney-McCoy, S., Sugarman, D.B., 1996. The Revised Conflict Tactics Scales (CTS2). *J. Fam. Issues* 17, 283-316.

- Substance Abuse and Mental Health Service Administration, 2013. Results from the 2012 National Survey on Drug Use and Health: Summary of National Findings. NSDUH Series H-46. Substance Abuse and Mental Health Services Administration, Rockville.
- Substance Abuse and Mental Health Service Administration, 2014a. Health Disparities. <http://www.samhsa.gov/health-disparities>. Accessed on October 19, 2016.
- Substance Abuse and Mental Health Service Administration, 2014b. Results from the 2013 National Survey on Drug Use and Health: Detailed Tables. Substance Abuse and Mental Health Services Administration, Rockville, MD.
- Wagner, E.F., 2008. Developmentally informed research on the effectiveness of clinical trials: A primer for assessing how developmental issues may influence treatment responses among adolescents with alcohol use problems. *Pediatrics* 121, S337-S347.
- Walton, M.A., Bohnert, K., Resko, S., Barry, K.L., Chermack, S.T., Zucker, R.A., Zimmerman, M.A., Booth, B.M., Blow, F.C., 2013. Computer and therapist based brief interventions among cannabis-using adolescents presenting to primary care: One year outcomes. *Drug Alcohol Depend.* 132, 646-653.
- Walton, M.A., Chermack, S.T., Shope, J.T., Bingham, C.R., Zimmerman, M.A., Blow, F.C., Cunningham, R.M., 2010. Effects of a brief intervention for reducing violence and alcohol misuse among adolescents: a randomized controlled trial. *JAMA* 304, 527-535.
- Walton, M.A., Cunningham, R.M., Goldstein, A.L., Chermack, S.T., Zimmerman, M.A., Bingham, C.R., Shope, J.T., Stanley, R., Blow, F.C., 2009. Rates and correlates of violent behaviors among adolescents treated in an urban emergency department. *J. Adolesc. Health* 45, 77-83.

- Walton, M.A., Resko, S., Barry, K.L., Chermack, S.T., Zucker, R.A., Zimmerman, M.A., Booth, B.M., Blow, F.C., 2014. A randomized controlled trial testing the efficacy of a brief cannabis universal prevention program among adolescents in primary care. *Addiction* 109, 786-797.
- White, A.M., MacInnes, E., Hingson, R.W., Pan, I., 2013a. Hospitalizations for suicide-related drug poisonings and co-occurring alcohol overdoses in adolescents (ages 12-17) and young adults (ages 18-24) in the United States, 1999-2008: Results from the Nationwide Inpatient Sample. *Suicide Life Threat Behav.* 43, 198-212.
- White, H.R., Fite, P., Pardini, D., Mun, E.Y., Loeber, R., 2013b. Moderators of the dynamic link between alcohol use and aggressive behavior among adolescent males. *J. Abnorm. Child Psychol.* 41, 211-222.
- White, H.R., Jackson, K.M., Loeber, R., 2009. Developmental sequences and comorbidity of substance use and violence. *Handbook on crime and deviance*. Springer. pp. 433-468.
- WHO ASSIST Working Group, 2002. The Alcohol, Smoking and Substance Involvement Screening Test (ASSIST): Development, reliability and feasibility. *Addiction* 97, 1183-1194.
- Wilhelmi, B.G., Cohen, S.P., 2012. A framework for "driving under the influence of drugs" policy for the opioid using driver. *Pain Physician* 15, 215-230.
- Wilson, K.M., Klein, J.D., 2000. Adolescents who use the emergency department as their usual source of care. *Arch. Pediatr. Adolesc. Med.* 154, 361-365.
- Windle, M., Spear, L.P., Fuligni, A.J., Angold, A., Brown, J.D., Pine, D., Smith, G.T., Giedd, J., Dahl, R.E., 2008. Transitions into underage and problem drinking: developmental processes and mechanisms between 10 and 15 years of age. *Pediatrics* 121 Suppl 4, S273-289.

- Wolfe, D.A., Crooks, C.V., Chiodo, D., Hughes, R., Ellis, W., 2012. Observations of adolescent peer resistance skills following a classroom-based healthy relationship program: A post-intervention comparison. *Prev. Sci.* 13, 196-205.
- Woodruff, S.I., Clapp, J.D., Eisenberg, K., McCabe, C., Hohman, M., Shillington, A.M., Sise, C.B., Castillo, E.M., Chan, T.C., Sise, M.J., Gareri, J., 2014. Randomized clinical trial of the effects of screening and brief intervention for illicit drug use: the Life Shift/Shift Gears study. *Addict. Sci. Clin. Pract.* 9, 8.
- Woolard, R., Baird, J., Longabaugh, R., Nirenberg, T., Lee, C.S., Mello, M.J., Becker, B., 2013. Project reduce: reducing alcohol and marijuana misuse: effects of a brief intervention in the emergency department. *Addict. Behav.* 38, 1732-1739.
- Zucker, R.A., Chermack, S.T., Curran, G.M., 2000. Alcoholism: A lifespan perspective on etiology and course. In: Sameroff, A.J., Lewis, M., Miller, R. (Eds.), *Handbook of Developmental Psychopathology*. Plenum, New York. pp. 569-587.
- Zucker, R.A., Donovan, J.E., Masten, A.S., Mattson, M.E., Moss, H.B., 2008. Early developmental processes and the continuity of risk for underage drinking and problem drinking. *Pediatrics* 121 Suppl. 4, S252-272.
- Zun, L.S., Downey, L., Rosen, J., 2006. The effectiveness of an ED-based violence prevention program. *Am. J. Emerg. Med.* 24, 8-13.
- Zun, L.S., Downey, L.V., Rosen, J., 2003. Violence prevention in the ED: linkage of the ED to a social service agency. *Am. J. Emerg. Med.* 21, 454-457.

Figure 1.

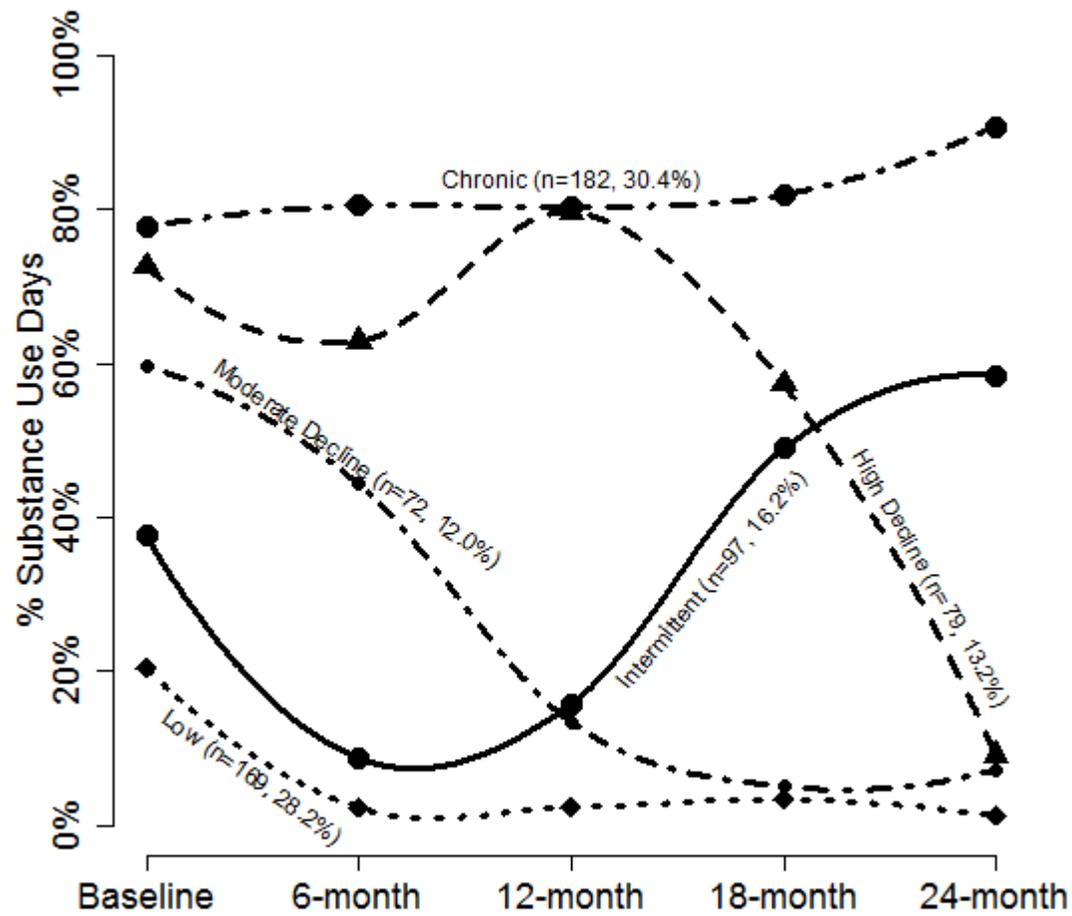


Figure 1. Marijuana use trajectory groups

Table 1: Mean marijuana use days at baseline, 6-, 12-, 18-, and 24-month follow-ups based on trajectory group membership.

Assessment	Low (n=169, 28.2%)	Intermittent (n=97, 16.2%)	Moderate Decline (n=72, 12.0%)	High Decline (n=79, 13.2%)	Chronic (n=182, 30.4%)
Baseline					
Cannabis	18.3 (25.1)	34.8 (33.7)	51.8 (32.9)	60.9 (32.4)	71.0 (29.5)
6-month					
Cannabis	2.2 (3.2)	6.8 (8.1)	41.7 (26.7)	61.3 (32.6)	71.8 (26.0)
12-month					
Cannabis	1.8 (3.5)	16.0 (18.8)	8.9 (11.5)	64.0 (31.2)	73.4 (27.1)
18-month					
Cannabis	3.2 (6.5)	43.0 (34.8)	6.4 (7.9)	56.0 (33.9)	73.0 (28.5)
24-month					
Cannabis	1.1 (2.2)	53.1 (31.4)	6.1 (9.8)	6.9 (9.9)	81.9 (16.3)

Note: Values are Mean (SD). Because marijuana use was measured for the past 30 days at baseline, and the past 90 days at each follow-up, the value for baseline days was multiplied by 3 to standardize the days presented for descriptive purposes; n= 599 (baseline), n=512 (6-month), n=502 (12-month), n=505 (18-month) and n=512 (24 month).

Table 2. Descriptive characteristics based on marijuana use trajectory group membership.

Variables	Low (n=169, 8.2%)	Intermittent (n=97, 16.2%)	Moderate Decline (n=72, 12.0%)	High Decline (n=79, 13.2%)	Chronic (n=182, 30.4%)
Age					
Baseline	20.0 (2.4)	19.6 (2.7)	19.9 (2.5)	20.3 (2.1)	20.3 (2.4)
12-Month	20.9 (2.3)	20.5 (2.8)	20.9 (2.5)	21.4 (2.1)	21.2 (2.4)
24-Month	22.0 (2.4)	21.3 (2.7)	22.0 (2.5)	22.3 (2.2)	22.2 (2.3)
Male					
Baseline	46.2%	61.9%	66.7%	63.3%	63.7%
12-Month	42.5%	58.8%	66.1%	61.1%	64.1%
24-Month	43.5%	55.7%	64.1%	63.5%	62.6%
Assault Injury Group					
Baseline	57.4%	63.9%	63.9%	54.4%	55.5%
12-Month	57.5%	66.3%	69.4%	51.4%	54.9%
24-Month	58.1%	65.8%	65.6%	54.1%	53.1%
Physical Aggression					
Baseline	6.3 (8.5)	9.5 (15.6)	11.1 (12.1)	12.4 (14.7)	11.4 (15.6)
12-Month	2.8 (7.3)	2.9 (5.9)	3.6 (7.4)	7.2 (15.2)	7.5 (13.8)
24-Month	1.7 (5.4)	4.2 (11.1)	2.0 (4.9)	4.3 (12.0)	3.2 (10.0)
Physical Victimization					
Baseline	13.0 (17.7)	14.3 (18.9)	13.7 (14.1)	14.2 (16.0)	13.6 (17.0)
12-Month	3.3 (7.1)	3.5 (8.1)	4.7 (8.1)	6.9 (12.4)	8.2 (14.0)
24-Month	1.7 (5.1)	5.8 (15.5)	1.3 (2.8)	4.1 (10.2)	3.8 (10.3)
Drug Treatment					
Baseline	10.7%	8.3%	5.6%	8.9%	8.2%
12-Month	5.2%	8.8%	11.3%	8.3%	5.9%
24-Month	6.1%	11.4%	10.9%	8.1%	4.1%
Incarceration					
Baseline	18.3%	20.6%	27.8%	30.4%	24.7%
12-Month	3.7%	7.5%	17.7%	2.8%	7.2%
24-Month	9.5%	8.9%	17.2%	23.0%	7.5%
Negative Peer Influences					
Baseline	13.5 (4.8)	13.6 (4.8)	14.0 (4.0)	14.6 (4.4)	15.6 (5.1)
12-Month	12.1 (3.9)	12.9 (4.0)	13.2 (4.7)	14.1 (4.4)	15.4 (5.0)
24-Month	11.6 (3.9)	14.1 (5.3)	12.5 (3.6)	13.2 (4.8)	14.6 (4.8)
Positive Peer Influences					
Baseline	9.0 (3.3)	8.9 (3.0)	9.0 (2.7)	8.9 (3.0)	8.3 (2.7)
12-Month	8.9 (3.2)	8.5 (2.9)	8.5 (2.4)	8.5 (2.6)	8.1 (2.9)
24-Month	8.6 (2.8)	8.3 (3.2)	8.8 (2.6)	7.8 (2.9)	7.7 (2.8)
Community Violence					
Baseline	5.7 (3.4)	6.4 (3.8)	6.5 (3.7)	7.6 (3.5)	7.3 (3.5)
12-Month	4.8 (3.9)	5.6 (3.7)	5.5 (3.7)	6.8 (4.1)	6.8 (3.6)
24-Month	4.0 (3.6)	6.0 (4.2)	4.7 (3.4)	5.1 (4.0)	6.0 (3.7)

Note: Values are Mean (SD) or %.

Table 3. Multinomial regression findings for baseline, 12-month, and 24-month variables associated with marijuana use trajectory group membership.

Variables	Intermittent RRR (CI)	Moderate Decline RRR (CI)	High Decline RRR (CI)	Chronic RRR (CI)
<u>Baseline</u>				
Age	0.94 (0.84-1.05)	0.99 (0.88-1.12)	1.04 (0.93-1.17)	1.04 (0.95-1.14)
Male	2.16 (1.24-3.76)**	2.72 (1.45-5.12)**	2.15 (1.17-3.98)*	2.26 (1.40-3.65)**
Assault Injury Group	1.13 (0.66-1.92)	1.07 (0.59-1.93)	0.69 (0.39-1.21)	0.78 (0.49-1.22)
Physical Aggression	1.04 (1.01-1.06)*	1.05 (1.02-1.08)**	1.04 (1.02-1.08)**	1.04 (1.01-1.06)**
Drug Treatment	0.70 (0.28-1.74)	0.38 (0.12-1.21)	0.57 (0.21-1.53)	0.50 (0.23-1.10)
Incarceration	0.96 (0.49-1.91)	1.36 (0.67-2.78)	1.48 (0.74-2.96)	0.99 (0.55-1.77)
Negative Peer Influences	0.97 (0.91-1.04)	0.98 (0.91-1.05)	0.98 (0.91-1.05)	1.05 (0.99-1.05)
Positive Peer Influences	0.99 (0.91-1.07)	1.00 (0.91-1.10)	1.01 (0.92-1.10)	0.92 (0.85-0.99)*
Community Violence	1.03 (0.95-1.12)	1.02 (0.93-1.12)	1.12 (1.03-1.22)*	1.07 (1.00-1.15)
<u>12-Months</u>				
Age	0.93 (0.83- 1.05)	1.01 (0.89-1.15)	1.11 (0.97-1.26)	1.06 (0.95-1.17)
Male	1.76 (0.98-3.16)	2.17 (1.12-4.20)*	2.28 (1.23-4.23)*	2.46 (1.46-4.12)**
Assault Injury Group	1.30 (0.72-2.34)	1.47 (0.76-2.85)	0.63 (0.35-1.16)	0.68 (0.41-1.13)
Physical Aggression	0.99 (0.95-1.04)	1.01 (0.97-1.05)	1.04 (1.01-1.08)*	1.04 (1.01-1.07)*
Drug Treatment	1.39 (0.45-4.32)	1.45 (0.45-4.70)	1.39 (0.42-4.63)	0.83 (0.28-2.48)
Incarceration	1.41 (0.39-5.10)	3.38 (1.04-11.0)*	0.38 (0.07-2.15)	0.84 (0.26-2.77)
Negative Peer Influences	1.03 (0.95-1.11)	1.03 (0.95-1.12)	1.07 (0.99-1.16)	1.14 (1.06-1.22)**
Positive Peer Influences	0.94 (0.86-1.04)	0.96 (0.86-1.06)	0.92 (0.83-1.02)	0.88 (0.80-0.96)**
Community Violence	1.05 (0.97-1.14)	1.04 (0.94-1.14)	1.10 (1.01-1.20)*	1.08 (1.00-1.16)*
<u>24-Months</u>				
Age	0.88 (0.79- 1.00)*	1.00 (0.88-1.13)	1.04 (0.92-1.17)	1.03 (0.93-1.14)
Male	1.69 (0.94-3.01)	2.20 (1.16-4.17)*	2.07 (1.11-3.86)*	2.34 (1.40-3.92)**
Assault Injury Group	1.30 (0.72-2.36)	1.27 (0.68-2.38)	0.68 (0.38-1.23)	0.80 (0.48-1.32)
Physical Aggression	1.02 (0.98-1.06)	1.00 (0.96-1.05)	1.03 (0.99-1.07)	1.01 (0.98-1.05)
Drug Treatment	1.64 (0.58-4.68)	1.50 (0.51-4.41)	0.81 (0.25-2.57)	0.51 (0.16-1.59)
Incarceration	0.40 (0.14-1.14)	1.17 (0.46-2.97)	1.79 (0.75-4.28)	0.32 (0.13-0.84)*
Negative Peer Influences	1.10 (1.02-1.19)*	1.02 (0.94-1.11)	1.06 (0.98-1.15)	1.15 (1.08-1.23)***
Positive Peer Influences	0.92 (0.83-1.02)	1.01 (0.91-1.11)	0.89 (0.81-0.99)*	0.85 (0.77-0.93)**
Community Violence	1.11 (1.02-1.21)*	1.04 (0.96-1.14)	1.05 (0.96-1.14)	1.11 (1.03-1.19)**

Note: Low is the reference group. RRR=Relative Risk Ratios

*p<.05, **p<.01, ***p<.001.