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Latent Growth Curve Modeling of Non-Injection Drug Use and Condomless Sexual Behavior from Ages 18 to 21 in Gay, Bisexual, and Other YMSM: The P18 Cohort Study

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Abstract

Background—HIV/AIDS continues to be a health disparity faced by sexual minority men, and is exacerbated by non-injection drug use.

Objectives—We sought to delineate growth in non-injection drug use and condomless sex in a sample of racially and economically diverse of gay, bisexual, and other young men who have sex with men (YMSM) as they emerged into adulthood between the ages of 18 and 21 and who came of age in the post-HAART era.

Methods—Behavioral data on drug use and condomless sex, collected via a calendar based technique over 7 waves of a cohort study of 600 YMSM, were analyzed using latent growth curve modeling to document patterns of growth in these behaviors, their associations, and the extent to which patterns and associations are moderated by race/ethnicity and socioeconomic status.

Results—Significant growth was noted in the frequencies of condomless oral and anal intercourse, alcohol to intoxication, marijuana use, and inhalant nitrate use. High levels of association were noted between all behaviors across time but associations did not differ by either race/ethnicity or socioeconomic status. The link between drug use and risky sexual behavior continue to be evident in YMSM with significant increases in these behaviors demonstrated as YMSM transition between adolescence and young adulthood.

Conclusions/Importance—Healthcare for a new generation of sexual minority males must address the synergy of these behaviors and also nest HIV prevention and care within a larger context of sexual minority health that acknowledges the advances made in the last three decades.

Conflict of Interest The authors have no conflict of interest to disclose.

Keywords

drug use; condomless sex; HIV; sexual minority; YMSM; latent growth curve modeling; longitudinal; cohort study

Alcohol and other drug use is prevalent among young gay, bisexual, and other young men who have sex with men (YMSM) (Halkitis et al., 2011; Newcomb, Ryan, Greene, Garofalo, & Mustanski, 2014; Outlaw et al., 2011; Wong, Schrager, Chou, Weiss, & Kipke, 2013) and is associated with sexual behaviors that place YMSM at risk for sexually transmitted infections (STIs), including HIV (Mustanski, Newcomb, Du Bois, Garcia, & Grov, 2011; Newcomb & Mustanski, 2014). In the United States, sexual minority young men are disproportionately affected by HIV (Centers for Disease Control & Prevention (CDC), 2016), and non-injection drug use has been associated with HIV transmission in this population throughout the history of the disease (Halkitis et al., 2011; Pollock et al., 2012). Moreover, the management of HIV has changed drastically over the last three decades (Beyrer et al., 2012; Lansky et al., 2010), and the meaning of HIV in the lives of young sexual minority men may be different than for those who came of age at the height of the epidemic in the 1980's and 1990's in the pre-HAART (Highly Active Antiretroviral Therapy) era (Kingdon et al., 2013; Moeller, Halkitis, Pollock, Siconolfi, & Barton, 2013). Thus, understanding how drug use is associated with sexual risk behaviors over time in a generation of YMSM who came of age post-HAART may provide valuable insight seeking to inform future prevention efforts (Kingdon et al., 2013).

YMSM appear to engage in more instances of substance use and sexual risk behaviors as they age (Perry N Halkitis et al., 2014; Kapadia, Bub, Barton, Stults, & Halkitis, 2015; Newcomb & Mustanski, 2014; Newcomb et al., 2014). Investigating these changes and their associations over time may provide particularly useful information regarding the health-related risks of YMSM during emerging adulthood, a period marked by rapid physical and psychological maturation (Arnett, 2000). Increased impulsivity and psychosocial stressors, including the potential challenges of coming out and negotiating a stigmatized sexual identity, make emerging adulthood an acutely vulnerable developmental stage for YMSM (Halkitis, Kapadia, Bub, et al., 2015). Additionally, increased substance use and sexual risk behaviors may be associated with myriad health-related concerns, including depression (Perdue, Hagan, Thiede, & Valleroy, 2003; Salomon et al., 2009) and intimate partner violence (Stults, Javdani, Greenbaum, Kapadia, & Halkitis, 2015, 2016; Wong, Weiss, Ayala, & Kipke, 2010). We need to examine these dynamic and evolving behaviors over time to understand how they may relate to poor health outcomes in this new generation of YMSM, defined as the generation of Millennials who came of age in the post HAART-era.

In the literature, researchers have noted significant differences in the level of drug use and sexual risk behaviors among YMSM by race/ethnicity and socioeconomic status (SES). White and upper-SES YMSM report greater frequency of substance use and condomless sex behaviors as compared to their non-White, lower-SES counterparts as noted in a meta-analysis of MSM (Millett, Flores, Peterson, & Bakeman, 2007), in samples of MSM across ages (Sullivan et al., 2014) where 74.6% of the Black MSM and 60.8% of the White MSM

were below age 30. This is also supported in other studies MSM (64% age 34 and under) (Magnus et al., 2010) and of YMSM (Halkitis & Pérez Figueroa, 2010), where the mean age of the participants was 18. These differences point to heterogeneity within the population and the need to further examine potential differences by race/ethnicity and SES in behavioral patterns as YMSM emerge into adulthood. However, there is limited information on the extent to which change in these behaviors over time vary by both race/ethnicity and SES in a new generation of YMSM as they emerge into adulthood.

The extant literature is limited in several ways. First, most studies utilize cross-sectional designs that cannot observe developmental patterns in drug use, sexual risk behaviors, or their associations (Carey et al., 2009; Kecojevic, Silva, Sell, & Lankenau, 2015; Newcomb & Mustanski, 2014). This is problematic, as these behaviors are dynamic and evolve over time, limiting our ability to examine either temporal associations or the development of these behaviors across time (Carey et al., 2009; Ellen et al., 2015; Mustanski, Garofalo, Herrick, & Donenberg, 2007; Parsons, Grov, & Golub, 2012). Second, studies employing longitudinal designs typically use samples comprised of older adult men who have sex with men (MSM) or youth where sexual minorities are only a small proportion of the overall sample (Perry N Halkitis et al., 2014), thereby diluting any understanding of these phenomena in young men generally, and in those who came of age after the first two decades of AIDS when treatments were available. Third, the few studies that examine changes in drug use and sexual risk behaviors over time do not account for potential differences by race/ethnicity and SES (Colfax et al., 2005; Halkitis, Mukherjee, & Palamar, 2009). YMSM is not a monolithic group, and failure to account for such differences limits our understanding of how important sociodemographic factors may be in explaining changes in these dynamic behaviors. Finally, to our knowledge, no other studies of YMSM examine whether race/ethnicity and SES moderate the longitudinal associations between drug use and sexual risk behaviors. This is an area of ongoing concern, as YMSM continue to be at risk for HIV infection and other health disparities disproportionately experienced by sexual minority men (Institute of Medicine, 2011; Wolitski, Stall, & Valdiserri, 2008).

To address gaps in the extant literature, the present study seeks to model changes in drug use, sexual risk behaviors, and their association over time, while controlling for differences in race/ethnicity and SES. Specifically, during a stage of human development when we would expect increases in both sets of behaviors, we sought to examine the pattern that emerges for YMSM and whether drug use and sexual risk behaviors are related over time.

Methods

Study design

Data for this analysis are derived from the Project 18 (P18) Cohort Study, a prospective study of YMSM residing in the New York City metropolitan area. The purpose of this study is to understand emergence of a syndemic (i.e, the confluence of health issues as directed by psychosocial burdens) (Halkitis, Wolitski, & Millett, 2013) in a generation of racially/ethnically and socioeconomically diverse YMSM who came of age in the 21st century. Study details and methodology for this project have been described previously (Halkitis et al., 2013). Participants were recruited into this study between May, 2009 and June, 2011 using

both active and passive recruitment techniques. Eligible participants were between 18–19 years old, biologically male, reporting sex with another man in the past six months, and self-reporting an HIV negative serostatus. Those deemed eligible provided written, informed consent.

Data on recent sexual and drug use behaviors were ascertained via an interviewer-administered, calendar-based approach methodology known as the Timeline Followback (TLFB). These are the data we present in the ensuing analyses (Robinson, Sobell, Sobell, & Leo, 2014; Sobell, Brown, Leo, & Sobell, 1996). These data were collected for the month prior to the assessment. Participants took part in seven study visits (baseline, 6-, 12-, 18-, 24-, 30-, and 36-months post-baseline), and thus those who took part in all seven waves, completed the TLFB at each assessment. Those who relocated from New York City only completed a computer-administered survey while those who completed the assessment in person completed the surveys and the TLFB. Consequently, our data source is based on those in person assessments. Data from all seven waves are included in the present analysis. The New York University Institutional Review Board approved the study protocol, and the study holds a federal certificate of confidentiality.

Measures

Demographic Characteristics—Participants self-reported race/ethnicity and perceived familial socioeconomic status (SES) at the baseline assessment. Perceived familial socioeconomic status was measured via a 5-point Likert scale (lower, lower middle, middle, upper middle, upper), which was categorized as lower, middle (lower middle, middle and upper middle), and upper perceived familial SES. Specifically the participants were asked "What do you perceive to be the economic class of the people who raised you?" Perceived familial SES was used instead of income as this measure has been shown to be a strong indicator of health in adolescents, with those of higher perceived SES demonstrating better health (Goodman, Huang, Schafer-Kalkhoff, & Adler, 2007). Moreover since participants are age 18 when they are asked this questions and likely not earning their own income nor necessarily are aware of the income of their parents, and as has been shown, measures of SES are fraught with complexities in heath disparities research because of "lack of precision and reliability of measures; difficulty with the collection of individual SES data; the dynamic nature of SES over a lifetime; the classification of women, children, retired and unemployed persons; lack of or poor correlation between individual SES measures" (Shavers, 2007), much of which would also manifest in our sample. Thus, we also utilized perceived familial SES as proxy indicator. The measures is based on the work of the MacArthur Research Network on Socioeconomic SES and Health (2009) and has been shown to be highly associated with other indicators of SES and particularly useful in young Black populations (Longmire-Avital & Miller-Duce, 2015). Moreover, as supported by Goodman et al. (2007) perceived SES is complex constructed and is informed by a variety of social factors, including age, race, and objective SES. Such an understanding of SES was more highly aligned with the underlying premises of our study.

Alcohol to Intoxication and Other Drug Use—Participant non-injection drug use behaviors during the 30 days preceding interview were obtained using the TLFB (Sobell et

al., 1996). Participants were asked which days they used any of the following substances: alcohol to intoxication, marijuana, inhalant nitrates, powder cocaine, ecstasy, GHB, ketamine, crack cocaine, heroin, rohypnol, methamphetamine, or pharmaceuticals without or in excess of their prescribed use. For the present analysis, and given the distribution of the data, we created sum scores indicating the total number of days that participants stated using alcohol to intoxication, marijuana, inhalant nitrates, and all other drugs to create four summary variables with scores indicating days of use. At baseline we assessed only alcohol use (i.e., not alcohol to intoxication) and thus those data are not reported at baseline.

Condomless Sex Acts—Participants reported each instance of condomless receptive oral intercourse (ROI), receptive anal intercourse (RAI), and insertive anal intercourse (IAI) during the 30 days preceding interview. Data on sexual activity were collected as counts for each of the three sexual behaviors. Total scores indicate instances of each act during the timeframe and accounts for multiple within a day of sexual experience.

Analytic Plan—Means and standard deviations were obtained for all study variables across time. Additionally, correlations among variables within time were obtained. Latent growth curve modeling (LGCM) was used to investigate whether participants' self-reported drug use and sexual activity increased between baseline and the 36-month follow-up and to determine whether changes in drug use predicted changes in condomless sexual activity. We began by fitting separate models for each drug use variable (i.e., alcohol to intoxication, marijuana use, inhalant use, and other drug use) as well as for each condomless sexual activity variable most associated with the transmission of HIV in gay, bisexual, and other MSM (receptive oral intercourse (ROI), insertive anal intercourse (IAI), and receptive anal intercourse (RAI) (CDC, 2016). Estimates of the final level (i.e., average level at 36-months) and linear rate of change between baseline and 36-months were obtained for each drug use and condomless sexual activity variable. Next, to account for the likelihood that participants used multiple drugs or engaged in multiple condomless sexual activities at one time, we fit two additional models: one in which we simultaneously estimated growth in the four drug use variables and allowed the intercepts and rates of change to correlate with one another and one in which we simultaneously estimated growth in the three unprotected sexual activity variables and allowed the intercepts and rates of change to correlate. By allowing the intercepts and rates of change for each variable to correlate, we were able to account for the comorbidity of drug use (i.e., high use of marijuana and high levels of alcohol to intoxication) or sexual activity, thereby obtaining a more accurate picture of participants' behaviors.

To explore whether changes in each drug use were associated with changes in all three condomless sexual activity variables, we fit a series of multivariate latent growth models in which we simultaneously estimated growth in one drug variable (e.g., alcohol to intoxication) and all three unprotected sexual activity variables (e.g., condomless RAI, IAI, and ROI) and predicted the intercepts and rates of change in the three unprotected sexual activity variables from the intercept and rate of change in drug use. In other words, we examined whether participants who reported increases in the frequency of alcohol use to intoxication over time also reported increases in one or more unprotected sexual activities.

Separate models were fit for each drug use variable, resulting in a total of four models. Again, the intercepts and rates of change in sexual activity were allowed to correlate to account for the possibility that participants engaged in multiple activities. Finally, to examine whether the effects of changes in drug use on changes in sexual activity varied by race/ethnicity or SES, we added to our models interactions between the intercept and rate of change in drug use and a set of dummy variables representing race/ethnicity or a set of dummy variables representing different levels of SES. Statistically significant interactions would suggest that the associations between changes in drug use and changes in sexual activity were not the same for all YMSM.

All models were initially fit without any control variables (i.e., unconditional models) and were subsequently re-fit controlling for participant race/ethnicity and perceived SES. Model fit was assessed using typical fit statistics including chi-square, CFI, and RMSEA. A small and non-significant chi-square value, a CFI close to 1, and a RMSEA value less than .08 all indicate good fit (Hu & Bentler, 1999). Note, however, that chi-square estimates are sensitive to large sample sizes and are thus considered quite conservative (Browne, Cudeck, Bollen, & Long, 1993), which is why other indices are considered. As is often the case in longitudinal studies, just over half (50.5%) of the participants were missing data for at least one of the six assessments (see Table 1 for sample sizes at each assessment). Because growth modeling does not require complete data to estimate an average intercept and rate of change, however, all analyses were based on the baseline sample. Further, there was no missing data for the control variables (i.e., race/ethnicity and perceived income). As previously noted (Halkitis et al., 2014b), no differential attrition was noted on key demographic factors. Further, we undertook analysis of the comparing the drug and sex behaviors at baseline of those who competed the TLFB at the 36-month assessment (72%) versus those did not complete that final assessment. No differences were noted other than for the oral sex variable much as those who were assessed on the TLFB in at the 36-month assessment reported a high rate of condomlesss oral sex at baseline as compared to those whom we did not assess via the TLFB at the final assessment (2.40 vs. 1.61, p = .03).

Study participants—A total of 2068 participants screened for the P18 study. Of those, 600 met eligibility criteria and were enrolled in the study, but data for 2 were not complete yielding a baseline sample of N = 598. Follow-up in person assessments were as follows: 6-month (N = 460), 12-month (N = 425), 18-month (N = 448), 24-month (N = 436), 30-month (N = 413), and 36 –month (N = 430). As a means of enhancing retention, participants could continue in the study even if an assessment was missed. This was to accommodate participants including those who may have been briefly incarcerated. The cohort was diverse in terms of race ethnicity as previously reported (Halkitis et al, 2015a). Specifically, 14.9% (n = 89) identified as African American, 38.3% (n = 229) identified as Hispanic, and 28.9% (n = 173) as White. In terms of perceived familiar SES 33.5% (n = 200) identified as low SES, while 37.1% (n =222), and 29.5% (n = 176) identified as middle and upper SES respectively. On average participants were 18 years old at baseline (M = 18.23, SD = 0.43, Md = 18). For those completing the assessment at 36-month in person, age was 21 years old (M = 21.27, SD = 0.48, Md = 21). We retained 72% (430 /600) of our baseline sample for in person assessments across seven waves of data collection, which include the administration

of the TLFB, although as is noted, complete data are not needed to estimate the parameters of interest.

Results

Drug use and condomless sexual activity

As shown in Table 1, across 7 waves participants reveal persistent substance use and condomless sexual activity. Specifically, self-reported alcohol to intoxication and marijuana increased across time as the YMSM emerged into adulthood. Inhalant use also increased somewhat over this time. Participants reported using other drugs just under one day per month across time, although there was considerable variability in the number of days other drugs were used. Self-reported condomless sexual activity also increased from baseline to 36-month follow-up as is also shown in Table 1. Participants reported increases in condomless ROI across time, from approximately 1.83 episodes per month to just under 3 episodes per month. Similarly, although participants reported overall increases in condomless IAI and RAI between baseline and the 36-month follow-up visit, there was considerable variability in reported episodes both within and across time. For example, condomless IAI increased between baseline and the 12-month follow-up visit, decreased through the 24-month follow-up visit, and then began to increase again. Moreover, the proportion of study participants engaging in the behaviors increased across time as noted in the change in proportions also reported in Table 1.

Correlations among the drug use and unprotected sexual activity variables within each assessment period can be found in Table 2. In general, drug use variables were positively and significantly correlated with one another, suggesting that participants who reported more frequent use of one drug (e.g., alcohol to intoxication) also reported more frequent use of other drugs (e.g., marijuana, inhalants, and other drugs). Similarly, the condomless sexual activity variables were strongly and positively associated with one another, again suggesting that more frequent engagement in one activity was related to more frequent engagement in other unprotected sexual activities. This pattern was evident across time. The pattern of correlations among the drug use variables and sexual activities differed across assessments. In general, however, more frequent use of alcohol and drugs was positively associated with higher levels of condomless sexual activity. For example, at baseline, participants who reported more frequent marijuana and inhalant use, also reported engaging in more condomless ROI and IAI; those who used other drugs more often reported higher levels of unprotected sexual activity.

Latent growth curve analyses

Drug use across time—Results indicated that days of alcohol to intoxication ($\beta = .023$, $p < .001$), marijuana use ($\beta = .091$, $p < .001$), and inhalant use ($\beta = .003$, $p < .05$) all increased over time; there was no significant change in other drug use over time. Next, to account for the possibility that participants engaged in the use of multiple drugs at one time, we modeled simultaneously growth in the four drug use variables and allowed the intercepts and rates of change to correlate. We were unable to obtain results for the model containing changes in the four drug use variables or for the model containing changes in alcohol to

intoxication, marijuana use, and inhalant use, likely due to the relatively limited variability in inhalant use across time; although it is possible that multi-collinearity was also an issue in these models. When we excluded inhalant use, a clear model emerged. Results from the model examining the simultaneous change in alcohol to intoxication, marijuana use, and other drug use are presented in Figure 1 (note correlations are not depicted in the figure). All three intercepts were statistically significant, suggesting there was actual (non-zero) use of alcohol to the point of intoxication ($B_0 = 2.86$, $p < .001$), marijuana ($B_0 = 8.14$, $p < .001$), and other drugs ($B_0 = .679$, $p < .001$) at the 36-month follow-up visit. Importantly, there was significant positive growth in days of alcohol to intoxication ($B_1 = .023$, $p < .001$), suggesting that even after accounting for changes in marijuana use and other drug use, participants increasingly engaged in alcohol consumption to the point of intoxication across time. Similarly, days of marijuana use increased significantly between baseline and the 36-month follow-up visit ($B_1 = .091$, $p < .001$), controlling for changes in alcohol and other drug use. Not surprisingly given the low levels of days of other drug use at each timepoint, there was no evidence of growth in other drug use over time.

Condomless sexual activity across time—Results indicated that instances of condomless ROI ($\beta = .029$, $p < .001$), condomless IAI ($\beta = .011$, $p < .01$), and condomless RAI ($\beta = .009$, $p < .05$) all increased over time. We then modeled simultaneously growth in the three condomless sexual activity variables and results are presented in Figure 2 (correlations are not depicted in the figure). All three intercepts were statistically significant, suggesting that participants regularly engaged in condomless ROI ($B_0 = 2.97$, $p < .001$), condomless IAI ($B_0 = .047$, $p < .001$), and condomless RAI ($B_0 = .049$, $p < .001$) at the 36-month follow-up visit. Controlling for the correlations among sexual activity intercepts and rates of change instances both ROI ($B_1 = .030$, $p < .001$) and IAI ($B_1 = .002$, $p < .01$) increased over time, suggesting participants engaged in more condomless anal sexual activity between baseline and the 36-month follow-up visit; there was no significant growth in RAI over time. Note that although we tested whether these growth patterns differed by race/ethnicity and SES, we found no evidence of moderation and thus do not report the results here.

Predicting condomless sex from drug use across time—Next, we fit a series of models to examine whether changes in drug use predicted changes in condomless sexual activity. Although a total of four models were fit (i.e., one for each drug use variable), we were only able to obtain results for two of the four models: alcohol to intoxication ($X^2 = 2073.50$, $p < .001$; CFI = .616; RMSEA = .093, $p < .001$) and marijuana use ($X^2 = 2191.78$, $p < .001$; CFI = .678; RMSEA = .091, $p < .001$). Alcohol use to intoxication at the 36-month follow-up visit was positively associated with both condomless ROI ($B = .197$, $p < .001$) and condomless RAI ($B = .054$, $p < .05$) but not with condomless IAI ($B = .010$, p = ns). Participants who reported more days of alcohol to intoxication also reported more instances of condomless ROI and RAI, even after taking into account their engagement in all other condomless sexual activity (i.e., the correlations among the intercepts and rates of change for ROI, IAI, and RAI). There were no significant associations between the rate of change in alcohol use and the rates of change in any of the sexual activity variables. Days of marijuana use at the 36-month follow-up visit (i.e., intercept) was also positively related to instances of

condomless ROI at the 36-month follow-up visit, even after taking into account all other condomless sexual activity, such that participants who reported more marijuana use also reported higher levels of ROI (B = .048, $p < .01$). No other statistically significant associations were found for either the intercepts or rates of change. Model-fit statistics for both models indicate a relatively poor fit, likely due to several factors, including relatively limited growth in the unprotected sexual activity variables, relatively limited variability in that growth (i.e., most people are changing in a similar way), and a model that could be considered quite conservative given the fact that we controlled for the associations among unprotected sexual activities.

Given the aforementioned limitations, we conducted a set of follow-up analyses in which we examined in separate models the associations between growth in each drug use variable with growth in each condomless sexual activity variable (i.e., we examined in sex variable, ROI, IAI, RAI, separately). Results are presented in Table 3. As expected, model fit was much better for each of the separate sex behavior models. However, as was the case when we attempted to model inhalant use across time, the three models we test for explaining condomless sex also would not converge likely due to the relatively little use of this substance. Days of alcohol to intoxication, days of marijuana use, and days of other drug use at the 36-month follow-up were all positively associated with instances of condomless ROI (B = .197, p < .001; B =.045, p < .01; B = 373, p < .001, respectively). However rate of change in all of the drug use variables was unrelated to growth in condomless ROI. Days of alcohol to intoxication and days of other drug use also were each independently positively related to instances of condomless RAI such that participants who reported higher levels of drug use also reported higher levels of condomless RAI (B = .05, p < .05; B = .142, p < .001, respectively); again rate of change in all of the drug use variables was unrelated to growth in condomless RAI. No significant associations (i.e., neither intercept or slope/rate) were found for any of the drug variables with IAI.

As a final step, we re-fit our models but accounted for potential differences in these associations by perceived familial SES and race/ethnicity. As was the case with our basic growth models, there was no evidence that race/ethnicity and SES moderated the associations between changes in drug use and changes in sexual activity. Thus, we re-fit our models controlling for race/ethnicity and perceived SES and found that the pattern of findings was identical to the pattern from the models without these controls and the coefficients did not change considerably so we have not included the results here.

Discussion

The synergy that exists between non-injection drug use and sexual behavior among gay, bisexual, and other MSM, can be traced throughout the course of the HIV in the United States (Halkitis, Levy, Moreira, & Ferrusi, 2014; Halkitis et al., 2011). What emerges from the scientific literature is an understanding that drug use and sexual risk behavior are best understood as co-occurring phenomena and part of a larger conception of a syndemic across the lifespan (Halkitis et al., 2012; _Halkitis et al., 2013; N. Halkitis, Kapadia, C. Ompad, & Perez-Figueroa, 2015). Additionally, they function in tandem with other health conditions,

including mental health burdens (Hanson et al., 2015; O'Cleirigh et al., 2013) and experiences of violence (Stults et al., 2015).

The findings of our investigation attempt to address several shortcomings of the extant literature and to develop new knowledge regarding the interplay between drug use and sexual risk behaviors in emerging adult sexual minority men. Participants in our cohort study were followed across seven waves of data collection between 2009 and 2014, as they emerged into adulthood from ages 18–19 to 21–22. This period of emerging adulthood is often associated with high levels of experimentation both in terms of drug use and sex (Arnett, 2005; Makarios, Cullen, & Piquero, 2015; Quinn & Harden, 2013; Steinberg, 2008; Stone, Becker, Huber, & Catalano, 2012; White et al., 2006), which may set the bases for lifelong behavioral patterns (Chassin, Flora, & King, 2004; Wagner & Anthony, 2002).

The results indicate that across 36-months of data collection there is significant growth in the use of drugs, namely alcohol to intoxication, marijuana, use of inhalant nitrates, although use of the latter remains relatively low throughout the period of assessment. Use of other drugs including those commonly cited in the literature as drivers of HIV, such as methamphetamine, remain relatively stable over time and aligns with previous investigations indicating that the onset of such "party" or "club" drugs often occurs at later ages among gay and bisexual men (Halkitis & Palamar, 2008). As might be expected, we detected associations between use of drugs at each of the timepoints, which support previous studies of poly-drug use (Patterson, Semple, Zians, & Strathdee, 2005; Stall et al., 2003) as well as associations of drug use across time (Halkitis, Palamar, & Mukherjee, 2007). As our findings indicate, there is a significant amount of use of alcohol to intoxication, marijuana, and other drug use at the 36-month assessment, even in models that control for the use of other substances, indicating that a subset of study participants are engaging in these drug use behaviors at ages 20–21. Inhalant nitrate use, which is often cited as a facilitator of HIV transmission in behavioral studies but with samples skewing slightly older (Buchbinder et al., 2005; Macdonald et al., 2008), remains low at the 36-month assessment relative to the other substances we examined in this sample of YMSM. This finding may be due to the very young age of study participants or potentially, a generational effect in relationship to the use of inhalants, a finding which we can continue to examine as the participants in this cohort study continue to age.

As is the case with drug use, condomless sex also increases as the YMSM emerge into adulthood. This was the case for all three behaviors that we examined, namely condomless receptive oral, condomless receptive anal, and condomless insertive anal intercourse. For all emerging adults, entree into adulthood is often associated with a higher frequency of sexual behavior (Arnett, 2000; Claxton & van Dulmen, 2013; Zarrett & Eccles, 2006), a finding that has also been clearly demonstrated in earlier studies of sexual minority men. Our data clearly indicate that YMSM regularly engage in all three behaviors at the 36-month assessment. High levels of association are also detected among the sexual behaviors at each timepoint. In models controlling for the associations between the sexual behaviors, we find independent significant growth of both insertive anal intercourse and receptive oral intercourse over the 36 month assessment period, as the participants become more sexually active.

Finally, through a series of bivariable tests conducted at each assessment and multivariable models examining associations of time, we find convincing evidence of the co-occurrence of drug use with condomless sexual activity. As has previous been noted, numerous studies, often based on cross-sectional data, have determined such associations (Kecojevic, Silva, Sell, & Lankenau, 2015; Newcomb & Mustanski, 2014), and a smaller number of studies (Colfax et al., 2005; Halkitis, Mukherjee, & Palamar, 2009) have examined these patterns across time. Our findings indicate that the link between drug use and sexual risk behavior continues to exist in a new generation of sexual minority men in this the fourth the decade of HIV. However, it is important to note that the most robust finding is with regard to alcohol to intoxication, which we found to be independently associated with both receptive oral and anal intercourse, both in models examining the relationship to these sex behaviors simultaneously and in ones examining sex behaviors independently. This finding with regard to alcohol to intoxication must be considered in light of the age of study participants, who at baseline are underage in terms of drinking, and who remain underage throughout the duration of most of our investigation. Still the relationship between drinking to intoxication and sexual risk is robust, and these findings align with previous investigations of alcohol use among YMSM (Colfax et al., 2004; Salomon et al., 2008). The role of alcohol as risk factor for sexual minority men must be underscored. Too often the focus of risk is directed to psychoactive drugs such as methamphetamine, ketamine, and other club/party drugs under the umbrella of sexualized drug use (Kipke et al., 2007). Yet alcohol must be considered a sexualized drug as it sexually disinhibits YMSM and provides cognitive escape (Woolf & Maisto, 2009), it is much more readily available to the population, and is often at the social venues where young sexual minority men engage with each other (Pollock et al, 2012; Wong, Kipke, & Weiss, 2008).

Findings with regard to marijuana are less constant, and findings with regard to inhalant nitrate use are near absent, as has been previously noted. Data regarding other drug use however merits our attention. While use of other drugs remains relatively low, as our growth curve models support, we do detect a strong association between use and both oral and anal condomless receptive acts. Given the psychoactive effects of many of the drugs included in this category, the impact on sex risk behaviors is not surprising and requires further attention as these YMSM age and likely increase their use of drugs such as methamphetamine.

A critical finding of our investigation is that the association between drug use and condomless sex does not differ by race/ethnicity. This builds upon our earlier reports from this cohort study that show that Black YMSM, who are most affected by HIV in the United States (CDC, 2015) and in our study (Halkitis, Kapadia, & Ompad, 2015), do not engage in more sexual risk behavior than their White peers (Kapadia et al., 2015). Moreover, similar findings are indicated for drug and alcohol use; any differences that do emerge are attenuated in light of socioeconomic status (Perry N Halkitis et al., 2014). Such findings support the notion that behavior in and of itself, is insufficient in explaining HIV prevalence in the Black population, supporting the work of others (Millett, Flores, Peterson, & Bakeman, 2007). Social and structural factors, including poverty and more limited access to quality health, which may lead to more untreated and unmanaged HIV infections within the population and greater psychosocial burdens which may engender risk, provide a clearer explanation of the drivers of these epidemiological patterns.

Limitations

Despite the strengths of our methods, there are limitations that should be considered. The implementation of the TLFB is limited to a one-month recall period, the month prior to assessment, thus failing to capture the totality of behaviors in the six months between assessments. Also with regard to the data, we also note that 28% of those assessed at baselines did not complete an in person assessment at the final assessment and thus have missing TLFB data at this timepoint. Still, those whom we did not assess at this final timepoint did not differ form those who did complete it on any key demographics, drug use, or sex behaviors, other than the frequency of condomless oral sex; although statistically significant the difference limited clinical significance (i.e., less than one act per month). Second, the limited use of psychoactive drugs (e.g., heroin, methamphetamine) and other substances (e.g., use of pharmaceuticals without a prescription) necessitated our amalgamation of these behaviors into an “other drug” use category for the purposes of analyses. Such aggregate scores are limited and provide little room for interpretation other than extrapolating that this set of drugs is not one of the other drugs we model (i.e., alcohol, marijuana, and inhalant nitrates). As use of these drugs increases over time, analyses of individual drugs may be undertaken. Also the limited use of inhalant nitrates created a condition by which models would not converge. This condition coupled with the use of an “other drug” category suggests that we may want to reconsider the handling of these data in future analyses, although this too is dependent on growth in use of the drugs. We note that TLFB data were not collected on those who relocated from the study site to another part of the country. However, our use of latent growth curve modeling was not dependent on following the entire sample for all seven waves of data collections and there is no evidence for differential attrition (Halkitis et al., 2014). While the cohort study has many design advantages, our sample is not a random one and thus limited in terms of generalizability both within the study region and more generally. Nevertheless, the sample is quite diverse, and in fact we oversample YMSM of color, a segment of the population disproportionately affected by the HIV. Moreover, the failure of a small number of the models to converge is likely due to relatively low levels of drug use or sexual activity and limited variability between individuals in these behaviors, two characteristics of the data that are critical for latent growth modeling. Additionally, the overlap in some of the behaviors (or the engagement in multiple behaviors at once) may have led to higher than average levels of multicollinearity, thus causing the models to fail. Finally, we recognize that we have utilized measure or perceived familial as compared to actual SES. Given the age of the study participants and associated complexities in measuring SES at this developmental stage (Shaver, 2007) and the literature supporting the use of this measure in studies of health (Goodman et al., 2007), we feel that perceived familial captures the construct as we conceptualized it as is a strong indicator of SES in which the participant was raised. Despite these limitations, the study design is strong in so much as data are gathered longitudinally from a sample that is diverse in terms of race/ethnicity and socioeconomic status. Moreover, our use of the TLFB provides a strong tool for gathering reliable behavioral data.

Conclusions

The findings of our analyses, based on an ongoing cohort study of sexual minority, emerging adult YMSM, suggest that this developmental period is one in which both drug use and risky sexual behavior rapidly evolve. In addition, the relationship between these co-occurring behaviors likely is bi-directional and mutually reinforcing. These results support the idea that HIV prevention and care must be nested within the broader context of gay men's health. To this end, medical practice focused on gay men's health must understand HIV in this context, with attention to the synergy that exists between drug use and sexual risk and also the numerous other health burdens young sexual minority men face including violence and mental health burdens, and finally within socio-political-economic circumstances of the time.

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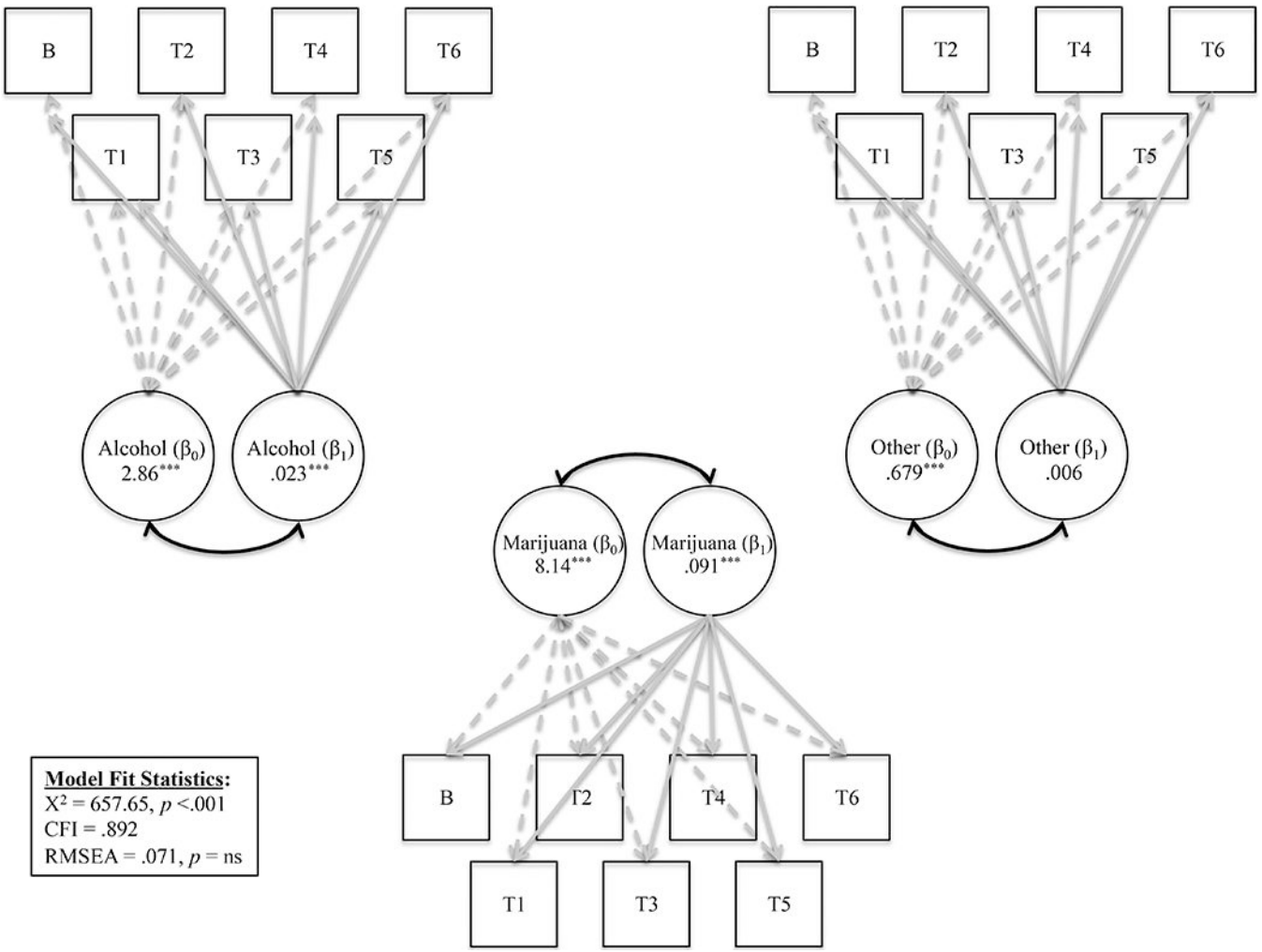

Figure 1.
Latent growth curve models depicting drug use over time

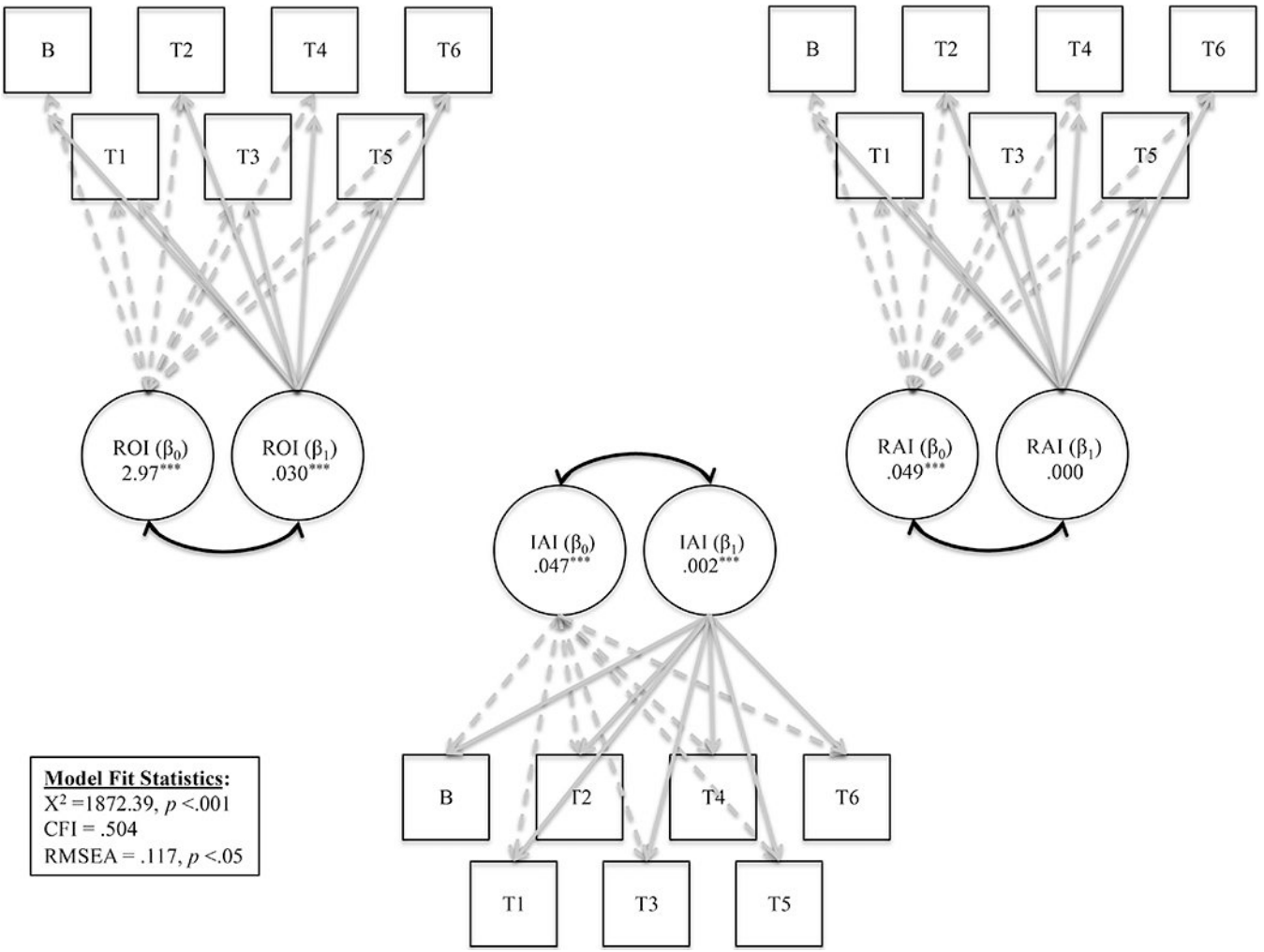

Figure 2.
Latent growth curve models depicting condomless sexual behavior over time

Table 1.

Participant drug use and condomless sexual behavior across time

	Assessment Period						
	Baseline (n = 598)	6 Months (n = 460)	12 Months (n = 445)	18 Months (n = 428)	24 Months (n = 436)	30 Months (n = 416)	36 Months (n = 430)
	%						
	Mean (SD) %	Mean (SD) %	Mean (SD) %	Mean (SD) %	Mean (SD) %	Mean (SD) %	Mean (SD) %
Drug Use							
# Days Alcohol to Intoxication	†	2.07 (3.28) 50.96%	2.51 (3.85) 59.55%	2.55 (3.28) 65.89%	2.66 (3.67) 65.60%	2.71 (3.71) 66.11%	2.73 (3.42) 67.67%
# Days Marijuana Use	4.78 (8.67) 46.23%	5.17 (8.88) 53.04%	5.60 (9.41) 51.01%	6.86 (10.47) 55.61%	6.90 (10.60) 52.52%	7.71 (11.06) 57.69%	8.14 (11.53) 56.28%
# Days Inhalant Use	.07 (.64) 2.51%	.07 (.42) 4.13%	.07 (.42) 3.60%	.08 (.43) 5.37%	.15(.76) 6.42%	.15 (.77) 7.21%	.20 (1.03) 7.67%
# Days Other Drug Use	.55 (2.55) 12.73%	.64 (2.40) 15.00%	.61 (2.15) 17.75%	.72 (2.57) 21.73%	.77 (3.08) 18.35%	.59 (1.86) 19.47%	.65 (2.11) 19.77%
Condomless Sexual Behavior							
Condomless ROI	1.85 (3.45) 54.61%	2.18 (3.89) 57.31%	2.31 (3.72) 57.98%	2.60 (3.76) 63.55%	2.38 (3.13) 63.39%	2.90 (4.13) 66.35%	2.92 (4.62) 62.79%
Condomless IAI	.40 (1.99) 11.73%	.55 (2.34) 12.83%	.70 (2.91) 16.40%	.63 (2.27) 16.59%	.54 (2.02) 16.97%	.74 (2.62) 19.47%	.83 (2.60) 23.39%
Condomless RAI	.52 (2.26) 14.41%	.64 (2.42) 16.96%	.57 (2.03) 17.75%	.65 (2.06) 17.99%	.65 (1.86) 20.41%	.69 (2.09) 20.19%	.98 (3.19) 22.33%

† Alcohol use not Alcohol use to intoxication was not assessed at baseline

Table 2.

Correlations of drug use and condomless sexual behavior variables across time

Baseline	1	2	3	4	5	6
1. Alcohol to Intoxication †	--					
2. Marijuana Use	--	--				
3. Inhalant Use	--	.08*	--			
4. Other Drug Use	--	.31***	.16***	--		
5. Condomless ROI	--	.17***	.05	.21***	--	
6. Condomless IAI	--	.09*	.10*	.08†	.56***	--
7. Condomless RAI	--	.05	.02	.16***	.48***	.43***
Month 6	**1**	**2**	**3**	**4**	**5**	**6**
1. Alcohol to Intoxication	--					
2. Marijuana Use	.21***	--				
3. Inhalant Use	.13***	.09*	--			
4. Other Drug Use	.29***	.27***	.17***	--		
5. Condomless ROI	.05	.05	.07	.01	--	
6. Condomless IAI	−.06	−.01	−.02	−.05	.23***	--
7. Condomless RAI	−.03	.03	−.02	.02	.51***	.14***
Month 12	**1**	**2**	**3**	**4**	**5**	**6**
1. Alcohol to Intoxication	--					
2. Marijuana Use	.23***	--				
3. Inhalant Use	.12*	.13**	--			
4. Other Drug Use	.28***	.22***	.09†	--		
5. Condomless ROI	.10*	.09*	.04	.07	--	
6. Condomless IAI	−.002	.09†	−.02	−.01	.60***	--
7. Condomless RAI	.01	.03	−.02	.01	.39***	.15**
Month 18	**1**	**2**	**3**	**4**	**5**	**6**
1. Alcohol to Intoxication	--					
2. Marijuana Use	.19***	--				
3. Inhalant Use	.12*	.11*	--			
4. Other Drug Use	.18***	.19***	.08†	--		
5. Condomless ROI	.13**	.05	.08	.11*	--	
6. Condomless IAI	.01	.03	.03	-.04	.38***	--
7. Condomless RAI	.07	-.01	.01	-.01	.44***	.46***

Month 24	1	2	3	4	5	6
1. Alcohol to Intoxication	--					
2. Marijuana Use	.16***	--				
3. Inhalant Use	.13**	.07	--			
4. Other Drug Use	.24***	.08	.08+	--		
5. Condomless ROI	.13**	.13**	.23***	.10*	--	
6. Condomless IAI	.07	.10*	.14**	.05	.34***	--
7. Condomless RAI	.09+	.14**	.21***	.03	.50***	.21***
Month 30	**1**	**2**	**3**	**4**	**5**	**6**
1. Alcohol to Intoxication	--					
2. Marijuana Use	.08	--				
3. Inhalant Use	.20***	.14**	--			
4. Other Drug Use	.22**	.15**	.11*	--		
5. Condomless ROI	.14**	.02	.11*	.16**	--	
6. Condomless IAI	.02	.07	.03	.11*	.58***	--
7. Condomless RAI	.10*	-.06	.01	.13**	.42***	.30***
Month 36	**1**	**2**	**3**	**4**	**5**	**6**
1. Alcohol to Intoxication	--					
2. Marijuana Use	.04	--				
3. Inhalant Use	.03	.18***	--			
4. Other Drug Use	.13**	.14**	.02	--		
5. Condomless ROI	.11*	.10*	.18***	.08	--	
6. Condomless IAI	-.03	.08+	.07	.05	.51***	--
7. Condomless RAI	.05	.06	.15**	.05	.50***	.21***

†Alcohol to intoxication was not assessed at baseline;

***$p < .001$,

**$p < .01$,

*$p < .05$,

+$p < .10$

Table 3.

Growth models explaining each condomless sexual behavior from drug use

	Condomless ROI		Condomless IAI		Condomless RAI	
	Intercept	**Rate of Change**	**Intercept**	**Rate of Change**	**Intercept**	**Rate of Change**
Alcohol to Intoxication						
Intercept	.197***		.008		.056*	
Rate of Change	1.90	.139	-.555	-.028	-1.08	-.087
Model Fit Statistics	$\chi 2 = 196.89^{***}$ RMSEA = .050 CFI = .927		$\chi 2 = 303.93^{***}$ RMSEA = .070 CFI = .859		$\chi 2 = 309.45^{***}$ RMSEA = .070 CFI = .856	
Marijuana Use						
Intercept	.045**		.010		.006	
Rate of Change	-.957	-.014	.694	-.014	.356	-.008
Model Fit Statistics	$\chi 2 = 267.72^{***}$ RMSEA = .056 CFI = .936		$\chi 2 = 378.59^{***}$ RMSEA = .072 CFI = .896		$\chi 2 = 349.06^{***}$ RMSEA = .070 CFI = .905	
Other Drug Use						
Intercept	.373***		.040		.142***	
Rate of Change	-2.39	.053	7.99	.250	.329	.207
Model Fit Statistics	$\chi 2 = 452.74^{***}$ RMSEA = .081 CFI = .781		$\chi 2 = 534.60^{***}$ RMSEA = .090 CFI = .724		$\chi 2 = 573.93^{***}$ RMSEA = .094 CFI = .708	

Note: Estimates for the model with changes in inhalants could not be obtained;

*** $p < .001$,

** $p < .01$,

* $p < .05$