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Gender Differences in Patterns of Substance Use and Delinquency: A Latent Transition Analysis

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Abstract

This study explores gender-specific patterns and transitions of adolescent substance use and delinquency in a sample of youths at ages 12, 15, and 18 ($N = 803$). Latent transition analysis identified “Primary Delinquent,” “Delinquency and Substance Use,” and “Low Risk” classes. Females were less likely to be in the “Primary Delinquent” class at age 12 than males. From 15 to 18, females were approximately equally likely to transition from “Primary Delinquent” to both other classes, whereas males were more likely to transition from “Primary Delinquent” to “Delinquency and Substance Use.” These gender differences in behavior can inform services.

Keywords

adolescence; delinquency; gender; substance use

Existing research has identified gender differences in the development of both substance use and delinquency. Noted differences by gender include frequency and severity of both behaviors, pathways to risk behavior and impact of risk factors, and developmental timing. Scholars have emphasized that male adolescents are generally more likely than females to abuse substances (Mennis & Mason, 2012) and commit delinquent offenses (Loeber, Capaldi, & Costello, 2013). Male and female youths also tend to experience certain substance use and delinquency risk factors (e.g., maltreatment and mental health symptoms) at different rates and with different consequences (Cauffman, 2008; Zahn, 2007), with females showing a greater tendency to decline or desist (Chen & Jacobson, 2012).

Longitudinal research on adolescent substance use and delinquency has proliferated following such studies as the Dunedin Longitudinal Study (Moffitt, Caspi, Rutter, & Silva, 2001), the ongoing Monitoring the Future study (e.g., Johnston, O’Malley, Miech, Bachman, & Schulenberg, 2014), and the National Longitudinal Study on Adolescent Health (Harris et al., 2009). Longitudinal statistical analysis of offending dates back at least to Wolfgang,

Figlio, and Sellin's (1972) study of a cohort of males born in Philadelphia in 1945. Findings from these and other longitudinal studies demonstrate the fluid developmental nature of substance use and delinquency among youths. It is important to understand persistence, escalation, de-escalation, and desistance in order to inform prevention and intervention targets in policy and practice. Although the empirical literature is now replete with studies of trajectories of adolescent problem behavior, these studies tend to focus on the development of either offending or substance use, with less consideration of how the two problems may co-vary over time. Furthermore, limited research has considered differences in the ways in which these problem behaviors develop in distinct ways by gender during adolescence.

To address these gaps, the current study seeks to understand transitions in substance use and delinquency among adolescents, with a focus on gender similarities and differences. We use latent transition analysis to identify, analyze, and compare mixtures of delinquent and substance-using behavior, transitions among classes, and behavioral change over time, employing a large, community-based longitudinal data set of adolescents. We also examine how class membership is related to demographic covariates. Approaching the study of substance use and delinquency in this manner has two advantages. First, substance use and delinquent behaviors may be better understood as states, rather than as qualities that are continuously distributed in a population. Second, identifying subtypes or classes of youths who are at lower or higher risk for specific behaviors may be more interpretable and provide clearer implications for intervention than growth models demonstrating change on a continuum.

Literature review

Gender similarities and differences in substance use and delinquency

The co-occurrence between delinquency and substance use is a consistent finding in the juvenile justice literature (e.g., Monahan, Rhew, Hawkins, & Brown, 2013; Tripodi & Bender, 2011), with degree of severity in one behavior often indicating severity in the other (Brunelle, Tremblay, Blanchette-Martin, Gendron, & Tessier, 2014). Among delinquent youths, males and females tend to have similar rates of problematic substance use (Welch-Brewer, Stoddard-Dare, & Mallett, 2011). Although research supports the idea that substance use and delinquency are associated for both female and male youths, the two genders have been shown to have different rates of problem behaviors, somewhat different presentations of these behaviors, and different pathways to risk behavior. Overall, males are more likely to use substances (Mennis & Mason, 2012) and exhibit offending behavior (Loeber et al., 2013), but more complex gender patterns have been identified in the literature.

With respect to delinquent or antisocial behaviors, Jennings, Maldonado-Molina, and Komro (2010) conducted a trajectory analysis of delinquent offending in a high-risk sample, and found that a subpopulation of females displayed a declining pattern of offending not found among the males in the study. A review of offending behavior (Fontaine, Carbonneau, Vitaro, Barker, & Tremblay, 2009) advocated further study of delinquency trajectories among female youths, with a specific focus on patterns that have so far been found to be distinct in females ("adolescence-limited" and "adolescence-delayed-onset," p. 378). In the

case of substance use, previous research has found that males may be more likely to be classified in heavy binge-drinking groups (Chassin, Pitts, & Prost, 2002), potentially obscuring substance use and abuse heterogeneity specific to female adolescents (Marti, Stice, & Springer, 2010). A longitudinal study of substance use found females to use substances more frequently early in adolescence, but males using more beginning in mid-adolescence (Chen & Jacobson, 2012).

Risk factors for delinquency are largely similar for both genders, and encompass such dimensions as family and peer relations, attachment to and achievement in school, neighborhood environment, mental health symptoms, and trauma history. However, gender differences are evident in that males and females respond to or are exposed to these risk factors differentially (Cauffman, 2008; Zahn, 2007). For example, victimization is associated with increased likelihood of delinquency for male and female youths, but the strength of the relation between maltreatment and delinquency may be stronger for females (Zahn et al., 2010). Furthermore, sexual violence is particularly prevalent in the histories of female offenders, relative to males (Chesney-Lind & Irwin, 2007). Regarding substance use, it has been suggested that males are more sensitive to a cluster of risk factors, including expectations that males will use substances, higher tolerance, and later development than female youths, particularly in late adolescence and early adulthood (Schulte, Ramo, & Brown, 2009). A study of mediators of the gender effect on substance use found that males and females experience victimization, school engagement, and peer associations differently, and that all these factors were associated with substance use. In other words, risk for substance use is gendered (Whaley, Hayes-Smith, & Hayes-Smith, 2013). Specific to substance use and delinquency, researchers and theorists have documented gender differences in both the incidence and the impact of various risk factors (Cauffman, 2008; Welch, Roberts-Lewis, & Parker, 2009).

Timing of substance use and delinquency

Temporal relations in the development of substance use and delinquency among adolescents are poorly understood. Delinquency has predicted later drug or alcohol use in some literature, particularly among males (Bui, Ellickson, & Bell, 2000; Cho et al., 2014) even as mean levels of offending decreased (Dembo, Wareham, & Schmeidler, 2007). Conversely, Wanner, Vitaro, Carbonneau, and Tremblay (2009) found that substance use preceded later antisocial behavior, as did a study of middle-school youths (Lynne-Landsman, Graber, Nichols, & Botvin, 2011). Some studies found reciprocal or reinforcing relations (D'Amico, Edelen, Miles, & Morral, 2008; Sullivan & Hamilton, 2007), with Mason and Windle (2002) noting this bidirectional association only among the male youths in their sample. In a seminal study of male youths, substance use and violent behavior were reciprocal at most time points, with the exception that marijuana use in early adolescence predicted violent behavior at older ages (White, Loeber, Stouthamer-Loeber, & Farrington, 1999).

One limitation of these studies relates to the conceptualization of substance use and delinquency as distinct phenomena in adolescence, when patterns of use and delinquency likely evolve together over time. One set of problem behaviors may predominate at a given developmental milestone and transition to a different pattern later in adolescence. Knowing

more about the timing and intersection of substance use and delinquency provides guidance for staging and targeting prevention and intervention efforts.

Study aims

Knowledge about gender-specific trajectories of substance use and delinquency can inform the timing and ordering of prevention and intervention services for substance use and delinquency for male and female youths. The present study addresses this gap in knowledge and provides guidance for improving prevention and intervention efforts. We aim to explore the relation between growth in delinquency and in substance use during adolescence in a community-dwelling sample, and to determine whether growth in one behavior predicts growth in another. This study focuses on gender similarities and differences in these patterns of growth and in the relations between demographic covariates and markers of behavior. Because of the lack of clarity in existing literature, specific hypotheses are not proposed, beyond the hypothesis that gender differences will be observed in class membership and in transitions among classes. Further relations and trajectories are observed without a priori assumptions regarding time order, severity, and degree of association with selected covariates.

Method

With a goal of understanding gender differences in the development of substance use and delinquent behaviors, we conducted a latent transition analysis (LTA). LTA is a specialized form of latent Markov model (Collins & Lanza, 2010) for longitudinal data analysis that characterizes categorical responses over time into classes that are not directly observed (i.e., latent), but can be understood based on response patterns of dichotomous, ordered categorical or continuous variables (Nylund, 2007; Velicer, Martin, & Collins, 1996). Often called a “person-centered” model (La Flair et al., 2013; McCutcheon, 2002), LTA has the capability of describing the probability of transitioning from one latent class to another latent class over time; this approach can be extended to include covariates to predict latent class membership as well as transition from one class to another. In longitudinal studies, latent classes are hypothesized to exist at each time point and are constrained to have equivalent parameterization over time; the number and nature of these latent classes are estimated from the observed data. The current analysis focuses specifically on substance use and delinquency classes and gender differences in transitions between classes.

Data and sample

This study analyzed data from the Project on Human Development in Chicago Neighborhoods (PHDCN; Earls, Brooks-Gunn, Raudenbush, & Sampson, 2007), a longitudinal study of individual, family, and neighborhood influences on child and youth development that focused on substance use and delinquency, among other behaviors. The PHDCN project included a neighborhood survey and a longitudinal survey of youths. For the neighborhood survey, the PHDCN utilized a multistage sampling design in which 343 neighborhood clusters were stratified by racial mix and socioeconomic status (Sampson, Raudenbush, & Earls, 1997). Within each neighborhood, the study sampled city blocks, and from within each city block, individual dwelling units. Finally, an adult resident was selected

within each unit, and this respondent provided information on neighborhood social, organizational, and political factors (Marz & Stamatel, 2005).

In the longitudinal phase of the PHDCN project, investigators derived a stratified probability subsample of 80 of the 343 PHDCN neighborhoods. Approximately 6,000 participants in seven age cohort groups (ages 0, 3, 6, 9, 12, 15 and 18 at Wave 1), along with their primary caregivers, were randomly sampled from the block groups (Earls et al., 2007) and were surveyed over three waves of data collection (1994–1997, 1997–1999, and 2000–2001; Marz & Stamatel, 2005). Using multiple cohorts, the PHDCN investigators sought to characterize development from early childhood through adulthood, with an emphasis on neighborhood, family, and individual factors that influence youth outcomes over time. For the current study, we subset PHDCN data to analyze a single cohort of adolescents ($N = 803$) who were age 12 at the first wave (1994–1997) of data collection, age 15 at Wave 2 ($N = 672$; 84% of Wave 1), and age 18 at Wave 3 ($N = 563$; 70% of Wave 1).

Measures

Latent class indicators—We constructed latent class indicators from self-reported measures of youth substance use and delinquent behaviors, measured during in-person interviews at each of the three waves of PHDCN data collection.

Substance use: The substance use measures in the PHDCN data were derived from the Composite International Diagnostic Interview (CIDI; Kessler & Mrozek, 1997) and Diagnostic Interview Schedule for Children (DISC-IV; Shaffer et al., 1993). Each youth was asked about frequency of alcohol and drug use by drug class, and about drunkenness. Four indicators were used to inform latent classes. In order to create categories with sufficient sample size for analysis, we recoded three substance use items as dichotomous (0 = no; 1 = yes) for past-year use of alcohol, marijuana, and other drugs (i.e., cocaine/crack, inhalants, psychedelics, heroin, barbiturates, tranquilizers, and amphetamines). We also included past-year self-reported drunkenness as a dichotomous indicator.

Delinquency: Using the Self-Report of Offending (SRO) measure, which asked youths about involvement in a wide variety of delinquent behaviors, we developed four delinquency indicators. The SRO, adapted for the PHDCN study from the Self-Report of Delinquency Questionnaire (Huizinga, Esbenson, & Weiher, 1991) and the Self-Report of Anti-social Behavior Questionnaire (Loeber, Stouthamer-Loeber, Van Kammen, & Farrington, 1989), is a 32-item measure that assesses lifetime and past-12-month engagement in delinquent and criminal behavior including violent crime, income-generating crimes, and status or public order offenses. Behaviors were measured dichotomously in terms of different types of offenses.

For the purposes of this study, we grouped indicators of “status/public order offenses,” “person offenses,” “property offenses,” and “drug offenses,” similar to the approach taken in Sickmund (2009). If a youth took part in a behavior under these groupings during the past 12 months, he or she was categorized as displaying that type of offending, yielding a dichotomous indicator of each offense type for each youth. Status/public order offenses included having run away, truancy, and disturbing the peace. Person offenses were

characterized by carrying a hidden weapon, mugging someone, committing a violent act inside or outside the home, throwing something at someone, or being in a gang fight. A youth was considered to have committed a property offense if he or she vandalized property, committed theft or burglary, had stolen something from home or from a car, fenced stolen goods, stole a vehicle, or used a weapon to extort goods or money. Drug offenses included dealing marijuana, cocaine/crack, or heroin.

Model covariates—Four model covariates assessed the probability of being in a given class based on sociodemographic characteristics including gender and race of the child, caregiver education level, and caregiver income. We coded gender and race dichotomously with 1 = male and 1 = non-White, respectively. Combining non-White racial categories together was necessary due to sparse cell sizes for certain classes. A dichotomous variable quantified whether the child's primary caregiver completed his or her high school education. A seven-level variable was used to assess the caregiver's income.

Analysis

All models were estimated using Mplus, Version 7 (Muthén & Muthén, 1998–2012), and used maximum likelihood with robust standard errors for model estimation. To conduct the latent transition analysis, we used a three-step modeling approach (Asparouhov & Muthén, 2013; Vermunt, 2010). First, we developed a latent class measurement model to extract latent classes from categorical response patterns. Per current practice in LTA, in Step 1, earlier class assignments (i.e., ages 12 and 15) were not used to predict later classes (ages 15 and 18). Instead, latent classes were estimated for each wave of data separately based on information from the indicators only. One categorical latent variable was estimated at each time point using the same eight manifest delinquency and substance use variables (see Figure 1 for manifest variables). The thresholds of each item were constrained to be equal across time points for measurement invariance, allowing us to model transitions over time. Information criteria evaluated were Akaike information criterion (AIC), Bayesian information criterion (BIC), sample-size adjusted Bayesian information criterion (ABIC), and the -2-log likelihood value, as well as model entropy. Lower absolute information criteria values are indicative of better fit overall. Entropy is a measure of classification quality bounded at 0 and 1, with higher values indicating better class separation (Clark & Muthén, 2009). In addition, we used substantive interpretability (Collins & Lanza, 2010; McCutcheon, 2002) to select the number of latent classes in the measurement model.

In Step 2 of model building, an estimation of the measurement error for each class is determined. We extracted the logit values for the classification probabilities class at each time point from the measurement model and used these values to create separate latent class analysis (LCA) models at the three time points. For each set of classes, the most likely class status was determined and used to assign each individual to a single class for each wave of data collection. In other words, the logit values from Step 2 are used in Step 3 to adjust for classification error, maintaining the same class for each individual at each time point (Asparouhov & Muthén, 2013; Vermunt, 2010). The final step of the process involved using the class assignment variable for each time as the sole indicator for latent classes for each

time point. We added the covariates (caregiver education, income, and race) of each latent class to evaluate probability of being in a specific class.

Finally, using the “knownclass” feature in Mplus, we estimated latent transition probabilities in a multiple group LTA model (see dashed lines in Figure 1) by gender to assess the role of gender differences in class assignment and latent transitions, based on the study aim to explore gender similarities and differences. The advantage to this approach is the ability to disaggregate developmental transitions by gender and see how females transition differently from males.

For measurement models (Steps 1 and 2), we handled missing data through full information maximum likelihood (FIML) estimation. For each model, when data were missing on one or more indicators all available information was used to derive the latent classes. When exogenous covariates were included in the model (Step 3), we conducted multiple imputation using a combination of data on class status (most likely class status and class probabilities), model indicators (status, person, and property offenses at age 12) and data on neighborhood from the PHDCN neighborhood surveys (social capital, social control, social disorder, and perceived danger). We then estimated models on 10 imputed data sets. The mechanics of this approach are explained in detail in Asparouhov and Muthén (2013).

This three-step method of conducting LTA addresses a number of weaknesses in one-step models, which may underestimate the association between covariates and class assignment (Vermunt, 2010). In prior practice, combining the measurement (latent class) and predictive (regression) aspects of LTA models has the effect of moving proportions of individuals in one class to another class when a covariate is added; this adds confusion to interpretation of the model. Vermunt’s (2010) revised three-step approach addresses classification uncertainty while separating the measurement model and model testing, eliminating this confusion.

Results

Descriptive information on latent class indicators and model covariates, reported by gender, is presented in Table 1. Examination of indicators shows that substance use increased at each time point, with alcohol use being the most commonly used substance, followed by marijuana use; use of other drugs was much less prevalent. Among the delinquency items, endorsement of drug offenses showed similar increases to those seen among drug use indicators, albeit at lower levels. Other forms of offending (status/public order, person, and property) showed greater stability over time with between 10% and 40% of individuals endorsing them. Gender differences were present among latent class indicators. Person offenses were more common among males at each age (12, 15, and 18), and males at age 18 were also significantly more likely than females to endorse property- and drug-related offending.

LTA measurement model development

Latent transition models with one through four classes were estimated using the eight indicators described in Table 1 for three time points. Model thresholds were constrained to equality over the three time points for measurement invariance, and regression paths were

not included in the models so that earlier classes could not inform later class membership. We used only the indicators at each time point to inform classification at that age such that, for example, class status at age 12 was not used to model class assignment at age 15. All information criteria decreased with the addition of each class (see Table 2), reflecting improved model fit. Although the four-class model showed better fit according to information criteria, it also yielded threshold effects in boundary estimates (in other words, little variability within classes) and very small class sizes (one class at one time point had no members in the four-class model); hence, we retained the three-class model as the most parsimonious and interpretable.

Figure 1 displays the class probabilities by the three latent classes. Class 1, “Primary Delinquent,” was distinctive based on high probability of endorsing status/public order, person, or property offenses, but low probability of endorsing substance use items. High probability of substance use as well as delinquency was present in Class 2, “Delinquent and Substance Use,” and Class 3 was comprised of individuals with a low likelihood ($<.15$ on average) of both delinquent and substance use behaviors; it was therefore designated the “Low Risk” class.

For LTA specification, class thresholds are constant over time so classes are substantively and mathematically the same at each time point. In Table 3, class prevalence rates are displayed by most likely class status. More than 70% of individuals were in the “Low Risk” class across the three time points. Membership in the “Primary Delinquent” class was 18% for the first two time points (ages 12 and 15), and then declined to 2% at age 18. A very small fraction of individuals were in Class 2, “Delinquent and Substance Use” at age 12, and percentages in these classes increased at age 15 (7%), and age 18 (30%).

LTA model transitions and predictors

Following measurement model development, we added predictors of class transition and sociodemographic model covariates, and modeled probabilities for class assignment and transition by gender. At age 12, class prevalence (Figure 2) in the “Primary Delinquent” class was lower in females (13.2%) than in males (24.9%), and the odds of being in this class (compared to “Low Risk,” which had prevalence rates of 84.7% for females and 74.8% for males) was also lower in females than males (OR = .462).

In terms of transitions from 12 to 15, females displayed greater stability in class membership with a .75 or greater probability of staying in the same class from age 12 to age 15. Conversely, males displayed variability in class membership. Males in the “Primary Delinquent” class (1) showed equal probability of transitioning into the “Delinquency and Substance Use” (P|Class 2 = .229) and “Low Risk” classes (P|Class 3 = .268). Stability in the “Low Risk” class (Class 3) was present for both genders with a probability of .80 or above of staying in this class from age 12 to age 15 for both males and females.

At age 18, both females and males displayed transitions out of the “Primary Delinquent” class (1) with less than 2% probability of both males and females staying in this class. Among females, the probabilities of transition to “Delinquency and Substance Use” (2; .455) and “Low Risk” (3; .517) classes were nearly equal. Males were more likely to

transition from Class 1 to the “Delinquency and Substance Use” (2; .726) than to the “Low Risk” (3; .259) class. It is notable that all individuals classified in the “Delinquency and Substance Use” class at age 15 stayed in this class at age 18 (regardless of gender), and the probability of individuals in the “Low Risk” class at age 15 moving to the “Delinquency and Substance Use” class at age 18 was .266 for females and .308 for males.

In the final models, transitions among classes were examined within each gender, taking into account other demographic covariates (race/ethnicity, caregiver income, and caregiver education). In this third step of model building, demographic covariates and prior class status were included as predictors of transition. Table 4 presents multinomial model coefficients predicting class transitions from age 12 to age 15 and from age 15 to age 18 using Class 3 (“Low Risk”) as the reference category. Among females, membership in Class 1 (“Primary Delinquent”) at age 12 was associated with greater likelihood of either staying in that class or transitioning to the “Delinquency and Substance Use” class, versus moving to the “Low Risk” class at age 15. Being in the “Delinquency and Substance Use” class at age 12 was also associated with staying in that class compared to transitioning into the “Low Risk” class at age 15. Among males, a similar profile was found, with a high likelihood of staying in the “Primary Delinquent” or “Delinquency and Substance Use” classes compared with transitioning to the “Low Risk” class at age 15, although these relations were weaker for those in the “Primary Delinquent” class at age 12.

The transition from age 15 to age 18 was somewhat different (Table 5). For females, transition from Class 1 (“Primary Delinquent”) to Class 2 (“Delinquency and Substance Use”) was less likely than transition to the low-risk class, suggesting that among females there may have been a desistance process from the primarily delinquent behavior. Conversely, female youths involved in “Delinquency and Substance Use” (Class 2) were more likely to stay in that class than to move to the “Low Risk” class. Among males, there was no significant relation between being in a higher risk class at age 15 and class membership at age 18.

Associations between sociodemographic covariates and class status differed by time point (see Table 5). Gender was significantly associated with membership in the “Primary Delinquent” class at age 12, with males more likely than females to appear in this class. At age 15, the odds of non-White youths being in the “Primary Delinquent” class (relative to the odds of being in the other classes) were more than 6 times as high as for White youths (OR = 6.63). At age 18, non-White individuals were significantly less likely to be in the “Substance Use and Delinquency” class. The covariates indicating caregiver education and caregiver income were not significantly related to class membership at any age.

Discussion

This study utilized data from the Project on Human Development in Chicago Neighborhoods to examine classifications of youths regarding substance use and delinquency, as well as the probability for individuals to “transition” to another latent class. LTA models suggest that delinquent behaviors were present in the absence of substance use, but the converse (non-delinquent substance use) was not identified. We found that delinquency, alone, was more

common in early adolescence (age 12) among males than females, although male youths were more likely to transition to substance use and delinquency or low-risk classes at age 15. Being in the substance use and delinquency class was associated with a very low probability of transition to low-risk status for both genders at each transition. Desistance to low-risk status was more common from the “Primary Delinquent” class, with a significant probability of transitioning to “Low Risk” at age 15 (.268) and age 18 (.259) among males. For females, desistance was common from the “Primary Delinquent” class at age 18 (.517). Conversely, a substantial proportion of both males (.308) and females (.266) transitioned from the “Low Risk” class to the “Delinquency and Substance Use” class, the highest-risk class identified, at age 18.

We found that a majority of youths were classified as “Low Risk” at each time point. This underscores that urban, community-dwelling youths across diverse neighborhood contexts have a low likelihood of engaging in risk behavior. Previous research has found no significant differences in substance use among youths in urban, rural, and suburban locations, so the prevalent “Low Risk” characterization may apply beyond this sample (Scheer, Borden, & Donnermeyer, 2000; c.f. Martino, Ellickson, & McCaffrey, 2008, for analysis on geographic differences in types and progression of substance use). This finding may have implications for primary prevention, in that the majority of adolescents are not involved in high-risk substance use or delinquency at any given time and as such the potential impact of increasing universal prevention is unknown.

Females were more likely than males to be classified in either the “Delinquency and Substance Use” class or the “Low Risk” class at age 12, although they were less likely to appear in the “Primary Delinquent” class. This is consistent with Chen and Jacobson (2012), who note that females use substances more frequently in early adolescence, and with many studies of delinquency showing higher levels of delinquency in male youths (e.g., Loeber et al., 2013; Lynne-Landsman et al., 2011). However, our findings add complexity to the gender dynamic in that a stronger connection appeared between substance use and delinquency in female youths at age 12 and later, without similarly stable connections between risk behaviors in male youths until the age-15-to-18 transition. On the other hand, male youths in this sample are more likely to move from the “Primary Delinquent” to the “Delinquency and Substance Use” class at both transition points, suggesting escalation of behavior among a subgroup of males. These findings extend research on gender similarities in trajectories from middle school-age youths (Lynne-Landsman et al., 2011), suggesting that adolescence may be a key developmental time in which gender differences in behavior can be observed.

The finding that a subgroup of female youths displays stability in both delinquent and substance-using behavior in early adolescence is troubling (.75 remaining in the “Delinquency and Substance Use” class from age 12 to 15), as it suggests a persistence at an early developmental stage not seen in the male youths in the sample. This gender difference is unexplained by the covariates included in the present analysis, but may be attributable to early pubertal development, associated with offending and substance use in the Great Smoky Mountains Study (Copeland et al., 2010), or to early sexual activity, found to predict

increased risk of delinquency (Armour & Haynie, 2007), possibly due to the influence of older male partners.

Gender differences in this study relate to and clarify findings from prior research. The co-occurrence between substance use and delinquency has been noted in other literature (Monahan et al., 2013; Tripodi & Bender, 2011); desisting from delinquency may be more likely when substance use does not complicate the level of risk. Among female youths, this is particularly important, as delinquent-only patterns of behavior appear to be less common. The pairing of substance use with delinquency suggests a need for comprehensive treatment covering multiple behaviors for adolescent female offenders. For those females in the “Primary Delinquent” class, however, the transition to the “Low Risk” class was more likely at age 18 than for males at the same age. This movement may be similar to the subpopulation identified in Jennings and colleagues’ study (2010), a group of female youths with a pattern of desistance not seen in males in the study.

At age 18, a substantial proportion of both male (.308) and female (.266) youths transition into Class 2, “Delinquency and Substance Use,” from the “Low Risk” class. As youths enter later adolescence, a group of low-risk youths of both genders enters a higher-risk class in which they display increased involvement in delinquency behaviors and substance use. It is notable that non-White youths are less likely (OR = .458) to be in this group compared with the “Low Risk” class (see Table 5), suggesting that delinquency and substance use at the oldest age is more common among White youths than youths of color, who may struggle with delinquency without the additional risk associated with substance use.

The selection of a three-class model distinguishes our findings from literature that identified four classes of delinquency and substance use (Salas-Wright, Lombe, Vaughn, & Maynard, 2014; Vaughn, Salas-Wright, DeLisi, & Maynard, 2014); however, the fourth class in previous studies captured a small group with particularly severe levels of substance use and offending. Because our data indicate presence rather than severity, this distinction may exist but be undetected here.

In theoretical terms, the gender differences identified may speak to developmental timing in adolescence. That female youths are more likely to display a pattern of ongoing delinquency and substance use from age 12 to 15, whereas male youths show a similar stability from 15 to 18, could indicate different responses to social and environmental influences at different ages. As Cauffman (2008) and Zahn and colleagues (2010) have noted, responses to risk factors may differ by gender, and these data show that early substance use may be a marker of particularly high risk in females. Findings support the consideration of female and male youths separately in models of problem-behavior development over time.

Limitations

Although the data source for this study is comprehensive in that it draws on youths in diverse neighborhoods, the sampling frame is comprised of one urban geographic area, the city of Chicago. This limits our ability to generalize findings, beyond contextualizing them given previous research with different samples. Relatedly, generalization to diverse ethnic

groups is limited based on the composition of the study sample. Measurement contributes additional limitations. Because indicators were limited to past-year recall, we do not have a measure of initiation of delinquency or substance use. Reliance on self-report data, measuring changes every three years rather than more frequently, and use of single-item behavioral indicators limits the ability to measure severity or subtle changes over time, and findings may be susceptible to social desirability or recall bias. Reliance on dichotomous indicators of behavior allows us to describe transitions between engaging and not engaging in substance use and delinquency, but does not capture severity of these behaviors. Furthermore, unmeasured covariates, such as neighborhood-level crime, availability of alcohol or other drugs, and parenting practices may have predictive value (e.g., Chen, Voisin, & Jacobson, 2013; Griffin, Botvin, Scheier, Diaz, & Miller, 2000; Herrenkohl et al., 2000) but are not included in this model. The local independence assumption of latent class analysis asserts that correlations between indicators must result from latent class membership, rather than from observed relations between constructs (Pickles et al., 1995). It is untestable, however, whether the associations between indicators of problem behavior are due to latent class membership or some other unmeasured variance. Finally, latent variable or person-centered models have been criticized for “reifying” classes, which are by definition not observable (Lanza & Rhoades, 2013). We selected the three-class model based on theoretical considerations, interpretability, and separation of indicators among classes; other interpretations of the data, including names and ordering of classes, are also possible.

Conclusion

Research has identified behavioral differences between boys and girls. The results of this study suggest gendered patterns of risk among urban, community-dwelling youths. Among females, combined early delinquency and substance use is particularly problematic, whereas among males, early primary delinquency is equally likely to result in desistance as in escalation. Prevention and intervention services may be most effectively targeted to females who endorse early initiation substance use and delinquency. For male youths, prevention services could be targeted to those displaying early delinquency to prevent substance-using behavior.

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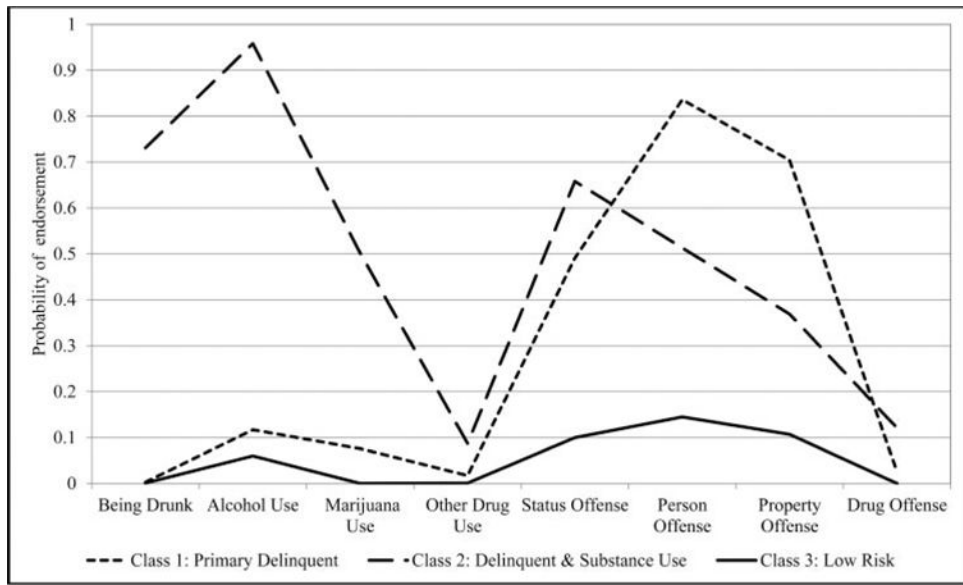


Figure 1.
Latent class probabilities by class status.

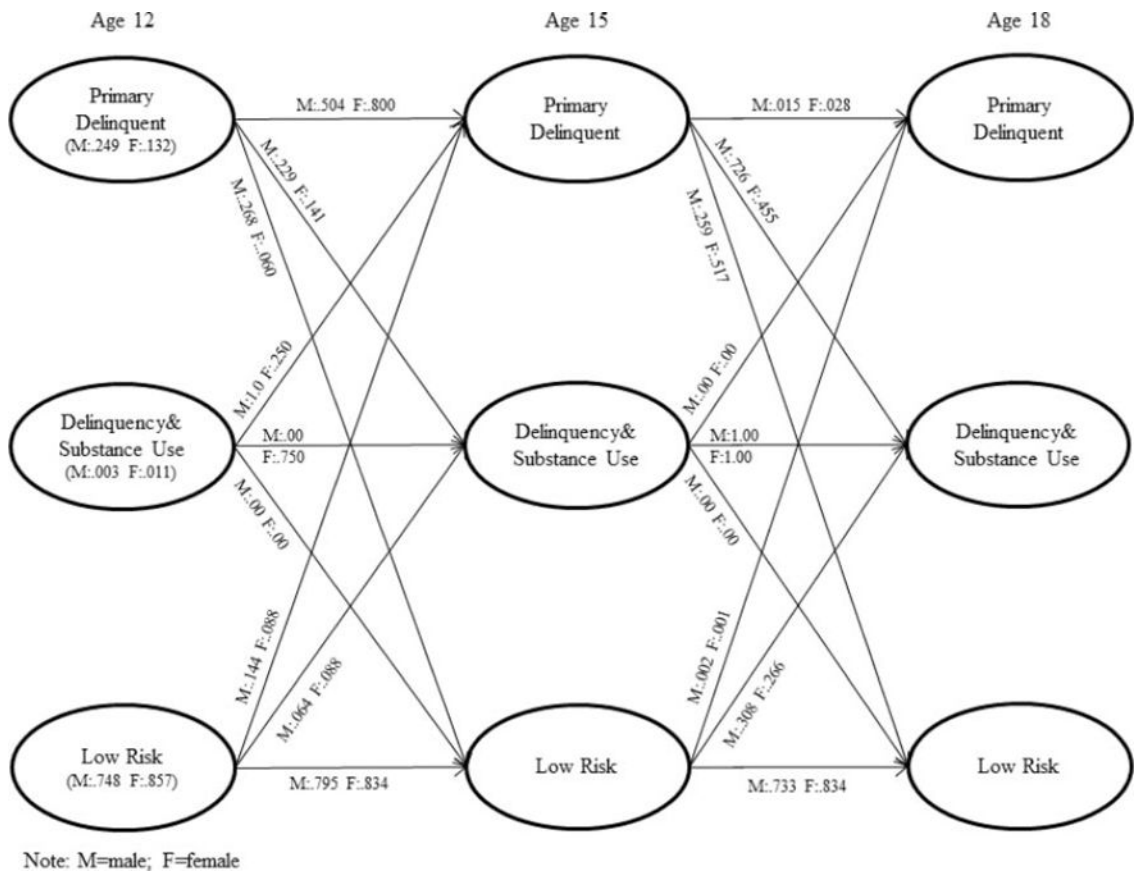


Figure 2.
Mean latent class and transition probabilities by gender.

Table 1

Gender differences by class indicators: Cohort 12.

	FEMALES %	MALES %	χ^2	<i>p</i>
<i>Latent class indicators</i>				
AGE 12	<i>N</i> = 411	<i>N</i> = 392		
Drunkenness	1%	.2%	2.42	.297
Alcohol use	3.9%	6.9%	4.39	.111
Marijuana use	1.7%	1.8%	.174	.916
Other drug use	.7%	.2%	1.29	.524
Status offense	8.7%	12.2%	2.60	.106
Person offense	25.8%	38.5%	14.94	<.001
Property offense	24.1%	27.0%	.920	.337
Drug offense	.2%	.5%	.77	.680
AGE 15	<i>N</i> = 343	<i>N</i> = 329		
Drunkenness	2.6%	7.9%	1.76	.414
Alcohol use	17.8%	18.5%	.640	.726
Marijuana use	3.5%	6.4%	3.36	.186
Other drug use	1.8%	1.8%	.299	.861
Status offense	28.6%	32.2%	1.06	.304
Person offense	27.4%	38.0%	8.57	.003
Property offense	26.0%	30.7%	2.98	.225
Drug offense	1.2%	3.0%	5.02	.081
AGE 18	<i>N</i> = 300	<i>N</i> = 263		
Drunkenness	24.3%	31.6%	4.68	.096
Alcohol use	42.0%	51.0%	4.60	.099
Marijuana use	18.7%	27%	5.59	.061
Other drug use	3.0%	3.0%	.009	.995
Status offense	35.0%	40.7%	4.42	.110
Person offense	32.3%	34.2%	9.48	.009
Property offense	11.0%	25.5%	21.44	<.001
Drug offense	2%	8.4%	12.03	.002
<i>Covariates</i>				
Non-White race	86.0%	85.8%	.007	.932
Caregiver high school education	54.6%	54.0%	.034	.852
Salary			7.25	.298
<\$5,000	10.3%	11.8%		
5,000–9,999	9.8%	9.7%		
10,000–19,999	19.3%	19.7%		
20,000–29,999	18.0%	23.3%		
30,000–39,999	17.3%	11.6%		
40,000–49,999	8.0%	8.9%		
>50,000	17.3%	15.7%		

Table 2

Model fit statistics based on the number of classes.

	Number of Classes			
	1	2	3	4
-2LL	-5759.537	-5222.890	-5047.213	-4937.028
AIC	11567.073	10483.780	10154.427	9956.056
BIC	11679.950	10573.141	10295.522	10148.886
ABIC	11603.735	10512.804	10200.254	10018.687
Entropy	N/A	.788	.718	.726

Note. LL = log likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion. ABIC = adjusted Bayesian information criterion.

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Table 3

Class prevalence based on most likely class membership.

	Age 12		Age 15		Age 18	
	N	%	N	%	N	%
Class 1: Primary Delinquent	147	18%	147	18%	19	2%
Class 2: Delinquent & Substance Use	5	<1%	60	7%	228	28%
Class 3: Low Risk	663	81%	608	75%	568	70%

Table 4

Likelihood of class transitions by gender.

	Age 12→Age 15			Age 15→Age 18		
	<i>b</i>	SE	OR	<i>b</i>	SE	OR
TRANSITION – FEMALE						
Primary Delinquent to Primary Delinquent	4.869	2.411	130.19*			
Primary Delinquent to Delinquent & Substance Use	25.72	1.222	***			
Delinquent & Substance Use to Primary Delinquent	3.240	2.214	25.53			
Delinquent & Substance Use to Delinquent & Substance Use	26.937	.137	***			
Primary Delinquent to Delinquent & Substance Use				246.594	509.526	
Primary Delinquent to Delinquent & Substance Use				-17.723	.000	***
Delinquent & Substance Use to Primary Delinquent				.893	.869	2.44
Delinquent & Substance Use to Delinquent & Substance Use				27.907	.000	***
TRANSITION – MALE						
Primary Delinquent to Primary Delinquent	2.340	.678	*			
Primary Delinquent to Delinquent & Substance Use	33.388	.136	***			
Delinquent & Substance Use to Primary Delinquent	2.404	.688	***			
Delinquent & Substance Use to Delinquent & Substance Use	9.941	.000	***			
Primary Delinquent to Delinquent & Substance Use				-61.746	150.809	
Primary Delinquent to Delinquent & Substance Use				-145.596	433.327	
Delinquent & Substance Use to Primary Delinquent				1.920	4.294	
Delinquent & Substance Use to Delinquent & Substance Use				38.644	50.208	

Note. Reference = Low Risk.

* $p < .05$.*** $p < .001$.

Table 5

Correlates of class membership by age.

	Age 12			Age 15			Age 18		
	<i>b</i>	SE	OR	<i>b</i>	SE	OR	<i>b</i>	SE	OR
<i>Primary Delinquent</i>									
Female	-.773	.224	0.462**	-.544	.397	0.580	-130.66	234.219	<.001
Income	-.084	.084	0.919	-.067	.113	0.935	-61.10	151.422	<.001
Non-White	-.196	.336	0.822	1.892	.870	6.633*	878.754	1858.439	<.001
High school education	.261	.243	1.298	-.061	.472	0.941	-97.62	221	<.001
<i>Delinquent & Substance Use</i>									
Female	1.217	1.275	3.377	.198	.478	1.219	-.190	.755	.827
Income	.306	.397	1.358	.227	.139	1.255	-.036	.088	.965
Non-White	.034	1.106	1.035	-.048	.543	0.953	-.780	.359	.458*
High school education	-.325	1.634	0.723	.745	.444	2.106	.121	.302	1.129

* $p < .05$.** $p < .01$.