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White and Black adolescent females differ in profiles and longitudinal patterns of alcohol, cigarette, and marijuana use

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Abstract

Emerging research suggests that White youth are more likely to show continuity of alcohol use in the year following drinking onset, compared to Black youth. Little is known, however, regarding racial differences in year-to-year continuity of alcohol, cigarette, and marijuana use during adolescence, particularly among females, who are at greater risk for certain substance-related harm than males. This study used latent class/transition analysis to identify profiles of past year alcohol, cigarette, and marijuana use at ages 13–17 in a community sample of 1076 adolescent females (57% Black, 43% White). Three profiles of past year substance use were identified in separate analyses by race: “no use,” “alcohol only,” and “polydrug use.” Although similar labels describe the profiles, the probability of endorsing use of a particular substance for a given profile differed by race, precluding direct comparison. Latent transition analyses of five annual waves covering ages 13–17 indicated that an intermittent pattern of use (e.g., use in one year, but not the next) was relatively low at all ages among White girls, but among Black girls, an intermittent pattern of use began to decline at age 15. Among Black girls, conduct problems at age 12 predicted substance using profiles at age 13, whereas among White girls, intentions to use alcohol and cigarettes at age 12 predicted substance using profiles at age 13. Racial differences in girls' substance use profiles suggest the potential utility of culturally-tailored interventions that focus on differences in risk for specific substances and relatively distinct early patterns of use.

Keywords

adolescent females; alcohol; cigarette; marijuana; race/ethnicity; conduct problems

National survey data indicate racial/ethnic differences in adolescent substance use, such that White adolescents report higher rates of alcohol, cigarette, and marijuana use compared to Black youth (Johnston et al., 2010; Substance Abuse and Mental Health Services Administration, 2011). In the context of these racial/ethnic differences, there also has been a narrowing gender gap in rates of substance use with females catching up to males in recent years (Johnston et al., 2010). The increasing prevalence of substance use among adolescent females is alarming because females are at greater risk for certain types of substance-related harm compared to males (Institute of Medicine, 2004; Nolen-Hoeksema, 2004). Specifically, substance using females, compared to males, may be at greater risk for dating

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violence (e.g., Foshee et al., 2001), risky sexual behavior and sexually transmitted disease (e.g., Hutton et al., 2008), and accelerated progression to nicotine dependence (DiFranza et al., 2002). Greater risk for harm among females may be due, for example, to greater effects of a substance at similar doses (e.g., alcohol), and contexts of use (e.g., with a substance-using romantic partner), which may facilitate the occurrence of substance-related harm relative to males (Nolen-Hoeksema, 2004). In the context of such risks, and the need to understand racial/ethnic differences in patterns and predictors of substance use, this study examined age-to-age changes in alcohol, cigarette, and marijuana use during adolescence in White and Black girls.

Prototypical profiles of adolescent substance use (e.g., “alcohol only,” “alcohol and tobacco use”) have been identified in cross-sectional data using latent class analysis (LCA) (e.g., Lanza & Collins, 2002; Reboussin, Hubbard, & Ialongo, 2007; Dauber et al., 2009; Lanza, Patrick, & Maggs, 2010; Cleveland et al., 2010). LCA is a person-centered approach to identifying latent classes or common profiles of substance use that reflect relatively distinct subgroups (Collins & Lanza, 2010). When alcohol, cigarette, and marijuana use have been used to derive substance use profiles in adolescents, 4–8 profiles have been identified, such as “no use,” “alcohol only,” “cigarette only,” and “alcohol, cigarette, and marijuana use” (e.g., Lanza et al., 2010; Cleveland et al., 2010). Differences across studies in the number and nature of the substance use profiles that have been identified may reflect, for example, differences in sample age range, recruitment method, and differences in the items (e.g., consumption of 5+ drinks per occasion) and time frames used.

Some studies have characterized substance use profiles in specific race/ethnic groups using LCA (e.g., Hispanic youth: Maldonado-Molina et al., 2007; Black youth: Reboussin et al., 2007). One cross-sectional study contrasted White and Black adolescent females (ages 13–19) on profiles based only on alcohol involvement (Dauber et al., 2009), and found four subtypes in White females (abstainers, experimenters, moderate drinkers, heavy drinkers), but only three subtypes in Black females (abstainers, experimenters, problem drinkers). Among Black females, the “problem drinker” class represented a level of alcohol involvement severity that was between the “moderate” and “heavy drinker” subtypes identified for White females, a result that reflects the overall lower level of alcohol severity among Black females (Dauber et al., 2009). The cross-sectional study by Dauber and colleagues (2009) suggests racial differences in alcohol use profiles among adolescent females, but was limited in examining only alcohol involvement, although concurrent use of other substances (e.g., concurrent use of alcohol and tobacco), is relatively common among youth (e.g., alcohol and tobacco: Orlando et al., 2005).

The longitudinal extension of LCA, latent transition analysis (LTA; Collins & Lanza, 2010) can be used to estimate not only continuity of substance use at adjacent time points, but has the specific advantage of estimating “backward” transitions in use (e.g., use of a substance in one year, and no use of that substance in the following year), which may be common in early adolescence. For example, a recent study focusing on alcohol use found that Black youth were less likely to drink in the year following initiation of drinking compared to White youth, whereas White youth were more likely to show continuity of alcohol use in the year after drinking onset (Malone et al., 2012). Further, LTA indicated that Black adolescent girls were more likely to be in abstainer and decreasing alcohol use classes at 1-year follow-up compared to White girls (Dauber, Paulson, & Leiferman, 2011). Although the LTA conducted by Dauber and colleagues (2011) identified important differences in alcohol severity between Black and White adolescent (ages 13–19) girls over 1-year follow-up, the study did not address other commonly used substances (e.g., cigarettes, marijuana), and did not provide information on age-to-age changes in substance use during adolescence. Trajectory or growth curve analyses also have been used to characterize race/ethnic

differences in the development of substance use, with research suggesting that White youth tend to show more steady escalation of alcohol use compared to Black youth (Flory et al., 2006). Trajectory analyses, however, are more limited in capturing experimental or intermittent (e.g., use of a substance in one year, but not the next) patterns of use, relative to LTA.

The current study addresses limitations of existing LCA and LTA studies by identifying prototypical substance use profiles based not just on a single substance (cf. Dauber et al., 2009; 2011), but on three substances commonly used by youth (i.e., alcohol, cigarettes, marijuana); and conducting LTA on five annual waves of data (most LTA studies have used <4 time points). Perhaps most importantly, the current study provides a unique contribution by examining change in substance use profile from age-to-age during adolescence in a relatively large sample of Black and White female adolescents, permitting identification of differences by race in age-related change points in emerging patterns of substance use. LTA is well-suited to capturing intermittent patterns of use and identifying the point of transition to a more persistent pattern of use, relative to trajectory analyses. The current study's age-to-age estimation of transition probabilities can provide information to inform the timing (i.e., age) and type (i.e., content addressing specific substances) of prevention efforts that may be most effective for specific race/ethnic groups of adolescent girls.

Beyond identifying adolescent substance use profiles, and examining changes in use, predictors of the profiles and of transitions between profiles over time warrant study as potential targets for intervention. A social developmental framework (Hawkins, Catalano, & Miller, 1992) proposes that individual (e.g., conduct problems, substance-related cognitions) and social (e.g., perceptions of peer substance use) factors play key roles in influencing risk for adolescent substance use. For example, prior analyses in the Pittsburgh Girls Study examined girls' expectancies or beliefs regarding the effects of substance use in relation to alcohol and cigarette use (Hipwell et al., 2005; Chung et al., 2008; Chung et al., 2010), and girls' conduct problems in relation to early alcohol use (Loeber et al., 2010). Importantly, among White girls in the Pittsburgh Girls Study, conduct problems predicted alcohol use at ages 11–13, but not at older ages (14–15), whereas among Black girls, conduct problems predicted alcohol use at ages 13–14, but not earlier (Loeber et al., 2010). These findings generally support conduct problems as a robust predictor of adolescent substance use (e.g., Brown et al., 2008; Windle et al., 2008), but also suggest possible differences by race in the association between conduct problems and substance use in girls that warrant further study.

In addition to examining conduct problems as a relatively robust predictor of substance use, two cognitive factors, intention to engage in substance use and perceived peer substance use, deserve attention as predictors of substance use profiles and transition probabilities. Intention to engage in a specific behavior, according to the theory of planned behavior (Ajzen, 2012), can serve as a proximal determinant of behavior. "Intention" reflects a composite of an individual's attitudes, outcome expectancies, and perceived norms regarding the behavior (Ajzen, 2012). "Intention to use" a substance has been associated concurrently and prospectively with adolescent substance use (e.g., Andrews et al., 2008; Skenderian et al., 2008; Maddahian, Newcomb, & Bentler, 1988; Hornik et al., 2008). "Intention to use" has been associated with current level of substance use among both White and Black adolescents, however, the strength of the association varied by race/ethnicity and type of substance (Maddahian et al., 1988), suggesting the importance of examining race/ethnic differences in this association.

Perceived peer substance use also is a relatively robust predictor of adolescent substance use (e.g., Curran, Stice, & Chassin, 1997), and may independently (i.e., over and above intention to use and conduct problems) predict a girl's substance use status, and changes in use over

time. Some research suggests race/ethnic differences in the importance of perceived peer use as a predictor of adolescent substance use. For example, perception of friends' cigarette smoking was a risk factor for an adolescent's smoking behavior, but the association was stronger among White, relative to Black, youth (Unger et al., 2001). Based on some research suggesting race/ethnic differences in the importance of certain risk factors as predictors of substance use (e.g., Wallace et al., 2009; Ellickson & Morton, 1999), we examined differences by race in the association between conduct problems, intention to use, and peer use in relation to substance use profiles in Black and White adolescent girls.

This longitudinal study aimed to identify prototypical profiles (latent classes) of past year alcohol, cigarette, and marijuana use (e.g., "no use," "alcohol use only") across ages 13 through 17, and to estimate transition probabilities among the profiles for adjacent time points in Black and White adolescent girls. Consistent with cross-sectional and longitudinal analyses characterizing race/ethnic differences in adolescent substance use (e.g., Johnston et al., 2010; Dauber et al., 2011; Flory et al., 2006; Orlando et al., 2005), we hypothesized that White girls would be more likely than Black girls to be in substance using (versus "no use") profiles. We also expected, based on the literature (e.g., Malone et al., 2012), that White girls would show greater age-to-age continuity of substance use (i.e., lower probability of "backward" transitions, e.g., from use to no use classes) than Black girls. Further, we tested the hypothesis that intention to use, perceived peer substance use, and conduct problems at age 12 would be more strongly associated with substance use profile at age 13, and transition probabilities over ages 13–17 among White, relative to Black, girls (e.g., Wallace et al., 2009). Identification of race/ethnic differences in risk for and continuity of substance use in adolescence has potential implications for refining culturally-tailored interventions for youth.

Method

Participants

The Pittsburgh Girls Study (PGS; $N=2,451$) is a population-based urban sample of girls first assessed at ages 5–8 (4 age cohorts), who have been followed annually. PGS sample ascertainment and methods have been detailed elsewhere (Hipwell et al., 2002; Keenan et al., 2010). Briefly, PGS oversampled low income neighborhoods, with 85% of eligible families completing the first wave of data collection. The current analyses used the two oldest of the four PGS age cohorts for whom data at ages 13–17 were available for analysis (at wave 1: age 7 $n=611$; age 8 $n=622$; total N at wave 1 for the two cohorts=1233), and excluded the small number of girls who, according to the caregiver's report, were not identified as White or Black ($N=70$: $n=38$ in age cohort 7 and $n=32$ in age cohort 8), and who did not provide substance use data at ages 13–17 ($N=87$; $n=42$ in age cohort 7 and $n=45$ in age cohort 8). Retention over follow-up was high: 88.7% over ages 12–17 (data collection years 2005–2012). The analysis sample included 1,076 girls (Black $n=611$, 56.8%; White $n=465$, 43.2%) who provided data on substance use for at least one wave from ages 13–17. In the analysis sample, a minority (35.7%) of families received public assistance at wave 1; lifetime substance use prior to age 13 was 13.4% for alcohol (including sips and tastes), 8.2% for cigarettes, and 2.6% for marijuana.

There were no statistically significant differences between participants included in the analyses ($n=1076$) and those who were not ($n=157$) on younger vs older cohort; receipt of public assistance at wave 1; single parent household; caretaker education <12 years vs >12 years; or girls' alcohol, cigarette, or marijuana use in each year through age 12. White girls were more likely to be excluded from the analysis sample due to the absence of substance use data at ages 13–17 than Black girls (10% vs 5% excluded, respectively; $\chi^2[1]=8.9$, $p<.01$).

Procedure

Annual in-home computerized interviews were conducted with the girl by highly trained research staff (Hipwell et al., 2002; Keenan et al., 2010). Participants were compensated for their time. All study procedures were approved by the University of Pittsburgh Institutional Review Board.

Measures

The Nicotine, Alcohol, and Drug Substance Use measure (Pandina, Labouvie, & White, 1984) assessed past year use of any alcohol (including sips and tastes), cigarettes, and marijuana at ages 13–17 (each substance coded 1=no, 2=yes at each age). Past year rates of substance use in PGS are generally similar to rates reported for national survey data (cf. Johnston et al., 2010; Substance Abuse and Mental Health Services Administration, 2011).

The following eight covariates were assessed at age 12. Receipt of public assistance in the past year was coded 0=no and 1=yes. Items assessing “intention to use” were asked separately for alcohol, cigarettes, and marijuana (“How likely is it that you would use [substance] even once or twice in the next year?”) using the following response categories: 1=definitely not, 2=probably not, 3=probably yes, 4=definitely yes (Maddahian et al., 1988; Ellickson & Morton, 1999; Hornik et al., 2008). Due to skewed distribution, intention variables were coded 0=“definitely not” and 1=“probably not” through “definitely yes” for each substance. Peer substance use was assessed separately for alcohol, cigarettes, and marijuana (“How many of your friends have used [substance]?”) using the following response categories: 0=none, 1=one peer, 2=some, 3=all (Curran et al., 1997; Johnston et al., 2010). Due to skewed distribution, peer use was coded 0=none and 1=one or more peers. Conduct problems (past year) were assessed using girl report at age 12 on the Child Symptom Inventory-Fourth Edition (Gadow & Sprafkin, 1994), which covers DSM-IV (American Psychiatric Association, 1994) symptoms of conduct disorder rated on a 4-point scale (0=never to 3=very often). Due to skewed distribution of the summary score, conduct problems were represented as a dichotomous variable coded 0=no past year problems and 1=1 or more conduct problems.

Data analysis

First, we used PROC LTA (version 1.1.7; Lanza et al., 2011) to test the fit of 2–5 classes across the 5 time points (ages 13–17), specifying invariance of item response probabilities (IRPs) for each latent class over time, separately for Black and White subsamples, per procedures outlined in Collins & Lanza (2010). Preliminary analyses indicated that it was not feasible to include substance use data at younger ages (ages 8–12) in the model due to data sparseness. Examining the fit of a specific number of latent classes simultaneously over 5 time points using LTA allowed for efficient identification of a substance use profile, which had the same meaning at each time point, in each subsample. The longitudinal model estimated the following parameters: latent class (profile) membership probabilities at Time 1, item response probabilities (IRPs) for each class (i.e., the probability of using alcohol, marijuana, and cigarettes), and transition probabilities between latent classes for consecutive time points. PROC LTA accommodates incomplete data using full information maximum likelihood estimation (Collins & Lanza, 2010). The best-fitting model was determined by considering the likelihood ratio G^2 (which is χ^2 distributed; lower value indicates better fit), Bayesian Information Criterion (BIC; lower value indicates better fit), Akaike Information Criterion (AIC; lower value indicates better fit), and the conceptual relevance of the latent classes identified (Collins & Lanza, 2010). Among the fit indices, BIC was preferred because it takes model complexity (i.e., the number of parameters estimated) into account in determining the best fitting model (Henson, Reise, & Kim, 2007).

Second, we tested the feasibility of using a multiple group approach to directly compare Black and White samples using the best fitting LTA model in each group (i.e., 3-class LTA model). Specifically, we compared a model in which IRPs were equal over time but free across racial groups to a model in which IRPs were equal over time and across racial groups. Results indicated a significant difference in IRPs across race ($\Delta G^2 = 292.03$, $df = 9$, $p < .001$), indicating that Black and White subgroups differed in substance use profiles. Thus, direct comparison of Black and White subsamples using LTA was not feasible, and separate analyses by race were conducted.

Third, we included eight covariates assessed at age 12 in the LTA model: receipt of public assistance; intention to engage in alcohol, marijuana, and cigarette use in the next year (asked separately for each substance); perceived peer use of alcohol, marijuana, and cigarettes (asked separately for each substance); and past year conduct problems. Proc LTA excludes cases with missing covariate data, resulting in covariate analysis sample sizes of 565 Black girls and 433 White girls. There were no statistically significant differences between cases that were included versus excluded from the covariate analyses on receipt of public assistance or alcohol, cigarettes, or marijuana use through age 12.

In the first covariate LTA model, the eight age 12 covariates (entered simultaneously) were used to predict latent class membership at age 13. The second covariate LTA model built on the first model by also using the significant predictors of profile membership at age 13 as predictors of the four transitions. Nested model comparison tested the significance of covariates as transition predictors.

Results

Prevalence of substance use and covariates by race

As expected, the prevalence of past year alcohol, cigarette, and marijuana use increased with age in both subgroups (Table 1). With regard to differences by race, prevalence of alcohol and cigarette use was higher among White girls than Black girls at each age as determined by χ^2 tests (at $p < .01$; see Table 1 for statistics), except for cigarette use at age 13, when there was no significant difference by race ($p = .08$). Prevalence of marijuana use was higher among Black, compared to White, girls at ages 13, 14, and 16 ($p < .05$). With regard to covariates assessed at age 12, Black girls were more likely than White girls to have received public assistance; to report intention to use marijuana; to perceive greater peer use of alcohol, marijuana, and cigarettes; and to report one or more conduct problems compared to White girls (see Table 1 for details).

Best fitting LTA model in Black and White subgroups

In the Black subgroup, the likelihood ratio G^2 indicated better fit with each additional class; the 3-class LTA had the lowest BIC, but the 4-class LTA had the lowest AIC (Table 2). The 3-class model was selected based on BIC, which favors model parsimony. The 3-class model included a “no use” class (IRPs = .00–.02); a class with some likelihood of alcohol use (IRP = .38; marijuana IRP = .22, cigarette IRP = .14); and a “polydrug use” class representing alcohol (IRP = .73), marijuana (IRP = .89), and cigarette (IRP = .59) use. The label “polydrug use” is used to represent girls who generally reported some combination (i.e., usually 2 or more) of alcohol, cigarette, and marijuana use in the past year; IRPs for the polydrug use profile suggest relatively high likelihood of alcohol and marijuana use for this profile. Note that the IRPs only indicate the likelihood of endorsing past year use of a specific substance, and that, in particular, the “polydrug use” profile represents cases with heterogeneous combinations of past year substance use (e.g., use of all 3 substances in the past year; only alcohol and tobacco; etc).

In the White subgroup, the likelihood ratio G^2 indicated better fit with each additional class; the 3-class LTA had the lowest BIC, but the 4-class LTA had the lowest AIC (Table 2). As above, the 3-class model was selected based on BIC and model parsimony. The 3-class model included a “no use” class (IRPs= .00–.07); an alcohol use class (alcohol IRP= .83, marijuana IRP=.10, cigarette IRP=.10); and a “polydrug use” class representing use of alcohol (IRP= .84), cigarettes (IRP= .89), and marijuana (IRP= .60). As above, the “polydrug use” label is used to represent girls who typically reported a combination (i.e., usually 2 or more) of alcohol, cigarettes, and marijuana use in the past year.

Prevalence of substance use profiles and transition probabilities: Analyses by race

Although a 3-class model was selected in both Black and White subsamples, and the identified profiles have similar labels (i.e., no use, alcohol use, polydrug use), we did not test for differences by race in profile prevalence because the IRPs for the substance use profiles differed by race (described above in step two of the approach to data analysis).

Descriptively, however, at age 13, the most common profile was “no use” in both groups (77% and 76% in Black and White girls, respectively; see Table 3). Estimated prevalence of the “alcohol use” and “polydrug use” profiles generally increased with age in each subsample (Table 3). In both subsamples, the largest reduction in the “no use” profile occurred between ages 13 and 14. Among Black girls, estimated prevalence of the “alcohol use” profile was greater than the “polydrug use” profile at all ages (age 13: $\chi^2 [1] = 66.1$, $p < .001$; age 14: $\chi^2 [1] = 54.3$, $p < .001$; age 15: $\chi^2 [1] = 73.8$, $p < .001$; age 16: $\chi^2 [1] = 35.4$, $p < .001$; age 17: $\chi^2 [1] = 70.8$, $p < .001$). Among White girls, estimated prevalence of the “alcohol use” profile was greater than the “polydrug use” profile only at ages 13 and 14 (age 13: $\chi^2 [1] = 37.3$, $p < .001$; age 14: $\chi^2 [1] = 17.2$, $p < .001$). Whereas the prevalence of the “alcohol use” profile was higher than “polydrug use” at all ages in Black girls, this difference was observed only at early ages (13–14) among White girls, possibly suggesting White girls’ greater involvement with more than one substance (e.g., alcohol and cigarettes) with age.

Table 4 presents transition probabilities for adjacent time points (e.g., probability of transitioning to “alcohol use” at age 14 from substance use status at age 13), estimated separately by race. Values along the diagonal indicate stability of substance use profile at two consecutive time points (e.g., Black girls in the “no use” profile at age 13 have probability of .82 for staying in that profile at age 14). Values in off-diagonal cells reflect the probability of transitioning to a different profile one year later. Of particular interest are “backward” transitions (i.e., intermittent use) that reflect use of a substance in one year, and no use of that substance in the following year. “Forward” transitions involve moving from no use to use of a substance, or an increase in the number of substances used in the following year.

Among Black girls, from age 13 to 14, although there were more “forward” (sum of “forward” transitions=.43) than “backward” transitions (sum of “backward” transitions=.34), the “backward” transitions suggest intermittent or experimental use in a subset of girls. From age 14 to 15, “backward” transitions among Black girls mainly involved moving from the “polydrug use” profile at age 14 to the “alcohol use” profile at age 15 (transition probability = .23). There was a decline in “backward” transitions starting at age 15, which occurred in the context of relatively high probability (.83–.99) of remaining in a given substance using profile.

Among White girls, the estimated probability of “backward” transitions was relatively low at all ages (sum of “backward” transitions across ages 13–17= .04–.13). White girls estimated to be in the “polydrug use” profile had high likelihood of remaining in that profile for each transition (probability of remaining in the “polydrug use” profile= .93–1.00), suggesting persistence of use.

Including covariates in the LTA model for each racial group

The eight age 12 covariates were entered simultaneously as predictors of the age 13 substance use profile in LTA analyses conducted separately in Black and White subsamples. Among Black girls, conduct problems at age 12 predicted age 13 substance use profile ($p=.0004$; Table 5), such that Black girls who reported any conduct problem had higher odds of membership in “alcohol use” (Odds ratio [OR]= 2.83) and “polydrug use” (OR= 5.50) profiles at age 13, relative to the “no use” profile. However, conduct problems were not a significant predictor of transition probabilities among Black girls ($\Delta G^2 = 30.26$, $df=24$, $p=.18$).

For White girls, intention to use alcohol ($p=.004$) and intention to use cigarettes ($p=.0004$) at age 12 predicted age 13 substance use profile (Table 6). White girls who reported intention to use alcohol had higher odds of membership in the “alcohol use” (OR= 3.56) and “polydrug use” (OR= 3.49) profiles at age 13, relative to the “no use” profile. Further, White girls who reported intention to use cigarettes at age 12 had higher odds of membership in the “polydrug use” profile (OR= 13.23) relative to the “no use” profile at age 13. With regard to prediction of transitions between profiles over time, intentions to use alcohol and cigarettes were not significant predictors of transitions among White girls ($\Delta G^2 = 40.78$, $df=36$, $p=.27$).

Results summary

Three substance use profiles, representing “no use,” “alcohol use,” and “polydrug use” (i.e., typically some combination of past year alcohol, marijuana, and tobacco use), were identified for Black and White girls. However, the 3 profiles are not directly comparable across race, due to differences in item response probabilities for the profiles. In both subsamples, the proportion in the “no use” profile showed the greatest decline between ages 13 and 14. As hypothesized, among White girls, an intermittent pattern of use was infrequent at all ages (i.e., 13–17), suggesting persistence of use once initiated, whereas among some Black girls, an intermittent pattern of use at ages 13–14 began to decline at age 15. In partial support of hypotheses regarding differences by race in the importance of risk factors as predictors of substance use profiles and transitions, conduct problems at age 12 were associated with substance use profiles among Black girls, whereas intention to use alcohol and cigarettes at age 12 predicted membership in substance using classes among White girls.

Discussion

This study provides a unique contribution to the literature by identifying substance use profiles based on simultaneous consideration of alcohol, marijuana, and cigarette use; and examining age-to-age change in substance use profile using annual data collected at ages 13–17, separately for Black and White girls. Differences by race in substance use profiles, longitudinal pattern of use, and risk factors were identified. Although 3 substance use profiles were identified for both White and Black girls, differences in the prevalence of certain substances (e.g., greater alcohol use among White than Black girls) contributed to differences by race in the profiles identified. Analysis of age-to-age data over five annual waves indicated a decline in the “no use” profile between ages 13–14, which may mark an important turning point for initiation of substance use among White and Black girls (cf. Faden, 2006; Johnston et al., 2010). Further, although White girls tended to show stability of use from year to year, some Black girls showed an early intermittent pattern of use at ages 13–14, which declined in prevalence after age 15. Racial differences in substance use profiles were related to distinct risk factors (cf. Bachman et al., 1991), suggesting the potential utility of tailored interventions.

The substance use profiles identified in this study are largely consistent with profiles reported in the literature (e.g., Lanza et al., 2010; Cleveland et al., 2010), but also involve certain differences. For example, no “cigarette use” only profile (e.g., Cleveland et al., 2010) was identified in the current analyses. When studies have identified a “cigarette use” only profile, it has typically represented only a minority of the sample (e.g., 8% in Cleveland et al., 2010; 5% in Lanza et al., 2010). Some research also suggests that use of only alcohol is more common than reporting only cigarette use, since most adolescent cigarette users also consume alcohol (Orlando et al., 2005). In addition, the current study estimated substance use profiles over a 5-year period that covered an active shift from a majority of non-users to an increasing minority of non-users with age. The lower base rates of substance use at younger ages, and the need to constrain item response probabilities for each of the three profiles to be equal across time, would tend to reduce the number of profiles identified. Nevertheless, a unique contribution of the current analyses is the identification, by race, of prototypical substance use profiles representing past year alcohol, cigarette, and marijuana use at each age, for ages 13 to 17.

An important point in interpreting the profiles identified in this study is that because the profiles were identified based on past year use of substance (rather than frequency of use), individuals estimated to be in the “alcohol use” profile could differ in past year frequency and quantity per occasion of alcohol use, and individuals estimated to be in the “polydrug use” profile also might differ in the frequency and usual quantity per occasion of past year use of a given substance. Due to relatively low rates of use at early ages, we focused on analysis of “use” versus “no use” in the past year. Within-profile heterogeneity may be lower at younger ages, when rates of substance use are relatively low, but would likely increase with age as some girls show escalation in the use of certain substances over time.

The substance use profiles identified in this study necessarily differ from those identified by Dauber and colleagues (2009; 2011: 4 alcohol subtypes in White females and 3 alcohol subtypes in Black females) because work by Dauber and colleagues focused only on alcohol involvement, and not other substances (i.e., marijuana, cigarettes), as in the current study. In addition, Dauber and colleagues (2011) reported on 1-year follow-up of a sample of 13–19 year old females, whereas the current analyses permitted analysis of age-to-age transitions in substance use profiles over five annual waves of data collection. Importantly, however, Dauber and colleagues were able to distinguish non-problem and problem drinkers in their analyses, a distinction that was not addressed here due to relatively low rates of substance use at early ages (and correspondingly low prevalence of substance-related problems at early ages).

It was not possible to directly compare the racial subgroups on prevalence of the substance using profiles and transition probabilities because there were differences by race in the IRPs for the profiles. These differences in IRPs reflect the generally higher prevalence of alcohol and cigarette use among White girls, compared to Black girls. Likewise, when other studies have conducted separate analyses by race, for example, when examining alcohol involvement subtypes using LCA (e.g., Dauber et al., 2011) or alcohol use trajectories (e.g., Flory et al., 2006), results have generally reflected the lower severity of alcohol use among Black youth. Racial differences in the substance use profiles suggest that prevention efforts might be tailored to the substances most commonly endorsed by a subgroup at a given age.

A novel feature of the current study involved examining specific ages at which certain types of transitions (e.g., backward transitions, continuity of use) were most likely among adolescent females. The finding that Black girls showed intermittent substance use in early adolescence (ages 13–14) is in accord with research indicating lower persistence of alcohol use among Black youth (e.g., Malone et al., 2012; Dauber et al., 2011). The current study

adds to the existing literature by simultaneously examining the use of cigarettes and marijuana, in tandem with alcohol. The person-centered approach to analysis provided by LTA also suggests that despite a steady increase in the prevalence of these substances with age, that among Black girls, the increase in prevalence of use at younger ages is not necessarily due to the same subset of girls reporting use of a substance from year to year. Further, the higher rate of intermittent use among Black girls at early ages may reflect early experimental or opportunistic episodes of use. In contrast to the pattern observed among Black girls, White girls were more likely to report substance use in consecutive years following onset of use, highlighting the importance of early intervention, particularly among White girls, to halt continuation of use.

The generally lower prevalence of alcohol and cigarette use, and intermittent, rather than continuous, pattern of substance use at early ages (13–14) among Black girls occurred, contrary to expectation, in the context of their greater apparent risk for substance use. Specifically, Black girls were more likely than White girls to report risk factors at age 12 such as receipt of public assistance, peer use, and conduct problems. As a possible explanation for this apparent discrepancy, some research suggests that protective factors (e.g., parental monitoring) play an important role in buffering risk for substance use (Bachman et al., 1991), particularly among Black urban youth (Griffin et al., 2000). Among the risk factors examined, only conduct problems at age 12 predicted substance use profile at age 13 among Black girls, suggesting that conduct problems might serve as an efficient screen to identify at-risk girls for early intervention (cf. Loeber et al., 2010). In addition, the finding that Black girls reported greater intention to use marijuana at age 12 than White girls, and the higher early prevalence of marijuana use among Black girls at ages 13–14 suggests that tailored intervention content for this subgroup might address not only reductions in conduct problems, but also cognitive factors such as intention to use marijuana (cf., intervention to address intention to use steroids: MacKinnon et al., 2001).

Among White girls, intention to use alcohol and cigarettes at age 12 predicted substance using profiles at age 13, suggesting that this cognitive factor plays an early important role, relative to conduct problems and peer use, as a predictor of substance use in this subgroup. Since intention to use is determined by a girls' attitudes toward use and users of the substance, peer norms regarding use, and perceived control to abstain from use (Azjen, 2012), intervention components could target these areas. For example, tailored intervention, based on a needs assessment, could provide corrective normative data on peer use and attitudes toward use, discussion of the pros and cons of engaging in use in order to promote abstinence, and facilitation and support of alternative healthy behaviors (cf. MacKinnon et al., 2001).

Study limitations warrant comment. Generalizability of results to other race/ethnic groups, males, and younger and older ages is limited. White, compared to Black, girls were more likely to be excluded from the analysis sample due to the absence of substance use data at ages 13–17; however, participants who were included vs excluded from the analysis sample did not differ on various indicators of socio-economic status (e.g., receipt of public assistance) or on use of alcohol, marijuana, or tobacco through age 12. Further, generalizability is limited due to regional and national variations in social, regulatory, and legal factors influencing adolescent substance involvement (e.g., attitudes toward use, availability). PROC LTA did not permit inclusion of sample weights in the analyses, which limits the generalizability of results. Inclusion of sample weights in similar analyses is a future direction for research. Analyses did not examine temporal sequencing of the initiation of each substance, and did not examine frequency of use in the past year or the occurrence of substance-related problems due to low rates of past year use at young ages. The alcohol use item included “sips and tastes” which is a relatively low threshold to determine whether

alcohol use occurred. In addition, substance-related problems and a wider range of substances were not included in the analyses due to low base rates for these types of items during the age range covered. Only selected risk factors were examined, and analyses did not include consideration of protective factors (e.g., parental supervision), which might influence adolescent substance use. Self-reported substance use data may have limitations. However, procedures were used to maximize validity of self-report (e.g., assurance of confidentiality).

Study findings on racial differences in substance use profiles and patterns of early use have public health implications with regard to understanding the emergence of substance-related health disparities in females. Although White girls were more likely to report alcohol and cigarette use than Black girls at ages 13–17, it appears that there were fewer racial differences in prevalence of marijuana use during the study time period. Prevention efforts may have maximal effect when tailored to specific substances that are most salient to certain subgroups of youth at specific ages. Further, study findings, which indicate that ages 13–14 represent an important change point in risk for transition from a “no use” to substance using profile in both White and Black girls has implications for informing the optimal timing of prevention efforts. Differences by race in the relative importance of risk factors that predict substance use profile also suggest the potential utility of tailored interventions which target risk factors that are most strongly associated with substance use in specific subgroups to maximize effectiveness.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1

Sample descriptive statistics

Past Year Use	Total Sample		Black Girls		White Girls		Black vs White Girls	
	N	%	N	%	N	%	$\chi^2(1)$	
Alcohol								
Age 13	196	18.6	80	13.4	116	25.5	24.2**	
Age 14	264	25.8	104	17.8	160	36.5	44.8**	
Age 15	301	29.6	130	22.4	171	39.3	33.3**	
Age 16	353	35.4	150	26.2	203	47.6	48.0**	
Age 17	407	41.4	177	30.9	230	56.0	61.1**	
Cigarette								
Age 13	66	6.3	34	5.7	32	7.0	0.5	
Age 14	111	10.8	49	8.4	62	14.2	8.1**	
Age 15	150	14.7	62	10.7	88	20.2	17.1**	
Age 16	191	19.2	86	15.0	105	24.7	14.2**	
Age 17	222	22.6	102	17.8	120	29.2	17.1**	
Marijuana								
Age 13	49	4.7	36	6.0	13	2.9	4.9*	
Age 14	126	12.3	84	14.4	42	9.6	4.9*	
Age 15	180	17.7	109	18.8	71	16.3	0.9	
Age 16	221	22.2	142	24.8	79	18.6	5.1*	
Age 17	236	24.0	143	25.0	93	22.6	0.6	

	Total		Black Girls		White Girls		Black vs White Girls	
	n	%	n	%	n	%	$\chi^2(1)$	
Received Pub Assist	377	35.7	309	51.6	68	14.8	152.7**	
Alcohol intent	139	13.2	83	13.9	56	12.4	0.5	
Marijuana intent	81	7.7	66	11.0	15	3.3	21.5**	
Cigarette intent	73	6.9	47	7.8	26	5.7	1.8	

	Total		Black Girls		White Girls		Black vs White Girls	
	n	%	n	%	n	%	$\chi^2(1)$	
Peer alcohol use	215	21.1	149	25.9	66	14.9	18.1	**
Peer marijuana use	147	14.4	118	20.5	29	6.6	39.1	**
Peer cigarette use	221	21.7	142	24.7	79	17.8	6.9	**
Conduct problems	150	14.2	121	20.2	29	6.4	40.4	**

Sample size at age 13: Total sample N =1076, Black girls n=611, White girls n=465.

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

Notes: Total sample size ranges from 1019–1057 due to missing data; Black sample size ranges from 576–600; White sample size ranges from 442–458.

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

Received Pub Assist=Received Public Assistance in the past year

Intention to use (dichotomous coding) represents the proportion endorsing: “probably not,” “probably yes,” or “definitely yes” combined versus “definitely not.”

Peer use (dichotomous coding) represents the proportion reporting no peer use vs any peer use.

Conduct problems represents the proportion endorsing any conduct problem.

Table 2

Comparison of Latent Transition Models, ages 13–17 (5 time points)

Black Girls (n=611) ^I				
Number of classes	Likelihood-Ratio G ²	Degrees of Freedom	AIC	BIC
2	1641.04	32,752	1671.04	1737.26
3	1501.27	32,732	1571.27	1725.79
4	1398.75	32,704	1524.75	1804.90
5	no convergence	--	--	--

White Girls (n=465) ^I				
Number of classes	Likelihood-Ratio G ²	Degrees of Freedom	AIC	BIC
2	1246.98	32,752	1276.98	1339.11
3	985.42	32,732	1055.42	1200.39
4	883.74	32,704	1009.74	1270.68
5	814.54	32,668	1012.54	1422.60

Notes:

^I Item-response probabilities are invariant across time. Bolded values indicate best fitting model according to a certain index of model fit
AIC= Akaike Information Criterion, BIC= Bayesian Information Criterion

Table 3

Estimated substance use profile prevalence at each age by race

Substance use profile prevalence at each age			
Black girls	No Use	Alcohol use	Polydrug use
Age 13	.77	.19	.04
Age 14	.66	.25	.09
Age 15	.53	.34	.13
Age 16	.48	.33	.18
Age 17	.41	.40	.18

White girls	No Use	Alcohol use	Polydrug use
Age 13	.76	.18	.05
Age 14	.61	.25	.14
Age 15	.56	.22	.22
Age 16	.46	.28	.26
Age 17	.38	.32	.29

Note: Black subsample n=611; White subsample n=465.

The "Polydrug use" class generally represents some combination (i.e., 2 or more) of alcohol, cigarettes, and marijuana use in the past year.

Table 4

Probabilities of transitioning between substance use profiles at ages 13–17 by race

Black girls	No use: Age 14	Alc use: Age 14	Polydrug use: Age 14	Forward Transitions	Backward Transitions
No Use: Age 13	.82	.16	.02	.18	
Alc Use: Age 13	.12	.63	.25	.25	.12
Polydrug: Age 13	.00	.22	.78		.22
	Age 15	Age 15	Age 15		
No Use: Age 14	.79	.19	.02	.21	
Alc Use: Age 14	.05	.76	.19	.19	.05
Polydrug: Age 14	.00	.23	.76		.23
	Age 16	Age 16	Age 16		
No Use: Age 15	.90	.10	.00	.10	
Alc Use: Age 15	.00	.83	.16	.16	.00
Polydrug: Age 15	.01	.00	.99		.01
	Age 17	Age 17	Age 17		
No Use: Age 16	.82	.18	.00	.18	
Alc Use: Age 16	.01	.88	.11	.11	.01
Polydrug: Age 16	.05	.14	.81		.19

White girls	No use: Age 14	Alc use: Age 14	Polydrug use: Age 14	Forward Transitions	Backward Transitions
No Use: Age 13	.79	.13	.08	.21	
Alc Use: Age 13	.04	.82	.14	.14	.04
Polydrug: Age 13	.00	.00	1.00		.00
	Age 15	Age 15	Age 15		
No Use: Age 14	.86	.09	.04	.13	
Alc Use: Age 14	.13	.65	.21	.21	.13
Polydrug: Age 14	.00	.00	1.00		.00
	Age 16	Age 16	Age 16		
No Use: Age 15	.80	.14	.06	.20	
Alc Use: Age 15	.02	.88	.11	.11	.02

White girls	No use: Age 14	Alc use: Age 14	Polydrug use: Age 14	Forward Transitions	Backward Transitions
Polydrug: Age 15	.03	.04	.93		.07
	Age 17	Age 17	Age 17		
No Use: Age 16	.75	.19	.06	.25	
Alc Use: Age 16	.12	.85	.03	.03	.12
Polydrug: Age 16	.01	.00	.99		.01

Notes: Black (n=611) and White (n=465) groups were analyzed separately. Invariance of item response probabilities across time was specified in the LTA model for each race.

Alc=alcohol. The “Polydrug use” class generally represents some combination (i.e., 2 or more) of alcohol, cigarettes, and marijuana use in the past year.

Bold font indicates membership in the same substance use profile at consecutive ages (e.g., ages 13 and 14); values representing stability (i.e., probability of staying in the same profile at consecutive ages) are on the diagonal. For example, among Black girls, the probability of staying in the “No use” profile at ages 13 and 14 is .82, and at ages 14 and 15 is .79; the probability of staying in the “Alcohol Use” profile at ages 13 and 14 is .63, and at ages 14 and 15 is .76.

“Forward transitions” refer to moving from a profile representing less substance involvement to a profile representing more substance involvement (e.g., transition from “no use” to “alcohol use”). Cells in the “Forward transitions” column represent the sum of the forward transition probabilities for a given row. As an example, for transitions between ages 13 and 14, forward transitions include moving from “no use” at age 13 to “alcohol use” at age 14 (transition probability=.16) and “polydrug use” classes (transition probability=.02) for a sum of .18 forward transitions for the “no use” class at age 13. In addition, the forward transition from “alcohol use” at age 13 to the “polydrug use” class at age 14 was estimated to be .25.

“Backward transitions” refer to moving from a profile representing greater substance involvement to a profile representing less substance involvement (e.g., transition from “alcohol use” to “no use”). Cells in the “Backward transitions” column represent the sum of the backward transition probabilities for a given row. As an example, for transitions between ages 13 and 14, backward transitions include moving from “alc use” at age 13 to “no use” at age 14 (transition probability=.12). In addition, the backward transition from “polydrug use” at age 13 to “alcohol use” class at age 14 was estimated to be .22 (the estimate for backward transition from age 13 “polydrug use” to “no use” at age 14 was 0).

Table 5

Latent transition analysis model with covariates: Black girls

Significance test for covariates (simultaneous entry) as predictors of age 13 (time 1) profile			
Covariate	Change in 2*log-likelihood	Degrees of Freedom	p-value
Public Assistance	0.00	2	Not significant
Alcohol Intention	2.02	2	0.36
Marijuana Intention	0.00	2	Not significant
Cigarette Intention	0.00	2	Not significant
Peer alcohol use	0.00	2	Not significant
Peer marijuana use	0.00	2	Not significant
Peer cigarette use	0.00	2	Not significant
Conduct problems	15.78	2	0.0004

Beta and Odds Ratios for age 13 (time 1) profile membership			
	No Use	Alcohol Use	Polydrug Use
Intercept			
B ₀ 's	reference group	-2.42	-5.86
Odds	reference group	0.09	0.00
Public Assistance			
B ₁ 's	reference group	-0.19	0.26
Odds ratios	reference group	0.82	1.30
Alcohol Intention			
B ₂ 's	reference group	0.78	-1.04
Odds ratios	reference group	2.19	0.35
Marijuana intention			
B ₃ 's	reference group	0.58	1.21
Odds ratios	reference group	1.79	3.36
Cigarette intention			
B ₄ 's	reference group	0.20	0.01
Odds ratios	reference group	1.22	1.01
Peer alcohol use			
B ₅ 's	reference group	0.36	0.20
Odds ratios	reference group	1.44	1.22
Peer marijuana use			
B ₆ 's	reference group	0.06	2.41
Odds ratios	reference group	1.07	11.12
Peer cigarette use			
B ₇ 's	reference group	0.41	-0.33
Odds ratios	reference group	1.50	0.72
Conduct problems			

Beta and Odds Ratios for age 13 (time 1) profile membership			
	No Use	Alcohol Use	Polydrug Use
B ₈ 's	reference group	1.04	1.70
Odds ratios	reference group	2.83	5.50

Note: n=565. Log-likelihood for overall model: -2758.46. The top part of the table indicates the statistical significance of each covariate (assessed at age 12). Covariates were entered simultaneously as predictors of age 13 substance use profile. The bottom part of the table reports betas and odds ratios for each covariate. Public Assistance: 0=No, 1=Yes. Intention to use: 0=Definitely No, 1=Probably No through Definitely Yes. Peer Use: 0=None, 1=One or more. Conduct Problems: 0=none, 1=1 or more.

Table 6

Latent transition analysis model with covariates: White girls

Significance test for covariates (simultaneous entry) as predictors of age 13 (time 1) profile			
Covariate	Change in 2*log-likelihood	Degrees of Freedom	p-value
Public Assistance	3.47	2	0.18
Alcohol Intention	11.06	2	0.004
Marijuana Intention	0.00	2	Not significant
Cigarette Intention	15.77	2	0.0004
Peer alcohol use	0.00	2	Not significant
Peer marijuana use	1.56	2	0.46
Peer cigarette use	0.00	2	Not significant
Conduct problems	0.00	2	Not significant

Beta and Odds Ratios for age 13 (time 1) profile membership			
	No Use	Alcohol Use	Polydrug Use
Intercept			
B ₀ 's	reference group	-1.74	-4.40
Odds	reference group	0.17	0.01
Public Assistance			
B ₁ 's	reference group	-0.52	1.23
Odds ratios	reference group	0.59	3.43
Alcohol Intention			
B ₂ 's	reference group	1.27	1.25
Odds ratios	reference group	3.56	3.49
Marijuana intention			
B ₃ 's	reference group	-0.62	0.05
Odds ratios	reference group	0.54	1.05
Cigarette intention			
B ₄ 's	reference group	0.16	2.58
Odds ratios	reference group	1.17	13.23
Peer alcohol use			
B ₅ 's	reference group	0.29	-0.13
Odds ratios	reference group	1.33	0.88
Peer marijuana use			
B ₆ 's	reference group	-0.05	1.68
Odds ratios	reference group	0.95	5.34
Peer cigarette use			
B ₇ 's	reference group	0.19	-0.22
Odds ratios	reference group	1.21	0.80
Conduct problems			

Beta and Odds Ratios for age 13 (time 1) profile membership			
	No Use	Alcohol Use	Polydrug Use
B ₈ 's	reference group	-0.62	0.47
Odds ratios	reference group	0.54	1.59

Note: n=433. Log-likelihood for overall model: -2166.90. The top part of the table indicates the statistical significance of each covariate (assessed at age 12). Covariates were entered simultaneously as predictors of age 13 substance use profile. The bottom part of the table reports betas and odds ratios for each covariate. Public Assistance: 0=No, 1=Yes. Intention to use: 0=Definitely No, 1=Probably No through Definitely Yes. Peer Use: 0=None, 1=One or more. Conduct Problems: 0=none, 1=1 or more.