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Examining the Heterogeneity of Polysubstance Use Patterns in Young Adulthood by Age and College Attendance

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Abstract

Substance use in young adulthood and polysubstance use (PSU), in particular, pose unique risks for adverse consequences. Prior research on young adult PSU has identified multiple classes of users, but most work has focused on college students. We examined PSU patterns by age and college attendance during young adulthood in two nationally-representative samples. Using National Epidemiological Survey on Alcohol and Related Conditions (NESARC) Wave 1 and NESARC-III datasets, multi-group latent class analysis (MG-LCA) was employed to examine PSU patterns based on age (18–24 vs. 25–34) and determine whether solutions were similar (i.e., statistically invariant) by college attendance/graduation. Classes were estimated by binary past-year use of sedatives, tranquilizers, opioids/painkillers, heroin, amphetamines/stimulants, cocaine, hallucinogens, club drugs, and inhalants, and past-year frequency of alcohol, cigarette, and cannabis use. PSU patterns largely replicated across waves. Model fit supported 3-class solutions in each MG-LCA: low frequency limited-range PSU (alcohol, cigarettes, and cannabis only), medium-to-high frequency limited-range PSU (alcohol, cigarettes, cannabis only), and extended-range PSU (all substances). Apart from one model, MG-LCA solutions were not invariant by college attendance/graduation, suggesting important differences between these groups. Except for alcohol, cannabis, and cigarette use frequency, results showed that probabilities of illicit and prescription drug use declined in the older age group. Findings also supported examining college and non-college youth separately when studying PSU. Extended-range polysubstance users may be uniquely vulnerable to co-ingesting substances, particularly for non-graduates, warranting future research to classify patterns of simultaneous PSU and identify predictors and consequences of high-risk combinations (e.g., alcohol and opioids).

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Contributors
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Conflict of Interest
The authors have no conflicts of interest to disclose.
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Keywords

college; non-college; polysubstance use; young adults; latent class analysis

Introduction

Young adulthood (i.e., ages 18–34) is a peak developmental period for substance use (Grant et al., 2003; Schulenberg et al., 2020). Some substance use in young adulthood is normative, with 82% of young adults ages 19–30 using alcohol, 40% using cannabis, and 19% using other illicit drugs in the past year (Schulenberg et al., 2020). However, high-risk substance use patterns (e.g., polysubstance use [PSU]) yield serious negative consequences, including unintentional injury, poorer psychological functioning, more persistent patterns of substance misuse and problems, and fatal and nonfatal overdose (Connor et al., 2014; Peppin et al., 2020; Saunders et al., 2016). Research characterizing the heterogeneity of use patterns has identified between three and five types of young adult substance users: polysubstance users, non-users or infrequent users, and users of specific combinations or levels of use (Bailey et al., 2019; Evans-Polce et al., 2016; Evans et al., 2020; Shi et al., 2020). In the existing PSU literature, three latent classes typically emerge: limited-range PSU (using alcohol/tobacco/cannabis); moderate-range PSU (in which amphetamines are added), and extended-range PSU (in which other non-medical prescription drug use and illicit drug use are added; Connor et al., 2014; Saunders et al., 2016). As suggested by Monitoring the Future (MTF) data, substance use patterns differ by age and college attendance (Schulenberg et al., 2020). Little work, however, has examined whether this heterogeneity in use patterns also encompasses nuanced differences in patterns of PSU across age and college attendance during young adulthood.

Age-Related Patterns during Young Adulthood

There is significant age heterogeneity in substance use patterns during young adulthood (see Jackson et al., 2008). Recent MTF data show that prevalence of past-year alcohol use in the U.S. peaked at ages 25–26, at 88% (Schulenberg et al., 2020). Past-year cigarette use prevalence has also been shown to peak around this time (Chen & Jacobson, 2012; Evans-Polce et al., 2015; Holford et al., 2014), with nationally-representative data showing a peak at ages 21–22 (24%; Schulenberg et al., 2020). Annual cannabis use prevalence also peaks during young adulthood (Chen & Jacobson, 2012), with some evidence showing a peak at 45% around ages 21–22 (Evans-Polce et al., 2015). Little work has examined longitudinal trajectories of illicit drug use, though 2019 MTF data indicated some stability in past-year illicit drug use from ages 20 to 30 (19–21%; Schulenberg et al., 2020).

Age-related trends are nuanced when examining individual illicit and non-medical prescription drug types. For example, stimulant use peaks around ages 21–22, depressant use around ages 29–30, and hallucinogen use between ages 19–20 (Schulenberg et al., 2020). Given that certain drug classes are often used concurrently, we would also expect nuanced age-related trends in PSU during young adulthood. Understanding these trends is critical because serious adverse outcomes, such as fatal overdose, often result from PSU (Peppin et al., 2020). Further, there appears to be potential age-related differences in PSU and its consequences, with overdose rates, in particular, showing age specificity (e.g., greater overdose rates among individuals ages 25–34 [38.4 per 100,000] relative to those ages 15–24 [12.6 per 100,000]; Hedegaard, Minino, & Warner, 2018). Although transitional factors (e.g., role transitions) occurring during young adulthood are shown to account for age-related changes in substance use (Arnett, 2000), it is also possible that other circumstances, such as college attendance/graduation, serve to amplify or mitigate risk for certain substance use patterns.

College Attendance-Related Patterns

Though college matriculation represents a unique period of converging social, environmental, and developmental risks for some young adults (Arnett, 2000), less is known about the transitional periods of non-college youth. A recent study comparing drinking patterns of college attendees and their non-college attending peers found riskier drinking patterns among college attendees (Linden-Carmichael & Lanza, 2018), corroborating some prior research indicating college attendees drink more heavily than non-college attendees (Blanco et al., 2008; Slutske, 2005; Slutske et al., 2004; see Carter et al., 2010, for a review). By contrast, other research has shown that drinking among non-college youth exceeds that of college-attending youth (e.g., Hingson et al., 2017; B. O. Muthén & Muthén, 2000; White et al., 2005). Non-college attendees, however, consistently smoke cigarettes at higher rates than college attendees (Buu et al., 2019; Lenk et al., 2012; Odani et al., 2019; White et al., 2005). Differences in cannabis use by college attendance are somewhat mixed. Rates of (any) past-year cannabis use are shown to be greater in non-college attendees than college-attending peers in some studies (Buu et al., 2019; Jang et al., 2019) but not others (Schulenberg et al., 2020). Cannabis use frequency seems to better differentiate between college and non-college individuals, such that non-college youth, relative to college attendees, endorse over twice the rate of daily cannabis use (Schulenberg et al., 2020).

Little work has compared other substance use for college- vs. non-college attendees. According to MTF, in 2019, college attendees, relative to non-college, were equally likely to endorse using cocaine (5.6% vs. 5.5%) and tranquilizers (3.0% vs. 3.4%), more likely to use amphetamines (8.1% vs. 5.9%), and less likely to use narcotics (1.5% vs. 3.3%), hallucinogens (5.3% vs. 7.9%), and sedatives (2.0% vs. 3.0%; Schulenberg et al., 2020). No work, however, has examined whether college attendance is associated with different PSU patterns in young adults (e.g., limited-range PSU vs. extended-range PSU). Even less epidemiological work has compared college graduate vs. non-graduate substance use. One study observed that college graduates had significantly lower odds of heavy drinking, as well as cigarette, cannabis, cocaine, and non-medical prescription drug use at age 35, relative to non-graduates (Merline et al., 2004); at the same time, non-college attendees report the highest rates of prescription opioid misuse, relative to college attendees and graduates (Schepis et al., 2018). Prescription stimulant misuse, however, was highest among college attendees and graduates, relative to non-college attendees (Schepis et al., 2018), consistent with evidence showing college attendees use more stimulants than non-college attendees (Ford & Pomykacz, 2016).

Present Study

Using two nationally-representative samples, the purpose of the present study was to understand the heterogeneity of substance use patterns during young adulthood (ages 18–34) and determine whether college attendance/graduation affects these patterns. Indeed, there is a potentially important conceptual distinction between attending college full-time (vs. not) and completing college (vs. not), such that the former may capture environmental and contextual indicators (e.g., access to substances) that may influence substance use patterns whereas the latter may reflect protective factors (e.g., socioeconomic status) that may affect substance use patterns. Data were drawn from NESARC Wave 1 and from NESARC-III, which afforded a historical examination of substance use patterns across a decade wherein significant changes in the normative and legal landscape of substance use occurred (e.g., cannabis legalization/decriminalization, opioid epidemic).

We leveraged latent class analysis, a person-centered technique used to identify latent class members based on similar patterns of use (Collins & Lanza, 2010), to examine use patterns across a full range of substances and compared these classes based on age strata (18–24 vs. 25–34). Using a multi-group analysis, we then tested whether these use patterns differ by college attendance/graduation (full-time college student vs. not; college graduate vs. not). We expected to extract between three and five classes, consistent with prior work across a range of samples (Evans-Polce et al., 2016; Jackson, Sher, & Wood, 2000; Schweizer et al., 2014; Shi et al., 2020), including large epidemiological samples (Jackson et al., 2014). We also expected to extract limited-range PSU and extended-range PSU classes based on prior work (Connor et al., 2014; Saunders et al., 2016), though we did not specify *a priori* hypotheses for the composition of these classes.

Method

Participants and Procedure

Data were from the 2001–2002 National Epidemiological Survey on Alcohol and Related Conditions (NESARC Wave 1 [NESARC-W1]; see Grant, Moore, & Kaplan, 2003) and the 2012–2013 NESARC-III study (Grant et al., 2014) conducted by the National Institute on Alcohol Abuse and Alcoholism. Target populations for both NESARC-W1 and NESARC-III were nationally representative and included civilian non-institutionalized adults (18+ years) residing in households or group quarters. Adults were randomly selected, and certain demographic groups were oversampled in each data collection to match the U.S. civilian population. Face-to-face interviews were conducted with each respondent (NESARC-W1 N=43,093; NESARC-III N=36,309). The present study analyses included only respondents who were between the ages of 18 and 34 years at enrollment (N=11,435 for NESARC-W1; N=11,657 for NESARC-III). These large sample sizes permitted us to investigate low base rate substance use behaviors.

Measures

Demographics.—Participants self-reported on their age, sex, race, ethnicity, and marital status.

Full-time college attendance.[1]

NESARC-W1.: Past 12-month *full-time* student status was assessed with response options "yes, full-time," "yes, part-time," and "no," based on grade level during the 2000–2001 school year. Options for grade level included: high school[2], enrolled in graduate equivalency degree (GED) program, 1st year through 5th year undergraduate, 1st through 3rd year graduate/professional, other, and "NA, not a student in the last 12 months." Full-time college attendance was defined as endorsing full-time student status in the last 12 months and endorsing being a 1st through 5th year undergraduate. This definition is consistent with the definition used by MTF (Schulenberg et al., 2020).

NESARC-III.: Consistent with prior work using this dataset (Linden-Carmichael & Lanza, 2018), and largely overlapping with the NESARC-W1 definition, participants were categorized as college attendees if they (1) reported being a full-time student in the past 12 months and (2) endorsed at least "some college" (but less than graduate education) as their highest level of education. See Table 1 for a full description of inclusion and exclusion criteria used to defined full-time college attendance, non-college attendance, college graduate, and non-graduate in NESARC-W1 and NESARC-III.

College graduate status[3].

NESARC-W1.: Highest grade or year of school completed was assessed with options for no formal schooling, some high school, completed high school/GED, some college (no degree), completed 2-year degree, completed college, and graduate/professional school. For the purposes of the present study, only individuals endorsing "completed college (bachelor's degree)" were coded as having graduated college.

NESARC-III.: Using an identical procedure, participants were categorized as being a college graduate if they reported completing college as their highest level of education.

Substance use indicators.

NESARC-W1.: Past-year substance use was assessed using binary indicators for lower base rate substances: sedatives, tranquilizers, opioids, amphetamine, cocaine, hallucinogen, heroin, and inhalants. To capture the nuance of use in the higher base rate substances, four-level ordinal frequency variables were constructed for alcohol and cannabis: less than monthly, monthly, weekly, and daily use. A similar four-level ordinal frequency variable was constructed for cigarettes: never/less than 100+ cigarettes ever smoked, monthly, weekly, and daily use.

NESARC-III.: Similarly, past-year use of lower base rate substances was assessed via binary indicators: sedatives/tranquilizers, painkillers, heroin, stimulants, cocaine, club

[1]Full-time college attendance was limited to the 18–24 age group, given only 5–8% of 25–34-year-olds endorsed being in college full-time in NESARC-W1 and in NESARC-III.
[2]Individuals attending high school were removed from all analyses, regardless of age.
[3]College graduate status was limited to the 25–34-year-old age group, given only 9–10% of 18–24-year-olds endorsed graduating college in NESARC-W1 and in NESARC-III.

drugs, hallucinogens, and inhalants. Identical four-level ordinal frequency variables were constructed for alcohol, cigarettes, and cannabis using NESARC-III data.

Data Analytic Plan

Multi-group latent class analysis (MG-LCA) was employed to identify patterns of past-year substance use in two age strata (i.e., ages 18–24 vs. 25–34) in each dataset and determine whether class solutions were invariant by college attendance (i.e., college attendee vs. non-college attendee for the younger group; college graduate vs. non-graduate for the older group). LCA is particularly well-suited to understand patterns of substance use (Collins & Lanza, 2010), which makes this approach an optimal method for examining PSU. Specifically, we examined four MG-LCA models in total: (1) NESARC-W1 ages 18–24 with full-time college attendance vs. not as the grouping variable, (2) NESARC-W1 ages 25–34 with college graduate vs. not as the grouping variable, (3) NESARC-III ages 18–24 with full-time college attendance vs. not as the grouping variable, and (4) NESARC-III ages 25–34 with college graduate vs. not as the grouping variable. Only substance use variables were used as input variables in the four MG-LCA models, as denoted by an asterisk in Table 2.[4]

MG-LCA was conducted in Mplus V8.3 using maximum likelihood with robust standard errors to estimate missing data (L. K. Muthén & Muthén, 2019). In each MG-LCA, thresholds and class probabilities could vary across groups. Models with two to five classes[5] were compared to determine the best-fitting model based on Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), and adjusted BIC, with lower values indicating more optimal models (Nylund-Gibson & Choi, 2018; Nylund et al., 2007). Entropy values were inspected to guide model selection, with a value closer to 1.0 suggesting a clearer delineation of classes (Celeux & Soromenho, 1996). We also considered interpretability and parsimony when selecting the best-fitting solution for each MG-LCA. When model selection criteria conflicted, we selected the model that had the most support across selection criteria. The large sample sizes of each subsample, which approached or well exceeded 1,000 participants (see Table 2), allowed us to interpret classes containing less than 5% of the sample (see Nylund-Gibson & Choi, 2018).

After selecting the best-fitting model for each MG-LCA, we constrained all parameters to be equal across groups (i.e., parameters were forced to equality based on the grouping variable – college attendance/graduation) and then compared this constrained MG-LCA to an unconstrained model (i.e., parameters were allowed to differ according to college attendance/graduation) using chi-square difference tests to determine whether the MG-LCA was invariant across groups. A statistically significant chi-square difference test determined that the MG-LCA was not invariant. An invariant MG-LCA indicates that the LCA solutions are not statistically different when grouped by college attendance/graduation, suggesting comparable substance use patterns for these groups (full-time college attendee

[4]We tested each LCA with a weighted and unweighted solution, given the complex sampling procedures used to collect NESARC-W1 and NESARC-III data. The weighted solutions were virtually identical to the unweighted solutions. Given the unweighted solution is preferred when parameter estimates are substantively similar (Vermunt, 2007), we present the unweighted solutions here.

[5]We also examined 6-class solutions for each MG-LCA, but these models did not reach convergence.

vs. non-college attendee and college graduate vs. non-graduate), whereas a non-invariant MG-LCA suggests meaningful differences in substance use patterns for these groups. We tested whether the conditional independence assumption for each model was satisfied by examining whether there statistically significant bivariate residuals after extracting latent classes.

Results

See Table 2 for demographic information for each subsample included in the present study. In NESARC-W1, 27% of young adults ages 18–24 were in college full-time, whereas the remaining 73% of youth in this age group were non-college attendees. Eighteen percent of young adults ages 25–34 had graduated college in NESARC-W1, whereas the remaining 83% had not graduated college. In NESARC-III, 23% of youth ages 18–24 were in college full-time vs. 77% of individuals in this age range were non-college attendees. Twenty-seven percent of individuals ages 25–34 were college graduates in NESARC-III; 73% of those ages 25–34 were non-graduates. Model fit statistics from two- to five-class solutions were examined for each MG-LCA to identify the best-fitting model (Nylund-Gibson & Choi, 2018). See Table 3 for model fit statistics. The conditional independence assumption was satisfied for each best-fitting model solution.

NESARC-W1 Ages 18–24 MG-LCA

BIC and adjusted BIC values supported a 3-class solution for this MG-LCA, whereas entropy and AIC supported the 4-class solution. Considering interpretability and parsimony, we selected the 3-class solution as the best-fitting model (see Figures 1A and 1B for class profiles and class membership percentages). Consistent with prior work on polysubstance use using LCA, we have adopted the terms limited-range and extended-range polysubstance use to define our latent classes (see Connor et al., 2014, for a review; see also Saunders et al., 2016).

The first group (Low Frequency-Limited-Range Polysubstance Users; LF-LR PSU) was characterized by low expected probabilities of higher frequency (i.e., at least weekly) alcohol, cigarette, and cannabis use, and near-zero endorsement of other substance use in the past year (81% vs. 86% of non-college vs. college youth, respectively, in this sample). Medium-High Frequency-Limited-Range Polysubstance Users (MHF-LR PSU) were characterized by moderate-to-high expected probabilities of higher frequency alcohol, cigarette, and cannabis use, and near-zero endorsement of other past-year substance use (16% vs. 12%). Extended-Range Polysubstance Users (ER PSU) were characterized by moderate-to-high expected probabilities of higher frequency alcohol, cigarette, and cannabis use, as well as moderate probabilities of all other substances (except for heroin and inhalants that were near-zero-to-low; 4% vs. 2%). When compared to an unconstrained model, the constrained model did not significantly worsen model fit ($\Delta\chi^2(51) = 54.76$, p=.33), which indicated this class solution was invariant across non-college and college attendees ages 18–24 in NESARC-W1.

NESARC-III Ages 18–24 MG-LCA

BIC, adjusted BIC, and entropy supported a 3-class solution for this MG-LCA, whereas only AIC favored a 4-class solution (see Figures 1C and 1D for class profiles and class membership percentages).

Consistent with NESARC-W1, the LF-LR PSU class was characterized by low expected probabilities of higher frequency alcohol, cigarette, and cannabis use, and near-zero endorsement of other substance use (86% vs. 89%). The MHF-LR PSU class was characterized by moderateto-high expected probabilities of higher frequency alcohol, cigarette, and cannabis use, as well as low probabilities of stimulant, painkiller, and hallucinogen use (12% vs. 8%). The ER PSU class was characterized by moderate-to-high probabilities of higher frequency alcohol, cigarette, and cannabis use, as well as moderate-to-high probabilities of all other substance use (except for heroin and inhalants, which were low; 2% vs. 3%). When compared to an unconstrained model, the constrained model exhibited poorer model fit, indicating non-invariance ($\Delta\chi^2(51)=81.56$, $p<.01$). Comparisons of plots suggested higher expected probabilities of more frequent cigarette use for non-college attendees, relative to college attendees, in the LF-LR PSU class. The expected probability of sedative/tranquilizer use was higher for college attendees in the ER PSU class, relative to their non-college peers.

NESARC-W1 Ages 25–34 MG-LCA

BIC, adjusted BIC, and entropy supported a 3-class solution for this MG-LCA, whereas only AIC favored a 4-class solution (see Figures 2A and 2B for class profiles and class membership percentages).

The LF-LR PSU class was characterized by low-to-moderate probabilities of higher frequency alcohol, cigarette, and cannabis use and near-zero endorsement of other substance use (92% vs. 76%). The MHF-LR PSU class was characterized by moderate-to-high expected probabilities of higher frequency alcohol, cigarette, and cannabis use, and near-zero endorsement of other past-year substance use (5% vs. 22%). In addition to moderate-to-high probabilities of higher frequency alcohol, cigarette, and cannabis use, the ER PSU class was characterized by low-to-moderate expected probabilities of all other substance use (3% vs. 1%). This 3-class solution was not invariant by college graduation status ($\Delta\chi^2(48)=75.48$, $p<.01$). Inspection of plots showed higher expected probabilities of more frequent cigarette use for non-graduates, relative to graduates, particularly in the LF-LR PSU class. Higher expected probabilities of amphetamine and cocaine use were observed for college graduates, relative to non-graduates, in the ER PSU class.

NESARC-III Ages 25–34 MG-LCA

BIC and adjusted BIC values supported a 3-class solution for this MG-LCA, whereas entropy and AIC supported the 4-class solution. Considering interpretability and parsimony, we selected the 3-class solution as the best-fitting model (see Figures 2C and 2D for class profiles and class membership percentages).

Consistent with NESARC-W1, the LF-LR PSU class was characterized by low expected probabilities of higher frequency alcohol, cigarette, and cannabis use, and near-zero endorsement of all other substance use (70% vs. 79%). The MHF-LR PSU class was characterized by moderate-to-high expected probabilities of higher frequency alcohol, cigarette, and cannabis use, and near-zero endorsement of all other substance use (27% vs. 17%). In addition to moderate-to-high expected probabilities of high frequency alcohol, cigarette, and cannabis use, the ER PSU class was characterized by moderate-to-high expected probabilities of all other substances except for heroin and inhalants (3% vs. 4%). This 3-class solution was not invariant by college graduation ($\Delta\chi^2(56)=112.51$, $p<.01$). Plots showed higher expected probabilities of more frequent cigarette use for non-graduates, relative to graduates, particularly for the MHF-LR PSU and ER PSU classes. Higher expected probabilities of more frequent cannabis use also were observed for non-graduates vs. graduates in the LF-LR PSU and MHF-LR PSU classes. Finally, the expected probability of painkiller use among non-graduates in the ER PSU class was double that of college graduates in the same class.

Discussion

We examined past-year substance use patterns during young adulthood, separated by age strata (18–24 vs. 25–34), in two nationally-representative datasets, and employed MG-LCA to determine whether class solutions were invariant by college attendance/graduation. We included both NESARC-W1 and NESARC-III data, which provided a historical comparison of young adult PSU patterns across one decade. Use patterns largely replicated across waves, with some notable differences. Across age strata and datasets, 3-class solutions were supported for each MG-LCA: Low Frequency-Limited-Range Polysubstance Users, Medium-High Frequency-Limited-Range Polysubstance Users, and Extended-Range Polysubstance Users. Apart from one model, class solutions were not invariant by college attendance, which demonstrates that PSU patterns for youth in college or with a college degree are significantly different than PSU patterns for those not in college or without a 4-year college degree.

Though substance use patterns largely replicated from 2001–2002 to 2012–2013, we observed some differences, such as a decline in cigarette use and increase in cannabis use over time. These findings are not surprising and are consistent with prior work (Compton et al., 2016; Grucza et al., 2016; Hasin et al., 2015; Sarvet et al., 2018; Schulenberg et al., 2020). Interestingly, these historical differences were not as apparent in the Extended-Range Polysubstance User class. This suggests that individuals who progress into extended-range PSU are less influenced by general societal norms for substance use and require more focused and targeted prevention and intervention.

As explained by Quek et al. (2013), prior work has presumed that individuals using multiple substances have progressively expanded their substance use preferences to incorporate use of more illicit drugs in accordance with a general “deviance.” Our findings generally supported this notion, with young adults, regardless of age, endorsing a range of use frequency for only alcohol, cigarettes, and cannabis vs. a full range of substances. More nuanced findings suggested some differences in PSU patterns by age, particularly for illicit drugs. Most illicit and non-medical prescription drug use was higher among 18–24-year-olds, apart from opioid/painkiller use that was mostly comparable between age groups. The continued use of opioids/painkillers beyond "emerging adulthood" (i.e., ages 18–25; Arnett, 2000) is particularly concerning considering the role opioids play in the current overdose epidemic (Seth et al., 2018). This is also concerning considering that most problematic substance use (e.g., heavy drinking, illicit drug use) drops considerably around age 25, except for a subset of persistent substance users, consistent with the notion of "maturing out" (Labouvie, 1996; Lee & Sher, 2018; Littlefield & Winograd, 2013; Winick, 1962). Few differences in alcohol, cigarette, and cannabis use frequency were noted between 18–24-year-olds and 25–34-year-olds, which corroborates prior research. Indeed, drinking frequency has been shown to remain stable during young adulthood while drinking quantity, particularly binge drinking, has been shown to decrease over time (Arria et al., 2016; Nealis et al., 2017; O'Neill & Sher, 2000). Therefore, we might expect to see age-related differences if alcohol, cigarette, and cannabis quantity, rather than frequency, were included as latent class indicators.

Apart from one model, compositions of the 3-class solutions were significantly different for youth in college full-time or with a college degree compared to youth not in college full-time or without a college degree. These findings support existing literature noting significant differences between these groups. In NESARC-III among 18–24-year-olds, a greater percentage of non-college youth were in the Medium-High Frequency-Limited-Range Polysubstance Users, whereas the size of the other two classes were comparable between non-college and college attendees. We also noted some specific differences in substance use endorsement for college vs. non-college attendees. For example, in NESARC-III, non-college 18–24-year-olds in the Low Frequency-Limited-Range Polysubstance Users class endorsed higher frequency cigarette use, relative to college attendees. On the other hand, same-aged college attendees in the Extended-Range Polysubstance Users class, relative to non-college youth, had greater endorsement of sedative/tranquilizer use.

In the older age group in NESARC-W1, higher probabilities of amphetamine and cocaine use were observed for college graduates in the Extended-Range Polysubstance Users class, relative to non-graduates. These differences were not observed in models using NESARC-III, though college attendees and graduates have been shown to use more stimulants than their non-college peers in research drawing data from the 2013 and 2015 National Survey on Drug Use and Health (Ford & Pomykacz, 2016; Schepis et al., 2018). Non-graduates also endorsed more frequent cannabis use, relative to graduates, in the Low Frequency-Limited-Range Polysubstance Users and Medium-High Frequency-Limited-Range Polysubstance Users classes, which is consistent with recent MTF data showing that non-college youth use cannabis more frequently (Schulenberg et al., 2020). Our findings also showed, in NESARC-III, that the probability of painkiller use among non-graduates in the Extended-Range Polysubstance Users class was double that of college graduates in this class.

Though the Extended-Range Polysubstance Users class made up a small percentage of each subsample, one might conjecture that individuals in this class are at unique risk for the simultaneous use of high-risk drug combinations. Though not directly tested in the present study, concurrent polysubstance users (i.e., past-year PSU) often use multiple substances simultaneously (Quek et al., 2013), which is a strong risk factor for acute adverse outcomes, particularly when two or more depressants are co-ingested (Brady & Li, 2013; Darke, 2003; Gudin et al., 2013; Hedegaard, Bastian, et al., 2018; Lyons et al., 2019). This evidence is potentially concerning for the Extended-Range Polysubstance Users class because this class was also marked by high probabilities of at least weekly alcohol use, which can adversely interact with both depressants (as indicated above) as well as stimulants when used simultaneously. Indeed, the latter combination, specifically alcohol and cocaine, creates a unique compound (i.e., cocaethylene) that can result in cardiotoxicity among other acute adverse outcomes (Brady & Li, 2013; Pennings et al., 2002). Overall, our findings support prior work showing that illicit drug use and non-medical prescription drug use are rarely used in isolation (Martin, 2008; Quek et al., 2013), with more frequent alcohol, cigarette, and cannabis use occurring in individuals using these substances.

Strengths and Clinical Implications

The present study has several strengths. We illustrated the importance of investigating PSU patterns, as opposed to substances used in isolation, which challenges the notion of examining a single substance without also considering how that fits into an overall pattern of use. By using two nationally-representative datasets collected a decade apart, we provided a historical examination of young adult substance use patterns from 2001–2002 to 2012–2013 wherein significant substance use-related changes took place. These two datasets also contained parallel variables and sampling strategies, allowing this study to make direct comparisons between the two. A strength of the present work included large sample sizes in each sample, allowing us to interpret small and understudied classes. Though we acknowledge that the extended-range PSU class was consistently small, this class is particularly high-risk and understudied. Thus, a strength of the present study also was to better understand polysubstance use patterns for individuals in this high-risk class, which would not be possible in smaller datasets. Finally, testing different thresholds of use for the most endorsed substances provided further nuance regarding the intensity of substance use in each class and shed light on the likelihood of simultaneous PSU in the Extended-Range Polysubstance Users class.

This is the first study, to our knowledge, to compare PSU patterns of college and non-college young adults across a full range of substances, which provides important information about the prevention and intervention efforts needed for these distinct groups. Historical trends suggested that individuals in the limited-range PSU classes may respond well to norms-based substance use interventions, such as personalized feedback interventions (Larimer et al., 2007; Miller et al., 2013; Samson & Tanner-Smith, 2015). However, the efficacy of this type of intervention has only been extensively studied in collegiate settings. In fact, a recent meta-analysis of substance use treatment in non-college settings found that treatments providing personalized feedback showed lower efficacy in non-college youth than treatments without personalized feedback (Davis et al., 2017). Though there is a clear need to better understand under what situations feedback works for non-college youth (e.g., when coupled with motivational interviewing; see Colby et al., 2018), meta-analytic findings were promising for electronically-delivered interventions, as they were equally effective as in-person interventions for this population (Davis et al., 2017). Thus, delivering treatment electronically to non-college youth may increase access to care without sacrificing treatment effectiveness, which is important given there is no single point of access to non-college attending youth, unlike college-based intervention programs.

Historical trends in the present study indicated that individuals engaging in extended-range PSU may not respond as well to norms-based interventions. Given the range of substances used in this group, increasing access to naloxone and fentanyl test strips in both college and non-college settings (e.g., through standing order at pharmacy, shelters, health care providers via co-prescribing; Behar et al., 2018), including to individuals in their social network who do not necessarily use these substances, is imperative to reduce overdose-related deaths.

Limitations and Future Directions

Findings should be interpreted considering limitations. Data were retrospectively collected using self-report measures, which is subject to recall bias. The most-recent NESARC wave (NESARC-III) was collected in 2012–2013, which limits the degree to which this data can inform current drug policy. PSU class(es) identified reflect concurrent PSU, rather than simultaneous PSU (Connor et al., 2014; Saunders et al., 2016), though our addition of alcohol, cigarette, and cannabis frequency (e.g., daily use) provides some indication about the possibility of simultaneous PSU. Nevertheless, given the strong link between simultaneous PSU and acute adverse outcomes (Barrett et al., 2006; Liu et al., 2018; Mallett et al., 2017; Martin, 2008), future work is needed to characterize patterns of simultaneous PSU across a range of substances.

In both datasets, the non-graduate group is heterogeneous, such that individuals may have never attended college, attended college but never completed, or may be attending college but have not completed their degree. Future studies could extend this work by examining potential nuance among non-graduates, as defined here, and determine whether substance use patterns differ accordingly. Socioeconomic status (SES) was not considered in the present study; existing research has found inconsistent relations between SES and substance use and whether college attendance explains relations between SES and use patterns (e.g., cocaine use, binge drinking; Hanson & Chen, 2007; Humensky, 2010; Patrick et al., 2012). Future research could extend the present study by examining the intersection of educational attainment and SES in predicting specific substance use patterns.

Conclusion

Young adult substance use patterns were largely consistent over the past decade, with exceptions of declining cigarette use and increasing cannabis use over time. Extended-range polysubstance use patterns, however, did not appear to differ as much across waves, suggesting less influence of societal norms on individuals who use illicit and non-medical prescription drugs. By contrast, limited-range polysubstance users seem to be more susceptible to changing norms, legalization, and availability of substances. We largely supported prior work by demonstrating three classes of concurrent polysubstance users, with two classes limited to alcohol, cigarette, and cannabis use and the other class endorsing a full range of substances in the past year. Differences in polysubstance use patterns among full-time college attendees and college graduates, relative to their non-college and non-graduate peers, extends the large literature noting differences in single substance use for these groups. Age strata and college attendance/graduation are important for understanding the heterogeneity in young adult polysubstance use patterns.

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Public Significance Statement:

This study showed the importance of studying substance use in the context of overall use patterns, rather than focusing on single substance use, as we highlight that most young adults engage in some form of polysubstance use in the past year. We also found important differences in polysubstance use patterns for non-college and college-attending youth, with results suggesting that non-graduates who use illicit drugs or prescription drugs non-medically may be a particularly vulnerable to co-ingesting substances that could lead to serious consequences, including fatal and nonfatal overdose.

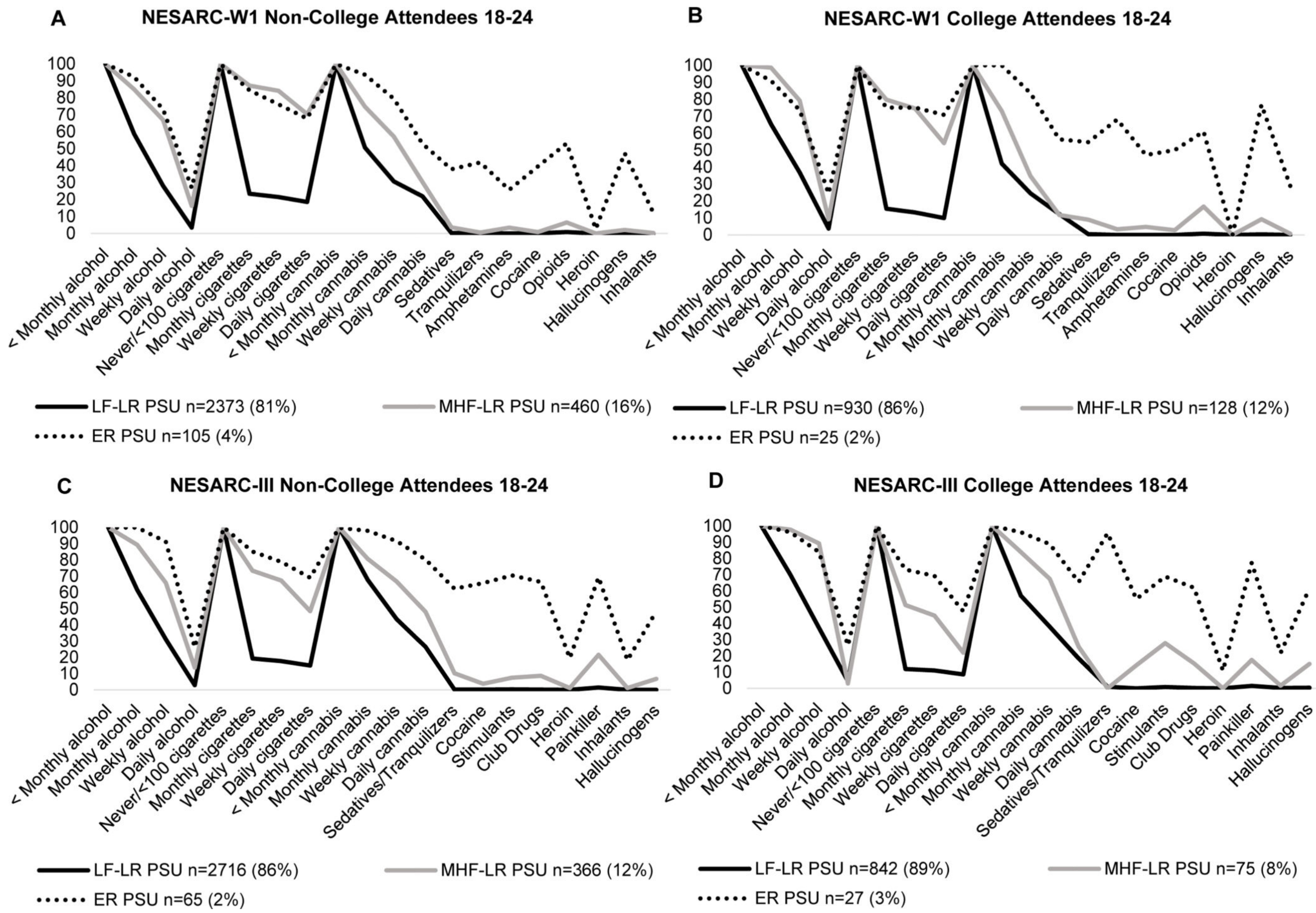

Figure 1.

Probabilities of past-year substance use endorsement by expected latent class membership among 18–24-year-olds in NESARC-W1 and NESARC-III. LF-LR PSU = Low Frequency-Limited-Range Polysubstance Users; MHF-LR PSU = Medium-High Frequency-Limited-Range Polysubstance Users; ER PSU = Extended-Range Polysubstance Users. Plots for alcohol, cigarette, and cannabis use ordinal variables are plotted cumulatively for ease of interpretation.

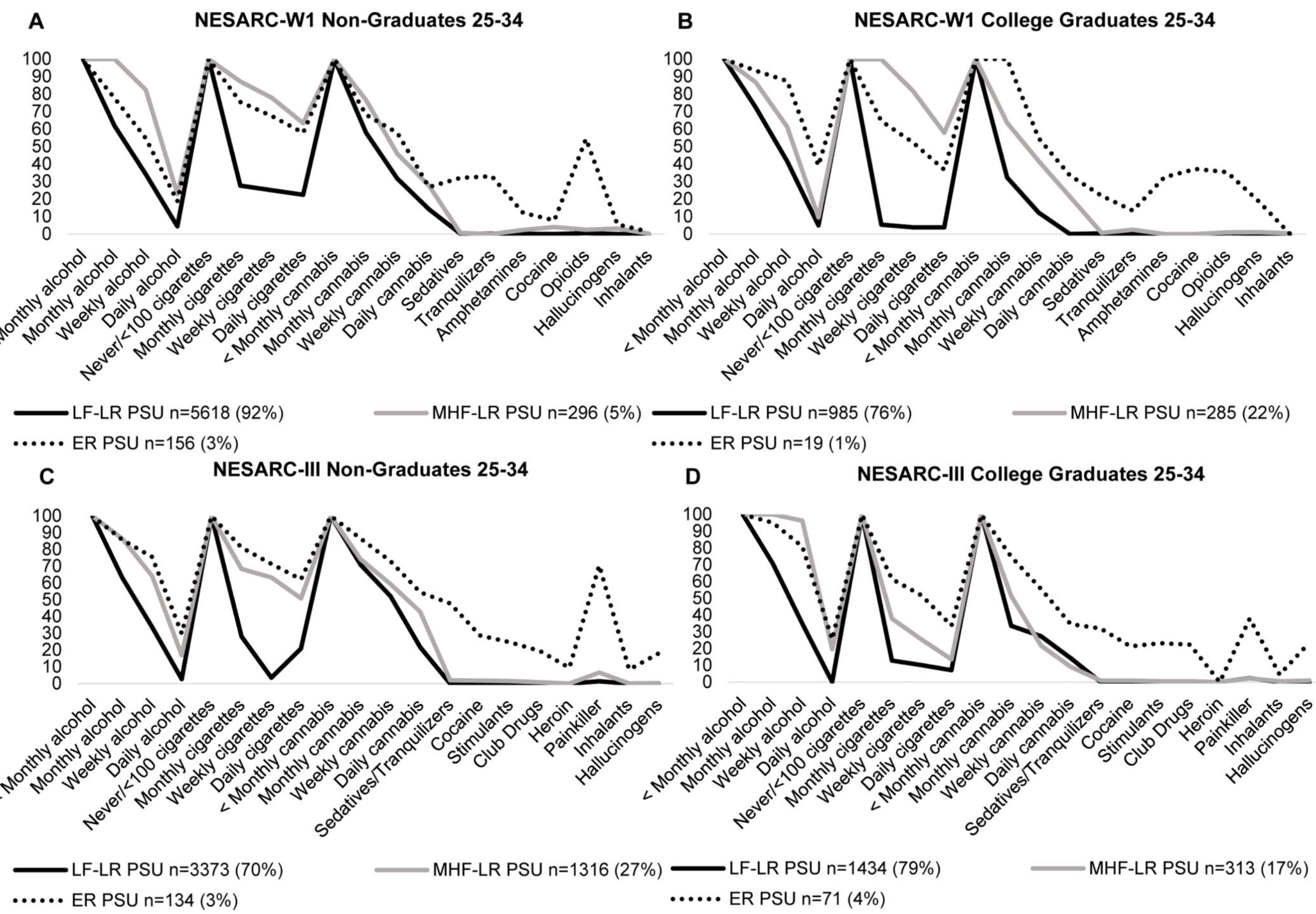

Figure 2.

Probabilities of past-year substance use endorsement by expected latent class membership among 25–34-year-olds in NESARC-W1 and NESARC-III. LF-LR PSU = Low Frequency-Limited-Range Polysubstance Users; MHF-LR PSU = Medium-High Frequency-Limited-Range Polysubstance Users; ER PSU = Extended-Range Polysubstance Users. Plots for alcohol, cigarette, and cannabis use ordinal variables are plotted cumulatively for ease of interpretation.

Table 1.

Operationalizing educational attainment using NESARC Wave 1 and NESARC-III data

Dataset	Ages 18–24	Ages 25–34
NESARC-Wave 1	**College Attendees**	**College Graduates**
	Inclusion:	Inclusion:
	Full-time student in the past 12 months 1st through 5th year undergraduate in 2000–2001	Completed bachelor's degree
	Exclusion:	Exclusion:
	Part-time or non-student in the past 12 months High school student Enrolled in GED program College graduate Graduate or professional school student	Less than bachelor's degree
	Non-College Attendees	**Non-Graduates**
	Inclusion:	Inclusion:
	Part-time or non-student in the past 12 months Enrolled in GED program	Less than bachelor's degree
	Exclusion:	Exclusion:
	High school student College graduate Graduate or professional school student	Graduate or professional student
NESARC-III[a]	**College Attendees**	**College Graduates**
	Inclusion:	Inclusion:
	Full-time student in the past 12 months At least "some college" as highest grade completed	Completed bachelor's degree
	Exclusion:	Exclusion:
	Less than "some college" (e.g., GED, high school) Completed technical 2-year degree Completed college Graduate or professional student	Less than bachelor's degree
	Non-College Attendees	**Non-Graduates**
	Inclusion:	Inclusion:
	Part-time or non-student in the past 12 months "Some college" or less (e.g., GED) as highest grade completed	Less than bachelor's degree
	Exclusion:	Exclusion:
	Completed college Graduate or professional student	Graduate or professional student

Note.

[a]The NESARC-III dataset does not include a variable to exclude high school students, which is inconsistent with our definition of college attendees and non-college attendees used in NESARC-Wave 1.

Table 2.

Descriptive statistics of subsample characteristics

	College Attendees 18–24 (*n* = 1083)	**Non-College Attendees 18–24 (*n* = 2938)**	**College Graduates 25–34 (*n* = 1289)**	**Non-Graduate: 25–34 (*n* = 6070)**
NESARC Wave 1				
Age	20.82 (1.62)	21.60 (1.81)	29.67 (2.86)	29.90 (2.79)
Sex				
Male	46%	46%	45%	42%
Female	54%	54%	55%	58%
Race/ethnicity				
White, not Hispanic	56%	43%	62%	47%
Black, not Hispanic	20%	18%	15%	20%
American Indian/Alaska Native, not Hispanic	1%	2%	1%	2%
Asian/Native Hawaiian/Pacific Islander, not Hispanic	6%	3%	8%	3%
Hispanic/Latinx	17%	34%	14%	29%
Marital Status				
Married	7%	24%	50%	51%
Cohabitating	3%	8%	3%	6%
Divorced	1%	1%	5%	8%
Separated	1%	2%	2%	4%
Never married	88%	64%	39%	31%
Past-year substance use				
*<Monthly alcohol	29%	33%	24%	33%
*Monthly alcohol	27%	27%	29%	27%
*Weekly alcohol	39%	32%	40%	33%
*Daily alcohol	5%	8%	7%	7%
*Never/<100 cigarettes	75%	62%	77%	65%
*Monthly cigarettes	3%	2%	5%	4%
*Weekly cigarettes	6%	5%	5%	4%
*Daily cigarettes	17%	31%	14%	28%

	College Attendees 18–24 (*n* = 1083)	Non-College Attendees 18–24 (*n* = 2938)	College Graduates 25–34 (*n* = 1289)	Non-Graduate: 25–34 (*n* = 6070)
*<Monthly cannabis	39%	30%	45%	35%
*Monthly cannabis	24%	18%	25%	25%
*Weekly cannabis	18%	19%	17%	20%
*Daily cannabis	19%	32%	14%	20%
*Sedatives	3%	2%	1%	1%
*Tranquilizers	2%	2%	<1%	1%
*Amphetamines	2%	2%	<1%	<1%
*Cocaine	2%	2%	<1%	<1%
*Opioids	4%	4%	1%	2%
*Heroin	0%	<1%	0%	0%
*Hallucinogens	3%	3%	1%	<1%
*Inhalants	<1%	<1%	<1%	<1%
	College Attendees 18–24 (*n* = 944)	**Non-College Attendees 18–24 (*n* = 3147)**	**College Graduates 25–34 (*n* = 1818)**	**Non-Graduates 25–34 (*n* = 4823)**
		NESARC-III		
Age	21.17 (1.74)	21.24 (2.01)	29.54 (2.79)	29.45 (2.84)
Sex				
Male	46%	46%	43%	43%
Female	54%	54%	57%	57%
Race/ethnicity				
White, not Hispanic	49%	38%	61%	40%
Black, not Hispanic	23%	25%	14%	26%
American Indian/Alaska Native, not Hispanic	1%	2%	<1%	1%
Asian/Native Hawaiian/Pacific Islander, not Hispanic	9%	5%	12%	3%
Hispanic/Latinx (any race)	18%	31%	12%	30%
Marital Status				
Married	5%	10%	45%	33%

	College Attendees 18–24 (*n* = 1083)	Non-College Attendees 18–24 (*n* = 2938)	College Graduates 25–34 (*n* = 1289)	Non-Graduate: 25–34 (*n* = 6070)
Cohabitating	7%	12%	10%	13%
Widowed	-	<1%	<1%	<1%
Divorced	<1%	1%	4%	7%
Separated	<1%	1%	1%	5%
Never married	87%	76%	40%	42%
Past-year substance use				
*<Monthly alcohol	25%	32%	19%	28%
*Monthly alcohol	29%	28%	25%	26%
*Weekly alcohol	40%	34%	48%	37%
*Daily alcohol	5%	6%	7%	9%
*Never/<100 cigarettes	82%	70%	78%	57%
*Monthly cigarettes	2%	3%	6%	4%
*Weekly cigarettes	5%	6%	6%	7%
*Daily cigarettes	11%	22%	10%	32%
*<Monthly cannabis	31%	25%	50%	25%
*Monthly cannabis	17%	19%	18%	16%
*Weekly cannabis	26%	17%	15%	22%
*Daily cannabis	26%	38%	17%	36%
*Sedatives/tranquilizers	4%	3%	2%	2%
*Cocaine	3%	2%	1%	2%
*Stimulants	6%	3%	1%	1%
*Club drugs	4%	3%	1%	1%
*Heroin	<1%	<1%	0%	<1%
*Painkillers	6%	6%	4%	6%
*Inhalants	1%	<1%	<1%	<1%
*Hallucinogens	4%	2%	1%	1%

Note. Means and standard deviations (in parentheses) are provided for age.

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*Denotes an input variable in each multi-group LCA model (i.e., NESARC Wave 1 ages 18–24 by college attendance vs. not; NESARC Wave 1 ages 25–34 by college graduate vs. not; NESARC-III ages 18–24 by college attendance vs. not; NESARC-III ages 25–34 by college graduate vs. not).

Table 3.

Latent class analysis model fit indices

	Number of classes			
	2-class	**3-class**	**4-class**	**5-class**
NESARC-W1 Ages 18–24 MG-LCA				
AIC	24261.52	**24144.09**	24124.91	24141.81
BIC	24708.77	**24818.12**	25025.71	25269.38
Adjusted BIC	24483.16	**24478.12**	24571.32	24700.60
Entropy	0.96	**0.84**	0.87	0.88
NESARC-W1 Ages 25–34 MG-LCA				
AIC	38355.71	**38274.83**	38268.21	38278.07
BIC	38818.25	**38972.10**	39200.20	39444.79
Adjusted BIC	38605.34	**38651.14**	38771.20	38907.74
Entropy	0.94	**0.88**	0.88	0.89
NESARC-III Ages 18–24 MG-LCA				
AIC	26851.88	**26654.78**	26603.49	26584.13
BIC	27300.35	**27330.65**	27506.75	27714.79
Adjusted BIC	27074.75	**26990.65**	27052.36	27146.00
Entropy	0.97	**0.87**	0.84	0.89
NESARC-III Ages 25–34 MG-LCA				
AIC	42928.75	**42844.88**	42776.83	42784.06
BIC	43411.63	**43572.59**	43749.38	44001.44
Adjusted BIC	43186.00	**43232.57**	43294.96	43432.63
Entropy	0.95	**0.73**	0.78	0.80

Note. MG-LCA = Multi-group Latent Class Analysis; AIC = Akaike’s information criterion; BIC = Bayesian information criterion. Best-fitting classes are in bold typeface.