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Continuity of drunk and drugged driving behaviors four years post-college

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Abstract

Background—Driving under the influence of alcohol is a leading cause of injury and premature death among young adults, and college-educated individuals are at particularly high risk. Less is known about driving under the influence of other drugs, which is on the rise.

Method—This study describes prospective seven-year trends in alcohol and other drug (AOD)-involved driving among a young-adult sample beginning with their second year of college (i.e., Years 2–8), and documents the extent of continuity in such behaviors across time. Originally recruited as incoming first-year students at one large public university, participants (n=1,194) were interviewed annually about how frequently they drove while drunk/intoxicated (DWI), after drinking any alcohol (DAD), and/or while under the influence of other drugs (DD). Follow-up rates were high (>75% annually).

Results—Among participants with access to drive a car, annual prevalence peaked in Year 4 (modal age 21) for both DWI (24.3%$_{wt}$) and DD (19.1%$_{wt}$) and declined significantly thereafter through Year 8 (both ps<.05). DAD was far more prevalent than DWI or DD, increasing from 40.5%$_{wt}$ in Year 2 to 66.9%$_{wt}$ in Year 5, and plateauing thereafter. Among marijuana-using

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Contributors

A.M. Arria and K.E. O'Grady contributed to the overall scientific direction of the project. K.M Caldeira, A.M. Arria, and H.K. Allen developed the manuscript. H.K. Allen, B.A. Bugbee, and K.B. Vincent managed the literature searches and summaries of previous work. K.M. Caldeira and K.E. O'Grady performed the statistical analyses. K.B. Vincent and B.A. Bugbee managed the day-to-day operational aspects of data collection and supervised staff involved in data collection. All authors assisted with writing and approved the final manuscript.

Conflicts of Interest

No conflicts declared.

participants, likelihood of DD was consistently greater than the likelihood of DWI among Heavy Episodic and Light-to-Moderate drinkers, and it declined significantly during Years 5–8 ($p<.05$).

Conclusion—Post-college declines in heavy drinking and DWI prevalence were encouraging but did not necessarily translate to reductions in likelihood of engaging in DWI, depending on drinking pattern. College-educated individuals represent an important target for AOD-involved driving prevention.

Keywords

alcohol; college students; drunk driving; driving after drinking; drugged driving; marijuana

1. Introduction

Driving under the influence of alcohol and other substances is a very serious public health problem (Asbridge et al., 2012; Brady and Li, 2014; Chou et al., 2006; Hingson et al., 2009; Laberge and Ward, 2004). In 2015, 10,265 fatalities occurred because of alcohol-impaired driving, representing 29% of all traffic-related deaths (National Highway Traffic Safety Administration, 2016), and drunk driving is a leading risk factor for premature death during adolescence and young adulthood (Feigelman and Gorman, 2010).

While the prevalence of drunk driving has been well documented, driving under the influence of other substances, specifically marijuana, either alone or in combination with alcohol has gained increasing attention during the last few years in the U.S. (Brady and Li, 2014; Li et al., 2013; Office of National Drug Control Policy, 2014; Voas et al., 2013a; Voas et al., 2013b) and internationally (Brubacher, 2015; Elvik, 2013; Fischer et al., 2014; Senna et al., 2010). Such concerns are fueled in part by increases in perceived availability of marijuana and related declines in risk perceptions and disapproval (Okaneku et al., 2015; Salas-Wright et al., 2015; Schuermeyer et al., 2014). Not surprisingly, according to national roadside survey data, the proportion of weekend night-time drivers testing positive for THC recently increased 48%, from 8.6% in 2007 to 12.6% in 2013–2014 (Berning et al., 2015). Equally concerning is the corresponding growth in the proportion of fatally injured drivers in the U.S. who test positive for substances other than alcohol (i.e., from 16.6% in 1999 to 28.3% in 2010), with marijuana being the most common (Brady and Li, 2014).

Considerable epidemiologic and experimental evidence suggests that marijuana use impairs driving performance (Lenne et al., 2010; Menetrey et al., 2005; Papafotiou et al., 2005; Ramaekers et al., 2006; Ronen et al., 2008; Sewell et al., 2009) and increases crash risk (Asbridge et al., 2012; Dubois et al., 2015; Hall, 2009; Laberge and Ward, 2004). In one large study of fatally injured drivers, the presence of any detectable THC was associated with more than a two-fold increase in the odds of culpability for a fatal crash, even after accounting for blood alcohol concentration (BAC) and other substances (Drummer et al., 2004). When THC concentrations were at or above 5 ng/ml, the odds of culpability increased more than six-fold, comparable with a BAC of 0.15%.

From college entry through the transition to young adulthood, risk for alcohol and other drug (AOD)-involved driving is high. Multiple cross-sectional studies on AOD-involved driving

among college students (Fairlie et al., 2010; Kenney et al., 2013; Kohn et al., 2014; McCarthy et al., 2007; Treloar et al., 2012; Whitehill et al., 2014; Zakletskaia et al., 2009) have documented the high prevalence of drunk driving (LaBrie et al., 2011; Paschall, 2003) and driving under the influence of other drugs (Benotsch et al., 2015). Among this population, prevalence estimates for driving after drinking (DAD) during the past three months range from 15% (Kenney et al., 2013) to 43% (McCarthy et al., 2007). Longitudinal research on AOD-involved driving is available among three college student samples, including the cohort that is the subject of the present study (Arria et al., 2011; LaBrie et al., 2012; Quinn and Fromme, 2012). Results show an increase in the prevalence of DAD across the college years (LaBrie et al., 2012; Quinn and Fromme, 2012) and that past DAD is a strong predictor of future DAD (LaBrie et al., 2012), indicating persistence over time. Research with the current cohort has documented the trends in driving while intoxicated (DWI), DAD, and drugged driving (DD) during college (Arria et al., 2011; Beck et al., 2010). Significant increases were observed at age 21 in prevalence and frequency of both DWI and DAD (Beck et al., 2010), even after accounting for age-related changes in access to drive a car, whereas DD was equally prevalent but remained stable throughout college (Arria et al., 2011).

To extend the current knowledge base about AOD-involved driving among college students, this study examined the continuity of such behaviors four years beyond college. With the transition from college to young adulthood comes an increase in responsibility and independence, and declines in heavy drinking, drug use, and other risky behaviors are known to coincide with conventional “adult” milestones like cohabitation, marriage, and parenthood (Duncan et al., 2006; Eitle et al., 2010; Leonard and Rothbard, 1999; Oesterle et al., 2011). We recently demonstrated how frequency of drinking increases in the post-college period in tandem with decreases in quantity (Arria et al., 2016). Moreover, declines in heavy drinking and other substance use during the middle and late twenties have been documented previously among both college-educated and other young adult populations (Brodbeck et al., 2013; Gotham et al., 1997; Jackson et al., 2001; Johnston et al., 2014), but have yet to be confirmed for AOD-involved driving. The present analyses will enable us to examine whether AOD-involved driving declines in a similar fashion.

Specifically, this study aims to (1) describe trends in AOD-involved driving during and after college; (2) examine the correspondence between changes in AOD-involved driving and concurrent changes in heavy episodic drinking and marijuana use; and (3) describe the degree of continuity of AOD-involved driving.

2. Methods

2.1. Sample

The College Life Study is a longitudinal prospective study of 1,253 individuals who were recruited in 2004 during their first year of college at a large, public university. After screening the entire population of incoming first-year students ages 17–19 (89% response rate) during the summer prior to college entry, a sample was selected for longitudinal follow-up. To ensure adequate statistical power, individuals whose screening responses indicated illicit drug use or nonmedical use of a prescription drug at least once during high school

were oversampled with 100% probability, and all others at 40%, while stratifying by race and sex to ensure demographic representativeness. Eight annual personal interviews were administered beginning with a baseline assessment during their first year of college. The baseline response rate was 87%, and subsequent follow-up rates were high (e.g., 91% in Year 2, 76% in Year 8). Follow-up continued regardless of academic status. The study was approved by the university's IRB, and participants received cash incentives for each assessment completed. Interviewers were trained extensively in confidentiality protection. More information on recruitment and sampling can be found in previous publications (Arria et al., 2008; Vincent et al., 2012).

Participants were demographically similar to the target population of full-time undergraduate students at the university (49% male, 72% non-Hispanic white). Seventy-four percent had a mother with a Bachelor's degree or higher, and 83% to 97% had access to drive a car, annually. By design, participants were ages 17–20 at their Year 1 assessment (modal age 18, 71%); thus, annual follow-up assessments correspond to modal ages 19–25, respectively.

The present analyses were based on annual data from Years 2–8, because past-year driving was not assessed in Year 1. Relative to the 59 participants who completed none of the follow-up assessments, the 1,194 with one or more follow-ups overrepresented women (52% vs. 36%, $p<.05$) but were similar with respect to race/ethnicity, mother's education, and baseline alcohol or cannabis use disorder. Most (87%) had graduated from college by Year 5.

2.2. Measures

2.2.1. Access to Drive a Car—Participants were asked annually about their access to drive a car during the past 12 months. During Years 2–4, the response was dichotomous ("Yes", "No"), and during Years 5–8 five ordinal responses were used (ranging from "Not at all" to "Daily"). For the present study, individuals who responded "No" or "Not at all" were excluded from analyses for that year.

2.2.2. AOD-Involved Driving—Consistent with prior research (Arria et al., 2011; Beck et al., 2010), participants were asked annually about three different driving behaviors they might have engaged in during the past year, using the format: "How many times did the following things happen to you during the past 12 months? You drove while drunk on alcohol; you drove after drinking alcohol; you drove while high on other drugs." Ordinal response options ranging from never (0) to 10 or more times (4) were later recoded to derive annual dichotomous variables (i.e., once or more vs. never) for driving while intoxicated (DWI), driving after drinking (DAD), and drugged driving (DD). DD was assessed as broadly as possible to include any type of DD. When asked to specify which drug(s) they had used during their DD episodes, most mentioned only marijuana (80% to 90% of those who endorsed DD in any given year), while several mentioned both marijuana and other drugs (7% to 17% annually). Individuals who only mentioned drugs other than marijuana were scarce (≤5% annually).

2.2.3. Alcohol and Marijuana Use—Past-year alcohol and marijuana use frequency were assessed annually, as well as typical alcohol quantity (number of drinks/drinking day). Later, drinking patterns for non-abstainers were defined as Heavy Episodic [typical consumption ≥4 drinks (women) or ≥5 drinks (men)] and Light-to-Moderate [typical consumption 1–3 drinks (women) or 1–4 drinks (men)]. Membership in a drinking category was allowed to vary over time. Thus, an individual who was categorized as a Heavy Episodic drinker in Year 2 might have been a Light-to-Moderate drinker in Year 3.

2.3. Analytic Strategy

Statistical weights were computed to account for the sampling design and attrition based on the ratio between the number of participants in any given assessment and the number of screened individuals within the corresponding race-sex-drug use cell of the original sampling frame of screened students (i.e., target population, N_{wt}=3,285). Thus, individuals who were sampled with 40% probability (see above) could be weighted to represent a larger number of individuals in the sampling frame relative to those who were sampled with 100% probability. For each driving behavior, annual prevalence was computed as a weighted percent to generalize back to the target population of college students. Year-to-year comparisons were tested for statistical significance using unweighted data. To understand the extent to which changes in AOD-involved driving could be explained by contemporaneous changes in substance use, trends were also plotted for the likelihood of DWI given a certain drinking pattern (i.e., Heavy Episodic and Light-to-Moderate drinking) and for the likelihood of DD given marijuana use. Trends were evaluated in a series of logistic models in which the dependent variable was a given driving behavior (DAD, DWI, DD), and the explanatory variable was study year. The latter two models were evaluated with the addition of a second explanatory variable (drinking pattern and marijuana use, respectively) and its first-order interaction with study year. In each model, pairwise comparisons between the estimated marginal means were evaluated using Bonferonni correction. Statistical significance of all comparisons was evaluated at α=.05 using unweighted data.

3. Results

3.1. Prevalence of AOD-Involved Driving

Figure 1 depicts the weighted annual prevalence of DAD, DWI, and DD. Among individuals with access to a car, DAD increased significantly during college and plateaued around 66%$_{wt}$ by Year 5 (modal age 22) for the duration of the study. Of the three driving behaviors we examined, this was the only behavior that showed no significant declines at any point during the seven-year study interval. Annual prevalence peaked at modal age 21 (Year 4) for both DWI (24%$_{wt}$) and DD (19%$_{wt}$). DWI increased significantly between Years 2 and 4, surpassing DD, and then declined slightly but significantly from 24%$_{wt}$ in Year 4 to 19%$_{wt}$ in Year 8. DD was stable at around 19%$_{wt}$ through Year 4, and thereafter began decreasing steadily and significantly throughout Years 5–8. Not surprisingly, far more participants admitted to DAD than DWI; unexpectedly, however, DAD plateaued during the post-college period, in contrast to the gradual declines seen in DWI and DD.

Restricting the sample to the 863 individuals with complete follow-up data through Year 8, and statistically adjusting for sampling and attrition, cumulatively $39\%_{wt}$ endorsed engaging in DWI in at least one but not every year, and $4\%_{wt}$ did so every year, or $43\%_{wt}$ overall. The corresponding estimates for DAD were $63\%_{wt}$ and $22\%_{wt}$ ($85\%_{wt}$ overall), and for DD were $23\%_{wt}$ and $5\%_{wt}$ ($28\%_{wt}$ overall).

3.2. Relationship Between Drinking Pattern and DWI

Trends in the probability of DWI differed among participants who did and did not engage in Heavy Episodic drinking (see Figure 2), as evidenced by a significant first-order interaction between assessment year and drinking pattern (p=.027). For Heavy Episodic drinkers, probability of DWI exhibited an inverted U-shaped trend, peaking at 41.0% in Year 6 (χ^2=17.0, df=6, p=.006). However, with the sole exception of a significant increase from 31.6% in Year 2 to 40.6% in Year 5 (p=.023), none of the pairwise comparisons between individual years were significantly different. By contrast, probability of DWI among Light-to-Moderate drinkers exhibited two distinct periods of stability: first, a stable trend around 10% during Years 2–3, and a second higher stable trend around 18% throughout Years 4–8 (χ^2=40.2, df=6, p<.001). Accordingly, the pairwise comparisons between years were all statistically significant across the two aforementioned periods (i.e., Years 2 and 3 contrasted against Years 4, 5, 6, 7, and 8; all ps<.001), and none were significant within either period. Moreover, DWI was consistently higher among Heavy Episodic drinkers than Light-to-Moderate drinkers, regardless of year, as evidenced by a significant main effect of the dichotomous drinking pattern variable (*AOR*=4.2, *95%CI*=2.9,6.2, p<.001).

3.3. DD Among Marijuana Users

Restricting the sample to marijuana users, likelihood of DD exhibited an inverted U-shaped trend (χ^2=14.4, df=6, p=.025; see Figure 2), marked by a significant decline from 46.2% in Year 5 to 37.0% in Year 8 (p=.029). None of the other pairwise comparisons between years were statistically significant (all ps>.05).

3.4. Substance Use Trends

To place the preceding findings in the context of contemporaneous substance use trends among the overall sample (i.e., regardless of access to a car), weighted annual prevalence of Heavy Episodic drinking and marijuana use are plotted in Figure 3. Both behaviors declined steadily after an initial period of stability. Statistical significance of such trends was evaluated via two GEE models using unweighted data. First, the model on probability of Heavy Episodic drinking indicated a stable interval during Years 2–4 (all ps>.15), followed by significant declines annually during Years 4–7 (all ps<.05). Although Heavy Episodic drinking did not change significantly between Years 7–8 (p=.19), it remained significantly lower in Year 8 than in Years 6–2 (all ps<.001). In the second model, probability of marijuana use did not change significantly from Year 2–3 (p>.99) but declined significantly throughout Years 3–6 (all ps<.01), and although Year 7 was not significantly different from either Year 6 or Year 8 (both ps>.60), the two-year decline from Year 6–8 was significant (p=.003).

Aggregating all available data across Years 2–8 (again, regardless of access to a car), binge drinking was significantly higher among individuals who used marijuana regularly (i.e., >12 times during the past year) or occasionally (i.e., 1–12 times during the past year) relative to those who did not use marijuana at all during the past year (60%, 54%, and 27%, respectively, $p<.001$). Conversely, binge drinkers were significantly more likely than non-binge drinkers to use marijuana regularly (37% vs. 18%) or occasionally (29% vs. 18%); only one-third (33%) of binge drinkers abstained from marijuana use completely, compared with 64% of non-binge drinkers.

3.5. Continuity of AOD-Involved Driving

In any given year, the majority of individuals who engaged in AOD-involved driving persisted in that behavior the subsequent year (see Table 1). For example, of the 187 individuals who reported DWI in Year 2 and were assessed in Year 3 (and had access to drive a car both years), 66.8% reported DWI again in Year 3. Persistence rates for DWI were similarly high regardless of year, ranging from 60.8% in Year 7 to 72.5% in Year 3, and higher still for DAD (≥83.9% annually). Persistence of DD was consistently as high or higher than for DWI, and lower than for DAD.

3.6. Co-occurrence of AOD-Involved Driving

As shown in Table 2, the proportion of DWI drivers who also engaged in DD during the same year declined steadily from 54.9% in Year 2 to 32.8% in Year 8. Conversely, in any given year, approximately half of DD drivers also engaged in DWI, with proportions ranging from 45.9% in Year 2 to 58.8% in Year 6.

3.7. Post-hoc: Crashes and Arrests

Although no data are available concerning any consequences that might have occurred in relation to a given driving occasion, data on past-year crashes and arrests were examined to provide a broader context of driving-related consequences among individuals who had access to drive a car. With respect to crashes, in Year 8, 11.6% of drivers said they had been involved in a crash at least once during the past year where they were the driver. This proportion differed significantly between individuals who did and did not engage in DWI (19.6% vs. 9.6%, $p<.001$) and DAD (14.2% vs. 6.2%, $p<.001$). With respect to arrests, in any given year, the proportion of drivers who were arrested was below 3% (ranging from 0.7% to 2.4% annually); this proportion included arrests for AOD-involved driving as well as arrests for any other reason.

4. Discussion

In this seven-year study of a large college student sample, both DD and DWI were highly prevalent, peaking in Year 4 at 19.1%$_{wt}$ and 24.3%$_{wt}$, respectively. Significant declines in both DD and DWI were observed beginning around the time of departure from college—that is, Years 4–5 (corresponding to modal ages 21 and 22, respectively). By contrast, no such declines occurred for prevalence of DAD. Not surprisingly, DAD was far more prevalent than DWI or DD, increasing from 40.5%$_{wt}$ in Year 2 to 66.9%$_{wt}$ in Year 5, and plateauing thereafter. These findings might be partially attributable to changes in participants' driving

patterns over time, such as by driving more frequently overall and specifically driving to more of their social activities, as compared with earlier in the study when they might have been walking to most of their social activities on or near campus.

During Years 2–4, when most participants were still in college, prevalence of both DWI and DAD increased significantly—even accounting for changes in students having access to drive a car—whereas DD remained stable. The observed increases in both DAD and DWI during the college years are consistent with prior evidence from college student samples (LaBrie et al., 2012; Quinn and Fromme, 2012). Interestingly, the finding that DAD plateaued after Year 4 mirrors the post-college trends in alcohol frequency that were recently documented among this sample (Arria et al., 2016).

An important contribution of this study is the finding that, although the overall prevalence of DWI declined in the later years of assessment, the likelihood of DWI among Light-to-Moderate drinkers and Heavy Episodic drinkers did not necessarily decline in a corresponding fashion; in fact, it was stable among Light-to-Moderate drinkers throughout Years 4–8, and among Heavy Episodic drinkers there was no significant change despite an apparent downward trend. This finding suggests that, even though some individuals might curtail their heavy drinking patterns after college (Donovan et al., 1983; Gotham et al., 1997; Jackson et al., 2001; Johnston et al., 2014), the likelihood of DWI remains high (between 30% and 40%) for the substantial proportion who do continue drinking heavily—which was more than one in four former students in this study ($28.6\%_{wt}$) by Year 8. Moreover, the finding that Light-to-Moderate drinkers showed no signs of curbing DWI stands in contrast to prior research documenting reductions in substance use and other risky behaviors following other important developmental milestones demarcating the transition to adulthood (Duncan et al., 2006; Oesterle et al., 2011). Prior evidence from this sample supports the notion that college graduation might be an important turning point in students' drinking patterns (Arria et al., 2016), but such changes might not translate to changes in likelihood of DWI as measured in the present study. Alternatively, we cannot rule out the possibility that the observed trends in DWI might be partially attributable to concomitant changes in overall driving behaviors; it is plausible, for example, that more frequent driving after college—relative to pre-graduation driving habits—might translate to greater opportunities for DAD and DWI to occur. Future research should include more detailed measures of driving patterns.

Findings also present some intriguing contrasts between DD and DWI. Throughout most of the study interval, DD was slightly less prevalent than DWI. Yet the likelihood of DD among marijuana-using participants remained consistently higher than the likelihood of DWI among Heavy Episodic or Light-to-Moderate drinkers. This result might reflect differences in risk perceptions around marijuana-involved driving vis-a-vis DWI among this sample. Some prior research suggests that college students tend to view driving under the influence of marijuana as less dangerous than DWI (Kohn et al., 2014; McCarthy et al., 2007), despite substantial evidence of the negative effects of marijuana use on driving ability (Lenne et al., 2010; Menetrey et al., 2005; Papafotiou et al., 2005; Ramaekers et al., 2006; Ronen et al., 2008; Sewell et al., 2009). It is also possible that marijuana use was an indicator of overall substance use problems and/or a marker for externalizing disorders relative to individuals

who only drank alcohol. Moreover, the present finding that likelihood of DD among marijuana users decreased significantly during Years 5–8—whereas the corresponding estimates for DWI (among either Heavy Episodic or Light-to-Moderate drinkers) did not—indicates that factors other than declining marijuana use could have contributed to the decline in DD prevalence. It is tempting to speculate, then, that DD might have declined due to developmentally-driven processes such as changes in attitudes about DD during the transition to adulthood; yet we cannot rule out other possible contributing factors such as changes in the contexts of marijuana use. Further research aimed at understanding the mechanisms by which such attitudes and behaviors might change developmentally could inform the creation of effective interventions targeting college students' attitudes around DD.

The present findings must be viewed in light of the study's limitations. First, participants were recruited from a single university, so generalizability to other college populations is unknown. Social desirability bias is possible whenever data are collected via self-report on sensitive topics, such as the illegal behaviors that were the focus of this research (i.e., DWI, DD, substance use). Although we used standard survey items, we are cognizant that terms like "drunk driving" are highly subjective for survey participants, especially for the one-year recall period in this study, so we cannot say how results might compare with more objective measures based on BAC. Given the normative nature of heavy drinking among this sample, it is likely some occasions that were reported as DAD would have been more accurately reported as DWI. Our interpretation of the findings related to drinking patterns pertains to change (or stability) in the likelihood of DWI from one year to the next, among individuals who were drinking at a certain level in a given year. The present study did not attempt to group or categorize individuals based on their entire drinking history longitudinally across seven years—although this is precisely what was done to categorize the three AOD-involved driving behaviors longitudinally. Given the retrospective nature of the survey items, we could not account for co-ingestion of multiple substances on any given driving occasion, nor could we distinguish between different types of drugs that might have been used on different driving occasions (although marijuana was mentioned predominantly). The present study focused on trends in prevalence of AOD-involved driving and does not address possible changes in frequency of such behaviors, which are important questions for future research. Lastly, although we restricted our analyses to individuals with access to drive a car each year, we cannot say how our trend analyses might have differed under a stricter inclusion criterion such as daily or weekly driving.

This study's findings are strengthened by its longitudinal, prospective design and high follow-up rates, as well as its large sample size. The ability to account for changes in students' access to drive a car is an important advancement over prior studies, especially considering that such access is likely to change considerably during and after college.

Findings highlight several areas for future research. First, given the high prevalence of DAD among this sample, future research should focus on understanding how college-educated young adults subjectively differentiate between DAD and DWI. Although not directly comparable because of differences in sample characteristics, national data estimate that the prevalence of DWI among young adults ages 18 to 25 is 19.4% (Center for Behavioral

Health Statistics and Quality, 2016). Interestingly, the national data show that college-educated 24- or 25-year-olds have a higher prevalence of DWI (25.6%) than 24- or 25-year-olds with some college (21.6%) or only a high school degree (13.4%). The National Survey on Drug Use and Health does not inquire about DAD, but it is plausible that DAD might be reported more honestly because it is less stigmatized and therefore might be a more useful target for screening and intervention. Second, the high prevalence of both DWI and DD—even seven years after college matriculation, and even with the likely underreporting due to social desirability and/or subjectively underestimating their level of intoxication—highlight the urgency of identifying effective intervention strategies to reduce AOD-involved driving among college-educated young adults. Third, the present findings echo other researchers' recent calls for more research on the effects of poly-substance use on driving (Dubois et al., 2015). Given that heavy drinkers tend to engage in other substance use, both simultaneously and concurrently (Haas et al., 2015; Midanik et al., 2007; O'Grady et al., 2008), researchers should examine AOD-involved driving comprehensively.

With respect to practical implications, the present findings suggest that college might be an ideal environment in which to intervene on AOD-involved driving. In many respects, college students represent a captive audience that is highly accessible for both universal messaging as well as screening and targeted interventions. It is plausible that interventions during college might have lasting effects on post-college behaviors. At the same time, it is apparent that other prevention strategies are needed to target college-educated adults long after they graduate from college. Given that one third (or more) of Heavy Episodic drinkers reported DWI in any given year, they remain a critically important target audience for preventing DWI. It is likely that reducing high-risk driving behaviors will help to curtail DWI, yet direct interventions are also needed. Prior research has shown the effectiveness of enforcement strategies including sobriety checkpoints and increased police patrols in reducing DWI both on college campuses and within the community (Clapp et al., 2005; Johnson, 2016; Sanem et al., 2015).

It is noteworthy that all three of the AOD-involved driving behaviors exhibited a high degree of persistence over time. Given that repeated episodes of such behavior are generally regarded as indicative of disorder (American Psychiatric Association, 2013), the finding has implications for prevention. College administrators might have a unique opportunity to leverage law enforcement reports to identify students with DWI violations and monitor students' follow-through on referrals for evaluation and treatment. Alternatively, students might be screened for AOD-involved driving during primary care visits. Comprehensive strategies are necessary to address high-risk drinking and associated consequences, including AOD-involved driving, to promote the future health and safety of young adults (Arria and Jernigan, in press).

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Highlights

- Annual prevalence peaked at modal age 21 for both driving while intoxicated (DWI) (24.3%$_{wt}$) and driving while under the influence of other drugs (DD) (19.1%$_{wt}$)
- Significant declines in both DD and DWI were observed starting around modal age 22
- DWI among Light-to-Moderate and Heavy Episodic drinkers did not significantly decline
- Driving after drinking any alcohol (DAD) increased significantly during college and plateaued at 65%$_{wt}$ by modal age 22
- The drug most often endorsed during DD was marijuana

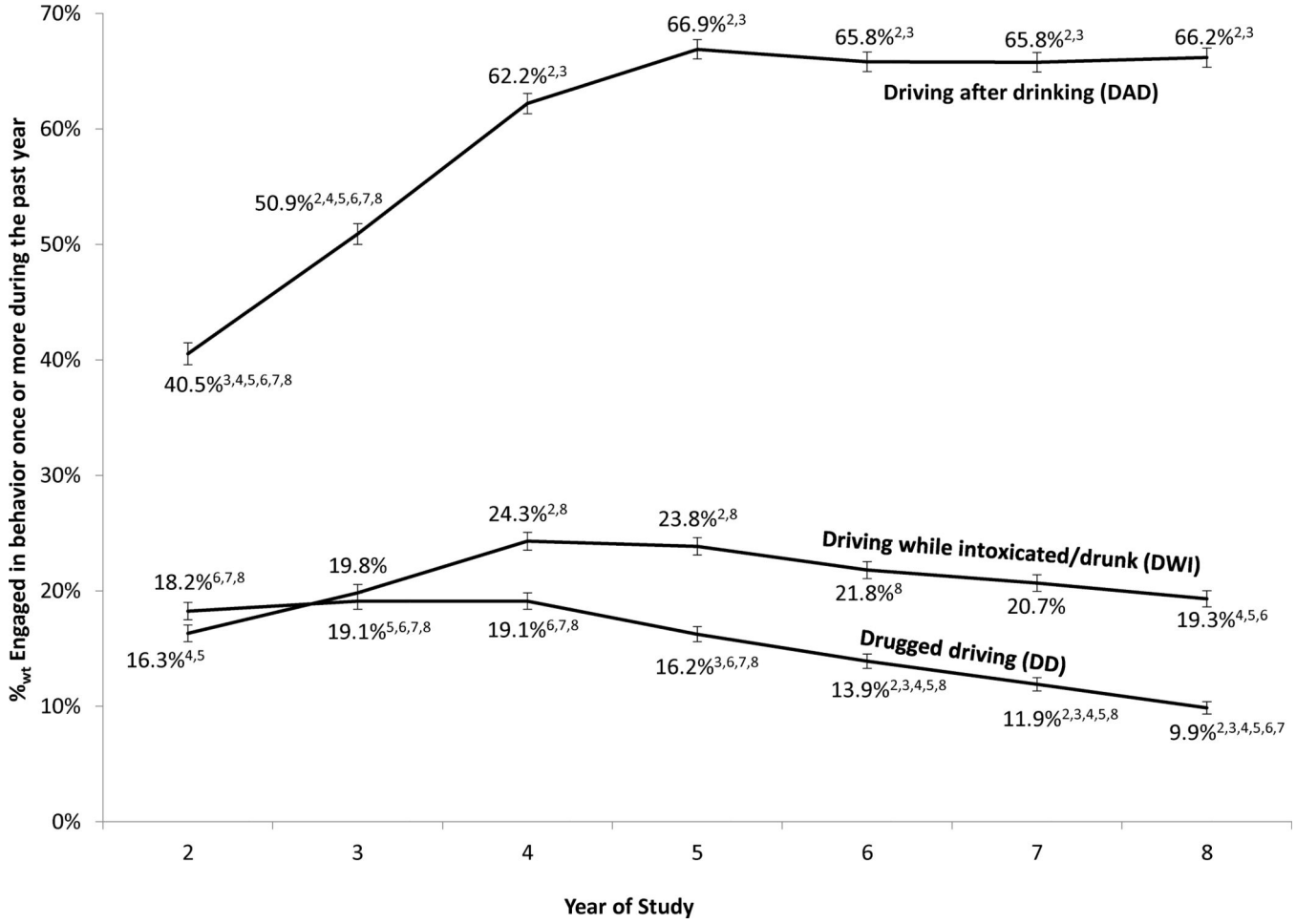

Figure 1. Weighted annual prevalence of alcohol and other drug (AOD)-involved driving

Note. Results are restricted to individuals with access to drive a car during the past year. All data are weighted for sampling and attrition. Bars depict standard errors of the weighted population proportions. Superscripts denote years for which estimates are significantly different from a given estimate ($p<.05$), based on results of separate repeated measures analyses that were conducted using unweighted data.

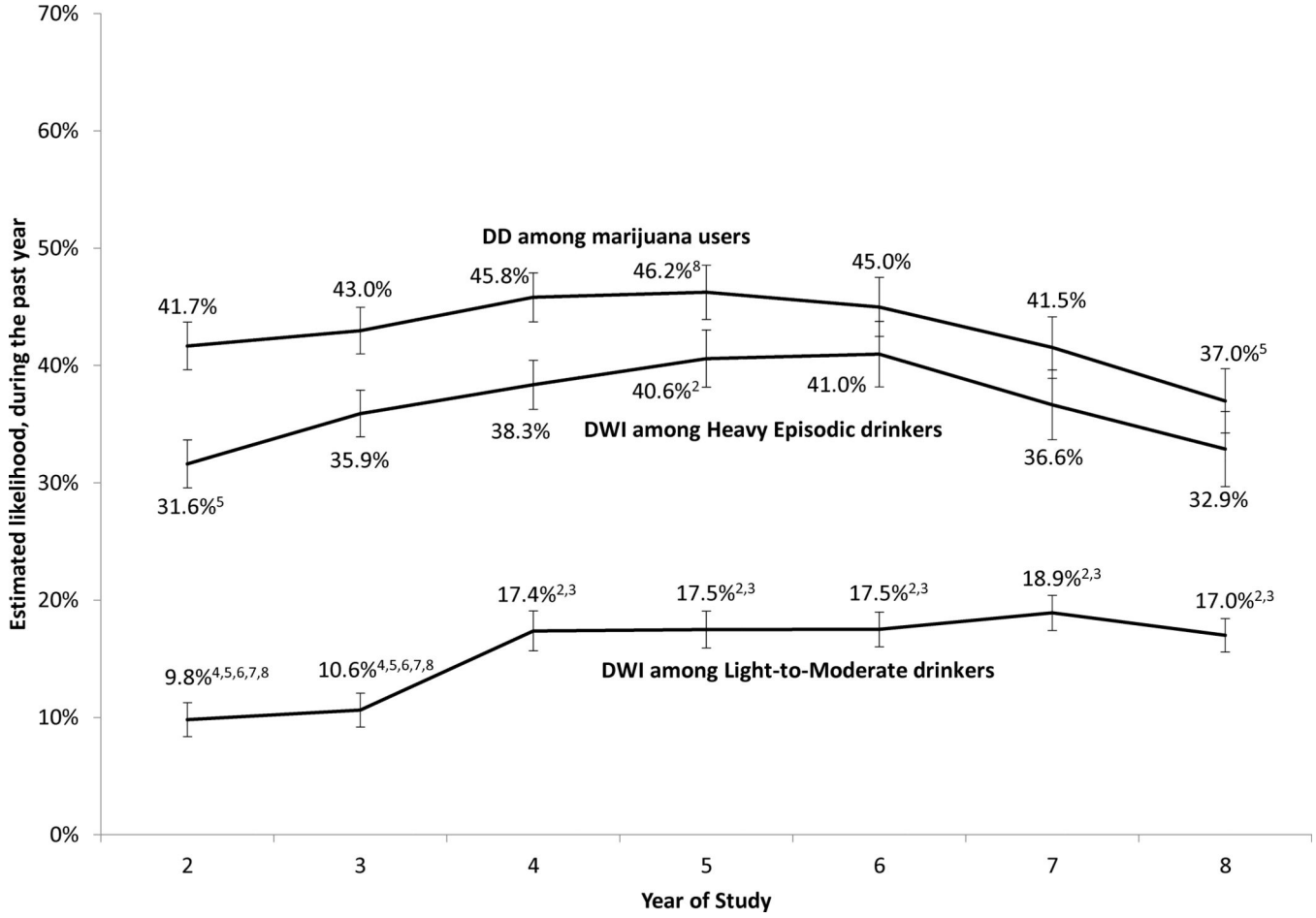

Figure 2. Estimated probability of drugged driving (DD) and drunk driving (DWI) for selected subsets based on drinking pattern and marijuana use

Note. Results are restricted to individuals with access to drive a car during the past year. Results reported as estimated marginal means (standard errors) adjusting for year. Superscripts denote years for which estimates are significantly different from a given estimate ($p<.05$). All data are unweighted.

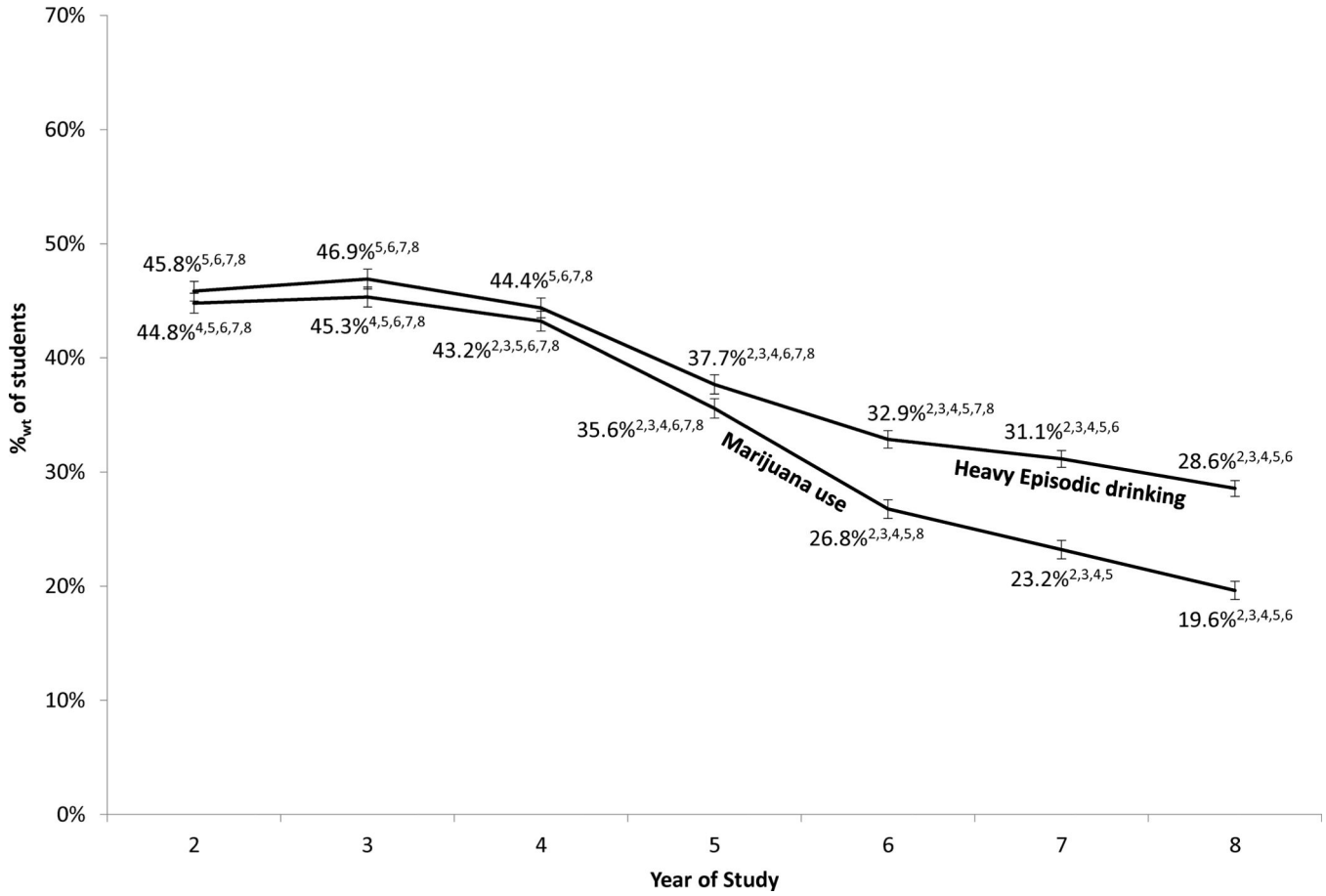

Figure 3. Weighted annual prevalence of Heavy Episodic drinking and marijuana use

Note. Results are statistically weighted to adjust for sampling and attrition. Results computed for the overall sample, regardless of access to drive a car (N_{wt}=3,285). Superscripts denote years for which estimates are significantly different from a given estimate (p<.05), based on results of separate repeated measures analyses that were conducted using unweighted data.

Table 1

Persistence of driving while drunk/intoxicated (DWI), driving after drinking (DAD), and driving under the influence of other drugs (DD), by year

	DWI		DAD		DD	
	***n* for the given year**	**% persisted subsequent year**	***n* for the given year**	**% persisted subsequent year**	***n* for the given year**	**% persisted subsequent year**
Year 2	187	66.8%	417	83.9%	222	73.9%
Year 3	244	72.5%	569	89.1%	255	75.7%
Year 4	268	67.2%	652	89.0%	237	75.1%
Year 5	256	68.8%	677	84.3%	206	68.4%
Year 6	231	65.8%	642	86.0%	162	75.3%
Year 7	209	60.8%	613	85.2%	138	67.4%

Note. For each row, % persisted is computed among *n* individuals who engaged in the behavior in the given year and had access to drive a car during the subsequent year. All data are unweighted.

Table 2

Correspondence between driving while drunk/intoxicated (DWI) and driving under the influence of other drugs (DD), by year

	n engaged in DWI	% also engaged in DD	*n* engaged in DD	% also engaged inDWI
Year 2	206	54.9%	246	45.9%
Year 3	258	51.6%	272	48.9%
Year 4	295	51.2%	262	57.6%
Year 5	268	44.8%	218	55.0%
Year 6	242	43.0%	177	58.8%
Year 7	225	35.6%	150	53.3%
Year 8	189	32.8%	117	53.0%

Note. Results restricted to individuals who had access to drive a car during the past year. All data are unweighted.