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Drug exposure opportunities and use patterns among college students: Results of a longitudinal prospective cohort study

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Abstract

Underage drinking and drug use among college students are major public health concerns, yet few studies have examined these behaviors and their associated risk factors and consequences prospectively. This paper describes the sampling and recruitment methods of a longitudinal study of 1,253 college students at a large, mid-Atlantic university. Incoming first-year students were screened during the unique window between high school and college in order to oversample drug users for longitudinal follow-up. Intensive recruitment strategies yielded a 95% cumulative response rate in annual interviews and semi-annual surveys. We report preliminary results on exposure opportunity, lifetime prevalence, initiation, continuation, and cessation of substance use for alcohol, tobacco, and ten illicit and prescription drugs during the first two years of college. Findings suggest that while some substance use represents a continuation of patterns initiated in high school, exposure opportunity and initiation of substance use frequently occur in college. Implications for prevention and early intervention are discussed.

Keywords

College students; Substance use; Longitudinal studies; Initiation; Epidemiology

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1.0. Introduction

Underage drinking and illicit substance use among college students are major public health concerns. Annually, at least 1,400 deaths are attributable to alcohol use on college campuses (1). High-risk drinking among young adults is associated with sexual assault, destruction of property, academic problems, accidental injury, and several adverse health consequences (2–5). Binge drinking and illicit drug use often co-occur (2,6–10), but in contrast to longitudinal studies of alcohol consumption (11), surprisingly few longitudinal prospective studies have examined patterns, correlates, and consequences of illicit drug use among college students. Little information is available on the patterns of initiation and cessation during college—that is, it is not known how often drug use is initiated after coming to college versus continuing a pattern that began in high school, and how often a pattern of regular drug use resolves among college students. Moreover, a majority of the conceptual models used to explain the onset and course of early drug use were developed from studying samples of adolescents, many of whom were deviant and disadvantaged (12–17). Although the application of these models to samples of educated, academically-achieving youths might be appropriate, other risk factors and consequences might be needed to fully describe the natural history and course of drug use and other health risk behaviors during this unique developmental window. For example, an important potential outcome of drug use among college students might be diminished expectations regarding career goals or difficulty establishing autonomy.

This paper describes results from the College Life Study (CLS), funded by the National Institute on Drug Abuse in October 2003 to address critical gaps in our knowledge base concerning the longitudinal patterns of illicit drug use among college students. At the time of this writing, the sixth wave of data collection is already underway with students in their junior year. Given the size of the sample (baseline $n = 1,253$), excellent response rates thus far, and the breadth of topics covered at multiple time points, it is anticipated that the study will be of use to a number of investigators from a variety of disciplines as well as college health practitioners. Findings from the study have already provided a unique and comprehensive view of emerging drug use problems, such as the nonmedical use of prescription drugs (18). It is anticipated that the CLS will yield new knowledge that can be used as the basis for early interventions targeted toward college-bound adolescents and college students who might be at risk for drug-related problems.

1.1. Organization of this Paper

This paper first describes in detail the methods that were used to sample, locate, and recruit the CLS longitudinal cohort. Second, issues of sample representativeness and response bias are addressed. This information provides the most comprehensive description of this prospective longitudinal sample. Third, we present weighted prevalence estimates for exposure opportunity to use tobacco, alcohol, and illicit drugs, including nonmedical use of prescription drugs, using data collected in the first four waves of data collection. Fourth, we describe patterns of drug use, including weighted prevalence estimates of such use, as well as initiation, continuation, and cessation of use during the first two years of college. Finally, we discuss the implications of the findings presented here, limitations of the overall study, and some future directions of our research with this cohort.

2.0. Methods

2.1. Overall Design of the College Life Study

Figure 1 displays the overall design of the study. We selected one large, public, mid-Atlantic university from which to recruit a sample of first-time, first-year students. Sampling occurred in two stages: first, we screened more than 3,400 incoming first-year college students during

new-student orientation; and second, we selected a stratified random sample of screener participants for longitudinal follow-up. In the second stage of sampling, we purposively oversampled drug users for the longitudinal cohort to ensure adequate statistical power to investigate drug use patterns across time. Annual face-to-face interviews and semi-annual self-administered surveys were conducted on a variety of topics. The study was approved by the University IRB and a Federal Certificate of Confidentiality was obtained. The following sections describe sampling, measures, data collection procedures, and response rates for each wave of data collection.

2.2. Screening the Incoming First-year Class

The first step was to screen a large enough group of first-year students from which a longitudinal cohort sample could be systematically sampled. For this purpose, we sought to administer a screening survey at new-student orientation during the summer of 2004 to all incoming first-time, first-year students ages 17 to 19 years old. With few exceptions, orientation is mandatory for all students attending this four-year university, and, in years prior to the start of the study, orientation attendance had exceeded 90% of the incoming first-year class. Accessing the orientation population reduced bias in our estimates of drug involvement by precluding any exposure to the college environment. This method was critically important since transition to drug use during college was of great interest.

2.2.a. Screening Survey Measures—The screening survey included questions on demographic characteristics and age of onset of drug use in the format “How old were you the first time you used...?”. The series assessed use of six illicit substances (marijuana, cocaine, heroin, ecstasy, hallucinogens, and amphetamines or methamphetamine) and nonmedical use of three types of prescription drugs (analgesics, stimulants, and tranquilizers). Items pertaining to prescription drugs specifically asked about nonmedical use only (“...were not prescribed for you or that you took only for the experience or feeling they caused”).¹ The screening survey also assessed alcohol and tobacco use, frequency and recency of drug use, parental monitoring, parents’ employment status, religiosity, and planned course of study, but these items were not used in the second stage to select our longitudinal cohort.

2.2.b. Screening Survey Procedures—As at most colleges, orientation sessions were very tightly scheduled during two-day periods throughout the summer. To avoid straining the orientation schedule, the university allowed us to add our 10-minute screening survey onto the university’s existing 30-minute survey of student characteristics and attitudes, which had been administered to incoming students for more than three decades. Students were escorted into a computer lab, where a research assistant explained both surveys, eligibility requirements, and read informed consent statements. Students were instructed to view written instructions about the surveys on a private computer terminal and enter their answers into the computer if they were 17 to 19 years old and consented to participate. The schedule of cash incentive payments was also explained: \$5 for completion of the screening survey, and if they were selected for the longitudinal portion of the study, they would receive \$50 for each annual interview and \$20 for each semiannual assessment. Informed consent was obtained to contact students for longitudinal follow-up and to obtain data on academic performance, demographics, and other domains from university administrative datasets. Paper versions of the screener were available in the case of computer failure, and were used for 17% of the surveys. Small but statistically significant mode effects were detected between the paper and electronic versions with respect to lifetime use of alcohol and marijuana, number of illicit drugs used, religiosity, parents’ employment status, and parental monitoring. However, evaluation of the associated ϕ^2 and

¹Henceforth in this paper, to save space, when we refer to use of “stimulants”, “tranquilizers”, and “analgesics”, we are referring to the nonmedical use of each these prescription drugs as described in this section.

η^2 coefficients for these comparisons indicated that the amount of variance explained by the survey method was quite small (all ϕ^2 and $\eta^2 < .006$).

2.2.c. Methods to protect confidentiality—Students who consented to be contacted for follow-up in the longitudinal study provided their name and contact information on a paper locator sheet. For students completing the survey on paper, the locator sheet was torn off and separated from their survey responses. Students completing the computer-based survey submitted their locator information on a separate sheet of paper. All students placed their locator sheets into the proctor's box as she walked through the aisles of the classroom, even if they chose to leave their locator form blank. In this way, the proctors had no way of tracing which student placed which locator sheet in the box. Moreover, to further protect participants' confidentiality, different study identification numbers were assigned for the locator sheets and the screening survey responses and linked through an encryption algorithm known only to the Principal Investigator and her designee. Participant payment records were kept confidential from university administrators by showing only identification numbers.

2.2.d. Screening Survey Response Rates—The target population of enrolled first-year students (ages 17 to 19), by definition, could not be identified conclusively until the end of the drop-add period in the fall semester of 2004. The university provided us with two datasets—one in the summer and one during the fall semester—containing demographic and contact information for the anticipated ($n = 3,802$) and actual ($n = 4,160$) class of eligible first-year students, respectively. Our recruitment efforts were aimed at the “anticipated” first-year class, but we reference the “actual” first-year class when evaluating the representativeness of our final sample.

A total of 3,347 students attended the computer lab sessions during orientation, and 3,300 of them participated in the screening survey (98.6%). The remainder of the “anticipated class” did not attend orientation. To access that population, we matched our records to the university dataset, identified 502 incoming students who had not submitted a screening survey response, and mailed letters to their home addresses inviting them to complete the screening survey from home via a web link. We received an additional 113 screening responses in response to this letter, bringing our total screening sample size to 3,413.

Because of the discrepancy between the anticipated and actual first-year class, response rates for the screening survey are of limited value, and were further complicated by the few participants who chose to remain anonymous. However, we estimate that, at most, a total of 3,849 (3,347 at orientation plus 502 by letter) students had the opportunity to participate in the screening survey, representing 92.5% of the actual first-year class. Among students who had the opportunity to participate, our response rate was at least 88.7% (3,413 out of a maximum of 3,849 students), and it was considerably higher among orientation attendees (98.6%).

To construct the sampling frame for the longitudinal study, two stages of inclusion criteria were applied, the first being more inclusive to maximize the sample size available for cross-sectional analyses. First, we excluded 12 participants who were not enrolled, did not meet the study's age requirements (17 to 19 years old), or reported using a fictitious drug included in the screening survey, resulting in a sample of $n = 3,401$ screening participants for cross-sectional analyses, representing 81.8% of the entire first-year class. Second, we excluded an additional 110 screening participants who did not consent to follow-up or whose drug use responses were missing or inadequate for sampling group assignment (see below). Thus our final sampling frame consisted of 3,291 students, or 79.1% of the first-year class.

2.3. Oversampling for Drug Users

Our sampling design was stratified by substance use history, race and gender. As mentioned earlier, our goal for longitudinal follow-up was to obtain a sample of students with a greater risk of using drugs as compared to the general population of screened first-year college students. Even though the study's primary purpose was to examine the natural history and consequences of drug use and not to estimate prevalence of such use, knowing the specific ways that our high-risk sample differed from the first-year class with regard to their demographic characteristics enabled us to weight back to represent the first-year class for prevalence estimation purposes when necessary.

As shown in Figure 2, we stratified the sampling frame into three groups based on students' lifetime illicit drug use as reported in the screening survey: 1) "**Prevalent cases**" defined as students who had already used some illicit substance other than marijuana ($n = 469$; 14.3% of the screened sample); 2) "**High risk cases**" defined as students who had used marijuana at least once in their lifetime but had not used any other illicit drugs ($n = 847$; 25.7% of the screened sample); and, 3) "**Low risk cases**" defined as students who had used neither marijuana nor any other illicit drug even once in their life ($n = 1,975$; 60.0% of the screened sample). Prevalent cases and high-risk cases were sampled with 100% probability; for low-risk cases, we selected a 40% random sample ($n = 790$) after stratifying by gender and race. Thus, our sample for longitudinal follow-up was comprised of 2,106 students.

2.4. Recruitment of the Longitudinal Cohort

Recruitment for the longitudinal cohort ($n = 2,106$) occurred on a rolling basis during the entire 2004–2005 academic year. Contact information for these students was culled from the locator sheets they submitted at the screening survey and administrative data obtained from the university. Students were first notified via a single email message in September 2004 that they had been selected for the longitudinal study and that they would receive fifty dollars for participating in a two-hour baseline interview. Students were asked to reply with on-campus contact information. All available contact information was entered into the study's recruitment database and printed on individual disposition sheets for each sampled student. Follow-up contacts were attempted using a combination of email, telephone, voicemail, and letters. Each attempt to contact the student was documented on that student's disposition sheet.

2.4.a. Response Rates for Baseline Interviews—After the initial email was sent to all potential participants ($n = 2,106$), 1.9% scheduled their baseline interview. Gaining cooperation usually required multiple contacts, including personal phone calls and several email messages. Staff were instructed to vary the days and times of their phone call attempts, and once phone contact was made, the refusal rate was very low. In total, we were able to intensively recruit 1,449 students. Of these 1,449 students, 1,253 (86.4%) completed the baseline interview. For the remaining 656 students who were not intensively recruited, resources ran out before we were able to make more than one email attempt. Of all students who completed their baseline interview, 29% of them required more than seven contact attempts to schedule and complete their baseline interview. Eight percent required more than 10 attempts, and 1% required more than 20 attempts.

2.4.b. Interviewer Training—Interviewers were graduate students, advanced undergraduates, or recent college graduates. A policy and procedures manual was developed and used as the guide for two four-hour training sessions, which included standard components on interviewing techniques, practice sessions, role playing and detailed instructions specific to our baseline interview. Before administering the interview on their own, interviewers completed five practice interviews with friends, reviewed those interviews with a supervisor,

and then administered two supervised interviews. Quality control and re-training occurred at regular intervals.

Recruitment and interview scheduling responsibilities were shared by a staff of one full-time recruiter and up to 18 part-time interviewers. (A total of 30 different people were involved in recruiting and interviewing throughout the entire year, including the PI and other full-time project staff.) The full-time recruiter's role was to consolidate and centralize some aspects of recruitment and scheduling, in order to offer each participant maximum flexibility and accessibility. Furthermore, the recruiter oversaw all recruitment activities, which helped to ensure consistent adherence to recruitment protocols among all staff.

2.5. Follow-up Assessments

As shown in Figure 1, follow-up assessments consisted of semi-annual self-administered assessments and annual face-to-face interviews. Participation in the baseline interview constituted eligibility for longitudinal follow-up; these 1,253 participants comprised the study cohort and were re-approached in each successive wave of data collection.

2.5.a. Recruitment Procedures for Follow-up Assessments—Each participant's follow-up assessments were completed on an individualized timeline of anniversaries and half-anniversaries projected forward from the date of their baseline interview. Participants were asked to update their contact information at every assessment, including email addresses and mobile phone numbers, which tend to remain permanent and were therefore critically important to maintaining contact during periods of frequent relocating. Interviewers also employed novel technologies as needed, such as contacting participants through social networking web sites and sending appointment reminders via text messaging, according to the preferences of individual participants. For each follow-up assessment, the anniversary date was printed on a new disposition sheet, along with the participant's most recent contact information, and all recruitment attempts were recorded. Participants who left the university were encouraged to continue participating in all phases of the study. Every participant in the original baseline sample ($n = 1,253$) was eligible for each follow-up wave—regardless of their participation in prior waves—and was approached to participate in every wave, unless they specifically requested to drop out of the study (18 individuals have dropped out as of this writing).

Semi-annual assessments were designed to be completed in approximately 30 minutes and were conducted 6 and 18 months after the baseline interview. A selection of repeated measures were obtained (e.g., general health, mental health, and substance use), as were certain static measures such as social context of drinking and perceived risk. At the beginning of the month in which their semi-annual assessments were due, participants received an email invitation from the College Life Study containing a link to a web-based survey form. The email also invited participants to contact research staff to request a paper version of the survey if they preferred. For participants who did not respond to the email invitation, individualized recruitment attempts were made via email, telephone, and conventional mail, and paper copies of the survey were mailed to all available addresses, along with postage-paid return envelopes.

Annual follow-up assessments conducted at 12 and 24 months were face-to-face interviews similar to the baseline in terms of content and format. Annual assessments provided repeated measures of substance use, abuse, dependence, social relationships, mental health, sexual activity, and other measures, and introduced additional static domains such as parenting style and family history. Participants received \$50 cash for participating in each annual assessment. Participants were also offered an additional \$20 bonus payment if they completed the interview within 4 weeks of their anniversary date. This strategy was adopted in the hope of increasing our overall response rate and optimizing the timeliness of follow-ups by minimizing the number of no-shows and schedule changes, which had been frequent problems during the baseline

phase. Interviews were conducted by telephone, when necessary, to facilitate continued participation among participants who had dropped out, transferred, or were studying abroad.

2.5.b. Follow-up Response Rates—A total of 897 participants completed the 6-month assessment, for a response rate of 72% of the longitudinal cohort ($n = 1,253$). The 12-month interview was completed by 1,142 participants, or 91% of the cohort. While these response rates were more than acceptable, we refined our procedures in subsequent waves to keep response rates high. For instance, an electronic version of the timeline followback (TF) calendar—described in the Measures section below—was administered as part of the 6-month assessment, but proved burdensome for many participants. Therefore, to preserve participants' enthusiasm for the study and ensure high response rates, we omitted the electronic TF from subsequent semi-annual assessments, and adapted the annual interviews to capture a longer period of time using the traditional TF. To date, more than 95% of the original longitudinal cohort have participated in at least one follow-up assessment.

2.6. Measures

Table I lists the major domains that have been measured in the CLS. More detailed discussions of each measure will be presented in forthcoming papers, as relevant. In this paper we present results on drug exposure opportunity and longitudinal patterns of substance use; we, therefore, describe these measures below.

2.6.a. Measures of Drug Exposure Opportunity and Use Patterns—Participants were assessed annually for exposure opportunity to use 12 categories of substances: alcohol, tobacco, marijuana, inhalants, cocaine, hallucinogens, heroin, amphetamines (including methamphetamine), ecstasy, prescription analgesics, prescription stimulants, and prescription tranquilizers. Questions on prescription drugs were restricted to nonmedical use. At baseline participants were assessed for the age at first opportunity (“How old were you the first time you were offered ...”) and the frequency of opportunity (“How many times in your life have you been offered ...”). Subsequent exposure opportunities were captured at each annual follow-up (“How many times in the past 12 months have you been offered ...”).

Lifetime substance use was measured at the baseline assessment. Separate items captured lifetime use frequency (“On how many days in your life have you used ...”) and age of initiation (“How old were you the first time you used ...”). Subsequent annual interviews assessed past-year frequency of use (“On how many days in the past 12 months have you used ...”). Recency of use (“When was the last time you used ...”) was assessed annually for each substance.

Frequency and patterns of substance use were assessed in even greater detail using the timeline followback (TF) technique (19), in which participants were asked to indicate the quantity of each substance they consumed on each calendar day. The TF has been used extensively in the study of drinking patterns (20–24) and has recently been used to study patterns of other drug use, for which reliability and validity has been examined and documented (25–27). However, to our knowledge, this is the first time the TF has been used to study patterns of illicit drug use longitudinally in a sample of college students. At baseline, participants completed the TF starting with college move-in day, just prior to the beginning of the fall semester of their first year, and continuing up through the date of the interview. In order to capture each subsequent 6-month period at each follow-up, we designed an electronic version of the TF to be administered at each semi-annual assessment, as a complement to the traditional paper-and-pencil version to be administered by interviewers at each annual assessment. After the 6-month assessment, however, we suspended future administration of the electronic version for the reasons discussed above. Annual results from the timeline followback will be presented in future papers.

2.7. Representativeness of the College Life Study Sample

Table II presents the demographic and academic characteristics of the entire first-year class and the screened population of first-year students. The characteristics of our screening sample were very similar to the first-year class, despite some small yet statistically significant differences. White students were slightly overrepresented (67.3% versus 64.8%) in the study cohort, as were females (50.2% versus 49.2%) and students affiliated with an honors group (37.1% versus 33.7%). Students who identified as Black or African-American were slightly underrepresented (11.8% versus 13.5%) as were students without an academic group affiliation (45.3% versus 49.0%).

The characteristics of the longitudinal cohort are less closely aligned with the first-year class because we deliberately oversampled experienced substance users, who were more likely to be white males. Table III presents the demographic and academic characteristics of the 2,106 students selected for recruitment into the longitudinal study, divided into three groups: 1) participants in the longitudinal study ($n = 1,253$); 2) unavailable students, those for whom resources expired before we could make contact ($n = 656$); and 3) refusals, those whom we reached but who refused to participate ($n = 197$). These three groups were essentially indistinguishable demographically; student athletes were the only group who were underrepresented at a statistically significant level, but the magnitude of the difference was quite small ($\phi^2 = .004$, $p < .01$).

2.8. Differential Response Rates by Demographic and Academic Characteristics

Recruitment was more difficult among some groups of participants than others. The mean number of attempts needed to contact participants was 5.82 for all completed baseline interviews. One-way ANOVAs confirmed that, on average, fewer attempts were needed for females (5.61, $p = .0161$) and participants with a college-educated parent (5.79, $p = .0118$), while more attempts were needed to recruit student athletes (7.13, $p = .0424$), males (6.14), and participants without college-educated parents (6.65). Interestingly, experienced substance users (i.e., prevalent and high-risk cases) were more easily recruited than low-risk cases (5.08, 5.47 and 6.92 respectively, $p < .0001$).

For individuals who were contacted, but reluctant to participate in the interview, recruiters were trained to discern the underlying cause for concern, attempt to address that concern to the individual's satisfaction, and if a refusal resulted, to document the reason for refusal. Out of 197 total refusals, more than two-thirds cited a general lack of interest (69.5%), while another 22.8% stated they were too busy and had time constraints. Only 4 individuals (2.0%) expressed discomfort with the idea of participating in a research study, and none expressed concerns about confidentiality. The remaining 5.6% of refusals cited miscellaneous reasons, mainly pertaining to a fear that participating might reflect negatively on them or their parents because of being in the military, working for the government, living in a small town, or because it was not required by his/her sports team. We had been somewhat concerned about the possible effects of "over-recruitment" that might have been created by other studies that were recruiting from the same population. However, none of our refusals appeared to have resulted from negative feelings about "over-recruitment." Nor did anyone mention the inconvenience of the interview location or time as a reason for refusing.

2.9. Statistical Analyses

2.9.a. Computation of Statistical Weights for Prevalence Estimation—To permit computation of prevalence estimates, case weights were calculated for participants in each of 30 groups, defined by crossing gender (Male, Female) by race (White, Black, Asian-American, Other, and Unknown) by sampling group (Prevalent, High Risk, Low Risk). The weights represented the inverse of the frequency of the group in the sample divided by the population

frequency for that group, where the population was the screened sample of the university's first-year student enrollment. Thus, this weighting scheme would yield a weighted sample size in each of the 30 groups equal to the number of participants in that group in the screened population, and the total weighted sample size would approximate the number of screened first-year students enrolled in the university ($n_{wt} = 3,285$).

2.9.b. Descriptive Analyses of Drug Exposure Opportunity—To summarize the timing of students' exposure to each drug, weighted data on age at first opportunity were plotted as the cumulative percent of students who ever had exposure opportunity to use a drug at each year of age. As noted above, opportunity to use was captured at baseline as the age in years at first offer, and at 12 months as the number of opportunities in the past year. Therefore, where the first opportunity occurred between baseline and 12 months, age at first opportunity was set to equal the participant's age at the time of the 12-month interview.

2.9.c. Descriptive Analyses of Longitudinal Patterns of Drug Use—With the exception of inhalants, weighted estimates of lifetime prevalence of use and opportunity to use were computed for each drug at screening, baseline, and 12 months. Prevalence estimates for inhalant use were computed at baseline and 12 months only, because inhalant use was not assessed at screening due to time constraints related to the orientation schedule. Beginning with the baseline interview, drug use data were treated cumulatively, such that any affirmative response constituted lifetime use at all subsequent times. (Because the screening survey was not administered by interviewers, it was considered to have a higher potential for error, particularly with respect to nonmedical use of prescription drugs. Therefore, screening data were only used cross-sectionally and did not contribute to subsequent prevalence calculations.) To show the change in prevalence over time, estimates of lifetime use at screening, baseline, and 12 months were plotted together as drug use profiles. Prevalence was computed as the weighted number of individuals who had ever used a drug, divided by the weighted number of individuals in the cohort ($n_{wt} = 3,285$). For this analysis, individuals with missing data were treated as non-users; therefore, all frequencies at 12 months should be considered lower-bound estimates, because it is possible that additional individuals used each substance but did not provide data at 12 months.

Longitudinal patterns of drug use transitions were derived from comparing lifetime use at baseline (corresponding to the first year in college, or Time 1) with drug use at 12 months (corresponding to the sophomore year, Time 2). Three different patterns of transition were then computed as rates: **Initiation** is the number of individuals who first used the drug between Times 1 and 2, divided by the number of non-users at Time 1; **Continuation** is the number who used the drug before Time 1 and again at Time 2, divided by the number of Time 1 users; and **Cessation** is the number of Time 1 users who stopped using by Time 2, divided by the number of Time 1 users.

3.0. Results

3.1. Exposure Opportunity for Alcohol, Tobacco, and Illicit Drug Use—Figure 3 presents the substance use exposure opportunities for alcohol, tobacco, and 10 illicit and nonmedical prescription drug use categories. As can be seen, by their sophomore year in college nearly all students had the opportunity to try alcohol and a large majority had the chance to try marijuana and tobacco. About half had the chance to try prescription stimulants nonmedically. Importantly, several other illicit drugs were also available to a substantial minority of students, with exposure opportunity exceeding 20%_{wt} for hallucinogens, prescription analgesics, ecstasy, and cocaine.

Exposure opportunity generally occurred earliest for alcohol, tobacco, and marijuana. The data depict a general trend of tobacco exposure occurring about half a year after alcohol, on average, followed by marijuana approximately one year later. During the high school years, exposure to all other drugs remained low until age 16, when certain drugs became more available: ecstasy, hallucinogens, and prescription analgesics and stimulants. Later, prescription stimulants and hallucinogens further diverged from that group to become noticeably more available by the time students were 18, after which exposure to stimulants continued to increase relative to hallucinogens. Similarly, cocaine, which was one of the least available drugs during high school, increased in exposure by the time students were 19.

On average, the oldest ages of first exposure opportunity were observed for cocaine (17.9), heroin (17.8), and prescription stimulants (17.7). In fact, as indicated by the 50th percentile marks, the majority of students who were ever exposed to these drugs were at least 18 years old the first time it was offered to them. The same was true for hallucinogens, although the mean age of first opportunity was slightly lower (17.4). These findings indicate that for many students, the timing of their first introduction to illicit drugs coincided with their transition from high school to college.

3.2. Lifetime Prevalence of Use—Figure 4 displays profiles of the lifetime prevalence (weighted frequencies) of 10 illicit drugs at screening (pre-college), baseline (first year), and 12 months (sophomore year), as well as the percent increase in prevalence between screening and 12 months. As expected, marijuana was the most prevalent drug, used by nearly 40%_{wt} of students prior to starting college, 50%_{wt} by their first year of college, and nearly 60%_{wt} by their sophomore year. Lifetime prevalence was less than 10%_{wt} for all other drugs prior to starting college, with prescription analgesics, hallucinogens, and prescription stimulants being the most prevalent. For all other drugs, lifetime prevalence was below 5%_{wt} prior to starting college.

During the first year of college, modest increases in use were observed for prescription analgesics, hallucinogens, and cocaine, but lifetime use of prescription stimulants doubled, surpassing use of prescription analgesics and hallucinogens. These trends continued into the sophomore year, when prescription analgesics and hallucinogens increased substantially and prescription stimulants doubled again. Interestingly, use of cocaine also doubled in the sophomore year, and use of prescription tranquilizers increased for the first time. It is also interesting to note that although prescription analgesics were the most prevalent drug used in high school (after marijuana), they were quickly outpaced by prescription stimulants once students began college. By sophomore year, more than one in five students had used prescription stimulants (22.6%_{wt}), one in six had used prescription analgesics (16.9%_{wt}), and one in 10 had used hallucinogens (11.5%_{wt}).

With respect to the change in lifetime prevalence from pre-college to sophomore year, the largest increases were observed for prescription stimulants and cocaine, both of which more than quadrupled (increases of 318.5% and 305.6%, respectively). This finding is particularly concerning, given the relatively brief time elapsed between assessments, and considering the high prevalence of prescription stimulant use (22.6%_{wt}) by sophomore year. On the other hand, fewer than 1 in 10 students used cocaine (7.3%_{wt}) by sophomore year, yet this still represents an estimated 240 students in the class under study. Substantial increases were also observed for hallucinogens (105.4% increase), prescription tranquilizers (102.9%), prescription analgesics (85.7%), and marijuana (47.5%). Although their absolute prevalence estimates remained low, use of ecstasy, heroin, and amphetamines also increased. (Lifetime prevalence of amphetamine use appeared to decrease between pre-college and first year; although, by definition, this would be impossible, these data reflect the modest inconsistencies in how some individuals responded to drug use questions in different waves of data collection).

3.3. Initiation, Continuation, and Cessation of Use—Table IV presents the weighted rates of drug use initiation, cessation, and continuation between the first (Time 1) and second (Time 2) years of college. For example, the first row of the table describes the transition patterns of marijuana use in this longitudinal analysis. Of the 1,504 individuals who had never used marijuana at Time 1, 12.8%_{wt} started using marijuana by Time 2. Of the 1,460 individuals who had used marijuana at least once in their lives at Time 1, one in five (19.6%_{wt}) ceased using while four out of five (80.4%_{wt}) continued using it between Times 1 and 2.

Overall, the risk of initiation of drug use between the first year and sophomore year was relatively low, fewer than one in ten for most drugs. Only marijuana (12.8%_{wt}) and prescription stimulants (11.7%_{wt}) were initiated at rates exceeding one in ten. Interestingly, more students initiated prescription stimulants than any other drug ($n_{wt} = 303$, data not shown in a table). Greater variability was observed in the rates of cessation and continuation of use among individuals who had used the drugs by Time 1. In general, for the less-prevalent drugs, most users ceased using by Time 2. While this pattern held true for prescription tranquilizers (63.3%_{wt} ceased using), inhalants (67.6%_{wt}), ecstasy (69.9%_{wt}), amphetamines (89.1%_{wt}), and heroin (100.0%_{wt}), the notable exception was cocaine, with only one in three users ceasing use (36.4%_{wt}). Conversely, the drugs with the highest rates of continuation were marijuana (80.4%_{wt} continued using), cocaine (63.6%_{wt}), prescription stimulants (60.7%_{wt}), and hallucinogens (57.0%_{wt}).

4.0. Discussion

4.1. Longitudinal Patterns of Drug Use—In this prospective study of 1,253 college students, exposure opportunity and initiation of substance use frequently occurred after starting college. By the sophomore year in college, prescription stimulants (for nonmedical use) were the most widely available drug after marijuana and had been used by one in five students. Prescription analgesics (for nonmedical use) and hallucinogens were the next most prevalent, used by more than 1 in 10 students by their sophomore year. The rate of increase in lifetime prevalence during the first two years of college was greatest for cocaine, hallucinogens, prescription stimulants, and prescription analgesics. These findings expand on those of other large-scale studies of lifetime prevalence and exposure opportunity among high school and college students (28–30).

4.2. Concordance with Other Findings in the Literature of College Drug Use—

Although it is tempting to compare these results to the findings from the national *Monitoring the Future* (MTF) study (29), which reports substantially higher lifetime prevalence estimates for ecstasy (10.2%), cocaine (9.5%), nonmedical use of prescription tranquilizers (10.6%), and inhalants (8.5%) among their college student sample, caution should be exercised in doing so for several reasons. First, the MTF sampled students ages 19–22, whereas our estimates are derived from a somewhat younger sample of incoming college students ages 17 to 19 at study outset. Second, the MTF includes students attending two-year colleges, including community colleges, whereas the CLS sample is drawn from a single four-year university in the mid-Atlantic region. As such, the CLS sample does not represent the drug use opportunities of students residing in all parts of the United States. Some illicit drug problems, such as methamphetamine, are more regional than others, which could account for the difference between our estimate of lifetime amphetamine use (1.5%) and the estimate from the MTF survey (12.7%). Lastly, as a face-to-face interview, the CLS assessments obtain detailed information on a broader range of nonmedical use of prescription drugs than what is unavailable to date in the MTF survey.

It is important to note that although exposure opportunity and drug use initiation may have occurred during the college years, this study cannot determine the extent to which these events

actually occurred at college. In fact, the trends are consistent with epidemiologic evidence in the general young-adult population (28,29). Thus, the implication is that college students are exposed to at least as much risk of drug use as non-students, and that the college environment is at least as risky as the non-college environment with respect to substance use in general, and possibly more risky with respect to certain specific drug classes (e.g., prescription stimulants). The college environment, therefore, does not appear to provide a sheltering influence for students who are at risk for substance use.

The prospective nature of this study permits it to address important questions about the timing and context of the initial exposure opportunity and onset of substance use. The findings presented here with respect to alcohol, marijuana, and tobacco lend support to the hypothesis that substance use patterns in college represent a continuation of patterns that were initiated in high school (31–33). For other illicit drugs, however, this study provides evidence that exposure opportunity and initiation frequently occur in college. For example, in this study, most students had already been offered alcohol, tobacco, and marijuana by age 16, whereas exposure to other illicit drugs (including nonmedical use of prescription stimulants, analgesics, and tranquilizers) tended to coincide with the transition to college. Similarly, relatively few students initiated use of alcohol, tobacco, or marijuana after starting college, but proportionately speaking, initiation of other illicit substances was much more common during college than in high school.

Findings from this study pertaining to several specific drug classes were especially concerning. Our estimates confirm recent findings of other investigators in college-student and young-adult populations showing that nonmedical use of prescription drugs is the most prevalent form of illicit substance use after marijuana and alcohol (28–30,34,35). For hallucinogens, cocaine, and prescription analgesics and prescription stimulants, both exposure opportunity and lifetime prevalence increased dramatically between the first two years of college. Cocaine and prescription stimulants exhibited the greatest proportional increases, raising several questions of epidemiological significance. Because we only sampled students at one university, it is possible that this trend is confined to the campus or the immediate geographic region. However, it is also possible that these drugs are linked more generally with college life today. Other recent studies have documented the increasing prevalence of prescription stimulant use among college students (36), but to our knowledge, no other studies have detected a similar trend in cocaine use among either college students or young adults in general. Moreover, few data have been available previously to indicate whether nonmedical use of prescription stimulants begins before or during college.

Another major contribution of this study is the finding that many students stopped using drugs by their sophomore year in college. Most users of prescription analgesics, prescription tranquilizers, inhalants, ecstasy, amphetamines, and/or heroin prior to Time 1 had quit by Time 2. Marijuana, on the other hand, appears to be a drug that many students initiate early and continue to use well into their college years. Rates of cessation were also low for prescription stimulants and cocaine.

The strengths of this study include its large sample size ($n = 1,253$), representativeness of the target population, and high response rate (95%). Importantly, this study's first wave of data collection occurred after high school graduation and before the start of the first year of college. This timing provided uniformity in how pre-college behaviors were assessed and the ability to capture a true picture of student life before any exposure to the college environment. A broad range of domains are assessed in this study, using measures that were based in large part on other large national studies. Measures of substance use are particularly thorough, including daily consumption as reported in the timeline followback. This unique method, although labor-intensive, provides considerable flexibility in assessing patterns of substance use, such as the ability to detect concurrent use of multiple substances, and to characterize the periodicity of

drug and alcohol consumption as it relates to life events. To our knowledge, this is the first study to measure patterns of drug and alcohol use in this way among college students.

4.3. Limitations—This study is subject to a number of limitations, including the potential for response bias, which is inherent to all studies using self-report methods (37,38). Some participants may not have been accurate historians in recalling events that occurred several years ago, such as the age they were first offered alcohol. Also, because we sampled students from one university, the generalizability of the findings is unknown. Some potential exists for attrition bias, as with other prospective studies, in that not every participant was assessed at each follow-up. However, the cumulative response rate exceeds 95% thus far, and no substantial differences were observed between responders and non-responders. Because the annual assessments were administered on a rolling basis over the duration of the entire academic year, prevalence estimates should be interpreted with caution, because responses reflect slightly different time periods. Future studies on these data will control for relevant background factors such as time elapsed in the current year and time of year (e.g., midterms, spring break). Finally, ages of initiation and exposure opportunity were not collected with sufficient precision to permit absolute estimation of whether the event occurred before or after starting college; this limits our ability to make inferences about the relative importance of environment versus maturation with respect to these events. Future studies using timeline followback data from this cohort will permit more precise estimates regarding initiation, continuation, and cessation of substance use, and these data will continue to be tracked in future waves of data collection.

4.4. Implications of the Current Findings for Prevention—These findings clearly demonstrate the need for prevention programs to be sustained throughout all stages of adolescent development. Today most prevention occurs in middle schools, but our findings suggest that most initiation occurs during the high school and college years (at least for college-bound students). Thus it follows that prevention programs would be worthwhile during the later years of high school and even into college.

The institutional nature of the college setting provides a uniquely controlled environment in which high-risk students could be targeted efficiently. Armed with information about the prevalence of drug use among college students, colleges and universities can position themselves to support research investigating what strategies are effective in influencing college students, and to design innovative programs aimed at enhancing protective factors and controlling the risk for substance use. Few studies are available to evaluate harm reduction strategies in college students (39), but there is some evidence that offering substance-free activities (40) may help provide appealing alternatives to students who might otherwise choose to drink or use drugs. Prevention programs can also capitalize on the fact that college students tend to overestimate the amount of drinking and drug use their peers are engaging in (41,42), and regard substance use as much more normative than it really is. Social marketing strategies aimed at correcting this misconception may be one effective way to decrease the risk of use.

4.5. Implications of the Current Findings for Early Intervention and Treatment—Finally, universities must make substance-abuse treatment services available for the substantial number of college students who need them, because prior evidence indicates that college students experience dependence and abuse at rates similar to the general population (43,44). Treatment programs should be designed to address the specific challenges intrinsic to college life, especially regarding the intensity of the social environment and academic pressures.

Universities can also implement more proactive policies to address the substance-related problems experienced by their students. First, campus health centers need comprehensive services to respond to the prevention and treatment needs of students, yet health centers are

typically resource-poor (45,46). Second, given that much substance use in college is a continuation of the patterns of use developed in high school, universities ought to provide early assessment and referral. As demonstrated in this study, incoming students may be screened for prior substance use to help identify high-risk populations. Third, university policies should involve and educate parents around prevention. Parents need to know that their college-bound children continue to face risks for substance use after they leave for college, and should be encouraged to continue to maintain good communication with their college-attending child and express disapproval of underage drinking and illicit drug involvement.

4.6. Future Directions for Research—Although college students may have certain advantages over their non-student counterparts in terms of risk and protective factors, as young adults they experience high rates of substance use and other risky behaviors. An important implication of these findings is the need for additional research into the predictors of substance use among college students, in order to facilitate identification of high-risk students and appropriate targeting of secondary interventions. Additionally, future studies should strive to understand the potential academic consequences of substance use—including from the nonmedical use of prescription drugs—like dropout and academic dismissal. Moreover, given what is already known about the prevalence of polydrug use (30,34,4749) and its consequences (50–53), investigators should focus on the total impact of substance use in general, rather than attempting to disentangle the consequences of individual drugs.

In this study, college students proved to be a highly accessible population for longitudinal follow-up, at least during the first two years of college. Considering the scientific value of longitudinal data in all disciplines and the difficulties inherent in recruiting and maintaining contact with a longitudinal cohort of participants (54–58), investigators should consider college student populations as a starting point in future longitudinal studies. In our experience, the ubiquity of personal mobile phones in this population was highly advantageous to recruitment efforts; mobile phones provide a relatively permanent and direct line of communication for follow-up contacts, and they optimize convenience and flexibility of communication between interviewers and participants attempting to coordinate their busy schedules. The extent to which the present cohort continues to be highly responsive in future waves of data collection remains to be seen.

Future analyses are underway to understand the factors associated with the continuation of high school drug use patterns as well as what factors might be associated with the initiation of drug use during college. Many prior studies of alcohol use during college have demonstrated the importance of high school drinking patterns in predicting the risk for continued drinking in college (33). The CLS will be able to address the fundamental question of whether or not college drug use patterns are simply an extension of high school patterns, explore how high school experiences influence the risk for drug use in college and examine how the risk might be moderated by individual, social, and environmental characteristics.

Moreover, we hope to develop models to better understand the predictors of changes in drug use. The CLS is systematically characterizing patterns of illicit drug use as important developmental changes are taking place, and examining how these patterns can be predicted on the basis of several personal, familial, and social characteristics. Lastly, we will use the rich longitudinal data to develop models to explain the complex associations between drug use and the following four primary outcomes: 1) high risk sexual activity; 2) academic performance; 3) drug dependence; and, 4) mental health, namely anxiety and depression. The longitudinal design allows for the examination of the reciprocal nature of many of these associations, the relative importance of past use to current use, and the question of how drug use, in combination with a number of personal, social, and environmental characteristics, influences change in students' individual trajectories. For example, it is anecdotally recognized that many college

students decrease their drug use by their senior year. However, little empirical evidence exists to differentiate among the experiences or characteristics of college students who decrease their drug use, who experience serious drug-related consequences such as dropout, and whose experiences lie somewhere in between.

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Figure 1. Longitudinal Design of the College Life Study

Note: Each wave of data collection spanned several months. The timeline depicts the approximate timing of the beginning and end of each wave of data collection.

Figure 2. Sampling Design for the College Life Study

Figure 3. Cumulative Weighted Frequency of Exposure Opportunity to Use Alcohol, Tobacco, and 10 Other Drugs, By Age in Years

Graphed lines depict the weighted cumulative percent of all students who ever had the opportunity to try a substance by each age, as of the sophomore year of college. Circles on the graph indicate the age by which 50% of all students who were ever exposed to the substance had experienced their first opportunity. The mean age at first opportunity is reported for all students who ever had the opportunity to try a substance. Amphetamines include methamphetamine, but do not include prescription or over-the-counter medications.

Figure 4. Profile Analysis of Weighted Lifetime Prevalence of Drug Use in the College Life Study for Three Consecutive Assessments

Percentages in **bold** correspond to lifetime prevalence of use by sophomore year. Percentages in *italics* correspond to the percent increase in lifetime prevalence from pre-college to sophomore year. Amphetamines include methamphetamine, but do not include prescription or over-the-counter medications. Use of inhalants was not assessed prior to college, so no percent change is reported.

Table I

Domains Assessed in the College Life Study

	Pre-College	First year	Follow-ups	
			Semi-annual (6, 18, 30 months)	Annual (12, 24 months)
Academic Performance in College		X	X	X
Behavioral Dysregulation		X		
Conduct Problems		X	X	X
Demographics	X	X	X	X
Religiosity	X	X		X
Drug Use Patterns and Consequences	X	X	X	X
▪ Tobacco Dependence		X		X
▪ Alcohol Dependence		X		X
▪ Marijuana Dependence		X		X
▪ Ecstasy Experiences		X		X
▪ Drug Knowledge		X		X
Family History of Alcohol and Drug Use Problems				X
Health Conditions and Treatment Utilization		X	X	X
Academic Performance in High School	X	X		
Involvement in Extracurricular Activities	X	X		X
Life Event Stress		X		X
Mental Health				
▪ Anxiety		X	X	X
▪ Depression		X	X	X
▪ Social Phobia		X		
Communication with Parents		X		X
Parental Monitoring and Supervision during Senior Year in High School	X			
Parenting Style				X
Perceptions of Drug Use				
▪ Perceived Harmfulness			X	X
▪ Perceived Availability			X	X
Personality and Temperament		X		
Quality of Relationships with Parents, Friends, Other Adults		X		X
Sexual Activity		X	X	X
Social Relationships		X		X

Table 2

Demographic and Academic Characteristics of First-Year Class and Screened Sample

	Freshman Class 4,160		Screening Sample 3,401	
	<i>n</i>	%	<i>n</i>	%
Gender				
Female	2048	49.2% *	1703	50.2%
Male	2112	50.8% *	1692	49.8%
Race				
White	2446	64.8% *	2089	67.3%
Black	510	13.5% *	366	11.8%
Asian	582	15.4% *	467	15.0%
Other	239	6.3% *	184	5.9%
Academic Groups				
Honors	1402	33.7% *	1262	37.1%
Athletes	177	4.3%	136	4.0%
Service	86	2.1%	73	2.1%
Undecided Majors	508	12.2%	428	12.6%
No Groups	2037	49.0% *	1542	45.3%

* Statistically significant difference ($p < .05$) between screening participants and freshman class.

Table 3

Demographic and Academic Characteristics of Students who Participated, Were Unavailable, or Refused to Participate in the College Life Study

	Baseline Participants		Unavailable ^a		Refusals ^b	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Gender						
Female	644	51.4%	322	49.1%	95	48.2%
Male	609	48.6%	334	50.9%	102	51.8%
Race						
White	885	70.8%	447	68.8%	142	72.4%
Black	121	9.7%	54	8.3%	18	9.2%
Asian	114	9.1%	72	11.1%	23	11.7%
Other	130	10.4%	77	11.8%	13	6.6%
Mother's Education						
High school or less	191	16.5%	119	20.1%	36	20.3%
Some college or technical	116	10.0%	55	9.3%	20	11.3%
Four-year college degree	439	37.9%	209	35.2%	62	35.0%
Graduate degree	413	35.6%	210	35.4%	59	33.3%
Academic Groups						
Honors	453	36.3%	236	36.0%	57	29.1%
Athletes [*]	38	3.0%	35	5.3%	13	6.6%
Service	33	2.6%	10	1.5%	5	2.6%
Undecided Majors	182	14.6%	94	14.3%	32	16.3%
No Groups	559	44.8%	293	44.7%	94	48.0%
All	1253	100.0%	656	100.0%	197	100.0%

^a Resource limitations prevented staff from contacting all sampled students; "unavailable" students are those who could not be contacted with available resources.

^b Students who were contacted but declined to participate are considered refusals.

* Statistically significant difference ($p < .05$) between baseline participants and baseline unavailables.

** Statistically significant difference ($p < .05$) between baseline participants and baseline refusals.

Rates of Initiation, Cessation, and Continuation of Drug Use During the First Two Years of College, By Drug (weighted n = 2,969)

Table 4

Drug	Time 1 Non-Users	Initiated Use by Time 2	Time 1 Users	Ceased Use by Time 2	Continued Use at Time 2
Marijuana	1504	12.8%	1460	19.6%	80.4%
Prescription Stimulants	2591	11.7%	377	39.3%	60.7%
Prescription Analgesics	2642	6.5%	319	58.6%	41.4%
Cocaine	2862	4.1%	99	36.4%	63.6%
Hallucinogens	2700	3.1%	263	43.0%	57.0%
Prescription Tranquilizers	2798	3.0%	128	63.3%	36.7%
Inhalants	2833	1.3%	136	67.6%	32.4%
Ecstasy	2877	1.3%	93	69.9%	30.1%
Amphetamines *	2916	0.7%	46	89.1%	10.9%
Heroin	2947	0.2%	5	100.0%	0.0%

Longitudinal data represent lifetime and past-year drug use reported during the first year (Time 1) and second year (Time 2) of college, respectively. Initiation is computed as the number of new users at Time 2 who had never used at Time 1, divided by all non-users at Time 1. Cessation is the number of Time 1 users who did not use at Time 2, divided by all Time 1 users. Continuation is the number of students who used at both Time 1 and Time 2, divided by all the Time 1 users.

* Amphetamines include methamphetamine but do not include prescription or over-the-counter medications.