Substance Use Disorder in Early Midlife: A National Prospective Study on Health and Well-Being Correlates and Long-Term Predictors

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Supplementary Issue: Externalizing and Internalizing Symptomology and Risk for Substance Abuse: Unique and Interactive Influences

ABSTRACT: This study used national multicohort panel data from the *Monitoring the Future* study ($N = 25,536$ from senior year classes 1977–1997 followed up to the age of 35 years in 1994–2014) to examine how early midlife (age 35 years) alcohol use disorder (AUD) and cannabis use disorder (CUD) are associated with adolescent and adult sociodemographics and health and well-being risk factors. Survey items adapted from DSM-5 diagnostic criteria were used to identify individuals who (a) showed symptoms consistent with criteria for AUD or CUD at age 35 years, (b) used the substance without qualifying for a disorder (nondisordered users), and (c) abstained from using alcohol or marijuana during the past five years. At age 35 years, the estimated prevalence of past five-year AUD was 28.0%, and that of CUD was 6.1%. Multinomial logistic regressions were used to identify variations in the relative risk of disorder symptoms as a function of sociodemographic characteristics, age 18 educational and social indices and substance use, and age 35 health and satisfaction indices and substance use. In the full models, age 18 binge drinking and marijuana use were found to be among the strongest predictors of age 35 AUD and CUD, respectively. Among age 35 health and well-being indicators, lower overall health, more frequent cognitive difficulties, and lower satisfaction with spouse/partner were consistently associated with greater risks of AUD and CUD. Some evidence was found for a *J-shaped* association between age 35 AUD or CUD status and health and well-being indices, such that nondisordered users were sometimes better off than both abstainers and those experiencing disorder. Finally, nondisordered cannabis use, but not CUD, was found to be more common in more recent cohorts. Implications are discussed regarding the importance of placing early midlife substance use disorder within the context of both adolescent substance use and adult health and well-being.

KEYWORDS: cannabis use disorder, alcohol use disorder, longitudinal, health and well being, J-shaped association

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Introduction

Conceptual and empirical advances in understanding the etiology of substance use and abuse have come from examining them in developmental context, giving attention to developmental antecedents as well as to how variation in substance use and abuse corresponds with the myriad shifting risk and protective factors and developmental tasks and transitions.[1–5] Much of the attention in the relevant literature regarding adult use and abuse has focused on early adulthood, with little attention to changes that may occur as individuals move through their 30 s when most are fully immersed in primary adult roles of spouse/partner, parent, and/or worker. Although the overall rates of substance use and use disorders tend to peak in early adulthood (early 20s) and then diminish for many with the assumption of adult roles,[6,7] substance use and abuse remain among the primary threats for morbidity and mortality across adulthood.[8,9] In particular, the multiple demands and challenges of early midlife may confer emergent vulnerability to substance use disorders; yet, attention in the literature to substance use and abuse during the 30s, as well as health and well-being in general,[10] is limited. In this study, building on a developmental conceptual framework that gives

attention to distal and proximal risk factors and focuses on embedding substance use and use disorder within the developmental context,[2,4,9,11] we used national prospective panel data to examine adolescent and adult predictors of symptoms of two of the most common substance use disorders, alcohol use disorders (AUDs) and cannabis use disorders (CUDs), at age 35 years. We bring the required attention to the long-term prediction of adult substance use disorder as a function of key adolescent academic, social, and substance use risk factors, as well as to key concurrent health and well-being correlates of adult substance use disorder.

Alcohol and marijuana use and use disorder at early midlife. Alcohol and marijuana are the two most commonly used psychoactive substances across the life course, and both are common during the 30s. Based on Monitoring the Future's (MTF) US national findings from 2014, the prevalence of age 35 annual alcohol use was 89.2%, that of 30-day alcohol use was 73.1%, and that of two-week binge drinking (five or more drinks in a row) was 24.0%; the prevalence of age 35 annual marijuana use was 20.0% and that of 30-day marijuana use was 11.1%.[12] Similar rates for US adults within this age range were found in the 2013 National Survey on Drug Use and Health.[13] Evidence suggests that among adults in USA, alcohol and marijuana use have shown an overall increase in the past 10–20 years.[12,14,15]

Substance use disorders in adulthood include both physiological difficulties and social and life task difficulties, with substance use disorders relating to less-than-optimal functioning in family, social, and work domains.[16] Setting aside the matters of cause and effect, those who experience AUDs and CUDs are expected to have problems in dealing with adulthood demands and challenges. Traditionally, the diagnostic assessment of substance use disorders was considered in terms of abuse and dependence (eg, DSM-IV), with one or both components reflecting disorder; starting in 2013, with the advent of DSM-5, diagnostic assessment involved consideration of a single substance use disorder component with levels of severity.[16]

Based on the 2001–2002 National Epidemiologic Survey on Alcohol and Related Conditions, the estimated rates of lifetime and 12-month AUDs (DSM-IV abuse and/or dependence) among US adults aged 18 years and older were 30.3% and 8.5%, respectively,[17] and the corresponding lifetime and 12-month rates for CUDs (DSM-IV abuse and/or dependence) were 8.5% and 1.5%, respectively[18]; both sets of rates tend to be higher among younger adults than older adults. Based on the US National Longitudinal Study of Adolescent Health (Add Health), when respondents were between ages 24 and 30 years in 2008–2009, the estimated rates of lifetime prevalence of AUD and CUD (DSM-IV abuse and/or dependence) were 25.0% and 12.2%, respectively.[19] Using the DSM-5 diagnostic criteria for mild to severe substance use disorder (two or more criteria), based on the 2012–2013 National Epidemiologic Survey on Alcohol and Related Conditions, the estimated rates of adult lifetime and 12-month AUDs were 29.1% and 13.9%, respectively,[20] and the corresponding rates for CUDs were 6.3% and 2.5%, respectively.[21] Despite differences in age-group definition, diagnostic criteria, and measurement year, there is some consistency across these rates, suggesting that in USA, one out of every three to four adults and one out of every 10–15 adults have experienced AUDs and CUDs, respectively, during their lifetime. These relatively high rates of adult substance use disorders do not translate into high rates of treatment: less than one in five of those with an AUD or CUD receive professional treatment,[18,20] instead going about their lives while experiencing these disorders or recovering on their own.

Experiencing a substance use disorder is expected to be more associated with health and well-being difficulties than using moderately. Substance use disorders are associated with several other psychiatric disorders.[17,18,22,23] Although embedded within these often comorbid psychiatric disorders are more general indices of health and well-being, there is limited evidence regarding how substance use disorders, especially in comparison to moderate (nondisordered) use, relate to general indices of health and well-being during adulthood.

As has long been recognized, light-to-moderate adult alcohol use is culturally sanctioned in USA and often associated with positive functioning and adjustment at physiological and psychological levels.[9,24–26] There is evidence to support a *J-shaped curve* relationship between alcohol use/use disorder and health such that light-to-moderate adult drinkers are better off than both abstainers and heavy/disordered drinkers.[27] There is some evidence, however, to question conclusions drawn about this association given that abstainers include many who formerly experienced AUD.[28] For marijuana, there has been some consideration of the J-shaped curve in terms of physiological effects, with marijuana users being less overweight and obese than nonusers.[29,30] Whether nondisordered marijuana users experience better health and well-being is an open question. Thus, in this study, we make comparisons among three groups in early midlife, abstainers, nondisordered users, and disordered users, regarding sociodemographic characteristics and adolescent and concurrent indices of health and well-being.

There is extensive evidence regarding the sociodemographic characteristics associated with AUDs and CUDs.[15,17–20,22,23,31] For AUDs, rates tend to be higher for men, Whites, those with higher educational attainment, those single or separated/divorced, and nonparents; for CUDs, rates tend to be higher for men, African Americans compared to Whites, those with lower educational attainment, and those single or separated/divorced. Religiosity is consistently related to lower rates of substance use disorders.[32] Regarding historic variation, recent evidence indicates that rates of AUDs, but not CUDs, are increasing among adults in USA.[15,20] In this study, we included the following sociodemographic characteristics: gender, race/ethnicity, parent education, cohort, marital status,

cohabitation, educational attainment, employment, financial independence, parental status, and religiosity.

AUDs and CUDs, along with heavy use of alcohol and marijuana, tend to be associated with overall poorer health.[9,33] As mentioned earlier, AUDs and CUDs are often comorbid with other psychiatric disorders, suggesting an array of possible health difficulties associated with AUDs and CUDs. For example, difficulties in sleeping are associated with heavy drinking,[34–36] and neuropsychological deficits are associated with AUDs[37] and marijuana use.[38,39] In this study, we consider associations between AUD and CUD symptoms at age 35 and a broad array of concurrent health indices and health behaviors, including overall physical health, overweight/obesity, vigorous exercise, trouble sleeping, cognitive difficulties, and injuries requiring medical help.

Life satisfaction is considered as an important component of well-being,[40] especially during middle adulthood.[41] There has been limited consideration of the association between life satisfaction and substance use disorders among adults. Limited evidence indicates a negative relationship between life satisfaction, including specific domains, such as satisfaction with spouse, and alcohol abuse.[42–45] In a sample of daily marijuana users in early adulthood, Looby and Earleywine[46] found that life satisfaction was negatively correlated with CUD symptoms. Some evidence suggests that when background and other characteristics are controlled, life satisfaction is unrelated to AUD and CUD symptoms.[45] In this study, with abundant background and other controls, we consider how satisfaction with spouse, job, standard of living, and free time at early midlife relate to AUD and CUD symptoms.

Adolescent substance use as predictors of adult substance use disorder. The extent to which adolescent characteristics and experiences foretell adult functioning and adjustment is a central developmental and etiological question.[9,11,47] The long-term connections between adolescent substance use and adult substance use and use disorder are of important prognostic value, helping to understand the roots of adulthood substance use disorders and setting the stage for effective screening and intervention. One characteristic of adolescent substance use that limits prognostic value is that it is often experimental.[9] Because there are few long-term prospective national data sets that follow young people well into adulthood, knowledge about how adolescent substance use in nonclinical samples relates to adult disorder, particularly CUDs, is relatively limited. Nonetheless, evidence indicates relatively robust prediction of middle adult substance use disorders from adolescent substance use, particularly regarding adolescent alcohol use and later AUDs,[47–52] and also later CUDs.[50] Importantly, most of these studies have shown that the predictive power of adolescent substance use holds within the context of other risk factors, such as childhood externalizing behaviors. In this study, we consider adolescent cigarette, alcohol, and marijuana use along with adolescent risk factors concerning academic performance, externalizing behavior, and unmonitored social time with friends, each of which prospectively relates to adulthood substance use and use disorders.[47–49,52–54] To better understand the prognostic significance of adolescent substance use for early midlife substance use disorders, we build on these studies by examining the impact of adolescent substance use within the context of both other adolescent risk factors as well as early midlife adulthood indices of health and well-being. We also bring attention to the prospective link between adolescent marijuana use and adulthood CUD, which has received relatively little attention in the literature.

In summary, relatively little is known about individuals from nonclinical samples who experience substance use disorders in early midlife, particularly their health, lifestyle, and psychosocial characteristics, and how they compare with nondisordered substance users and abstainers. The prospective relationship of adolescent alcohol and other drug use to early midlife substance use disorders is also not well documented. Thus, this study offers some needed insight into the etiology and predictors of early midlife substance use disorders. The purpose of this study is to examine how age 35 AUD and CUD are associated with adolescent and early midlife sociodemographic characteristics and health and well-being risk factors.

Methods

MTF is an ongoing study of substance use among adolescents and adults.[12] This project has used questionnaires administered in classrooms to survey nationally representative samples of approximately 16,000 American high school seniors (modal age 18 years) each year since 1975. Approximately 2400 individuals are randomly selected from each senior year cohort for biennial follow-up via mailed questionnaires. Drug users are oversampled for follow-up, and the follow-up sample is weighted to adjust for the differential probability of selection and for attrition. More detailed descriptions of the MTF study design and procedures can be found in Bachman et al.[55], in Johnston et al.[12], and on the MTF website (www.monitoringthefuture.org).

Sample. The sample used in the present analyses is comprised of cohorts of 12th graders from the high school classes of 1977–1997 who were followed up till age 35 years in 1994–2014, resulting in 25,536 eligible cases for analysis. The sample was 47.8% male, 75.0% White, 12.3% Black, 6.8% Hispanic, and 4.9% other race/ethnicity; 68.0% were married at age 35, and 45.2% reported having attained a bachelor's degree or higher (Table 1).

The retention rate of those who provided age 35 data among those selected for follow-up was 54%. This retention rate is less than ideal but reflects the reality of long-term longitudinal studies of drug use,[56,57] and survey research more generally[58]; MTF's retention rates compare reasonably well with other long-term studies.[59,60] Previous attrition analyses in other MTF longitudinal analyses that used age 35 data[49,50]

Table 1. Selected sample descriptives for age 35 AUD and CUD status categories.

	OVERALL %	ABSTAINERS %	NON-DISORDERED DRINKERS (NDD) %	AUD %
Alcohol Use Disorder (AUD) Status				
Overall		11.4%	60.6%	28.0%
Gender				
Male	47.8%	40.5%	43.3%	61.6%
Female	52.2%	59.5%	56.7%	38.4%
Race/Ethnicity				
White	75.0%	64.7%	76.3%	79.6%
African American	12.3%	22.8%	11.5%	8.0%
Hispanic	6.8%	5.5%	6.7%	6.9%
Other race/ethnicity	5.9%	7.0%	5.6%	5.5%
Marital status at age 35				
Married	68.0%	72.0%	72.0%	58.0%
Cohabiting	8.7%	4.0%	7.6%	13.7%
Single/separated/divorced/engaged/widowed	23.3%	24.0%	20.4%	28.3%
Educational attainment at age 35				
Associate's degree or lower	54.8%	65.0%	52.2%	55.3%
Bachelor's degree or higher	45.2%	35.0%	47.8%	44.7%
		ABSTAINERS %	**NON-DISORDERED USERS (NDU) %**	**CUD %**
Cannabis Use Disorder (CUD) Status				
Overall		78.0%	15.9%	6.1%
Gender				
Male		45.1%	53.6%	67.9%
Female		54.9%	46.4%	32.1%
Race/Ethnicity				
White		74.5%	78.9%	73.7%
African American		12.6%	9.4%	13.7%
Hispanic		7.1%	5.4%	6.5%
Other race/ethnicity		5.8%	6.4%	6.1%
Marital status at age 35				
Married		72.4%	54.6%	47.5%
Cohabiting		6.6%	16.1%	17.0%
Single/separated/divorced/engaged/widowed		21.0%	29.3%	35.5%
Educational attainment at age 35				
Associate's degree or lower		53.7%	54.4%	66.2%
Bachelor's degree or higher		46.3%	45.6%	33.8%

Note: Unweighted $N = 25{,}536$.

indicated that respondents who remained in the study were more likely to be women, to be White, to report higher parent education, religious attendance, high school grades, and college expectations, and to report consuming alcohol and marijuana less often at age 18. Evidence from other longitudinal drug studies indicate that retention varies by gender, race/ethnicity, marital status, and initial drug use.[57] This evidence suggests differential attrition with respect to substance use and other respondent characteristics. Thus, to account for sample biases due to differential attrition, all analyses were weighted using the attrition weights. These attrition weights were calculated as the inverse of the probability of participation at age 35 based on a logistic regression model using the following predictors measured at age 18: gender, race/ethnicity, college plans, truancy, high school grades, number of parents in the home, religiosity, parental education, alcohol use, cigarette use, marijuana use, other illicit drug use, region, cohort, and sampling weight correcting for oversampling of age 18 substance users.

Measures

Age 18 measures. From the 12th grade surveys, we included sociodemographic measures, educational and social indicators, and substance use indices.

Sociodemographics. Age 18 sociodemographics included gender, race/ethnicity, parent education (as a proxy for socioeconomic status), and cohort. Gender was coded 1 = male and 0 = female. Race/ethnicity was assessed by asking "How do you describe yourself?" Response options included American Indian, Asian American, African American, Cuban American, Mexican American, Puerto Rican, other Latin Americans, White, and others/not listed (for early cohorts included in this analysis, the response options were American Indian, Black or Afro-American, Mexican American or Chicano, Puerto Rican or other Latin American, Oriental or Asian American, White or Caucasian, and others). Race/ethnicity was recoded into a series of mutually exclusive dichotomies to indicate White, Black, Hispanic, and others (including American Indian, Asian American, and others). White was used as the reference group in analyses. To assess the level of parental education in the household, respondents were asked separately for each parent "What is the highest level of schooling your father/mother completed?" Response options ranged from grade school to graduate school and included do not know/does not apply. Parent education was recoded to indicate either parent completing some college or more (coded 1) compared to high school education or less (coded 0). To control for historic changes in the normative prevalence of substance use among senior year high school students, a series of dichotomous variables was created specific to the two substances depending on the historic periods of increasing and decreasing use among 18-year olds.[12,61] For alcohol, the time periods were grouped as 1977–1986, 1987–1993, and 1994–1997, periods during which binge drinking increased, then decreased, and then increased again, respectively. For marijuana, the time periods were grouped as 1977–1991 and 1992–1997, periods during which annual marijuana use declined and then increased, respectively.

Age 18 educational and social indicators. To consider academic performance, externalizing behavior, and unmonitored social time with friends, we included high school grades, truancy, and evenings out for fun and recreation. Consistent with previous MTF analyses,[49,50] and based on preliminary sensitivity analyses (not shown) to determine appropriate cut points, we dichotomized these measures to facilitate analyses and interpretation; given our use of multinomial regression analyses to address the research questions, dichotomous predictors provide more straightforward interpretations. To measure high school grades, respondents were asked "Which of the following best describes your average grade so far in high school?" Responses were recoded to indicate 1 = C+ or lower versus 0 = B− or better to indicate lower high school grades as a risk factor. Students' truancy in high school was assessed by asking "During the last four weeks, how many whole days of school have you missed because you skipped or 'cut'?" Responses were recoded to indicate 1 = any skipping versus 0 = no skipping. For evenings out, students were asked "During a typical week, on how many evenings do you go out for fun and recreation?" The responses were dichotomized to indicate 0 = less than three nights out/week and 1 = three or more nights out/week. Tetrachoric correlations among these three dichotomous variables ranged from 0.12 for low grades and evenings out to 0.31 for truancy and evenings out.

Age 18 *substance use.* Cigarette use was assessed by asking "How frequently have you smoked cigarettes during the past 30 days?" Binge drinking was assessed by asking "Think back over the last two weeks. How many times have you had five or more drinks in a row?" Marijuana use was assessed by asking "On how many occasions (if any) have you used marijuana (grass, pot) or hashish (hash, hash oil) during the last 12 months?" These MTF substance use items have been used effectively for over four decades and have been shown to be reliable and valid assessments.[12,62,63] Correlations ranged from 0.36 for cigarette use and binge drinking to 0.46 for binge drinking and marijuana use. For the present analyses, 30-day cigarette use, two-week binge drinking, and 12-month marijuana use responses were dichotomized to indicate 1 = any and 0 = none.

Age 35 measures. From the age 35 surveys, we included sociodemographics, health indices, life satisfaction indices, substance use, and AUDs and CUDs.

Sociodemographics. Partner status was created as a combination of two variables. Marital status was indicated by the response to the following question: "What is your current marital status?" Reponses included married, engaged, separated, divorced, widowed, and single. Cohabitation was assessed with the question "Are you currently living with a partner to whom you are not married?" Responses to the two questions were combined to create the following three mutually exclusive categories: married, cohabiting, and not married/not cohabiting. Not married/not cohabiting (ie, those who reported being single, separated, divorced, engaged, or widowed) was the reference group for analysis in comparison to the married and cohabiting categories.

Parental status was assessed with the question "How many children do you have (including stepchildren or adopted children)?" Responses ranged from none to six or more and were recoded to indicate 1 = any children and 0 = no children.

Respondent's educational attainment at age 35 was obtained with the question "What is the highest degree you earned?". Responses included *less than a high school diploma*, *high school diploma or equivalency*, *associate's degree*, *bachelor's degree*, *master's degree*, and *doctoral degree or equivalent*. For analysis, the item was recoded to indicate 1 = bachelor's degree or more compared to 0 = associate's degree or less. Previous and preliminary analyses indicate that this split between bachelor's and associate's degrees, effectively highlighting the four-year

(and typically residential) college experience, is important regarding substance use.[64,65]

Respondent employment was asked with the question "Which best describes your employment last week? (If on vacation, answer for the week before the vacation.)" Responses were recoded to 1 = employed (2+ jobs, one full-time job, and one part-time job) and 0 = not employed (homemaker, laid off, and no paid employment) for analysis.

Financial independence was assessed with a series of separate questions asking the respondent about their sources of income: "During the past 12 months, how much (if any) of your total household financial support (including that for your spouse and children) came from each of the following sources? a) Your parents? b) Your spouse's parents? c) Unemployment compensation? and d) Welfare (TANF, food stamps, etc.)." If the respondent indicated *none* to all four questions, they were coded as 1 = financially independent. Otherwise, they were coded as 0 = financially dependent for analysis.

Religiosity was assessed by combining the responses to the following two questions: "How often do you attend religious services?" with response options ranging from never to about once a week or more and "How important is religion in your life?" with response options ranging from not important to very important. The mean of the two items was then split at the median and dichotomized to indicate 1 = higher religious commitment compared to 0 = lower religious commitment.

Health indicators. Six indicators of health were included; these indicators and the items we used are consistent with how other large-scale surveys measure adulthood health (eg, Health and Retirement Study).[66]

Overall good physical health was measured with eight items of the questions under the heading "During the last 30 days, on how many days (if any) did you have the following problems or symptoms?" Response options ranged from none to 20+ days. Items included headache, sore throat or hoarse voice, trouble with sinus congestion, runny nose or sneezing, coughing spells, chest colds, coughing up phlegm or blood, and shortness of breath when you were not exercising. The questions were reverse-coded, and a mean of these eight items was created and used in analyses, with higher values indicating better physical health (alpha reliability = 0.78).

To assess being overweight or obese, BMI was calculated using the responses to the questions "What is your current height (in feet and inches) without shoes?" and "What is your current weight (in pounds) without shoes or clothing?" Measurements were converted to meters and kilograms, and the standard BMI calculation (kg/m^2) was computed. Respondents with BMI >25 were coded as overweight/obese (1), and those with BMI ≤25 were coded 0.

Frequency of exercising was measured with the item "How often do you exercise vigorously (jogging, swimming, calisthenics, or any other active sports)?" Six response options ranged from never to every day. This item was included as a continuous predictor in the analyses.

To assess sleep and cognitive difficulties, questions were asked headed with "During the last 30 days, on how many days (if any) did you have the following problems or symptoms?" Seven response options ranged from none to 20+ days. The *trouble sleeping* item was used as a continuous predictor. Cognitive difficulties included *trouble remembering things*, *difficulty thinking or concentrating*, and *trouble learning new things*. A mean of the three cognitive variables was included in analysis (alpha reliability = 0.79), with a higher value indicating more days experiencing cognitive difficulties.

Frequency of doctor visits for injuries was measured with the following two items: "In the last 12 months, how many times (if any) have you seen a doctor or other professional for each of the following?" (a) for an injury suffered in a fight, assault, or auto accident and (b) for any other accidental injury. Six response options ranged from none to 10+ times. A mean of the two items was used in analysis, with a higher value indicating higher frequency of visits.

Correlations among these six health indicators ranged from −0.26 between overall good physical health and trouble sleeping to 0.38 between trouble sleeping and cognitive difficulties.

Life satisfaction. Four questions about various aspects of life satisfaction, consistent with relevant literature about components of adult life satisfaction (summarized in the "Introduction" section), were asked with the header question "How satisfied are you with…." Specific items included (a) the way you get along with your spouse or partner? (b) your job? (c) your standard of living – the things you have like housing, car, furniture, recreation, and the like? and (d) the amount of time you have for doing things you want to do? A seven-item response scale ranged from completely dissatisfied to completely satisfied, with a *not applicable* (ie, missing data) option for the items pertaining to job and spouse/partner. The satisfaction items were used as continuous measures in analysis, with higher values indicating more satisfaction. Correlations among these variables ranged from 0.21 between satisfaction with job and satisfaction with relationship with spouse/partner to 0.38 between satisfaction with the amount of time to do what you want and satisfaction with standard of living.

Substance use at age 35. The questions assessing use of cigarettes, alcohol, and marijuana at age 18 were repeated at age 35, using identical wording, response options, and recoding. As mentioned earlier, these items have been shown to be reliable and valid assessments; as further validation of using these items with adults, our rates of substance use are very consistent with those obtained from the National Survey on Drug Use and Health.[12,13] Dichotomous measures of 30-day cigarette use, 2-week binge drinking, and 12-month marijuana use were created for analysis to indicate 1 = any use and 0 = no use. Tetrachoric correlations among these three variables at age 35 ranged from 0.41 between cigarette use and binge drinking to 0.50 between cigarette use and marijuana use. Tetrachoric correlations between age 18 and age 35 substance use were

0.67 for cigarette use, 0.43 for binge drinking, and 0.58 for marijuana use. Because current alcohol use and marijuana use at age 35 are embedded in the AUD and CUD status measures, respectively, age 35 two-week binge drinking was excluded in the AUD analyses, and age 35 12-month marijuana use was excluded in the CUD analyses.

Age 35 AUD and CUD. In the age 35 survey, respondents were asked if they had used any alcohol or marijuana in the past five years. If yes, they were instructed to "Think back over the last five years. Did your use of alcohol or marijuana cause you any of the following problems?" Separate response columns were given for alcohol and marijuana, with four response options ranging from no to a lot. Although these measures of symptoms of AUD and CUD do not yield a clinical diagnosis, the items are largely consistent with how substance use disorders have been measured in other large-scale surveys[67–69] and have been used in past MTF studies to reflect DSM-IV alcohol and marijuana use disorders.[49,50] Covering the last five years (rather than lifetime or 12 months period as is typical in substance use disorder assessment) may limit cross-study consistency; potential advantages are that this timeframe covers the period of the early- to mid-30 s when early midlife begins, and a five-year assessment window is more likely to capture recurring or relapsing disorders than a 12-month assessment window.

The age 35 MTF survey questions included the following 8 of the 11 criteria specified in the substance use disorder revision of the DSM-5[16]: (2) *Desire to cut down or quit but could not* is indicated by "You wanted to try to stop or cut down, but you found that you could not." (4) *Unable to resist use* is indicated by "You felt such a strong desire to use the drug that you could not resist it or think of anything else." (5) *Failure to fulfill role obligations* is indicated by "Caused you financial difficulties." (6) *Continued use despite recurrent or persistent social problems* is indicated by four items, including "hurt your relationship with your parents," "hurt your relationship with your spouse, fiancée, or girlfriend/boyfriend," "hurt your relationship with your friends," and "caused you to get into an angry argument." (8) *Continued use when physically hazardous* is indicated by "Caused you to drive unsafely." (9) *Continued use despite harmful effects* is indicated by five items, including "caused you to be less stable emotionally," "caused you to have less energy," "made you feel bad (eg, depressed, anxious, and ashamed) for more than just a few days," "caused your physical health to be bad," and "you continued to use the drug even though you knew it was harmful to do so." (10) *Tolerance* is indicated by "You found that over time you needed more of the drug to get the same effect." And (11) *withdrawal* is indicated by two items, including "stopping or reducing your use of the drug made you physically ill or sick" and "you used the drug to avoid 'hangovers' or after-effects of the drug." The questions that cover criteria 1, 3, and 7 are not available in the MTF survey: (1) *taken in larger amounts or over a longer period of time than was intended*, (3) *great deal of time spent in activities to obtain*, *use*, *or recover from its effects*, and (7) *important social*, *occupational*, *or recreational activities are given up or reduced because of use*.

Respondents were coded as exhibiting each criterion if they responded other than *no problem* to any item representing that criterion (0 = no problem on any item versus 1 = any problem on any item). These eight dichotomous indicators were summed to obtain an overall number of criteria endorsed. We followed the recommended practice that any use disorder (including mild, moderate, or severe) is indicated by meeting two or more of the criteria.[16,20,21] Based on the total score, we categorized respondents into abstainers (ie, had not used the substance in the past five years), non-disordered users (ie, used but endorsed none or one of the eight criteria), and disordered (AUD or CUD) users (ie, used and endorsed two or more of the eight criteria). Tetrachoric correlations between alcohol and cannabis abstainers, between non-disordered users, and between disordered users were 0.16, −0.10, and 0.25, respectively.

Analyses. With national multicohort prospective panel data, we estimate the prevalence of age 35 AUDs and CUDs, using the survey items adapted from DSM-5 diagnostic criteria, and compare those experiencing AUDs and CUDs with those who used the substance without qualifying for a disorder (non-disordered users) and those who did not use alcohol or marijuana in the past five years (abstainers). Using multinomial logistic regressions, we examine the risks of disorder associated with age 18 and age 35 sociodemographic characteristics, age 18 educational and social indicators, age 35 health indicators and life satisfaction, and age 18 and age 35 substance use. SAS v9.4 was used to obtain the sample descriptives and correlations (PROC FREQ and PROC CORR). For the multinomial logistic regression models that predict the categories of disorder (AUD or CUD), nondisordered use, and abstainers, we used Mplus v7.4 to obtain the relative risk ratios (RRR) and associated 95% confidence intervals (CIs) of the association of the predictors to each category of the outcome. To include all possible cases and adjust for item missingness, we used full information maximum likelihood estimation, a missing data algorithm available within Mplus.[70] We note here that missing data regarding the substance use disorders were minimal: 3.5% missing data for AUD status and 1.6% missing data for CUD status. As described earlier, the analyses were also weighted to account for differential attrition.

Results

Our primary goal in this study was to examine how AUDs and CUDs at early midlife were associated with adolescent and early midlife sociodemographics and health and well-being indicators, including adolescent substance use.

Preliminary analyses. The proportions of the sample in three categories of use and disorder for alcohol and marijuana, respectively, in the past five years were AUD = 28.0%, non-disordered drinkers (NDD) = 60.6%, and alcohol abstainers = 11.4%; CUD = 6.1%, nondisordered cannabis users

(NDU) = 15.9%, and marijuana abstainers = 78.0%. The majority of the sample regarding alcohol and marijuana was NDD and abstainers, respectively, underscoring distinctions across the AUD and CUD status categories. Table 1 provides selected sociodemographic characteristics of respondents in these categories (significant differences by socioeconomic characteristics in the multivariable models are considered below). Regarding AUD status, compared to the total sample, men, Whites, and nonmarrieds (both those cohabiting and those not married/not cohabiting) were overrepresented in the AUD category, with little difference by educational attainment. Regarding CUD status, men, nonmarrieds, and those with lower educational attainment were overrepresented in the CUD category, with little difference by race/ethnicity. In preliminary analyses (not shown), we considered interactions among gender, race/ethnicity, and educational attainment and found no consistent evidence for differences in predictors by subgroups.

In considering bivariate correlations (tetrachoric for dichotomous variables) among the other predictors and AUD and CUD categories (data not shown), all correlations between adolescent educational/social indicators and AUD and CUD were significant ($P < 0.05$ or lower) but small; the largest was for truancy, 0.13 with AUD and 0.10 with CUD. Adolescent substance use was significantly ($P < 0.001$) correlated with age 35 AUD and CUD for cigarette use (0.16 and 0.12, respectively), for binge drinking (0.22 and 0.12, respectively), and for marijuana use (0.19 and 0.21, respectively). For age 35 health indicators, most correlations with AUD and CUD were significant ($P < 0.05$ or lower) and small; the largest was for cognitive difficulties (0.11 and 0.07, respectively). For age 35 satisfaction indicators, all correlations with AUD and CUD were negative, significant ($P < 0.05$ or lower), and small; the largest was for satisfaction with spouse/partner (−0.12 and −0.07, respectively) and satisfaction with standard of living (−0.11 and −0.10, respectively).

In preliminary analyses (not shown), we added blocks of predictors sequentially (first age 18 sociodemographics plus educational/social indicators plus substance use and then age 35 sociodemographics plus health indicators plus satisfaction indices plus substance use) to consider changes in predictors as we progressed to fuller models. As would be expected, some of the predictors became smaller across the models, but for the most part, conclusions about the importance of predictors changed little. Because our research questions pertain to the full models with appropriate controls of possible confounding variables, we present only the full models, with all predictors added simultaneously, here.

AUD multinomial models. Table 2 summarizes findings from the multinomial models predicting the three categories regarding age 35 AUD status. Significant findings are discussed below.

Age 18 predictors. Regarding sociodemographics, men compared to women were at 1.7 times the risk (based on the RRR, which control for all other predictors) of being in the AUD category than in the abstainer category and at 2.0 times the risk of being in the AUD category than in the NDD category. Men compared to women were at *less* risk of being in the NDD category than in the abstainer category; that is, among those without an AUD, the RRR of 0.84 means that men are less likely than women to be NDD (controlling for all other predictors). African Americans compared to Whites were at less risk of being in the AUD category than in the abstainer or NDD categories and of being in the NDD category than in the abstainer category. Hispanics compared to Whites were at greater risk of being in the AUD or NDD categories than in the abstainer category. Those in the other race/ethnicity groups compared to Whites were at less risk of being in the AUD or NDD categories than in the abstainer category. For parent education (at age 18), respondents with a parent with some college or more compared to those with parent(s) with a high school degree or less were at greater risk of being in the AUD category than in the other two categories and of being in the NDD category than in the abstainer category. Cohort was not a significant predictor of age 35 AUD status.

Regarding the age 18 education and social indicators, those with C+ or lower high school grades compared to those with B− or higher grades were at less risk of being in the AUD category than in the NDD category. Those who were high on truancy and on evenings out at age 18 compared to their counterparts were at greater risk of being in the AUD category than in the two other categories.

In these models, controlling for all other age 18 and 35 predictors, all three age 18 substance use indices were significant predictors of age 35 AUD status. In particular, those who were binge drinkers at age 18 compared to those who were not had over three times (RRR = 3.12) the risk of being in the AUD category than in the abstainer category, had 1.7 times the risk of being in the AUD category than in the NDD category, and had 1.8 times the risk of being in the NDD category than in the abstainer category. Those who were current cigarette smokers at age 18 compared to those who were not were at greater risk of being in the AUD category than in the other two categories. Those who were annual marijuana users at age 18 compared to those who were not were at greater risk of being in the AUD category than in the other two categories and of being in the NDD category than in the abstainer category.

Age 35 predictors. Regarding age 35 sociodemographics, those who at age 35 were married compared to those who were not married/not cohabiting were at lower risk of being in the AUD category than in the other two categories; those who were cohabiting compared to those who were not married/not cohabiting were at greater risk of being in the AUD or NDD categories than in the abstainer category. Those who were parents compared to those who were not were at less risk of being in the AUD category than in the NDD category. Those who received a bachelor's degree or higher compared to those who

Table 2. Relative risk ratios: age 18 and age 35 predictors of past five-year alcohol use disorder (AUD) drinkers, nondisordered drinkers, and abstainers.

	AUD AS COMPARED TO ABSTAINERS RRR(CI)	AUD AS COMPARED TO NON-DISORDERED DRINKERS (NDD) RRR(CI)	NON-DISORDERED DRINKERS (NDD) AS COMPARED TO ABSTAINERS RRR(CI)
Age 18 Predictors			
Sociodemographics			
Male	1.693(1.520, 1.887)***	2.008(1.882, 2.142)***	0.844(0.765, 0.930)**
African American[a]	0.512(0.423, 0.620)***	0.784(0.676, 0.911)**	0.653(0.566, 0.754)***
Hispanic[a]	1.646(1.289, 2.101)**	1.157(0.988, 1.355)	1.423(1.150, 1.759)**
Other race/ethnicity[a]	0.588(0.477, 0.724)***	0.866(0.749, 1.000)	0.679(0.570, 0.809)***
Parent education: at least some college	1.428(1.283, 1.589)***	1.168(1.091, 1.249)***	1.223(1.114, 1.343)***
Cohorts 1987–1993[b]	1.058(0.948, 1.181)	1.063(0.992, 1.139)	0.995(0.904, 1.096)
Cohorts 1994–1997[b]	1.091(0.941, 1.265)	1.045(0.956, 1.142)	1.044(0.916, 1.191)
Education and social indicators			
Lower high school grades	0.956(0.839, 1.090)	0.901(0.832, 0.977)*	1.061(0.944, 1.192)
Truancy	1.379(1.220, 1.558)***	1.263(1.178, 1.354)***	1.092(0.977, 1.220)
3+ Evenings out /week	1.184(1.070, 1.310)**	1.108(1.039, 1.181)**	1.068(0.978, 1.167)
Substance use			
Any 2-week binge drinking	3.121(2.748, 3.545)***	1.722(1.601, 1.852)***	1.813(1.616, 2.034)***
Any 30-day cigarette use	1.229(1.077, 1.402)**	1.112(1.029, 1.203)*	1.104(0.982, 1.242)
Any 12-month marijuana use	1.621(1.397, 1.881)***	1.296(1.194, 1.407)***	1.251(1.093, 1.431)**
Age 35 Predictors			
Sociodemographics			
Married[c]	0.735(0.601, 0.899)*	0.713(0.624, 0.816)***	1.030(0.901, 1.179)
Cohabiting[c]	1.612(1.203, 2.162)**	1.086(0.930, 1.269)	1.484(1.159, 1.900)**
Parent	0.870(0.765, 0.989)[†]	0.790(0.732, 0.853)***	1.101(0.980, 1.237)
Bachelor's degree or higher	1.976(1.768, 2.209)***	1.084(1.011, 1.161)	1.824(1.654, 2.012)***
Employed	1.764(1.531, 2.033)***	1.261(1.137, 1.398)***	1.399(1.247, 1.569)***
Financially independent	1.117(0.987, 1.266)	0.878(0.812, 0.949)**	1.273(1.141, 1.421)***
Religiosity	0.284(0.255, 0.317)***	0.782(0.732, 0.836)***	0.363(0.330, 0.400)***
Health indicators			
Overall good physical health	0.953(0.895, 1.014)	0.930(0.897, 0.965)**	1.024(0.968, 1.084)
Overweight/obese	0.920(0.830, 1.019)	0.895(0.840, 0.953)**	1.028(0.939, 1.126)
Exercising vigorously	1.127(1.080, 1.176)***	1.040(1.014, 1.067)*	1.084(1.043, 1.126)**
Trouble sleeping	1.123(1.089, 1.158)***	1.086(1.067, 1.105)***	1.034(1.006, 1.063)*
Cognitive difficulties	1.099(1.046, 1.154)**	1.202(1.167, 1.239)***	0.914(0.874, 0.955)**
Doctor visit for injuries	0.931(0.820, 1.057)	0.977(0.906, 1.054)	0.952(0.852, 1.064)
Life satisfaction			
Satisfaction with spouse/partner	0.819(0.778, 0.861)***	0.870(0.845, 0.896)***	0.941(0.898, 0.985)*
Job satisfaction	0.944(0.901, 0.989)*	0.989(0.964, 1.015)	0.954(0.915, 0.995)*
Satisfaction with standard of living	1.054(1.001, 1.110)[†]	0.990(0.961, 1.020)	1.064(1.016, 1.115)*
Satisfaction with free time	0.930(0.892, 0.970)**	1.030(1.005, 1.056)*	0.903(0.871, 0.937)***
Substance use			
Any 30-day cigarette use	3.695(3.132, 4.360)***	1.765(1.627, 1.914)***	2.094(1.794, 2.444)***
Any 12-month marijuana use	6.594(4.692, 9.269)***	1.774(1.601, 1.966)***	3.716(2.668, 5.177)***

Notes: Unweighted $N = 25{,}536$. CI pertains to 95% CIs about the relative risk ratios. [a]Reference group is White. [b]Reference group is cohorts 1977–1986. [c]Reference group is single/separated/divorced/engaged/widowed. *$P < 0.05$. **$P < 0.01$. ***$P < 0.001$. [†]Although the CI does not include 1.0, the reported P-values for the coefficients of parent and satisfaction with standard of living are 0.08 and 0.09, respectively.

received an associate's degree or less were at greater risk of being in the AUD and NDD categories than in the abstainer category. Those who were employed, compared to those who were not, were at greater risk of being in the AUD category than in the other two categories and of being in the NDD category than in the abstainer category. Those who were financially independent at age 35 compared to those who were not were at greater risk of being in the NDD category than in the other two categories. Greater age 35 religiosity was associated with less risk of being in the AUD category than in the other two categories and of being in the NDD category than in the abstainer category.

Regarding health indicators, greater reported overall health was associated with less risk of being in the AUD category than in the NDD category. Those who were overweight/obese compared to those who were not were at less risk of being in the AUD category than in the NDD category. More vigorous exercise was associated with greater risk of being in the AUD and NDD categories than in the abstainer category and of being in the AUD category than in the NDD category. More frequent trouble with sleeping was associated with greater risk of being in the AUD category than in the other two categories and of being in the NDD category than in the abstainer category. More frequent cognitive difficulties were associated with greater risk of being in the AUD category than in the other two categories and of being in the abstainer category than in the NDD category. Doctor visits for injuries were not significantly associated with AUD status.

Regarding age 35 life satisfaction, higher satisfaction with spouse/partner was associated with lower risk of being in the AUD category than in the other two categories and of being in the NDD category than in the abstainer category. Greater job satisfaction was associated with less risk of being in the AUD category than in the abstainer category. Greater satisfaction with standard of living was associated with greater risk of being in the NDD category than in the abstainer category. Greater satisfaction with free time was associated with lesser risk of being in the NDD category than in either the AUD category or the abstainer category and of being in the AUD category than in the abstainer category.

Finally, those who used cigarettes or marijuana at age 35 compared to their counterparts were at greater risk of being in the AUD category than in the other two categories and of being in the NDD category than in the abstainer category.

CUD multinomial models. Table 3 summarizes findings from the multinomial models predicting the three categories regarding age 35 CUD status. Significant findings are discussed below.

Age 18 predictors. Regarding age 18 sociodemographics, men compared to women were at over twice the risk of being in the CUD category than in the abstainer or non-disordered user (NDU) categories (RRR = 2.2 and 2.1, respectively). African Americans compared to Whites were at greater risk of being in the CUD category than in the other two categories. None of the other racial/ethnic groups were significantly different compared to Whites regarding age 35 CUD status. Respondents whose parents had at least some college compared to those who did not had greater risk of being in the CUD or NDU categories than in the abstainer category. More recent cohorts (senior year classes of 1992–1997) compared to earlier cohorts (1977–1991) were at greater risk of being in the NDU category than in either the CUD category or the abstainer category.

Regarding the education and social indicators, high school grades did not significantly relate to age 35 CUD status. Those with more truancy and on evenings out at age 18 compared to their counterparts were at greater risk of being in the CUD or NDU categories than in the abstainer category; in addition, those with more evenings out were at greater risk of being in the CUD category than in the NDU category.

In these models, controlling for all other age 18 and age 35 predictors, age 18 marijuana use was a significant predictor of age 35 CUD status. Those who were annual marijuana users at age 18 compared to those who were not were at 4.5 times greater risk of being in the CUD category than in the abstainer category, 1.5 times greater risk of being in the CUD category than in the NDU category, and 3.1 times greater risk of being in the NDU category than in the abstainer category. Age 18 cigarette use was not significantly associated with age 35 CUD status. Those who were binge drinkers at age 18 compared to those who were not were at greater risk of being in the NDU category than in the abstainer category.

Age 35 predictors. As shown in Table 3, regarding age 35 sociodemographics, those who were married compared to those who were not married/not cohabiting were at lower risk of being in either the CUD category or the NDU category than in the abstainer category. Those cohabiting compared to those not married/not cohabiting were at greater risk of being in the NDU category than in the abstainer category. Parents, compared to non-parents, were at less risk of being in the CUD or NDU categories than in the abstainer category. Those who earned a bachelor's degree or higher compared to those with an associate's degree or lower were at greater risk of being in the NDU category than in either the CUD category or the abstainer category. Those who were financially independent at age 35 compared to those who were not were at less risk of being in the CUD category than in the other two categories and of being in the NDU category than in the abstainer category. Greater age 35 religiosity was associated with less risk of being in the CUD or NDU categories than in the abstainer category.

Better overall health was associated with less risk of being in the CUD category than in the other two categories. More vigorous exercise was associated with greater risk of being in the NDU category than in the abstainer category. More frequent cognitive difficulties were associated with greater risk of being in the CUD category than in the other two categories. Overweight/obese, trouble sleeping, and doctor visits for injuries were not associated with CUD status.

Table 3. Relative risk ratios: age 18 and age 35 predictors of past five-year cannabis use disorder (CUD) users, nondisordered cannabis users, and abstainers.

	CUD AS COMPARED TO ABSTAINERS RRR(CI)	CUD AS COMPARED TO NON-DISORDERED USERS (NDU) RRR(CI)	NON-DISORDERED USERS (NDU) AS COMPARED TO ABSTAINERS RRR(CI)
Age 18 Predictors			
Sociodemographics			
Male	2.181(1.925, 2.471)***	2.095(1.840, 2.386)***	1.041(0.959, 1.130)
African American[a]	1.561(1.237, 1.970)**	1.483(1.154, 1.906)**	1.052(0.892, 1.242)
Hispanic[a]	1.087(0.806, 1.465)	1.269(0.927, 1.739)	0.856(0.694, 1.055)
Other race/ethnicity[a]	1.048(0.811, 1.355)	0.998(0.760, 1.310)	1.051(0.894, 1.235)
Parent education: at least some college	1.298(1.151, 1.464)***	0.953(0.841, 1.080)	1.362(1.253, 1.480)***
Cohorts 1992–1997[b]	0.891(0.777, 1.023)	0.793(0.688, 0.915)**	1.123(1.032, 1.224)*
Education and social indicators			
Lower high school grades	0.850(0.741, 0.976)[†]	0.897(0.779, 1.033)	0.948(0.861, 1.044)
Truancy	1.431(1.262, 1.622)***	1.166(1.024, 1.326)	1.227(1.130, 1.333)***
3+ Evenings out/week	1.392(1.224, 1.583)***	1.192(1.042, 1.363)*	1.168(1.080, 1.263)**
Substance use			
Any 12-month marijuana use	4.520(3.917, 5.217)***	1.459(1.257, 1.692)***	3.099(2.830, 3.395)***
Any 30-day cigarette use	1.053(0.907, 1.223)	0.947(0.812, 1.105)	1.111(1.014, 1.218)
Any 2-week binge drinking	1.066(0.927, 1.226)	0.955(0.825, 1.105)	1.117(1.020, 1.223)*
Age 35 Predictors			
Sociodemographics			
Married[c]	0.595(0.450, 0.786)**	0.792(0.634, 0.988)[†]	0.751(0.658, 0.858)***
Cohabiting[c]	1.163(0.863, 1.567)	0.815(0.642, 1.034)	1.428(1.216, 1.677)***
Parent	0.653(0.570, 0.749)***	0.894(0.778, 1.028)	0.730(0.667, 0.799)***
Bachelor's degree or higher	0.936(0.825, 1.062)	0.770(0.674, 0.881)**	1.215(1.117, 1.322)***
Employed	0.917(0.759, 1.108)	0.798(0.659, 0.966)[†]	1.150(1.018, 1.298)
Financially independent	0.529(0.465, 0.601)***	0.669(0.586, 0.763)***	0.791(0.721, 0.867)***
Religiosity	0.571(0.502, 0.651)***	1.161(1.010, 1.334)	0.492(0.454, 0.534)***
Health indicators			
Overall good physical health	0.869(0.817, 0.924)***	0.848(0.797, 0.903)***	1.024(0.979, 1.071)
Overweight/obese	0.974(0.863, 1.098)	1.030(0.910, 1.166)	0.945(0.875, 1.021)
Exercising vigorously	1.054(1.005, 1.105)	1.008(0.960, 1.059)	1.046(1.014, 1.078)*
Trouble sleeping	1.024(0.992, 1.058)	1.003(0.970, 1.037)	1.021(0.999, 1.044)
Cognitive difficulties	1.157(1.102, 1.214)***	1.128(1.072, 1.187)***	1.026(0.988, 1.065)
Doctor visit for injuries	1.127(0.980, 1.295)	1.020(0.896, 1.160)	1.105(1.012, 1.206)
Life satisfaction			
Satisfaction with spouse/partner	0.858(0.814, 0.905)***	0.906(0.858, 0.957)**	0.947(0.912, 0.983)*
Job satisfaction	1.016(0.972, 1.063)	1.012(0.967, 1.060)	1.004(0.973, 1.037)
Satisfaction with standard of living	0.940(0.895, 0.987)*	1.019(0.969, 1.071)	0.922(0.890, 0.956)***
Satisfaction with free time	0.987(0.943, 1.033)	0.933(0.889, 0.978)*	1.059(1.027, 1.091)**
Substance use			
Any 30-day cigarette use	3.247(2.816, 3.745)***	1.373(1.186, 1.589)***	2.365(2.156, 2.595)***
Any 2-week binge drinking	1.979(1.744, 2.246)***	0.907(0.797, 1.032)	2.183(2.008, 2.374)***

Notes: Unweighted $N = 25{,}536$. CI pertains to 95% CIs about the relative risk ratios. [a]Reference group is White. [b]Reference group is cohorts 1977–1991. [c]Reference group is single/separated/divorced/engaged/widowed. *$P < 0.05$. **$P < 0.01$. ***$P < 0.001$. [†]Although the CI does not include 1.0, the reported P-values for the coefficients of lower grades, employed, and married are 0.052, 0.052, and 0.083, respectively.

Regarding satisfaction at early midlife, higher satisfaction with spouse/partner was associated with less risk of being in the CUD category than in the other two categories and of being in the NDU category than in the abstainer category. Greater satisfaction with standard of living was associated with less risk of being in the CUD or NDU categories than in the abstainer category. Greater satisfaction with free time was associated with greater risk of being in the NDU category than in the other two categories. Job satisfaction was not associated with CUD status.

Finally, those who were cigarette smokers or binge drinkers at age 35 compared to their counterparts were at greater risk of being in the CUD or NDU categories than in the abstainer category, and cigarette users were at greater risk of being in the CUD category than in the NDU category.

Discussion

This study was undertaken to examine AUD and CUD at early midlife, using national prospective data to examine the long-term prediction of adolescent risk factors as well as the concurrent early midlife indicators of health and well-being. Based on a developmental conceptual framework that gives attention to distal and proximal risk factors and focuses on embedding substance use and disorder within the developmental context,[2,4,9,11] we bring the required attention to the long-term prediction of adult substance use disorder as a function of key adolescent academic, social, and substance use risk factors and to key concurrent health and well-being correlates of adult substance use disorder.

Of particular importance, we focus on substance use and use disorders during early midlife. Compared to what we know about long-term and concurrent predictors of substance use and substance use disorders during the transition to adulthood, we know relatively little about the predictors of use and disorder during midlife. Substance use and use disorders tend to peak during the transition to adulthood and then decline with the assumption of adult roles.[6,9,71] As individuals move into midlife, compared to when they are younger and older adults, they tend to have higher family demands (especially ones who cross generations), higher work-related demands, and greater work–family conflicts.[10] Early midlife, roughly between ages 30 and 40, is an understudied time of the lifespan during which the subjective age varies greatly (with some feeling as young adults and some feeling as middle aged),[72] and that directly precedes middle age, roughly understood to be from ages 40 to 60.[10] Early midlife is also perceived as the prime of life.[73] Developmental changes surrounding the entrance into midlife also raise important developmental questions about unfolding health and well-being. As responsibilities tend to peak, it may be that substance use disorders become more consequential; thus, substance use disorder at midlife deserves more attention. We find considerable evidence about important adolescent risk factors for, and concurrent health and well-being correlates of, early midlife AUD and CUD. Findings are summarized below with respect to the relevant literature, integrating across the alcohol and marijuana results.

Age 18 and age 35 sociodemographic correlates of AUDs and CUDs. As we shown in this national sample of 35-year olds, the rates of five-year AUD and CUD are estimated to be 28.0% and 6.1%, respectively. Despite differences across studies in age-group definition, diagnostic criteria, and measurement year, these rates are largely consistent with evidence indicating that roughly 25%–33% adults experience AUD in their lifetime and roughly 6%–10% adults experience CUD in their lifetime.[17–21,74] We used the DSM-5 diagnostic criteria[16] for mild-to-severe substance use disorder (two or more criteria), which some evidence suggests yields somewhat higher prevalence of use disorders compared to the DSM-IV criteria[21,75]; this may help explain why our five-year rates may be somewhat higher than might be expected in reference to lifetime rates. That the AUD and CUD rates we find here are consistent with rates from other, more measurement-intensive national studies provides important validity information about the MTF substance use disorder items, especially given that this is the first MTF study using the DSM-5 symptom criteria.

Further validity information comes from the findings regarding differences among sociodemographic groups, as summarized below, that are generally consistent with other epidemiological evidence.[15,17–20,22,23] In the full multivariable models, we found that men in early midlife were roughly twice as likely as women to experience AUDs and CUDs (in comparison to the other categories). African Americans compared to Whites were at less risk for AUDs and at greater risk for CUDs (in comparison to the other categories). Compared to Whites, Hispanic respondents were at greater risk and other race/ethnicity respondents were at less risk of being in the AUD and NDD categories (in comparison to the abstainer category); neither of these race/ethnicity categories was related to CUD status.

Consistent with the ubiquitous marriage effect whereby substance use decreases with marriage (and then increases with divorce),[71,76–78] we found that respondents who at age 35 were married compared to those neither married nor cohabiting were at less risk of being in the AUD and CUD categories (in comparison to the other categories) and at less risk of being in the NDD and NDU categories than in the respective abstainer category. Those who were cohabiting at age 35 compared to those who were not married/not cohabiting were at greater risk of being in the AUD and CUD categories (in comparison to the respective abstainer category) and of being in the NDD category than in the abstainer category; this set of findings clearly shows that the benefits of the marriage effect do not apply to cohabitation. Those who were parents compared to those who were not were at less risk of being in the AUD category (in comparison to NDD category) and of being in the CUD category (in comparison to the abstainer category); parents were also at less risk of being in the NDU

category than in the abstainer category. Greater age 35 religiosity was associated with less risk of being in the AUD category (in comparison to the other two categories) and of being in the CUD category (in comparison to abstainer category) and less risk of being in the NDD category than in the abstainer category.

Higher socioeconomic status was not a protective factor against heavier substance use. Across generations, respondents whose parents had at least some college compared to those who did not had greater risk of being in the AUD category (in comparison to the other two categories) and of being in the CUD category (in comparison to the abstainer category only); in addition, they had greater risk of being in the NDD and NDU categories (nondisordered cannabis users) than in the respective abstainer category. Similarly, respondents who by age 35 had higher educational attainment were at greater risk of being in the AUD and NDD categories (in comparison to the abstainer category) and of being in the NDU category (in comparison to both CUD and abstainer categories). Those who were employed at age 35 were also at greater risk of being in the AUD category (in comparison to the other categories) and of being in the NDD category (in comparison to the abstainer category); employment was not significantly associated with CUD status. Financial independence at early midlife showed a more complex pattern – it was associated with less risk of being in the AUD category (in comparison to the abstainer category only), of being in the CUD category (in comparison to the other two categories), and of being in the NDU category (in comparison to the abstainer category) but at greater risk of being in the NDD category (in comparison to the other two categories).

With respect to historic changes in the experience of substance use disorder symptomatology, we found that more recent cohorts (senior year classes 1992–1997) compared to earlier ones (1977–1991) were at greater risk of being age 35 NDU rather than being CUD or being abstainers. This is consistent with findings that although marijuana use among adults has been increasing in recent years,[12,15] rates of CUDs among marijuana users have been declining.[15] These findings suggest the changing characteristics of adult marijuana users and underscore the interconnections between epidemiology and etiology, particularly that substance use etiology varies in important ways across recent history.[4,61] They also underscore the historical embeddedness of findings, suggesting that current knowledge about possible causes and consequences of substance use must be continually tested with new cohorts. In contrast, among the cohorts included, we found no significant association between cohort and AUD status.

Adolescent risk factors for early midlife substance use disorders. We followed young people from their senior year in high school to age 35. Across these 17 years, controlling for numerous sociodemographic and other risk factors at adolescence and early midlife correlates, age 18 substance use was found to significantly predict age 35 substance use disorders. Not surprisingly, this is especially true when considering the same substance over time. For alcohol use, those who had at least one binge drinking episode in the two weeks prior to assessment at age 18 compared to those who did not were at over three times the risk and almost two times the risk of experiencing age 35 AUD symptoms compared to being an abstainer and NDD, respectively. For marijuana, those who at age 18 used marijuana at least once in the past 12 months versus those who did not were at 4.5 times and 1.5 times the risk of being CUDs at age 35 rather than being abstainers or NDU, respectively. Cross-substance predictions were also significant in the multivariate models with numerous controls predicting AUD status: those who were cigarette users or marijuana users at age 18 were at greater risk of being in the age 35 AUD category (in comparison to the other two categories). For predicting age 35 CUD status, however, cigarette use and binge drinking were not significantly associated with CUD in the multivariate models. These findings, especially regarding within-substance continuity, coincide with the findings of Odgers et al.[47] that show the strong predictive power of teen substance use on adult substance use disorder within the context of numerous childhood and adolescent controls including for externalizing difficulties. This suggests a strong element of continuity across nearly two decades of the life course, and the possible impact of adolescent experiences on adulthood functioning and adjustment,[4,11] suggesting the value of early and comprehensive screening for potential substance use disorder.

In addition to substance use at age 18, we considered other potential adolescent risk factors for early midlife substance use disorder in the domains of academic performance (low high school grades), externalizing behavior (truancy), and unmonitored social time (three or more evenings out per week). In general, truancy and evenings out were associated with significantly greater risks of being in the age 35 AUD category (in comparison to the other two categories) and of being in the CUD and NDU categories (in comparison to the abstainer category). High school grades did not emerge as significant predictors of age 35 AUD or CUD status (with the exception of lower grades being associated with less risk of AUD compared to NDD). These findings suggest the long arm of some adolescent risk factors for later substance use and disorder that extend beyond early adulthood.[47–52,54]

Early midlife health and well-being correlates of substance use disorders. In our multivarible models with multiple controls for sociodemographics and adolescent and early midlife risk factors, we considered several indices of adult health and well-being as predictors of AUD and CUD status.

Several health indicators were found to be significantly associated with AUD and CUD status (some of these associations reflect J-shaped curve relations, as discussed in next subsection). In particular, overall health and cognitive difficulties were significantly associated with both AUD and CUD status: better overall health was associated with less risk of being in

the AUD category (in comparison to the NDD category) and of being in the CUD category (in comparison to the other two categories); and more frequent cognitive difficulties were associated with greater risk of being in the AUD category (in comparison to the other two categories) and of being in the CUD category (in comparison to the other two categories). In addition, greater trouble sleeping was associated with an increased risk of being in the AUD category (in comparison to the other two categories); it was not significantly associated with CUD status. These findings suggest that some of the real daily health difficulties associated with midlife substance use disorders pertain to difficulties with overall health, cognitive tasks, and sleep. Considering the multiple demands for midlife adults,[10] these health difficulties, as predictors or outcomes of substance use disorders, can serve as daily impediments to optimal functioning. It is likely that substance use disorders and these health and well-being difficulties are reciprocally related, building on each other across adulthood.

We examined life satisfaction, an important component of well-being,[40] especially during middle adulthood.[41] Satisfaction with spouse/partner emerged as a relatively strong and consistent predictor, with higher satisfaction relating to lower risk of being in the AUD and CUD categories (in comparison to the other two categories for both). This brings important information to the understanding of the marriage effect discussed earlier[71,76–78] by showing that it is a matter of not just marriage status but also satisfaction with the relationship. Greater satisfaction with job and free time were associated with less risk of being in the AUD category (in comparison to the abstainer category). Greater satisfaction with standard of living and free time was associated with less risk of being in the CUD category (in comparison to the abstainer category only and to the NDU category only, respectively). As with the health indicators, these components of life satisfaction are likely reciprocally related to substance use disorders and reflect very real day-to-day insults to optimal health and well-being.

J-shaped curve. Light-to-moderate alcohol use is often associated with some positive physiological and psychological functioning,[9,24–26] suggesting the so-called J-shaped curve whereby light-to-moderate drinkers are modestly better off than abstainers and much better off than heavy/disordered drinkers.[27] We found some evidence for this J-shaped curve relationship for alcohol use whereby NDDs were better off than abstainers. This was true for overall health (better among NDD than those experiencing AUD with no difference between abstainers and those experiencing AUD), vigorous exercise (more frequent among NDD and those experiencing AUD than abstainers), cognitive difficulties (more frequent among those experiencing AUD and abstainers than NDD), and satisfaction with standard of living (higher for NDD than both those experiencing AUD and abstainers). In addition, NDDs were more likely than abstainers to have a bachelor's degree, to be employed, and to be financially independent. NDDs and abstainers were not different with regard to age 18 truancy, evenings out, and cigarette use, nor with regard to being married or a parent at age 35; they were not different on overweight/obesity or job satisfaction. In contrast, abstainers were better off than NDDs with regard to higher religiosity, less trouble with sleeping, greater satisfaction with spouse/partner, greater satisfaction with free time, and less age 35 cigarette and marijuana use.

We found more limited evidence for a J-shaped curve for marijuana use. For the most part, NDU fell in between abstainers and those experiencing CUDs on most predictors for which there were significant effects, including satisfaction with spouse/partner and satisfaction with standard of living. Exceptions were that NDUs were better off than abstainers with regard to greater financial independence, more frequent vigorous exercise, and greater satisfaction with free time. Furthermore, NDUs were not different from abstainers (with both being better off than those experiencing CUDs) for overall good health and less frequent cognitive difficulties. Given that we also found that NDU has become more common among more recent cohorts (consistent with that in Ref. 15), it is likely that the possible J-shaped curve for adult marijuana use is a moving target.

Despite the evidence for any J-shaped relationship for alcohol and marijuana use, we acknowledge that strong conclusions about the possible benefits of light-to-moderate use of adult alcohol or marijuana are not warranted given that any group of adult abstainers include those who formerly experienced substance use disorders; lasting effects of substance use disorders could contribute to lower health and well-being among current abstainers.[28] Furthermore, for the purposes of public health messaging, we also recognize the importance of awaiting more convincing evidence about any J-shaped relationship for adult marijuana use given that the "a little bit is good for you" messaging has complicated alcohol use education efforts.[79]

Strengths, limitations, and future directions. The national, multicohort, long-term longitudinal data represent important strengths of this study. Multiple cohorts allows for understanding how etiology may shift historically,[61] and long-term follow-ups of young people into early midlife provide the required evidence regarding what matters during adolescence in terms of adulthood functioning and adjustment.[11] Limitations of this study include the exclusion of high school dropouts in the sampling frame, the lack of earlier childhood and adolescent data, the brief self-administered questionnaires regarding AUD and CUD symptoms that are descriptive and do not represent clinical diagnoses, and panel attrition. The use of self-report measures of substance use and use disorder, essential given MTF is a large-scale survey study, is an important limitation, given we are relying on respondents' perception and veracity, and thus should use caution in interpreting the findings; nonetheless, previous considerations of the reliability and validity of MTF substance use measures provide reasonable confidence in the

findings.[12,62,63] Regarding panel attrition, our use of attrition weights helps address potential sample biases due to differential attrition; nonetheless, even with attrition weights, it is likely that those suffering profound and enduring substance use disorders are underrepresented in MTF, and thus, our findings are likely conservative in terms of health and well-being correlates of substance use disorders.

In addition to correcting for our limitations, future research would benefit from including more *upstream* childhood data to place any adolescent effects within a broader developmental context and to help consider selection effects.[47] In addition, considering the longitudinal and heterogeneous courses of adolescent and young adult substance use[4] and their associations with midlife substance use disorders would likely provide richer insights. Finally, given that AUDs and CUDs are not stable across adulthood,[80,81] an understanding of how health and well-being risk and protective factors relate to transitions into and out of substance use disorders will be an important next step in future research.

Summary and Conclusions

Using national multicohort prospective data from high school classes 1977–1997 in the MTF study, we bring the required attention to the long-term predictors and concurrent correlates of substance use disorder at early midlife. We found that the estimated rates of age 35 AUDs and CUDs were 28.0% and 6.1%, respectively, based on the DSM-5 definition of mild-to-severe disorder. Within a multivariable model, including numerous sociodemographic controls and risk factors assessed at ages 18 and 35, there were four sets of major findings. First, we found that age 18 binge drinking and marijuana use were among the strongest predictors of age 35 AUD and CUD, respectively, suggesting strong continuity in etiological connections from late adolescence to early midlife. Second, among age 35 health and well-being indicators, we found that lower overall health, more frequent cognitive difficulties, and lower satisfaction with spouse/partner were consistently associated with greater risks of AUD and CUD, suggesting some of the health and well-being difficulties associated with early midlife substance use disorders that can serve as daily impediments to optimal functioning. Third, we found some evidence for a J-shaped association between age 35 AUD status and health and well-being indices, such that NDDs were sometimes better off than both abstainers and those experiencing AUD; and we found some limited evidence for a similar association for age 35 CUD status. Finally, we found cohort variation in age 35 CUD status such that NDU, but not CUD, increased for more recent cohorts, suggesting the changing characteristics of adult marijuana users and underscoring the implication that current knowledge about the etiology of substance use and substance use disorders may change in tandem with changes in policy, public opinion, availability, and other cultural and individual secular changes. This supports the value of continuing to test these associations in new cohorts, particularly in the current changing legal and attitudinal context.

Author Contributions

Conceived and designed the experiments: JS, MP, DK. Analyzed the data: DK, JS. Wrote the first draft of the manuscript: JS, MP, DK. Contributed to the writing of the manuscript: JS, MP, DK, JM, JLM, PO. Agree with manuscript results and conclusions: JS, MP, DK, JM, JLM, PO. Jointly developed the structure and arguments for the paper: JS, MP, DK. Made critical revisions and approved final version: JS, MP, DK, JM, JLM, PO. All authors reviewed and approved of the final manuscript.

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