Non-medical use of prescription opioids during the transition to adulthood: a multi-cohort national longitudinal study

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ABSTRACT

Aims To examine non-medical use of prescription opioids (NMUPO) patterns during the transition from adolescence to adulthood, and assess individual characteristics and other substance use behaviors associated with longitudinal patterns of NMUPO. **Design** Nationally representative samples of high school seniors in the United States (wave 1: modal age 18 years) were followed longitudinally across three biennial follow-up waves (waves 2, 3 and 4: modal ages 19/20, 21/22 and 23/24 years). **Setting** Data were collected via self-administered questionnaires to high school seniors and young adults. **Participants** The longitudinal sample consisted of 27 268 individuals in 30 cohorts (high school senior years 1976–2005) who participated in all four waves. **Measurements** Self-reports of NMUPO and other substance use behaviors. **Findings** Approximately 11.6% [95% confidence interval (CI) = 11.2%, 12.0%] of the sample reported past-year NMUPO in at least one of the four waves. Among those who reported past-year NMUPO in at least one wave, 69.0% (67.6%, 70.4%), 20.5% (19.3%, 21.7%), 7.8% (7.1%, 8.6%) and 2.7% (2.3%, 3.1%) reported NMUPO at one, two, three and four waves, respectively. Several wave 1 variables were associated with greater odds of multiple waves of NMUPO and individuals who reported more waves of NMUPO had greater odds of other substance use behaviors. **Conclusions** Although most non-medical use of prescription opioids among 18-year-olds in the United States appears to be non-continuing, approximately one-third of the sample reporting non-medical use of prescription opioids appear to continue use beyond age 18 and have elevated odds of other substance use behaviors at ages 23/24.

Keywords Adolescents, epidemiology, longitudinal, non-medical use, prescription opioids, substance use.

INTRODUCTION

The rates of medical and non-medical use of prescription opioids (NMUPO) have been rising steadily over the past 15–20 years in the United States [1–12]. Although the United States represents less than 5% of the world's population, Americans consume 80% of the global opioid supply, and 99% of the global hydrocodone supply [10]. While there are several national studies that examine the extent of NMUPO in the United States, there is limited information regarding this public health issue in other developed countries. As a result, cross-national comparisons of NMUPO are difficult to ascertain at this time [12].

In the United States, NMUPO among adolescents and young adults has increased significantly over the past two decades and is most prevalent among individuals 18–25 years of age [1–7]. In 2010, approximately 2 million people aged 12 years or older initiated NMUPO within the past 12 months, which was greater than the estimated number of those who initiated use of any other illicit drug with the exception of marijuana [7]. The estimated number of emergency department visits involving NMUPO more than doubled between 2004 and 2008 for patients younger than 21 years of age [8]. Although there have been recent advances in the understanding of NMUPO, considerable gaps in knowledge remain due to

limitations in measures and study designs [9–12]. In particular, there are few longitudinal studies, leaving gaps in our understanding of individual patterns of NMUPO over time and of risk factors that identify accurately those individuals at greatest risk for chronic patterns of NMUPO [11].

To date, most large-scale national epidemiological studies have been cross-sectional and have revealed high levels of NMUPO with past-year prevalence rates as high as 10% among secondary school students and 20% among college students in the United States [2,3,13,14]. The age at peak risk for initiating NMUPO is 16 years, and the majority of NMUPO is initiated prior to the age of 18 among early and middle-aged adults [2,3,15]. The limited longitudinal evidence suggests that most NMUPO is experimental, but that earlier use sets the stage for later substance use disorders [16]. Based on the National Epidemiologic Survey on Alcohol and Related Conditions, approximately four in every five adults aged 18 years or older in the United States who engaged in NMUPO ceased using 3 years later, but that NMUPO among 18–24-year-olds was associated with greater odds of developing a substance use disorder 3 years later [16]. Furthermore, a cross-sectional study found that the initiation of NMUPO before 18 years of age was associated with significantly higher odds of developing prescription opioid abuse and dependence versus those individuals who began using at or after 18 years of age [17]. Indeed, more than 40% of individuals in the United States who retrospectively reported initiating NMUPO at age 18 or younger developed prescription drug use disorders in their life-time [17]. Taken together, these results indicate that NMUPO during the transition from adolescence to adulthood warrants longitudinal examination to distinguish experimental from escalating use.

Much attention has been devoted to the identification of longitudinal patterns of alcohol and marijuana use across the transition to adulthood [18–20]; similar attention has not been given to NMUPO. In addition, although several cross-sectional studies have found strong associations between NMUPO and other substance use behaviors [13,14,21,22], none have considered how NMUPO relates to other substance use over time. To fill these critical gaps in current knowledge, our purpose is to be the first national study to describe longitudinal patterns of NMUPO during the transition to adulthood, to assess demographic and individual characteristics associated with these patterns of NMUPO and to examine other substance use behaviors associated with patterns of NMUPO. We analyze national panel data from the Monitoring the Future (MTF) study [2,3] and provide a more comprehensive understanding of the heterogeneity associated with NMUPO and its developmental course among adolescents as they move into adulthood.

METHODS

The present study used national panel data from the MTF study conducted in the United States [3,23]. Based on a three-stage sampling procedure, MTF has surveyed nationally representative samples of approximately 17 000 high school seniors each year since 1975, using questionnaires administered in classrooms. Stage 1 is the selection of geographic areas; stage 2 is the selection of schools; and stage 3 is the selection of students within each school. Approximately 2400 high school seniors are selected for biennial follow-ups each year using mailed questionnaires. The biennial follow-up surveys begin 1 year after high school for one random half of each cohort and 2 years after high school for the other half. For the purpose of these analyses, the two halves were combined (combining modal ages 19/20, 21/22 and 23/24 years) due to sample size concerns and lack of significant differences across the two halves on substance use measures. Individuals who used illicit drugs in high school were oversampled for the follow-up surveys. Corrective weighting was used in the analyses to adjust for the unequal probabilities of selection that occurred at any stage of sampling. The project design and sampling methods are described in greater detail elsewhere [3,24].

Sample

The sample for the present study consisted of respondents who were surveyed as high school seniors (wave 1) from 1976 to 2005, and who were surveyed in their first, second and third biennial follow-up surveys (waves 2, 3 and 4, respectively). Given the aims of the present study, the 30 cohorts were combined and analyses were conducted with 27 268 respondents (weighted number in longitudinal sample) who provided data at all four waves, yielding a retention rate of just under 50%. Relaxing this requirement and imputing missing data would have increased our longitudinal sample, but given our focus on individual developmental patterns of NMUPO this full-data inclusion criterion was necessary. This longitudinal sample consisted of 59% females, 82% whites, 7% blacks, 5% Hispanics and 6% other racial/ethnic groups or not specified. As illustrated in Table 1, attrition analyses at wave 1 revealed that those retained in the longitudinal sample differed compared to those who attrited. For instance, individuals retained in the longitudinal sample were more likely to be female and white, report good grades in high school, have higher parent education, have any college plans and have lower rates of skipping class, evenings out, 2-week binge drinking and past-year marijuana use. In addition, individuals retained in the longitudinal sample had lower rates of past-year NMUPO and past-year non-medical use of amphetamines and/or tranquilizers.

Table 1 Wave 1 sample characteristics for the longitudinal sample and attrition sample.

	Longitudinal sample n = 27 268 % (95% CI)	Attrition sample n = 27 862 % (95% CI)
Gender		
Male	40.7 (40.0–41.4)	54.6 (53.9–55.3)
Female	59.3 (58.6–60.0)	45.4 (44.7–46.1)
Race/ethnicity		
Black	7.4 (6.6–8.1)	16.5 (15.1–17.9)
White	82.1 (81.0–83.1)	65.4 (63.7–67.1)
Hispanic	4.9 (4.4–5.5)	10.0 (8.9–11.1)
Other	5.6 (5.2–6.0)	8.1 (7.7–8.5)
Geographical region		
South	30.2 (28.6–31.7)	37.2 (35.7–38.8)
Northeast	21.7 (20.3–23.1)	19.7 (18.5–20.8)
Midwest	31.3 (29.7–32.9)	23.9 (22.6–25.2)
West	16.8 (15.5–18.1)	19.2 (17.9–20.6)
Urbanicity		
Farm/country	19.2 (18.1–20.3)	17.1 (16.2–18.0)
Small city or larger	80.8 (79.7–81.9)	82.9 (82.0–83.8)
Parent education		
Some college	65.2 (64.1–66.3)	62.5 (61.5–63.6)
High school or less	34.8 (33.7–35.9)	37.5 (36.4–38.5)
High school GPA		
B– or higher	82.8 (82.2–83.4)	70.7 (69.9–71.5)
C+ or lower	17.2 (16.6–17.8)	29.3 (28.5–30.1)
College plans		
Yes college plans	51.7 (50.6–52.8)	44.7 (43.7–45.7)
No college plans	48.3 (47.2–49.4)	55.3 (54.3–56.3)
Truancy		
Did not skip any days	68.4 (67.4–69.3)	60.8 (59.8–61.8)
Skipped any days	31.6 (30.7–32.6)	39.2 (38.2–40.2)
Work intensity		
No work	22.5 (21.8–23.1)	24.9 (24.2–25.6)
1–15 hours/week	33.6 (33.0–34.3)	26.5 (25.9–27.1)
16+ hours/week	43.9 (43.1–44.7)	48.6 (47.8–49.4)
Evenings out		
Less than 3 weekly	52.8 (52.1–53.5)	48.6 (47.8–49.3)
3 or more weekly	47.2 (46.5–47.9)	51.4 (50.7–52.2)
Binge drinking		
No, past 2 weeks	70.5 (69.7–71.3)	64.7 (63.9–65.5)
Yes, past 2 weeks	29.5 (28.7–30.3)	35.3 (34.4–36.1)
Marijuana use		
No, past 12 months	68.4 (67.6–69.3)	60.7 (59.9–61.5)
Yes, past 12 months	31.6 (30.7–32.4)	39.3 (38.5–40.1)
Senior year cohort		
1976–91	60.0 (57.6–62.5)	42.2 (39.8–44.7)
1992–2001	30.9 (28.6–33.2)	42.0 (39.5–44.5)
2002–05	9.1 (7.8–10.3)	15.7 (13.8–17.7)

All frequencies and percentages are weighted. CI = confidence interval; GPA = grade point average.

Measures

Using six randomly distributed questionnaire forms, the MTF assesses demographic and psychosocial characteristics and standard measures of substance use.

NMUPO

NMUPO was assessed at all four waves with an item asking respondents on how many occasions (if any) they had used prescription opioids on their own, without a doctor's orders (e.g. Vicodin®, OxyContin®, Percodan®, Percocet®, Demerol®, Dilaudid®, morphine, methadone, opium, codeine), during the past 12 months. The response scale was (1) no occasions, (2) one to two occasions, (3) three to five occasions, (4) six to nine occasions, (5) 10–19 occasions, (6) 20–39 occasions and (7) 40 or more occasions. It should be noted that the list of examples was updated in 2002 and several 'older' medications (e.g. laudanum, Talwin®) were replaced with more 'current' medications (e.g. Vicodin®, OxyContin®, Percodan®, Percocet®, Dilaudid®). The addition of these new examples was followed by an uptick in prevalence of NMUPO, probably due in part to the changed question [2,3].

Demographic and life-style characteristics

Demographic and life-style characteristics were assessed at wave 1 and consisted of student self-reports of the following: gender, race/ethnicity (black, white, Hispanic, other), urbanicity (where grew up, farm/country versus not), parental education (some college versus high school or less), high school grade point average (B– or higher versus C+ or lower), college plans (any plans versus no plans), truancy (did not skip any days in the past 4 weeks versus one or more skipped days), work intensity (no work versus 1–15 hours per week versus 16 or more hours per week), social evenings out (fewer than three per week versus three or more per week), past 2-week binge drinking (any versus none) and past-year marijuana use (any versus none). Geographic region of the country (Northeast, Midwest, South, West) was based on school location information. Senior year cohort was split into three periods based on the high school class survey year (1976–91, 1992–2001 and 2002–05). These three cohort periods were selected due to decreases in the prevalence of NMUPO among high school seniors following 1991 and a change in wording for the NMUPO measure in 2002, resulting in an increase in the prevalence of NMUPO [2,3]. Cut-points in the covariates were determined based on sensitivity analyses; categorical covariates were desirable given our analytical and descriptive approaches.

Other substance use behaviors

Other substance use behaviors were assessed at wave 4, including 2-week binge drinking (any versus none) and past-year marijuana use (any versus none). We also included past-year other non-medical prescription drug use—including amphetamines (e.g. Ritalin®,

Dexedrine®) and/or tranquilizers (e.g. Ativan®, Klonopin®, Valium®, Xanax®)—which were measured with the following questions: 'On how many occasions (if any) have you used [specified drug class] during the last 12 months?'. The response scale for each substance was the same as for NMUPO. A single dichotomous variable was created for analysis from the separate measures to indicate prevalence of use for one or more of these drug classes.

Data analysis

Given that this was the first national study to examine longitudinal patterns of NMUPO systematically during the transition from adolescence to adulthood, we took a straightforward descriptive approach to addressing our research questions. First, the patterns of past-year NMUPO and the number of waves of past-year NMUPO were described using simple frequency tables. Secondly, multivariable logistic regression models were used to examine the relationships of wave 1 demographics and life-style characteristics with the following three patterns of past-year NMUPO: (i) at one wave only, (ii) at two or more waves and (iii) at all four waves. These three patterns of NMUPO were chosen to capture experimental use at one wave only, repeated use at two or more waves and chronic use at all four waves. Finally, we examined the prevalence of wave 4 substance use behaviors (i.e. binge drinking in the past 2 weeks, marijuana use in the past year and other non-medical use of prescription drugs in the past year) by the number of waves of NMUPO (i.e. no waves, one, two, three and four waves). Multivariable logistic regression models were used controlling for wave 1 demographic and life-style characteristics to understand the unique contribution of NMUPO patterns to wave 4 substance use behaviors. Analyses incorporated the complex sample design variables and were weighted for follow-up sampling selection using SAS version 9.3 SURVEY commands (MEANS, FREQ, LOGISTIC, REG) as appropriate.

RESULTS

Approximately 11.6% (95% CI = 11.2%, 12.0%) of the sample reported past-year NMUPO in at least one of the four waves of measurement. The mean level of occasions of past-year NMUPO in the sample held relatively steady over the four waves. The weighted mean frequency of past-year NMUPO (response scale ranged from 1, 'no occasions' to 7, '40 or more occasions') was 1.09 at wave 1 (modal age 18) and 1.08 at waves 2, 3 and 4 (modal ages 19/20, 21/22 and 23/24 years, respectively). As shown in Table 2, there were 16 possible patterns of past-year NMUPO over time. The majority of high school

seniors who reported past-year NMUPO at wave 1 did not engage in this behavior again at waves 2, 3 or 4.

In the second phase of the analyses, multivariable logistic regression analyses indicated that several wave 1 variables, including race/ethnicity (white), truancy, binge drinking, marijuana use and senior year cohorts after 1991, were associated with significantly greater odds of all three patterns of past-year NMUPO (see Table 3). For example, the odds of past-year NMUPO at two or more waves were more than six times greater among high school seniors who reported past-year marijuana use at wave 1 compared to those who did not use marijuana. Other covariates were related less consistently to NMUPO patterns. High school seniors who reported 'other' race/ethnicity and those who spent three or more evenings out per week had greater odds of past-year NMUPO at one wave only and at two or more waves. High school seniors with at least one college educated parent had greater odds of past-year NMUPO at two or more waves and at all four waves. Those who had lower grade point averages and reported being Hispanic had greater odds of past-year NMUPO at one wave only while high school males had greater odds of past-year NMUPO at two or more waves. High school seniors without plans to attend college had greater odds of past-year NMUPO at all four waves. Finally, urbanicity and work intensity were not associated with any of the three patterns of NMUPO.

In the third phase of the analyses, we examined the wave 4 (modal ages 23/24) prevalence rates of binge drinking in the past 2 weeks, marijuana use in the past year and other non-medical use of prescription drugs in the past year as a function of the number of waves of NMUPO and wave 1 covariates from phase 2 of the analyses. As shown in Table 4, binge drinking was the most common substance use behavior among those who never engaged in past-year NMUPO, whereas past-year marijuana use was the most common substance use behavior among those who reported any past-year NMUPO over four waves. Substance use behaviors at wave 4 were more prevalent among those who reported more waves of past-year NMUPO.

As presented in Table 4, multivariable logistic regression analyses confirmed that substance use behaviors at wave 4 were highly associated with number of waves of past-year NMUPO after adjusting for covariates. The odds of substance use behaviors at wave 4 were significantly greater among those who reported more waves of NMUPO compared to those who never engaged in NMUPO. Notably, individuals who reported NMUPO at all four waves had approximately four times greater odds of binge drinking in the past 2 weeks, approximately 17 times greater odds of marijuana use in the past year and approximately 39 times greater odds of non-medical use

Table 2 Frequencies and patterns associated with non-medical use of prescription opioids over four waves.

Past-year non-medical use of prescription opioids	Number of waves	Frequency (n)	Overall sample (%) (95% CI)	Non-medical users (n = 3173) (%) (95% CI)
No waves	0	24 096	88.4 (88.0–88.7)	–
Wave 1 only	1	733	2.7 (2.5–2.8)	23.1 (22.0–24.3)
Wave 2 only	1	487	1.8 (1.6–1.9)	15.3 (14.2–16.5)
Wave 3 only	1	493	1.8 (1.7–2.0)	15.5 (14.4–16.7)
Wave 4 only	1	477	1.7 (1.6–1.9)	15.0 (13.8–16.2)
Waves 1 and 2	2	165	0.6 (0.5–0.7)	5.2 (4.6–5.8)
Waves 1 and 3	2	72	0.3 (0.2–0.3)	2.3 (1.9–2.7)
Waves 1 and 4	2	67	0.3 (0.2–0.3)	2.2 (1.8–2.5)
Waves 2 and 3	2	97	0.4 (0.3–0.4)	3.1 (2.5–3.6)
Waves 2 and 4	2	68	0.3 (0.2–0.3)	2.2 (1.7–2.6)
Waves 3 and 4	2	179	0.7 (0.6–0.7)	5.6 (4.9–6.4)
Waves 1, 2 and 3	3	76	0.3 (0.2–0.3)	2.4 (2.0–2.8)
Waves 1, 2 and 4	3	44	0.2 (0.1–0.2)	1.4 (1.1–1.7)
Waves 1, 3 and 4	3	42	0.2 (0.1–0.2)	1.3 (1.0–1.6)
Waves 2, 3 and 4	3	87	0.3 (0.3–0.4)	2.8 (2.2–3.3)
All four waves	4	84	0.3 (0.3–0.4)	2.7 (2.3–3.1)
Total	–	27 268		
Number of waves				
No waves		24 096	88.4 (88.0–88.7)	–
One wave		2 189	8.0 (7.7–8.3)	69.0 (67.6–70.4)
Two waves		650	2.4 (2.2–2.5)	20.5 (19.3–21.7)
Three waves		249	0.9 (0.8–1.0)	7.8 (7.1–8.6)
Four waves		84	0.3 (0.3–0.4)	2.7 (2.3–3.1)
Total		27 268		

All frequencies and percentages are weighted. CI = confidence interval.

of other prescription drugs in the past year than those who had not reported NMUPO at any of the four waves.

DISCUSSION

The findings of the present study extend what is known about the longitudinal patterns of NMUPO among adolescents during the transition to adulthood in several important ways. Sixteen different longitudinal patterns associated with NMUPO were described, and the most prevalent pattern of use included those who reported NMUPO only in their senior year of high school. The majority of individuals who reported NMUPO in their senior year of high school did not engage in this behavior 1–2 years later and even fewer reported NMUPO 3–6 years later. The results of this study were consistent with a previous study that found the majority of adults (18 years or older) who engaged in NMUPO in the United States ceased using 3 years later [16]. Thus, the present study represents an important first step towards understanding the heterogeneity and persistence associated with NMUPO from a longitudinal perspective.

Multivariable logistic regression analyses identified several common wave 1 variables that were associated with significantly greater odds of engaging in multiple waves of past-year NMUPO including race/ethnicity (white), truancy, binge drinking, marijuana use and more recent high school senior year cohorts (1992–2005). The findings of the present study indicated that white adolescents and those who engaged in multiple problem behaviors while in high school were at increased risk for more chronic patterns of NMUPO during the transition to adulthood. The results also provided additional support for a significant increase in NMUPO among adolescents and young adults over the past two decades [1–3,5,6]. Based on the recent increases in prevalence of NMUPO in the United States, additional prevention and intervention efforts are clearly warranted to reduce NMUPO among adolescents and young adults.

We found significant associations between longitudinal patterns of NMUPO and other substance use behaviors, such as binge drinking, marijuana use and non-medical use of other prescription drugs. While only about 3% of non-medical users reported NMUPO at all four waves, nearly all these individuals reported other substance use behaviors at ages 23/24. The odds of substance use behaviors were significantly greater among individuals who reported more waves of past-year

Table 3 Logistic regression results for selected non-medical use of prescription opioids patterns.

Wave 1 characteristics	Non-medical use at one wave only		Non-medical use at two or more waves		Non-medical use at all four waves	
	(%)	Adjusted OR (95% CI)	(%)	Adjusted OR (95% CI)	(%)	Adjusted OR (95% CI)
Gender						
Male	8.6	Referent	4.4	Referent	0.1	Referent
Female	7.7	1.00 (0.91,1.09)	3.1	0.79 (0.70,0.89)**	0.2	0.75 (0.55,1.03)
Race/ethnicity						
Black	3.2	Referent	1.1	Referent	0.0	Referent
White	8.7	2.26 (1.73,2.95)***	3.9	2.46 (1.57,3.84)***	0.2	9.34 (1.26,69.19)*
Hispanic	6.0	1.59 (1.11,2.27)*	2.4	1.34 (0.76,2.33)	0.1	3.86 (0.45,33.42)
Other	5.8	1.78 (1.28,2.47)**	3.0	2.07 (1.21,3.55)**	0.0	1.96 (0.20,19.56)
Geographical region						
South	7.4	Referent	3.2	Referent	0.1	Referent
Northeast	8.2	0.87 (0.78,0.98)*	4.0	0.98 (0.82,1.17)	0.2	0.72 (0.45,1.16)
Midwest	7.9	0.88 (0.79,0.98)*	3.4	0.90 (0.76,1.05)	0.2	0.68 (0.45,1.04)
West	9.0	1.07 (0.93,1.24)	4.2	1.08 (0.89,1.33)	0.2	1.06 (0.67,1.70)
Urbanicity						
Farm/country	6.8	Referent	2.8	Referent	0.1	Referent
Small city or larger	8.3	1.07 (0.95,1.20)	3.8	1.00 (0.85,1.17)	0.2	1.29 (0.83,2.01)
Parental education						
Some college	8.5	Referent	4.3	Referent	0.2	Referent
High school or less	7.2	0.92 (0.83,1.01)	2.4	0.67 (0.58,0.78)***	0.1	0.59 (0.38,0.91)*
High school GPA						
B- or higher	7.5	Referent	3.4	Referent	0.2	Referent
C+ or lower	10.4	1.18 (1.05,1.32)**	4.6	1.08 (0.94,1.25)	0.2	1.17 (0.78,1.74)
College plans						
Yes college plans	7.6	Referent	3.5	Referent	0.1	Referent
No college plans	8.6	1.03 (0.93,1.14)	3.8	1.13 (0.99,1.29)	0.2	1.80 (1.27,2.55)**
Truancy						
Did not skip any days	6.5	Referent	2.3	Referent	0.1	Referent
Skipped any days	11.5	1.24 (1.13,1.37)***	6.4	1.64 (1.44,1.86)***	0.3	1.68 (1.17,2.40)**
Work intensity						
No work	7.0	Referent	3.1	Referent	0.1	Referent
1–15 hours/week	7.4	0.96 (0.85,1.09)	3.2	0.91 (0.76,1.09)	0.2	1.24 (0.80,1.93)
16+ hours/week	9.0	1.04 (0.92,1.17)	4.1	0.98 (0.84,1.15)	0.2	1.14 (0.74,1.74)
Evenings out						
Less than 3 weekly	6.1	Referent	2.1	Referent	0.1	Referent
3 or more weekly	10.1	1.17 (1.06,1.28)**	5.3	1.44 (1.26,1.64)***	0.2	1.22 (0.86,1.74)
Binge drinking						
No, past 2 weeks	5.8	Referent	2.0	Referent	0.1	Referent
Yes, past 2 weeks	13.6	1.32 (1.19,1.46)***	7.6	1.70 (1.48,1.95)***	0.4	2.44 (1.66,3.57)***
Marijuana use						
No, past 12 months	4.1	Referent	1.1	Referent	0.0	Referent
Yes, past 12 months	16.3	3.62 (3.23,4.05)***	9.1	6.30 (5.30,7.48)***	0.4	13.07 (6.80,25.12)***
Senior year cohort						
1976–91	7.6	Referent	2.7	Referent	0.1	Referent
1992–2001	8.0	1.29 (1.16,1.42)***	4.1	2.17 (1.87,2.53)***	0.2	3.12 (2.05,4.74)***
2002–05	11.0	1.88 (1.61,2.21)***	8.0	4.88 (4.06,5.87)***	0.4	9.71 (6.39,14.75)***

*P < 0.05; **P < 0.01; ***P < 0.001. OR = odds ratio; CI = confidence interval; GPA = grade point average. Referent indicates reference group.

NMUPO, and these high rates did not decline at ages 23/24 as they do typically for these substance use behaviors as adolescents transition to adulthood [3,25–27].

High school graduation represents a major developmental transition for many adolescents in the United States. Adolescents and young adults often assume responsibility for their own medication management during the transition to adulthood, which may contribute to the high rates of NMUPO found in this age group [2–4,7]. Past work has found that the majority of adolescents and young adults who report NMUPO obtain

Table 4 Bivariate and logistic regression results for substance use behaviors associated with non-medical use of prescription opioids.

Number of waves of non-medical use	Wave 4 binge drinking past 2 weeks		Wave 4 past-year marijuana use		Wave 4 past-year other non-medical prescription drug use[a]	
	%	Adjusted OR (95% CI)[b]	%	Adjusted OR (95% CI)[b]	%	Adjusted OR (95% CI)[b]
No waves	33.1	Referent	22.5	Referent	6.0	Referent
One wave	52.9	1.99 (1.82,2.17)***	55.8	3.88 (3.56,4.23)***	26.3	5.14 (4.62,5.71)***
Two waves	61.6	2.59 (2.24,2.99)***	71.1	7.71 (6.53,9.11)***	45.1	12.05 (10.43,13.93)***
Three waves	72.2	3.61 (2.83,4.59)***	84.8	16.14 (11.99,21.73)***	56.4	18.51 (14.75,23.22)***
Four waves	73.3	4.10 (2.81,5.99)***	85.7	17.83 (11.00,28.90)***	71.8	39.24 (28.04,54.90)***

***$P < 0.001$. OR = odds ratio; CI = confidence interval. [a]Other non-medical prescription drug use included non-medical use of prescription amphetamines and/or tranquilizers. [b]AOR indicates odds ratios are adjusted for the effects of gender, race/ethnicity, geographical region, parent education, high school grade point average, college plans, truancy, evenings out and senior year cohort (odds ratios for these variables are not shown). Referent indicates reference group.

prescription opioids from their friends for free and more than a third obtain them from their own leftover prescription [2,7,28,29]. The present study found that more than one in every nine individuals in the sample reported past-year NMUPO in at least one of the four waves of measurement. Although there is some evidence based on the present study that the mean frequency of past-year NMUPO held steady for the sample, the prevalence of NMUPO for the sample was lower over time, suggesting that those reporting NMUPO were using more frequently. The lack of mean level change across the transition to adulthood belies the underlying changes in individual patterns, with the most common NMUPO pattern being to use at only one wave, suggesting a strong proclivity towards experimental use only.

The present investigation has several strengths that build upon previous substance abuse research examining NMUPO among adolescents and young adults. First, this study includes nationally representative samples of high school seniors in the United States. Secondly, multiple cohorts of high school seniors were followed longitudinally across four waves, enabling an assessment of NMUPO over time and historical change. To date, most national studies have been cross-sectional and have not examined patterns of NMUPO by following adolescents from a modal age of 18 to 24 years of age.

The present study also has some limitations that need to be taken into account when considering the implications of the findings. First, the updates to the prescription opioid category in 2002 may have contributed to the associations between patterns of NMUPO and later cohorts (2002–05). However, no such wording changes were made between 1992 and 2001, and these cohorts were also associated with significantly increased odds of NMUPO, which argues for increases of NMUPO in later cohorts. Changes in wording in longitudinal studies always represent a challenge to tracking prescription

medications over time, and the updates in the 2002 question make it undeniably more difficult to interpret the trends. However, similar changes were made to prescription medication questions in other national studies (e.g. National Epidemiologic Survey on Alcohol and Related Conditions, National Survey on Drug Use and Health, College Alcohol Study) and, on balance, creating questions that include 'current' medications is more important than maintaining items with obsolete wording. An additional limitation is that the survey items did not specify the quantity of prescription opioids that was used on each occasion. Finally, retention over all four waves was approximately 50%; males, non-whites and those who reported NMUPO and other problem behaviors were less likely to participate in the study over time based on attrition analyses. Thus, it is very likely that individuals who experienced the most serious patterns of and consequences associated with NMUPO are under-represented in the longitudinal sample, suggesting that our findings represent an underestimation of high use patterns and potential consequences.

Based on increases in NMUPO and prescribing of opioids over the past two decades [30–32], future research should examine the association between prescribing patterns of prescription opioids and NMUPO among adolescents and young adults. Based on the long-term health risks associated with early initiation of NMUPO, the prediction of future NMUPO during childhood and early adolescence represents an important topic for future research [15,17]. Previous research has shown that heavy drinking and other substance use behaviors tend to decline as young adults assume greater responsibilities [3,19,25–27]. An important question for future research, based on the present findings, is whether the typical decline in substance use behaviors holds equally well for NMUPO based on the high abuse potential of prescription opioids [32].

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