Birth-Cohort Trends in Lifetime and Past-Year Prescription Opioid-Use Disorder Resulting From Nonmedical Use: Results From Two National Surveys*

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ABSTRACT. Objective: This study aims to test whether recent increases in the reported prevalence of opioid-use disorder in the United States occurred across all age groups (period effect), consistently only among younger age groups (age effect), or varied according to year of birth (cohort effects). **Method:** Joint analysis of data from the 1991-1992 National Longitudinal Alcohol Epidemiologic Survey (NLAES) and the 2001-2002 National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), focusing on individuals ages 18-57, grouped by 10-year age intervals. Sample sizes for the present analyses were 30,846 for the NLAES and 31,397 for the NESARC. Prevalence of lifetime and past-year prescription opioid-use disorder resulting from nonmedical use (abuse and dependence) was examined. **Results:** Within birth cohorts, prevalence of lifetime prescription opioid-use disorder increased during the 10 years between surveys, indicating the importance of age effects. In addition, lifetime and past-year prevalence of prescription opioid-use disorder was higher among more recent birth cohorts as compared with earlier birth cohorts, indicating the importance of cohort effects. Consistent with a period effect, cross-cohort comparisons showed that risk for prescription opioid-use disorder has increased for all individuals regardless of their birth cohort membership from the NLAES to the NESARC survey. **Conclusions:** Findings suggest that more problems (abuse and dependence) may emerge as prescription opioid users get older and that more recent birth cohorts are at higher risk for prescription opioid problems. (*J. Stud. Alcohol Drugs, 71,* 480-487, 2010)

THERE HAVE BEEN SUBSTANTIAL INCREASES in the availability of prescription opioids in the United States, as evidenced by the increase in the number of prescriptions for opioids in the past 15 years (Cicero et al., 2007; Compton and Volkow, 2006; Van Zee, 2009; Zacny et al., 2003). Pain medications such as prescription opioids can be effective when used properly, but these drugs can be addictive and dangerous when used improperly because they have a high misuse potential. One type of improper use is nonmedical use—defined as "use to get high, using more than prescribed, using it for indications other than those intended by the prescriber, or for other experiences, sensations, or effects beyond the boundaries of approved prescribing procedures or indications as dispensed" (Anthony et al., 1994, p. 244). The development of dependence on prescription opioids resulting from nonmedical use is associated with adverse consequences, including comorbidity with other substances of abuse. Huang et al. (2006) showed that lifetime prescription opioid-use disorders resulting from nonmedical use are strongly associated with other prescription-drug-use disorders, alcohol-use disorders, and illegal-drug-use disorders.

Evidence for increase in nonmedical use includes reports that nonmedical use of prescription opioids in the U.S. population age 18 years and older doubled within a 10-year time span, from 0.6% in 1991-1992 to 1.3% in 2001-2002 (Blanco et al., 2007). The estimated prevalence of past-year disorders (abuse/dependence) from nonmedical prescription opioid use has also increased in this same period, from 0.1% in 1991-1992 to 0.3% in 2001-2002 (McCabe et al., 2008). However, studies to date have not attempted to determine whether more recent birth cohorts are at higher risk than earlier cohorts or the degree to which risk for prescription

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opioid-use disorder resulting from nonmedical use increases or decreases with age. Variation by birth cohort is an important aspect of the epidemiology of prescription opioid-use disorder. Cohorts at high risk for the disorder resulting from nonmedical use should be targeted for intervention, and examination of the environments unique to certain birth cohorts can aid in the identification of etiologic factors. The current article uses a repeated cross-sectional approach (Firebaugh, 1997) to disentangle potential age, period, and cohort effects in prescription opioid-use disorders in the United States.

Rates of prescription opioid-use disorder resulting from nonmedical use have been found to vary by age, with lifetime and past-year disorders more common among younger adults (Becker et al., 2008a, 2008b; Huang et al., 2006; Martins et al., 2009). In addition, the changes in the prevalence of prescription opioid use and disorder are linked with possible influences of time, changes with age, or both. Further, the introduction of new types of prescription opioid compounds could increase use among the entire population, regardless of age (period effect), or alternatively, the uptake of the new compounds could vary across age. For example, the elderly might use new medications more for relief of pains attributable to aging, suggesting the presence of a cohort effect. It is also possible that age effects would arise whereby younger cohorts would be at higher risk for use at both time points, because there is a general tendency for younger people to report higher rates of psychopathology and substance-related problems (Grucza et al., 2008; Simon and VonKorff, 1992).

Evidence for birth cohort effects in health outcomes is relevant for both epidemiological surveillance and etiologic research (Hasin et al., 2007). For surveillance, health outcomes that differ by birth cohort should be analyzed and presented by year of birth rather than year of observation or year of death, because the latter approaches can obscure the interpretation of trends. For etiologic investigations, the identification of particular birth cohorts with increased risk of a health outcome provides an anchor for hypothesis generation and testing regarding early life factors that may contribute to the development of the outcome over time.

Analysis of data from repeated cross-sectional surveys facilitates such an examination by allowing change within birth cohorts to be disentangled from differences between birth cohorts (Firebaugh, 1997). This has previously been applied to combined data from the National Longitudinal Alcohol Epidemiologic Survey (NLAES; Grant, 1997) and National Epidemiologic Study on Alcohol and Related Conditions (NESARC; Grant et al., 2006) to demonstrate cohort differences in lifetime prevalence of alcohol use and dependence (Grucza et al., 2008; Keyes et al., 2008). Moreover, lifetime disorder data can be combined with past-year disorder estimates to analyze changes in both the number of users with a disorder and the persistence of disorders within birth cohorts. Likewise, differences in lifetime disorder and persistence across cohorts can be evaluated.

In this article, we combine information from the NLAES and NESARC, two U.S. national surveys conducted 10 years apart. Our goal was to test whether the increases in prevalence of prescription opioid-use disorder resulting from nonmedical use occurred across all age groups (period effect), occurred consistently only among younger age groups (age effect), or varied according to year of birth (cohort effects). To evaluate evidence for age effects, we examine changes within birth cohorts over the 10-year period between surveys. To evaluate evidence for cohort effects, we examine differences between similarly aged birth cohorts born 10 years apart. To evaluate period effects, we examine whether changes across time are consistent across age groups. In addition, to assist in the comparisons of prescription opioid-use-disorder prevalence changes within birth cohorts, we also report changes in the lifetime and past-year prevalence of nonmedical prescription opioid use within birth cohorts over the same period.

Method

Sample

The NLAES was conducted in 1991-1992 (N = 42,862, response rate of 90%); the NESARC was conducted in 2001-2002 (N = 43,093, response rate of 81%). Both surveys focused on alcohol and drug use; Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric Association, 1994) substance-use disorders; associated impairment; and comorbid psychiatric disorders in samples representative of the adult (18 and older), noninstitutionalized, civilian population of the United States. Data were collected in all 50 U.S. states and the District of Columbia. Blacks and young adults were oversampled in both surveys and Hispanics were oversampled in the NESARC. Face-to-face interviews were administered by experienced lay interviewers from the U.S. Census Bureau. Respondents were informed about measures taken to ensure the confidentiality of the information they provided and informed consent was obtained from all subjects. Further details for both surveys and comparative descriptions of methods are available elsewhere (Compton et al., 2004; Dowling et al., 2006; Grant et al., 2004; Grucza et al., 2008; Simoni-Wastila et al., 2004).

Change in cohort composition as a result of differential mortality is a potential confounder for these analyses. Hence, the present analyses focuses on the subset of subjects ages 18-57 at the time of the survey. The upper age limit of 57 serves to mitigate the potential effects of differential mortality on cohort composition (Grucza et al., 2008). The analysis sample for this study includes 30,843 persons in the NLAES and 31,397 persons in the NESARC.

Measures

Both surveys used the Alcohol Use Disorder and Associated Disabilities Interview Schedule-DSM-IV Version (AUDADIS-IV) to assess substance use and dependence as well as other psychiatric disorders. Nonmedical use of prescription opioids was described to respondents as using a prescription opioid: "without a prescription, in greater amounts, more often, or longer than prescribed, or for a reason other than a doctor said you should use them." In both surveys, an extensive list of prescription opioids was shown to each respondent. The same wording was used in each survey and a more extensive list of specific prescription opioids is available elsewhere (Grant et al., 2006). The same questions were administered the same way by interviewers who underwent similar, extensive training (Compton et al., 2004). To ensure equality of measurement across the NLAES and NESARC, prescription opioid-use disorder resulting from nonmedical use (abuse/dependence) was considered positive in both samples only if respondents in the NESARC used prescription opioids nonmedically 12 or more times on a lifetime basis (this threshold is created in the NESARC by combining the lifetime and past-year use variables with the frequency of use variables, for instance, if respondents used prescription opioids only in the past year, they were classified as users only if they used prescription opioids at least once a month in the past 12 months; more details are available on request).

Prescription opioid-use disorder resulting from nonmedical use was defined as per DSM-IV substance abuse and dependence criteria. Test-retest reliability for AUDADIS-IV past-year opioid-disorders (abuse/dependence) diagnosis resulting from nonmedical use in general population and clinical settings was good to fair with a κ agreement of .59 for past-year dependence (Grant et al., 1995; Hasin et al., 1997). From this point onward, for simplicity, prescription opioid disorder resulting from nonmedical use will be referred to as prescription opioid-use disorder.

Subjects were categorized into 10-year age groups (18-27, 28-37, 38-47, and 48-57) in both the NESARC and NLAES. Individuals who were 18-27 in the NLAES are from the same birth cohort of individuals who were 28-37 10 years later in the NESARC (both groups were born from approximately 1964 to 1973). Similarly, individuals who were 28-37 in the NLAES are from the same birth cohort of individuals who were 38-47 in the NESARC (both groups were born from approximately 1954 to 1963). Cohorts born between 1944 and 1973 were represented in both surveys, whereas those born between 1974 and 1983 were represented in the NESARC only (individuals ages 18-27 in 2001-2002), and those born between 1934 and 1943 were represented in the NLAES only (individuals 48-57 in 1991-1992).

Statistical analyses

Because of similarities in the sampling universe, definitions of outcome variables, and other methodological characteristics, simultaneous analysis of the NLAES and NESARC constitutes a repeated cross-sectional analysis. When subjects from the NESARC, conducted in 2001-2002, are grouped by age and compared with subjects of the same age range from the NLAES, conducted in 1991-1992, the primary distinction between the two are cohort differences, where the ranges of birth years are offset by 10 years.

Proper methods for the detection of age, period, and cohort effects have been the source of debate for decades (Glenn, 2005; Mason et al., 1973). We used basic descriptive methods to examine evidence for the presence of age, period, and cohort effects separately, a basic epidemiologic method that involves the comparison of prevalence within certain groups. Three comparisons were made.

First, we evaluated evidence for age effects by examining changes in prevalence across age within each cohort group. For example, we started with the same cohort of people (e.g., born between 1964 and 1973) and compared the prevalence of prescription opioid-use disorder when they were 18-27 years old (one cohort assessed by NLAES) with the prevalence obtained when they were 28-37 years old (same cohort assessed by NESARC). Second, we evaluated evidence for cohort effects by examining changes in prevalence across cohorts within each age group. For example, the prevalence in the 1964-1973 NLAES birth cohort was compared with the similarly aged (i.e., 18-27 years) 1974-1983 NESARC birth cohort. Third, we evaluated evidence for period effects by examining the prevalence of prescription opioid-use disorder across all age groups between the NLAES and the NESARC. For example, period effects would be implicated if the prevalence is higher for all age groups in the NESARC compared with the NLAES. These prevalences were calculated for four outcomes: lifetime disorder among the overall population within each cohort, lifetime disorder among lifetime users within each cohort, past-year disorder among the overall population within each cohort, and past-year disorder among lifetime users within each cohort.

Effects were statistically evaluated on both the additive and multiplicative scale. On the additive scale, we provided proportions with 95% confidence intervals and annotations for unadjusted p values. Differences in proportion on the additive scale are most directly relevant for public health, because they provide a measure of the absolute risk increase associated with a particular exposure (in this case, age and birth cohort). On the multiplicative scale, we provided odds ratios (ORs) and 95% confidence intervals (CIs) derived from weighted logistic regressions to examine overall cross-cohort comparisons. Differences in proportion on the multiplicative scale are most directly relevant for etiologic investigation, because they provide a measure of the relative

increase associated with an exposure compared with a state of being unexposed (Feise, 2002; Perneger, 1998; Rothman, 1990).

All statistical analyses were conducted using the Stata 10.0 statistical software package (StataCorp LP, College Station, TX). Variance estimation used a Taylor linearization method appropriate for the complex design of each survey. Significance of between-survey differences in prevalence estimates were assessed using two-sample *Z* tests. Chi-square tests were used to assess the significance of within-survey age-cohort effects. Reported *p* values reflect comparison-wise error rates; that is, no adjustment for multiple testing was introduced (Bender and Lange, 2001). The study aims made Type-I (false positive) and Type-II (false negative) errors of equal concern.

Results

Intracohort comparisons: Lifetime and past-year prevalence of nonmedical prescription opioid use and prescription opioid-use disorder resulting from nonmedical use

Table 1 compares equivalent birth cohorts across the two surveys with respect to lifetime and past-year prevalence of nonmedical prescription opioid use. Because lifetime prescription opioid use is a cumulative behavior and we have controlled for the effects of population change, we expect the primary contribution to changes in lifetime prevalence between NLAES and NESARC to be new cases of prescription opioid use. There were no significant changes in lifetime use within birth cohorts as they aged (e.g., lifetime prevalence in the 1964-1973 birth cohort was 3.2% in the NLAES and 3.4% in the NESARC, 10 years later), suggesting that initiation of nonmedical use of prescription opioids beyond age 27 (the upper limit of the youngest age category) is rare. Nonetheless, Table 1 also shows that past-year use increased among older birth cohorts between the NLAES and NESARC: among those born in 1944-1953 we see a 60% increase, and among those born in 1954-1963 there is a 56% increase. This tendency is particularly clear when evaluating past-year use, conditioned on lifetime use, as shown in the bottom of Table 1 (e.g., there is a 64% increase in past-year use from the NLAES to the NESARC [20.9% to 34.3%] among lifetime users born in the 1954-1963 birth cohort). However, discrepancies in lifetime and past-year reports of prescription opioid use could occur in older cohorts because of differential reporting of lifetime or past-year use with increasing age within cohorts across the two surveys, or there might be other forms of heterogeneity that may not reflect age effects. Results were essentially unchanged when analyses were limited to U.S.-born subjects, eliminating immigration as a possible source of within-cohort change (not shown; available on request).

Because lifetime prescription opioid-use disorder is a cumulative diagnosis, we expect the primary contribution

Table 1. Intracohort (rows) comparisons of lifetime and past-year prevalence (%) of nonmedical prescription opioid use

	Age ranges (*n*)		Estimated use, % [95% CI]		
Birth cohort	NLAES 1991-1992	NESARC 2001-2002	NLAES 1991-1992	NESARC 2001-2002	Intracohort difference[a]
Lifetime use					
1974-1983	–	18-27 (7,168)	–	3.9 [3.4, 4.5]	–
1964-1973	18-27 (7,746)	28-37 (8,527)	3.2 [2.8, 3.6]	3.4 [2.9, 3.9]	6%
1954-1963	28-37 (10,221)	38-47 (8,840)	4.2 [3.7, 4.6]	4.1 [3.6, 4.7]	-2%
1944-1953	38-47 (7,820)	48-57 (6,862)	2.8 [2.4, 3.2]	2.6 [2.1, 3.0]	-7%
1934-1943	48-57 (5,056)	–	1.1 [0.8, 1.5]	–	–
Total (1944-1973)	18-47 (25,787)	28-57 (24,229)	3.4 [3.2, 3.7]	3.4 [3.1, 3.7]	0
Past-year use					
1974-1983	–	18-27 (7,168)	–	2.5 [2.0, 2.9]	–
1964-1973	18-27 (7,746)	28-37 (8,527)	1.3 [1.0, 1.6]	1.6 [1.2, 1.9]	23%
1954-1963	28-37 (10,221)	38-47 (8,840)	0.9 [0.7, 1.1]	1.4 [1.1, 1.7]	56%*
1944-1953	38-47 (7,820)	48-57 (6,862)	0.5 [0.3, 0.7]	0.8 [0.6, 1.0]	60%*
1934-1943	48-57 (5,056)	–	0.1 [0.0, 0.2]	–	–
Total (1944-1973)	38-47 (7,820)	28-57 (24,229)	0.9 [0.8, 1.0]	1.3 [1.1, 1.5]	44%***
Past-year use among lifetime users					
1974-1983	–	18-27 (255)	–	62.5 [54.8, 69.3]	–
1964-1973	18-27 (260)	28-37 (266)	41.3 [34.5, 48.0]	46.9 [39.6, 54.3]	14%
1954-1963	28-37 (398)	38-47 (332)	20.9 [16.6, 25.2]	34.3 [27.8, 40.8]	64%***
1944-1953	38-47 (237)	48-57 (177)	18.2 [12.5, 23.9]	31.7 [23.8, 39.8]	74%*
Total (1944-1973)	18-47 (895)	28-57 (775)	26.3 [23.0, 29.5]	37.9 [33.7, 42.1]	44%***

Notes: NLAES = National Longitudinal Alcohol Epidemiologic Survey; NESARC = National Epidemiologic Study on Alcohol and Related Conditions. [a]Difference between 2001-2002 (NESARC) and 1991-1992 (NLAES) lifetime prevalence estimates for a given birth cohort.
*$p < .05$; ***$p < .001$.

TABLE 2. Intracohort (rows) comparisons of lifetime prevalence of prescription opioid-use disorder

	Age ranges (*n*)		Disorder, % [95% CI]		
Birth cohort	NLAES 1991-1992	NESARC 2001-2002	NLAES 1991-1992	NESARC 2001-2002	Intracohort difference[a]
Lifetime disorder in the overall population					
1974-1983	–	18-27 (7,168)	–	1.4 [1.1, 1.8]	–
1964-1973	18-27 (7,746)	28-37 (8,527)	0.8 [0.6, 1.0]	1.3 [1.0, 1.6]	62.5%**
1954-1963	28-37 (10,221)	38-47 (8,840)	1.1 [0.8, 1.3]	2.0 [1.6, 2.3]	81.8%***
1944-1953	38-47 (7,820)	48-57 (6,862)	0.9 [0.6, 1.1]	1.0 [0.7, 1.3]	11.1%
1934-1943	48-57 (5,056)	–	0.3 [0.2, 0.5]	–	–
Total (1944-1973)	38-47 (7,820)	28-57 (24,229)	0.9 [0.8, 1.1]	1.4 [1.3, 1.6]	55.5%***
Lifetime disorder among lifetime users					
1974-1983	–	18-27 (255)	–	36.5 [29.1, 44.0]	–
1964-1973	18-27 (269)	28-37 (266)	24.6 [18.8, 30.4]	37.6 [30.4, 44.7]	52.8%**
1954-1963	28-37 (398)	38-47 (332)	26.3 [21.2, 31.5]	47.3 [40.5, 54.0]	79.8%***
1944-1953	38-47 (237)	48-57 (177)	30.6 [23.6, 37.6]	39.6 [31.2, 48.1]	29.4%
1934-1943	48-57 (57)	–	31.1 [17.2, 45.2]	–	–
Total (1944-1973)	18-47 (692)	28-57 (775)	26.9 [23.5, 30.3]	42.4 [32.1, 48.7]	57.6%***

Notes: NLAES = National Longitudinal Alcohol Epidemiologic Survey; NESARC = National Epidemiologic Study on Alcohol and Related Conditions. [a]Difference between 2001-2002 (NESARC) and 1991-1992 (NLAES) lifetime prevalence estimates for a given birth cohort.
**$p < .01$; ***$p < .001$.

to changes in lifetime prevalence between the two assessments (NLAES [1991-1992] and NESARC [2001-2002]) to be new cases of prescription opioid-use disorder. Table 2 compares equivalent birth cohorts across the two surveys with respect to lifetime prevalence of prescription opioid-use disorder. The estimated lifetime prevalence of disorder in the NESARC data as compared with the NLAES data was higher among those born between 1954 and 1963 (an 82% increase) and 1964 and 1973 (a 63% increase). The same pattern of increase for lifetime disorder between the two surveys was also seen when the sample was restricted to lifetime users (among lifetime users born in 1954-1963 there was an 80% increase, and among those born in 1964-1973 there was a 53% increase).

Changes in the estimated past-year prevalence of prescription opioid-use disorder over the 10 years between surveys for similar cohorts are evaluated in Table 3. Past-year disorder remained stable in the 1964-1973 and 1944-1953 birth cohorts but significantly increased among those born in 1954-1963 (a 488% increase). An increase in the past-year disorder estimate for past-year users born between the years 1954 and 1963 was also found when restricted to the sample of lifetime users (533% increase).

Another notable feature of Table 3 is the strong associa-

TABLE 3. Intracohort (rows) comparisons of past-year prevalence of prescription opioid-use disorder

	Age ranges (*n*)		Disorder, % [95% CI]		
Birth year	NLAES 1991-1992	NESARC 2001-2002	NLAES 1991-1992	NESARC 2001-2002	Intracohort difference[a]
Past-year disorder in the overall population					
1974-1983	–	18-27 (7,168)	–	0.6 [0.4, 0.9]	–
1964-1973	18-27 (7,746)	28-37 (8,527)	0.3 [0.2, 0.5]	0.3 [0.2, 0.4]	-13%
1954-1963	28-37 (10,221)	38-47 (8,840)	0.08 [0.03, 0.1]	0.5 [0.3, 0.7]	488%***
1944-1953	38-47 (7,820)	48-57 (6,862)	0.1 [0.04, 0.2]	0.2 [0.05, 0.3]	25%
1934-1943	48-57 (5,056)	–	0.04 [0.01, 0.08]	—	–
Total (1944-1973)	38-47 (7,820)	28-57 (24,229)	0.2 [0.1, 0.2]	0.3 [0.2, 0.4]	55%*
Past-year disorder among lifetime users					
1974-1983	–	18-27 (255)	–	15.8 [10.0, 21.7]	–
1964-1973	18-27 (269)	28-37 (266)	9.8 [5.4, 14.2]	8.0 [4.2, 11.8]	-18%
1954-1963	28-37 (398)	38-47 (332)	1.8 [0.6, 3.0]	11.4 [6.8, 15.9]	533%***
1944-1953	38-47 (237)	48-57 (177)	4.4 [1.4, 7.3]	6.1 [2.1, 10.0]	38.6%
1934-1943	48-57 (57)	–	4.0 [0.3, 7.6]	—	–
Total (1944-1973)	18-47 (692)	28-57 (775)	4.8 [3.2, 6.4]	9.1 [6.5, 11.6]	89.6%**

Notes: NLAES = National Longitudinal Alcohol Epidemiologic Survey; NESARC = National Epidemiologic Study on Alcohol and Related Conditions. [a]Difference between 2001-2002 (NESARC) and 1991-1992 (NLAES) past-year prevalence estimates for a given birth cohort.
*$p < .05$; **$p < .01$; ***$p < .001$.

TABLE 4. Cross-cohort comparisons of lifetime and past-year prescription opioid-use disorder

Age	Birth years		NESARC relative to NLAES OR [95% CI][a]
	NLAES	NESARC	
Lifetime disorder			
18-27	1964-1973	1974-1983	1.8 [1.2, 2.9]**
28-37	1954-1963	1964-1973	1.2 [0.8, 1.7]
38-47	1944-1953	1954-1963	2.3 [1.6, 3.3]***
48-57	1934-1943	1944-1953	2.9 [1.7, 5.1]***
Past-year disorder			
18-27	1964-1973	1974-1983	2.0 [1.0, 3.9]*
28-37	1954-1963	1964-1973	3.6 [1.5, 8.4]**
38-47	1944-1953	1954-1963	3.8 [1.7, 8.5]**
48-57	1934-1943	1944-1953	3.5 [1.2, 10.1]*

Notes: NLAES = National Longitudinal Alcohol Epidemiologic Survey; NESARC = National Epidemiologic Study on Alcohol and Related Conditions. [a]Odds ratio for NESARC relative to NLAES; corresponds to odds ratio for birth years included in NESARC age group (third column), relative to the preceding birth cohort, which is represented in the NLAES (second column).
*$p < .05$; **$p < .01$; ***$p < .001$.

tion between birth cohort and past-year prevalence. In each survey, for past-year disorder, the prevalence is greater among more recent birth cohorts (upper rows) than cohorts born in the years before 1964 (lower rows). These patterns were probed further in cross-cohort analyses.

Cross-cohort comparisons: Lifetime and past-year prevalence of lifetime and past-year prevalence of prescription opioid-use disorder

Prevalence among similar age groups can also be compared across temporally adjacent birth cohort groups (Table 4). For example, the first row shows a change of 80% in the prevalence of lifetime disorder among 18- to 27-year-olds in the cohorts born between 1974 and 1983 as compared with those born between 1964 and 1973. Thus, these analyses evaluate differences between birth cohorts, while controlling for age. Lifetime disorder increased across almost all pairs of birth cohorts that were compared, which is consistent with a period effect, particularly among earlier birth cohorts (comparing those born in 1944-1953 in the NESARC versus those born in 1934-1943 in the NLAES, OR = 2.9, CI [1.7, 5.1], $p < .001$). Past-year disorder also increased among all pairs of birth cohorts, especially among earlier birth cohorts (comparing those born in 1944-1953 in the NESARC versus those born in 1934-1943 in the NLAES, OR = 3.5, CI [1.2, 10.1], $p < .05$).

Discussion

The main aim of this study was to explore whether the increases in prevalence of prescription opioid-use disorder resulting from nonmedical use occurred across all age groups (period effect), occurred consistently only among younger or older age groups (age effect), or varied according to year of birth (cohort effects). We found evidence for age, period, as well as cohort effects.

Indicative of age effects, prevalence of lifetime prescription opioid-use disorder increased during the decade between surveys within most birth cohorts. In addition, the prevalence of past-year disorder increased across age in the 1954-1963 birth cohort. These findings suggest that more problems (abuse and dependence) may emerge as prescription opioid users get older (age effect). For instance, for those in the 1954-1963 birth cohort, past-year disorder increased by 533% in the past decade, even though the number of lifetime users was essentially unchanged (398 in the NLAES survey versus 332 in the NESARC survey). This pattern contrasts sharply with trends observed for other drugs, in which dependence generally declines with age, even among lifetime users (Warner et al., 1995).

Indicative of cohort effects, lifetime as well as past-year prevalence of prescription opioid disorder was usually highest among more recent birth cohorts. For example, the prevalence of lifetime disorder was 1.4% among those born in 1974-1983 in the NESARC, compared with 0.8% among those born in 1964-1973 in the NLAES (when both birth cohorts were ages 18-27 years old). These observations suggest that more recent birth cohorts are at higher risk for prescription opioid problems. In addition, greater past-year use and disorder among more recent birth cohorts may reflect an increased propensity toward chronicity among more recently born lifetime users. This is of concern because studies have shown that the majority of individuals who meet criteria for substance-use disorders (including prescription opioids) did not receive treatment for substance abuse or dependence (Hasin et al., 1997; Warner et al., 1995; Zacny and Lichtor, 2008). It is also important to keep in mind that respondents who meet criteria for prescription opioid-use disorder resulting from nonmedical use have a strong likelihood of also having other prescription drug-, alcohol-, and illegal drug-use disorders, and comorbidities need to be taken into account when treating these individuals (Huang et al., 2006; McCabe et al., 2008).

Indicative of period effects, cross-cohort analyses of past-year prescription opioid-use disorder showed significant increases in the NESARC survey as compared with the NLAES survey in all birth cohorts. These observations are consistent with a period effect; that is, the risk for prescription opioid-use disorder increased for all individuals regardless of their birth cohort membership.

Past-year prescription opioid-use disorder resulting from nonmedical use was consistently higher among younger birth cohorts, which mirrors and extends associations described by Blanco et al. (2007), demonstrating that younger individuals (ages 18-34) in both surveys were more likely to meet criteria for prescription drug abuse/dependence. In addition, our study expands on findings from other studies

showing that past-year prescription opioid-use disorder has increased in recent years, a phenomenon that could possibly be linked to approval of several new opioid drug formulations containing hydrocodone, oxycodone, and codeine in the mid- to late 1990s (U.S. General Accounting Office, 2004). For example, oxycodone (OxyContin) was approved in 1996 for the general U.S. population, a time between the NESARC and NLAES surveys. Moreover, this could be related to the increase in sales of prescription opioids during the same period (Manchikanti and Singh, 2008). These drugs may have been diverted for nonmedical use.

Although this study contributes to the existing literature on the epidemiology of prescription opioid-use disorder, it has a number of limitations. First, as in other national surveys, the measures to assess nonmedical use of opioids in the NLAES and NESARC did not distinguish between patients who misused their own medication or individuals who nonmedically used someone else's opioids, or even whether respondents were using opioids for pain relief, to self-medicate psychiatric disorders, or solely as a recreational drug (Boyd et al., 2006; McCabe et al., 2007, 2008; Zacny and Lichtor, 2008). However, findings from Huang et al. (2006) showing a high comorbidity between prescription opioid-use disorders resulting from nonmedical use and illegal drug-use disorders could suggest that individuals who develop prescription opioid-use disorder after nonmedical use are more likely to have obtained these drugs illegally than legitimately via a health care provider's prescription. Moreover, the NESARC and NLAES surveys did not assess motives for nonmedical use of opioids; thus, nonmedical users who use only for pain relief and nonmedical users who have other motives for use (e.g., recreational use at parties) are grouped together, even though they might differ in their propensity to have opioid use-related problems (Zacny and Lichtor, 2008). Further, there is no information on the source of the participants' prescription opioid supplies, which may be unique in many aspects of use and disorders. In addition, respondents may significantly underreport their drug use in face-to-face surveys (Grucza et al., 2007; Tourangeau and Smith, 1996), although relative trend estimates will still be valid if these effects are consistent across time and cohort. The correspondence between these trends and increases in the number of prescriptions written for opioids (Cicero et al., 2007; Compton and Volkow, 2006; Van Zee, 2009; Zacny et al., 2003) provides further support for their validity.

Despite its limitations, this study has several strengths. The NLAES and NESARC used similar methodology and contained nearly identical survey wording which allowed for valid comparisons of estimates based on data collected in these two national studies. Further, the inclusion of DSM-IV criteria to assess lifetime and past-year opioid-use disorders in 1991-1992 and 2001-2002 represents an important strength for these two national studies (McCabe et al., 2008). The large, nationally representative samples of the NLAES and NESARC allowed for calculation of national prevalence estimates for opioid-use disorders by birth cohort.

In conclusion, this study's findings suggest that age, cohort, and period effects are related to prescription opioid-use disorder resulting from nonmedical use in the past decade, which has implications for continued etiologic investigations of prescription opioid-use disorders. Notably, data suggest that more recent birth cohorts are more likely to have prescription opioid-use disorders and that the risk for opioid-related problems has increased across time in all birth cohorts. Future national studies need to investigate further the health care needs and costs of treating the subpopulation that develops prescription opioid-use disorder.

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