

Changes in Cigarette Use and Nicotine Dependence in the United States: Evidence from the 2001–2002 Wave of the National Epidemiologic Survey of Alcoholism and Related Conditions

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Cigarette use is the leading preventable cause of death among adults in the United States.¹ According to the Centers for Disease Control and Prevention, cigarettes are responsible for approximately 440 000 deaths annually.² Since 1964, when the first surgeon general's report on smoking and health was released, awareness concerning the harmful effects of cigarette use has risen, and in recent years, there has been evidence of a decline in cigarette use. In 2003, the US Department of Health and Human Services reported that the frequency of smoking among adults had declined from 25% in 1990 to 23% in 2000 and 22.5% in 2002.³ Recent studies indicate that this effect may have reached a plateau between 2004 and 2006.⁴

The overall decline from 1964 levels is viewed as confirmatory evidence that public health efforts to increase awareness of the health risks of cigarettes^{4,5} and to decrease cigarette use (e.g., through increased taxation) have succeeded in altering cigarette use behavior.⁶ However, previous studies have mainly addressed tobacco use or cigarette smoking per se rather than examining amount of cigarette use (i.e., frequency and duration) in detail. Specifically, they have not addressed the regular, heavy cigarette use that frequently characterizes nicotine dependence, which is the pattern of use thought to be the most detrimental to health and longevity.

Among studies that have examined prevalence rates of cigarette consumption across time, few have focused specifically on the prevalence of nicotine dependence, and most have not distinguished between nicotine dependence and nondependent cigarette use in prevalence estimates. However, nicotine dependence warrants study as a separate area of concern. The *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV)*,

Objectives. We examined the roles of gender and poverty cigarette use and nicotine dependence among adults in the United States.

Methods. Our data was drawn from participants in the 2001–2002 National Epidemiological Survey of Alcoholism and Related Conditions, a nationally representative sample of US adults 18 years and older.

Results. The overall rate of cigarette use declined between 1964 and 2002. Nicotine dependence does not appear to have declined overall, and there is evidence that nicotine dependence has increased among women in recent cohorts. The odds of nicotine dependence among cigarette users appear to have increased significantly in recent cohorts.

Conclusions. Despite recent declines in cigarette use, the prevalence of nicotine dependence has increased among some groups and has remained steady overall, which may be hampering public health initiatives to reduce cigarette use. Efforts to study or curb cigarette use should therefore take nicotine dependence into account. (*Am J Public Health.* 2009;99:XXX–XXX. doi:10.2105/AJPH.2007.127886)

defines nicotine dependence as a mental disorder,⁷ and research has suggested that nicotine dependence is as strong an addiction and is as difficult to treat as cocaine addiction.⁸ In addition, researchers have established that trends in prevalence of cigarette use are not necessarily parallel with trends in prevalence of nicotine dependence.^{9,10} However, studies that have measured fluctuations in the prevalence of cigarette use have failed to measure fluctuations in nicotine dependence,¹¹ despite the fact that cigarette use and nicotine dependence are likely to have distinct risk factors, courses, treatments, prevention strategies, and outcomes.^{9,12–14} In addition, the outcomes associated with nicotine dependence are thought to be far more severe than those associated with occasional cigarette use, because negative health outcomes are thought to be fairly proportionate to the number of cigarettes smoked.^{14–20}

Another factor that has changed dramatically in the epidemiology of tobacco consumption and dependence over the past several decades is gender. There have been

substantial disparities between men and women in the prevalence of cigarette use and nicotine dependence over the past forty years, with smoking being far more common among men for most of that time.²¹ However, recent evidence suggests a relatively narrow gender gap in smoking prevalence.²² Little is known about gender differences and changes in prevalence of nicotine dependence over the past several decades.

Socioeconomic status has also been shown to be associated with differences in prevalence of cigarette use. Some reports have suggested that cigarette use may be disproportionately common among those in poverty,^{23–28} and rates of cigarette use among adults in different socioeconomic groups are thought to have shifted over time.²⁹ Still, previous studies have not provided information on potential disparities in nicotine dependence by gender and poverty status. This information would ideally be elicited by studies that track changes in prevalence of nicotine dependence by means of repeated general population surveys that use consistent

measures, carried out over many years. Unfortunately, such data are not available, but given the major public health importance of cigarette use and nicotine dependence, we sought a different way to address these questions. To that end, we decided to use data from a large, cross-sectional survey with excellent measures of cigarette use and nicotine dependence in the United States,³⁰ taking steps to minimize biases from reporting and differential mortality.

In this study, we had 3 goals: (1) to examine rates of nondependent cigarette use over 4 recent birth cohorts among adults in the United States, (2) to examine the prevalence of nicotine dependence among adults over these 4 birth cohorts, and (3) to examine the results by gender and poverty status in order to elicit changes in cigarette use and nicotine dependence among groups that may be especially vulnerable, including women and those in poverty.

METHODS

Sample

Our sample was drawn from participants in the 2001–2002 National Epidemiological Survey of Alcoholism and Related Conditions (NESARC), a nationally representative survey of 43 093 civilian noninstitutionalized participants 18 years and older in the United States. Details of the sampling frame are described elsewhere.^{31–34} The National Institute on Alcohol Abuse and Alcoholism (NIAAA) sponsored the study and supervised the fieldwork, which was conducted by the US Census Bureau. Young adults, Hispanics, and African Americans were oversampled, and the study achieved an overall response rate of 81%. To adjust for nonresponse and selection probability, the sample was weighted and adjusted to reflect the 2000 US Census. The research protocol, including informed-consent procedures, received full ethical review and approval from the US Census Bureau and the US Office of Management and Budget. To minimize potential bias from smoking-related mortality among older birth cohorts, we included in the present sample only respondents born after 1946 (N=30161).

Interviews were conducted by 1800 professional Census Bureau interviewers who used computer-assisted software with built-in checks for skipped items, logic, and consistency. All interviewers had experience in administering

other national health-related surveys, with 5 years being the average level of experience. All interviewers received 10 days of NIAAA-directed training in how to administer the NESARC. The interviews were spot-verified by regional supervisors who contacted a random 10% subset of all respondents after their interviews, for quality-control purposes.

Measures

The interview instrument used was the NIAAA Alcohol Use Disorder and Associated Disabilities Interview Schedule-*DSM-IV* (AUDADIS-IV).³⁴ This instrument was specifically designed to be administered by experienced lay interviewers and was developed to measure substance use and mental disorders in large-scale surveys. The instrument assesses nicotine dependence in a unique module separate from the assessment of other substance use. Respondents are considered to have ever used cigarettes if they have smoked 100 or more cigarettes in their lifetime. Variables for cigarette use, frequency of use, and duration of use showed excellent test-retest reliability, with interclass correlation coefficients of 0.83 to 0.84.³²

The AUDADIS-IV used a list of more than 40 questions to assess nicotine dependence, obtaining extensive information on time frames for nicotine use and nicotine dependence. *DSM-IV* diagnoses of nicotine dependence⁷ were made when a respondent met at least 3 of 7 criteria for nicotine dependence, which are (1) needing more nicotine to achieve desired effect, (2) experiencing nicotine withdrawal syndrome, (3) using cigarettes more than intended, (4) experiencing a persistent desire or unsuccessful efforts to cut down on nicotine use, (5) spending a great deal of time using cigarettes (e.g., chain-smoking), (6) giving up activities in favor of nicotine use, and (7) continuing to use cigarettes despite recurrent physical or psychological problems likely to have been caused by nicotine use. Nicotine withdrawal syndrome was diagnosed according to *DSM-IV* criteria. Time frames for diagnosis included the previous 12-month period and prior to the previous 12-month period, with a diagnosis in either time frame sufficient for a “lifetime” diagnosis.

The test-retest reliability of the nicotine-dependence diagnosis was assessed via a random subsample of 347 respondents who were reinterviewed with the nicotine-dependence

module up to 10 weeks after initial appraisal.³¹ The diagnoses for the previous 12 months (i.e., the current diagnosis) and for the period prior to the previous 12 months both had good reliability ($\kappa=0.63$ and 0.60, respectively).

Further, we used a series of linear regression analyses to validate the diagnoses by examining the association between nicotine dependence and physical disability scores on the Short Form-12v2 (SF-12) survey. The SF-12 is a generic quality-of-life survey with well-tested reliability and validity, and it is often used with large populations. Nicotine dependence is robustly associated with physical disability; thus, a valid diagnosis of nicotine dependence should correlate with physical disability. We found nicotine dependence to be a highly significant ($P<.001$) predictor of 6 physical disability subscales: (1) limitations in physical functioning because of physical problems, (2) role impairment because of physical problems, (3) general physical health, (4) bodily pain, (5) vitality, and (6) overall physical disability (all analyses were controlled for age, personality disorders, current comorbid alcohol and drug use, and mood and anxiety disorders). Respondents with nicotine dependence had significantly greater physical disability and dysfunction than did respondents who did not have nicotine dependence.³⁶

Respondents with family incomes at or below 100% of the official poverty level as designated by the US Department of Agriculture³⁵ were considered to be living in poverty. This poverty level is defined in the legislative section of the 1981 Omnibus Budget Reconciliation Act, which requires the Secretary of Health and Human Services to update the poverty level annually.³⁵ All other respondents were included in the nonpoverty group.

Birth cohorts were defined by year of birth as reported by respondents, and were divided into 4 categorical subgroups: 1946 to 1957, 1958 to 1967, 1968 to 1977, 1978 to 1985. Preliminary analyses suggested homogeneity of risk within these quartiles, increasing confidence that the true prevalence of the outcome did not vary substantially within categories.

To obtain standard errors adjusted for the complex sample characteristics of the NESARC, we used SUDAAN to conduct all analyses.³⁷ We used cross-tabulations to calculate the prevalence of any cigarette use, any nicotine

dependence, and any nicotine dependence among cigarette users for each birth cohort, and for subsets by gender and poverty status. In addition to these descriptive statistics, we used logistic regression to present the likelihood of cigarette use, nicotine dependence, and nicotine dependence among cigarette users in each birth cohort compared with those born between 1950 and 1958 (the reference group). In analyses, we controlled for ethnicity (5 groups: non-Hispanic White, non-Hispanic African American, non-Hispanic American Indian/Alaska Native, non-Hispanic Asian/Native Hawaiian/Pacific Islander, and Hispanic), gender, education (less than high school education, high school education, and more than high school education), and marital status (never married; widowed, separated, or divorced; and married). Logistic regressions were also used to obtain the likelihood of cigarette use, nicotine dependence, and nicotine dependence among cigarette users in each birth cohort by gender and poverty status.

RESULTS

In the NESARC sample used in this analysis, 43.1% (SE=0.9%) reported lifetime cigarette use, and 19.7% (SE=0.6%) reported current nicotine dependence. Among cigarette users, 45.8% (SE=0.7%) reported lifetime nicotine dependence. In unadjusted odds ratios (ORs), men were more likely to exhibit cigarette use (OR=1.52) and to be nicotine-dependent (OR=1.46), but among cigarette users, men were not more likely to be nicotine-dependent than were women (Table 1). Blacks, Asians/Native Hawaiians/Pacific Islanders, and Hispanics were less likely to exhibit cigarette use and be nicotine-dependent than Whites. American Indians/Alaska Natives were significantly more likely than were previous cohorts to be nicotine-dependent and to exhibit nicotine dependence among cigarette users, although they were not more likely to engage in cigarette use than were Whites. Lower levels of

education and personal income were also associated with significantly increased likelihood of cigarette use and nicotine dependence compared with those with higher levels of education and income.

The overall odds of cigarette use were significantly lower with each successive birth cohort (Table 2). The same general trend was evident among men overall and among men in poverty, although this was not consistently the case among men not in poverty. Among women overall, those in more recent birth cohorts had lower odds of cigarette use compared with previous cohorts; among women in poverty, however, only those in the most recent birth cohort were less likely to use cigarettes. This is in contrast to women not in poverty, among whom only the 1968 to 1977 birth cohort was significantly less likely to use cigarettes. The most recent cohort of non-poverty women did not show a significant decline in cigarette use. Cohort was a

TABLE 1—Prevalence of Cigarette Use, Nicotine Dependence, and Nicotine Dependence Among Cigarette Users: National Epidemiologic Survey of Alcoholism and Related Conditions, 2001–2002

	No.	Cigarette Use		Nicotine Dependence		Nicotine Dependence Among Cigarette Users	
		% (SE)	OR (95% CI)	% (SE)	OR (95% CI)	% (SE)	OR (95% CI)
Gender							
Men	13 368	45.0 (0.8)	1.52 (1.42, 1.63)	21.6 (0.7)	1.46 (1.35, 1.58)	45.4 (1.0)	1.05 (0.95, 1.16)
Women (Ref)	16 793	37.5 (0.9)	1.00	17.8 (0.6)	1.00	47.8 (0.9)	1.00
Race							
African American	5 905	31.8 (1.1)	0.48 (0.44, 0.53)	13.3 (0.7)	0.44 (0.39, 0.50)	41.1 (1.4)	0.67 (0.59, 0.77)
American Indian/Alaska Native	500	56.1 (3.0)	1.27 (0.99, 1.63)	33.6 (2.8)	1.46 (1.13, 1.87)	58.2 (3.6)	1.36 (1.02, 1.82)
Asian/Native Hawaiian/Pacific Islander	1 095	24.0 (1.8)	0.41 (0.34, 0.51)	9.0 (1.0)	0.34 (0.27, 0.44)	35.5 (3.7)	0.56 (0.40, 0.78)
Hispanic	6 774	28.5 (1.6)	0.37 (0.31, 0.43)	9.1 (0.8)	0.25 (0.20, 0.31)	31.8 (1.7)	0.43 (0.36, 0.51)
White (Ref)	15 887	46.1 (0.5)	1.00	23.2 (0.5)	1.00	48.9 (0.8)	1.00
Marital status							
Widowed/separated/divorced	5 201	56.1 (1.2)	1.78 (1.64, 1.93)	29.0 (1.0)	1.80 (1.65, 1.98)	51.4 (1.3)	1.41 (1.24, 1.59)
Never married	9 137	36.0 (0.9)	0.95 (0.87, 1.04)	18.3 (0.7)	0.96 (0.86, 1.07)	50.4 (1.2)	1.08 (0.96, 1.20)
Married or living with someone (Ref)	15 823	40.6 (0.8)	1.00	18.4 (0.6)	1.00	43.6 (0.9)	1.00
Education							
Less than high school	4 248	48.6 (2.4)	2.08 (1.81, 2.37)	23.5 (1.7)	1.80 (1.56, 2.07)	48.4 (1.9)	1.05 (0.90, 1.22)
High school	8 365	48.5 (1.0)	1.62 (1.50, 1.75)	23.7 (0.8)	1.43 (1.31, 1.56)	47.3 (1.1)	0.98 (0.88, 1.09)
Some college or above (Ref)	17 548	36.2 (0.6)	1.00	17.0 (0.5)	1.00	45.4 (0.9)	1.00
Personal income, \$							
0–19 999	13 513	40.6 (1.1)	1.69 (1.45, 1.97)	21.1 (0.8)	1.87 (1.55, 2.26)	51.6 (1.0)	1.51 (1.23, 1.86)
20 000–34 999	7 306	44.4 (0.9)	1.72 (1.49, 1.99)	20.6 (0.7)	1.58 (1.32, 1.90)	45.2 (1.2)	1.17 (0.96, 1.42)
35 000–69 999	7 027	41.4 (0.9)	1.41 (1.22, 1.62)	17.8 (0.7)	1.28 (1.05, 1.55)	40.8 (1.3)	1.02 (0.83, 1.25)
≥70 000 (Ref)	2 315	34.6 (1.3)	1.00	14.6 (1.0)	1.00	39.2 (2.0)	1.00

Note. OR=odds ratio; CI=confidence interval. All sample respondents were born in 1946 or later.

TABLE 2—Prevalence and Odds of Cigarette Use, by Birth Cohort, Gender, and Poverty Status: National Epidemiologic Survey of Alcoholism and Related Conditions, 2001–2002

	No.	Born 1946–1957 (n=9112; Ref)		Born 1958–1967 (n=9092)		Born 1968–1977 (n=7696)		Born 1978–1985 (n=4261)	
		% (SE)	OR (95% CI)	% (SE)	OR (95% CI)	% (SE)	OR (95% CI)	% (SE)	OR (95% CI)
Total ^a	30 161	48.6 (0.9)	1.00	40.7 (0.9)	0.76* (0.71, 0.82)	36.6 (0.9)	0.68* (0.62, 0.74)	34.4 (1.1)	0.56* (0.49, 0.63)
Men									
Total ^b	13 368	55.1 (1.1)	1.00	43.0 (1.1)	0.61* (0.55, 0.69)	39.2 (1.1)	0.54* (0.48, 0.61)	38.0 (1.3)	0.44* (0.37, 0.52)
In poverty ^c	1 667	64.9 (4.3)	1.00	56.1 (4.0)	0.76 (0.51, 1.13)	38.2 (3.6)	0.44* (0.29, 0.66)	30.8 (2.2)	0.26* (0.16, 0.41)
Not in poverty ^c	11 701	54.4 (1.1)	1.00	41.7 (1.1)	0.63* (0.57, 0.71)	39.3 (1.1)	0.63* (0.55, 0.71)	41.3 (1.6)	0.74* (0.61, 0.89)
Women									
Total ^b	16 793	42.4 (1.2)	1.00	38.6 (1.2)	0.93 (0.84, 1.04)	34.0 (1.2)	0.83* (0.74, 0.94)	30.8 (1.4)	0.66* (0.56, 0.79)
Poverty ^c	3 178	45.5 (2.9)	1.00	46.6 (2.9)	1.23 (0.92, 1.64)	37.9 (2.7)	0.98 (0.73, 1.31)	26.7 (2.1)	0.54* (0.38, 0.76)
Not in poverty ^c	13 615	42.0 (1.2)	1.00	37.5 (1.2)	0.89 (0.79, 1.00)	33.2 (1.2)	0.81* (0.71, 0.91)	33.0 (1.8)	0.84 (0.69, 1.02)

Note. OR=odds ratio; CI=confidence interval.

^aControlled for ethnicity, gender, income, education, and marital status.

^bControlled for ethnicity, income, education, and marital status.

^cControlled for ethnicity and marital status.

*P<.05.

significant predictor of cigarette use (F=21.2; P<.001), and there was minimal overlap of 95% confidence intervals (CIs), indicating that the observed monotonic decrease is significant.

In contrast to results for cigarette use, Table 3 shows little evidence of any consistent relationship between cohort and nicotine dependence or of any significant change in prevalence of nicotine dependence by cohort. There were several changes from year to year among various subgroups, but across time

there was a lack of any significant change in prevalence.

Overall, the odds of nicotine dependence among cigarette users increased with each birth cohort (Table 4), and there was an overall increase in the prevalence of nicotine dependence among cigarette users by birth cohort. The prevalence of nicotine dependence was 41.0% in the 1946 to 1957 cohort, 46.0% in the 1968 to 1977 cohort, 51.9% in the 1968 to 1977 cohort, and 54.0% in the

1978 to 1985 cohort. Among cigarette users, those in the youngest cohort were 1.53 times more likely to become nicotine dependent than were those in the oldest cohort (95% CI=1.29, 1.82). Thus, the lack of a clear difference in nicotine dependence across cohorts appears to result from 2 opposing but simultaneous phenomena: an overall decline in cigarette use accompanied by an overall increase in nicotine dependence among cigarette users.

TABLE 3—Prevalence and Odds of Nicotine Dependence, by Birth Cohort, Gender, and Poverty Status: National Epidemiologic Survey of Alcoholism and Related Conditions, 2001–2002

	No.	Born 1946–1957 (n=9112; Ref)		Born 1958–1967 (n=9092)		Born 1968–1977 (n=7696)		Born 1978–1985 (n=4261)	
		% (SE)	OR (95% CI)	% (SE)	OR (95% CI)	% (SE)	OR (95% CI)	% (SE)	OR (95% CI)
Total ^a	30 161	20.2 (0.7)	1.00	19.5 (0.8)	1.03 (0.94, 1.14)	19.7 (0.8)	1.12* (1.02, 1.24)	18.8 (0.8)	0.91 (0.79, 1.05)
Men									
Total ^b	13 368	22.9 (0.9)	1.00	20.5 (1.0)	0.92 (0.80, 1.06)	21.4 (1.0)	1.03 (0.89, 1.19)	20.9 (1.2)	0.85 (0.69, 1.03)
In poverty ^c	1 667	32.9 (4.1)	1.00	23.8 (3.3)	0.68 (0.43, 1.08)	19.2 (2.9)	0.70 (0.42, 1.17)	18.2 (1.9)	0.50* (0.30, 0.81)
Not in poverty ^c	11 701	22.2 (0.9)	1.00	20.2 (1.0)	0.94 (0.81, 1.09)	21.7 (1.0)	1.07 (0.92, 1.26)	22.2 (1.5)	0.93 (0.74, 1.17)
Women									
Total ^b	16 793	17.5 (0.8)	1.00	18.6 (1.0)	1.17* (1.03, 1.33)	18.0 (0.9)	1.22* (1.06, 1.42)	16.7 (1.0)	0.98 (0.80, 1.19)
Poverty ^c	3 178	24.7 (2.2)	1.00	24.6 (2.1)	1.17 (0.85, 1.61)	21.5 (2.1)	1.26 (0.91, 1.75)	15.8 (1.6)	0.95 (0.65, 1.39)
Not in poverty ^c	13 615	16.7 (0.8)	1.00	17.8 (1.0)	1.15 (1.00, 1.33)	17.3 (0.9)	1.22* (1.04, 1.43)	17.1 (1.3)	1.25 (0.99, 1.57)

Note. OR=odds ratio; CI=confidence interval.

^aControlled for ethnicity, gender, income, education, and marital status.

^bControlled for ethnicity, income, education, and marital status.

^cControlled for ethnicity and marital status.

*P<.05.

TABLE 4—Prevalence and Odds of Nicotine Dependence Among Cigarette Users, by Birth Cohort, Gender, and Poverty Status: National Epidemiologic Survey of Alcoholism and Related Conditions, 2001–2002

	No.	Born 1946–1957 (n=9112; Ref)		Born 1958–1967 (n=9092)		Born 1968–1977 (n=7696)		Born 1978–1985 (n=4261)	
		% (SE)	OR (95% CI)	% (SE)	OR (95% CI)	% (SE)	OR (95% CI)	% (SE)	OR (95% CI)
Total ^a	11 680	41.0 (1.0)	1.00	46.0 (1.3)	1.26* (1.11, 1.42)	51.9 (1.3)	1.58* (1.38, 1.80)	54.0 (1.6)	1.53* (1.29, 1.82)
Men									
Total ^b	5 773	40.5 (1.4)	1.00	43.9 (1.7)	1.22* (1.03, 1.45)	50.7 (1.8)	1.59* (1.31, 1.93)	53.6 (2.4)	1.57* (1.23, 2.00)
In poverty ^c	706	51.0 (5.1)	1.00	43.2 (4.6)	0.76 (0.44, 1.32)	50.7 (5.8)	1.23 (0.65, 2.32)	54.1 (4.5)	1.18 (0.64, 2.16)
Not in poverty ^c	5 067	39.6 (1.5)	1.00	44.0 (1.7)	1.27* (1.06, 1.52)	50.7 (2.0)	1.69* (1.37, 2.07)	53.5 (2.6)	1.84* (1.42, 2.37)
Women									
Total ^b	5 907	41.7 (1.5)	1.00	48.2 (1.7)	1.31* (1.10, 1.56)	53.3 (1.7)	1.57* (1.31, 1.88)	54.6 (2.2)	1.52* (1.18, 1.95)
Poverty ^c	1 171	54.7 (3.7)	1.00	52.9 (3.2)	1.02 (0.69, 1.51)	57.2 (3.6)	1.39 (0.90, 2.15)	60.1 (4.2)	1.89* (1.14, 3.12)
Not in poverty ^c	4 736	40.0 (1.5)	1.00	47.4 (1.9)	1.37* (1.13, 1.66)	52.3 (1.8)	1.67* (1.38, 2.02)	52.1 (2.6)	1.64* (1.24, 2.15)

Note. OR=odds ratio; CI=confidence interval.

^aControlled for ethnicity, gender, income, education, and marital status.

^bControlled for ethnicity, income, education, and marital status.

^cControlled for ethnicity and marital status.

* $P < .05$.

DISCUSSION

We examined cigarette use and nicotine dependence among adults in the United States, and we investigated the roles that gender and poverty may have played in changes in cigarette use and nicotine dependence that have occurred over the past several decades. This study has 3 key findings: (1) consistent with previous reports, the overall prevalence of cigarette use declined between 1964 and 2002 in the general population. (2) The overall prevalence of nicotine dependence did not decline in the population as a whole, and the prevalence of nicotine dependence increased among several recent cohorts of women. (3) The prevalence of nicotine dependence among cigarette users increased with each successive cohort.

Consistent with previous results, our findings suggest that there has been a decline in cigarette use among adults in the United States between 1964 and 2002 and that this decline has leveled off in recent years.^{38,39} Yet, despite the declining prevalence of cigarette use, these data show that the prevalence of cigarette use in the population was still at 34.4%, more than one third of the population, in 2002. This is a significant decrease from a prevalence of 48.6% in previous cohorts, but the United States is still far from meeting the *Healthy People 2010* goal of reducing prevalence of cigarette use to below 12%.^{39,40}

The data do not show evidence of a decline in nicotine dependence in the general population over the birth cohorts examined. This suggests that statistical reports on the overall rate of “cigarette use” or “cigarette smoking” may not reflect the most accurate or complete picture of the problem of cigarette use among adults in this country, because these reports do not track nicotine-dependent cigarette use, nor do they distinguish between dependent and nondependent cigarette use. Yet there is a need to track nicotine-dependent cigarette use because nicotine-dependent smokers use more cigarettes and the amount of cigarettes used (as measured by cigarette packs smoked per year multiplied by number of years of smoking) has been shown to be associated with greater risk of cigarette-related illnesses.^{17–21} Nicotine-dependent cigarette use may entail an increased number of pack-life years caused by a decreased likelihood of quitting, which might thereby place dependent smokers at greater risk of cigarette-related illness.

By taking nicotine-dependent cigarette use into account, we found that despite a decline in the overall prevalence of cigarette use, the percentage of the population who use cigarettes most heavily and who are dependent on cigarettes has not declined. Our results are consistent with the possibility that antismoking efforts have successfully reduced the number

of people who start smoking, but our results also suggest that, among those who do start smoking, the risk of nicotine dependence appears to be increasing. The reason for this trend is not known. It has been speculated that this finding may be caused by a so-called “hard-core” effect, whereby the relatively new social pressures to abstain from cigarette use serve to “weed out” many casual cigarette users, leaving a more dedicated group of smokers who will continue to use and who are at greater risk of nicotine dependence.^{41,42} An alternative explanation is that if factors such as social norms within families encourage initial cigarette use, then genetic factors within those same families may encourage nicotine dependence.^{43–47}

Although the prevalence of cigarette use has been frequently monitored, little has been reported on trends in nicotine dependence among cigarette users.¹³ Our results provide new data suggesting that the prevalence of nicotine dependence among cigarette users in the United States has increased over the past several birth cohorts, but not in the population as a whole. These findings also indicate that vulnerable populations, such as women living in poverty, have the highest prevalence of nicotine dependence among cigarette users. This is troubling because it means that children of women in poverty may be more likely to be exposed to environmental tobacco smoke, which has been

shown to be a risk factor for asthma in children.⁴⁸ This postulated mechanism of effect is consistent with trends showing that the highest rates of pediatric asthma in the United States tend to be among youth living in poverty.⁴⁹ Although these data do not justify causal inferences regarding associations between nicotine dependence among women in poverty and pediatric asthma among youth in poverty, they may shed light on the importance of evaluating nicotine dependence as well as cigarette use.

Another possible explanation for the increase in nicotine dependence among cigarette users could be changes in cigarettes that increase their addictiveness. Although we were not able to test this hypothesis directly in this study, investigators have found evidence to suggest that the content of cigarettes has been manipulated over the past several decades in ways that have contributed to the addictiveness of cigarettes, putting those who initiated smoking during that time to be at greater risk of becoming addicted.^{50–51} This explanation is consistent with our findings and would be worth examining in future investigations.

Our findings also suggest an increase in the odds of nicotine dependence among adults who use cigarettes. This trend stands in clear contrast to the widely cited reports that cigarette use is declining in the United States. However, these reports are largely based on data on “cigarette smoking”³ and usually do not track nicotine dependence per se. Surprisingly, the increase in nicotine dependence appears to be mostly driven by those who are not in poverty. The group most at risk of nicotine dependence among cigarette users is women in poverty in the most recent birth cohort, whose risk is substantially higher than that calculated for the overall population.

These data suggest that the risk of nicotine dependence among both men and women who use cigarettes appears to be increasing with each successive birth cohort, regardless of socioeconomic background, although pairwise comparisons by cohort were not conducted. This finding is somewhat surprising given that information on the dangers associated with cigarette use is more readily available to recent cohorts and is provided to them earlier in life than was the case for previous generations. However, although cigarette smoking-prevention efforts may in fact lower the number of people

who start using cigarettes (i.e., ever use cigarettes), such efforts may not be effective among an already nicotine-dependent population. Research has suggested that nicotine dependence is as difficult to treat as cocaine addiction, although the treatments for these 2 addictions differ drastically.⁸ Whereas treatment programs for cocaine or alcohol addiction strongly discourage the heaviest users from attempting to quit on their own, smoking cessation programs often place the burden of quitting on the individual. In addition, insurance and medical care for smoking cessation is poorly funded and relatively difficult to obtain. Perhaps these discrepancies may help to explain why so many Americans continue to use cigarettes despite their greater knowledge of the attendant health risks, the high cost of cigarettes, and the restricted availability of smoking areas in public places.

This study has several important limitations. First, rates of cigarette use and nicotine dependence among older cohorts may be lower than expected as a result of premature mortality caused by heavy cigarette smoking. Yet, if premature mortality were solely responsible for lower rates of cigarette use and nicotine dependence among older cohorts, the rates would probably be much lower than they are and there probably would not have been such consistent declines observed over cohorts.

In addition, recall bias could have contributed to underreporting. Therefore, other sources of prospectively collected longitudinal data will be needed to replicate these results. Also, the social undesirability of smoking may have induced respondents to underreport their cigarette use or nicotine dependence. (It is not clear whether such a report bias would differ by cohort.) Finally, these findings are only generalizable to the US population, indicating the need for future studies to examine international trends in nicotine dependence, given that rates of cigarette use and nicotine dependence are likely to differ globally. For instance, evidence suggests that, in contrast to US trends, cigarette use is continuing to rise in developing countries such as China.⁵² ■

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Contributors

R.D. Goodwin originated the study, supervised all aspects of its implementation, and led the writing of the article. K.M. Keyes assisted with the study and completed the analyses. D.S. Hasin assisted with synthesis and interpretation of findings. All authors contributed to writing and reviewing drafts of the article.

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Human Participant Protection

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References

1. Doeschler MP, Elizabeth J, Jerant A, Hart G. Tobacco prevalence and trends in smoking: a national rural study. *J Rural Health*. 2006;22:112–118.
2. Centers for Disease Control and Prevention. Annual smoking-attributable mortality, years of potential life lost, and economic costs—United States, 1995–1999. *MMWR Morb Mortal Wkly Rep*. 2002;51:300–303.
3. *Reducing Tobacco Use: A Report of the Surgeon General*. Atlanta, GA: Centers for Disease Control and Prevention; 2000.
4. Centers for Disease Control and Prevention. Cigarette smoking among adults—United States, 2006. *MMWR Morb Mortal Wkly Rep*. 2007;56:1157–1161.
5. Fichtenberg CM, Glantz SA. Association of the California Tobacco Control Program with declines in cigarette consumption and mortality from heart disease. *N Engl J Med*. 2000;343(24):1772–1777.
6. Zhang B, Cohen J, Ferrence R, Rehm J. The impact of tobacco tax cuts on smoking initiation among Canadian young adults. *Am J Prev Med*. 2006;30:474–479.
7. *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*. Washington, DC; American Psychiatric Association; 1994.
8. Jain A. Treating nicotine addiction. *BMJ*. 2003;327:1394–1395.
9. Breslau N, Johnson E, Hiripi E, Kessler R. Nicotine dependence in the United States—prevalence, trends, and smoking persistence. *Arch Gen Psych*. 2001;58:810–816.
10. Kandel DB, Chen K. Extent of smoking and nicotine dependence in the United States: 1991–1993. *Nicotine Tob Res*. 2000;2:263–274.

11. *Progress Review on Tobacco Use: A Report of the Surgeon General*. Atlanta, GA: Centers for Disease Control and Prevention; 2003.
12. Donny EC, Dierker LC. The absence of DSM-IV nicotine dependence in moderate-to-heavy daily smokers. *Drug Alcohol Depend*. 2007;89:93–96.
13. Shiffman S, Paty J. Smoking patterns and dependence: contrasting chippers with heavy smokers. *J Abnorm Psychol*. 2006;115:509–523.
14. Hu MC, Davies M, Kandel DB. Epidemiology and correlates of daily smoking and nicotine dependence among young adults in the United States. *Am J Public Health*. 2006;96:299–308.
15. Schmitz N, Kruse J, Kugler J. Disabilities, quality of life, and mental disorders associated with smoking and nicotine dependence. *Am J Psychiatry*. 2003;160:1670–1676.
16. Samet JM. The health benefits of smoking cessation. *Med Clin North Am*. 1992;76:399–415.
17. Newcomb PA, Carbone PP. The health consequences of smoking: cancer. *Med Clin North Am*. 1992;76:305–331.
18. McBride PE. The health consequences of smoking: cardiovascular diseases. *Med Clin North Am*. 1992;76:333–353.
19. Sherman CB. The health consequences of cigarette smoking: pulmonary disease. *Med Clin North Am*. 1992;76:357–375.
20. Hyland A, Cummings M. Changes in measures of nicotine dependence using cross-sectional and longitudinal data from COMMIT. Bethesda, MD: National Cancer Institute; 2003. Monograph 15.
21. *The Health Consequences of Smoking: A Report of the Surgeon General*. Atlanta, GA: Centers for Disease Control and Prevention; 2004.
22. *Women and Smoking: A Report of the Surgeon General*. Atlanta, GA: Centers for Disease Control and Prevention; 2001.
23. *Prevalence Data—Nationwide Tobacco Use. National Center for Chronic Disease Prevention and Health Promotion: Behavioral Risk Factor Surveillance System*. Washington, DC: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion; 2000.
24. Emmons KM, Hammond SK, Fava JL, Velicer WF, Evans JL, Monroe AD. A randomized trial to reduce passive smoke exposure in low-income households with young children. *Pediatrics*. 2001;108:8–25.
25. King G, Bendel R, Delaronde SR. Social heterogeneity in smoking among African Americans. *Am J Public Health*. 1998;88:1081–1086.
26. Scarinci IC, Robinson LA, Alfano CM, Zbikowski SM, Klesges RC. The relationship between socioeconomic status, ethnicity, and cigarette smoking in urban adolescents. *Prev Med*. 2002;34:171–178.
27. Weinreb L, Goldberg R, Perloff J. Health characteristics and medical service use patterns of sheltered homeless and low-income mothers. *J Gen Intern Med*. 1998;13:389–397.
28. Centers for Disease Control and Prevention. Cigarette smoking among adults—United States, 1999. *MMWR Morb Mortal Wkly Rep*. 2001;40:869–873.
29. Harwood GA, Salsberry P, Ferketich AK, Wewers ME. Cigarette smoking, socioeconomic status, and psychosocial factors: examining a conceptual framework. *Public Health Nurs*. 2007;24:361–371.
30. Grant BF, Stinson FS, Dawson DA, Chou SP, Ruan J, Pickering RP. Co-occurrence of 12-month alcohol and drug use disorders and personality disorders in the US: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Arch Gen Psychiatry*. 2004;61:361–368.
31. Grant BF, Dawson DA, Stinson FS, Chou PS, Kay W, Pickering R. The Alcohol Use Disorder and Associated Disabilities Interview Schedule-IV (AUDADIS-IV): reliability of alcohol consumption, tobacco use, family history of depression and psychiatric diagnostic modules in a general population sample. *Drug Alcohol Depend*. 2003;71:7–16.
32. Grant BF, Moore TC, Kaplan K. *Source and Accuracy Statement: Wave 1 National Epidemiologic Survey on Alcohol and Related Conditions (NESARC)*. Bethesda, MS: National Institute on Alcohol Abuse and Alcoholism; 2003.
33. Compton WM, Grant BF, Colliver JD, Glantz MD, Stinson FS. Prevalence of marijuana use disorders in the United States:1991–1992 and 2001–2002. *JAMA*. 2004;291:2114–2121.
34. Grant BF, Dawson DA, Hasin DS. *The Alcohol Use Disorder and Associated Disabilities Interview Schedule-DSM-IV version (AUDADIS-IV)*. Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism; 2001.
35. Omnibus Budget Reconciliation Act of 1981, 42 USC §9902(2) §673.2 (1981).
36. Ware JE, Kosinski M, Turner-Bowker DM, Gandek B. *How to Score Version 2 of the SF-12 Health Survey*. Lincoln, RI: Quality Metrics; 2002.
37. *Software for Survey Data Analysis (SUDAAN), Version 9.01*. Research Triangle Park, NC: RTI International; 2002.
38. Giovino GA, Henningfield JE, Tomar SL, Escobedo LG, Slade J. The epidemiology of tobacco use and dependence. *Epidemiol Rev*. 1995;1:48–65.
39. Troscclair A, Caraballo R, Malarcher A, Husten C, Pechacek T. Cigarette smoking among adults—United States, 2003. *MMWR Morb Mortal Wkly Rep*. 2005;54:509–513.
40. *Healthy People 2010*. Second ed. Washington, DC: US Dept of Health and Human Services; 2000.
41. Jarvis MJ, Wardle J, Waller J, Owen L. Prevalence of hardcore smoking in England, and associated attitudes and beliefs: cross sectional study. *BMJ*. 2003;326:1061.
42. Auguston EM, Marcus SE. Use of the current population survey to characterize subpopulations of continued smokers: a national perspective on the “hard-core” smoker phenomenon. *Nicotine Tob Res*. 2004;6:621–629.
43. Hill K, Hawkins J, Catalano R, Abbott R, Guo J. Family influences on the risk of daily smoking initiation. *J Adolesc Health*. 2005;37:202–210.
44. Bobo JK, Husten C. Sociocultural influences on smoking and drinking. *Alcohol Res Health*. 2000;24:225–232.
45. Schepis TS, Rao U. Epidemiology and etiology of adolescent smoking. *Curr Opin Pediatr*. 2005;17:607–612.
46. Dick DM, Viken R, Purcell S, Kaprio J, Pulkkinen L, Rose RJ. Parental monitoring moderates the importance of genetic and environmental influences on adolescent smoking. *J Abnorm Psychol*. 2007;116:213–218.
47. Secko D. Craving nicotine: it's in the genes. *Can Med Assoc J*. 2005;172:175–176.
48. Le Souef PN. Pediatric origins of adult lung diseases. 4. Tobacco related lung diseases begin in childhood. *Thorax*. 2000;55:1063–1067.
49. Halfon N, Newacheck PW. Childhood asthma and poverty: differential impacts and the utilization of health services. *Pediatrics*. 1993;91:56–61.
50. Hoffmann D, Djordjevic MV, Hoffmann I. The changing cigarette. *Prev Med*. 1997;26:427–434.
51. Gray N. The consequences of the unregulated cigarette. *Tob Control*. 2006;15:405–408.
52. Kumra V, MarkoffWho's smoking now? BA. The epidemiology of tobacco use in the United States and abroad. *Clin Chest Med*. 2000;21:1–9.