CME Article #3

Trends in U.S. Smoking Rates in Occupational Groups: The National Health Interview Survey 1987–1994

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Learning Objectives

- Identify current rates of cigarette smoking in 209 occupations, and ways in which occupation and gender interact to determine smoking rates.
- Describe trends in smoking rates over the years 1987–1994, and characterize those occupational groups in which rates increased or declined in this period.
- Describe possible job-related measures for lowering prevalence rates of cigarette smoking.

Abstract

It is unknown if reductions in U.S. adult smoking rates are uniform across occupational groups. The National Health Interview Survey (NHIS) is a multistage area probability cross-sectional survey of the U.S. civilian population. Data on occupational and smoking status were collected on 141,122 adult participants from the 1987, 1988, and 1990–1994 NHIS annual surveys. Overall smoking rates ranged from 58% in roofers to 4% in physicians, with higher rates found among blue collar professions. There were reductions in smoking from 1987–1994 within 72% of occupational groups; 19 of these downward trends were significant and occurred exclusively within white collar professions. Blue collar workers continue to smoke in large numbers, whereas white collar workers report lower rates along with corresponding significant downward trends in rates among selected occupational groups. The development of effective smoking prevention strategies targeting blue collar groups is needed. (J Occup Environ Med. *2004;46:538–548*)

Each year cigarette smoking is responsible for over 440,000 deaths in the United States.[1] Furthermore, an estimated 8.6 million Americans suffer from 1 or more chronic conditions, including selected cancers, heart attack, stroke, chronic bronchitis and emphysema, which are attributed to cigarette smoking.[2] Tobacco use is also associated with higher employee turnover, absenteeism, lower productivity, and higher medical costs[3–5]; a portion of these costs is reduced when employees quit smoking.[6,7]

Yearly per-capita cigarette tobacco consumption in the United States peaked in the early 1950s at 10.4 pounds and has fallen in 1990 to 4.8 pounds per adult 18 years of age or older.[8] Although corresponding smoking rates have generally fallen in the years since the initial reports on the health hazards of tobacco use, these trends have not been uniform across the U.S. population. For example, adult trends in smoking prevalence, initiation, and/or cessation rates vary by state,[9,10] social class,[11,12] gender,[13] and race/ethnicity.[13,14]

Trends in smoking rates in some occupational groups have also been reported. However, the analyses were typically limited to broad occupational groupings of 12 or less categories and/or were conducted in small, regional, or nonrepresentative samples of working adults.[15–18]

Smoking trends in specific occupational groups have not been extensively examined in the United States. Average annual reductions in smok-

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David J. Lee has no has no commercial interest related to this article.

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DOI: 10.1097/01.jom.0000128152.01896.ae

ing prevalence among physicians were reportedly higher than for nurses from 1975–1991.[19] The proportion of ever-smokers among men and women employed as radiology technicians has steadily declined in subsequent birth cohorts beginning in the late 1930s and early 1940s.[20] However, a comparative analysis of trends in smoking rates across U.S. occupational groups with employment levels as small as 100,000 persons has never been undertaken. The present analysis examines 8-year smoking trends, from 1987–1994, in U.S. adults employed in occupations that number 100,000 or more persons.

Methods

Study Population and Design

The National Health Interview Survey (NHIS) is conducted annually by the National Center for Health Statistics (NCHS).[21] The NHIS is a continuous, multipurpose, and multistage area probability cross-sectional survey of the U.S. civilian noninstitutionalized population living at addressed dwellings. Each year nearly 50,000 households are selected to participate in the NHIS. Approximately 120,000 persons are interviewed using a primary household respondent, with all adults at home participating in the interview. In most cases, participants themselves answered interview questions, and for the remaining participants, the responses were obtained from other household members. The response rate has ranged between 95% and 98%.[21]

Information on employment during the 2 weeks before the interview was collected for all persons aged 18 years or older to determine the person's current employment status. Although labeled "SOC" codes in their documentation,[22] the NHIS actually uses the U.S. Census Occupational Codes to classify workers. In 1992, the NHIS began using the 1990 version of the U.S. Census Occupational Codes.[23] Before 1992, the 1980 U.S. Census codes were used. There were differences in 26 of the occupational categories between the 1980 version and the 1990 version. These categories were programmatically recoded in the 1986–1991 datasets to categories compatible with the 1990 version.

To assess trends in broad occupational groups, we initially used a 13-category grouping consistent with the approach taken in previous papers analyzing smoking data from the NHIS.[18,24] We restricted analyses to occupational groups with an estimated employment of 100,000 persons or more. This restriction was necessary to ensure reasonably stable trend estimates and is an approach consistent with that taken in previous NHIS occupational smoking analyses.[18,24]

The NHIS 1987–1994 did not include questions about tobacco use in its core household interview. However, each year the NCHS randomly administered supplemental surveys within the households selected to participate in the NHIS. Supplement topics generally varied from year to year (eg, health promotion and disease prevention, cancer control). Some supplemental surveys contained varying numbers of questions on tobacco use; with the exception of 1989, in the years 1987–1994, at least some adult respondents or their designated proxy informants were asked if they or other family members had smoked at least 100 cigarettes in their lifetime. Additional smoking questions were then asked among those responding yes to this question. There were slight differences in the wording of these subsequent questions. For example, some supplements used the following question: "Do you smoke cigarettes now?" whereas other supplements asked: "Do you now smoke cigarettes everyday, somedays, or not at all?" Responses from these questions were used to estimate the prevalence of current cigarette use. A small percentage of participants who responded "yes" to the first question on smoking at least 100 cigarettes did not have valid data on the subsequent question inquiring about current cigarette use (0.55%) and were excluded from further analyses. Complete smoking data were available for 141,122 participants of the 1987, 1988, and the 1990–1994 NHIS.

Analysis

As a result of the complex sample survey design, analyses were completed using the Software for the Statistical Analysis of Correlated Data (SUDAAN) package to take into account sample weights and design effects.[25] For pooled prevalence estimates, sample weights were adjusted to account for the aggregation of data over multiple survey years by dividing the original weight by 7, the number of years combined.[26] To determine if there were any statistically significant trends in smoking over the 8-year period, a weighted linear regression model was fitted to the annual survey-adjusted rates within 206 of the 209 occupational groups (3 occupational categories, added in 1992, were excluded from trend analyses). The weight used for each annual rate was the inverse of its variance.

Results

Table 1 presents the overall and gender-specific cigarette smoking prevalence rates and corresponding standard errors (SE) in 13 occupational groups. Also provided in Table 1 are the results from the linear trend analyses (including the slope [ie, yearly change in smoking rate], its standard error, and corresponding *P* value). The highest and lowest smoking rates were reported by workers employed in "transportation/ material moving" (40%) and "professional specialty" occupations (15%), respectively; these were also the 2 occupations with the highest and lowest smoking rates for both female and male workers (female: 36%, 15%; male: 41%, 15%). There were increasing smoking rate trends in

TABLE 1
Total and Gender-Specific Prevalence of Cigarette Smoking and Eight-Year Smoking Trends in 13 Occupational Categories*

			Annual Prevalence Rate							Trend	
	Sample Size	Rate† ± SE	1987	1988	1990	1991	1992	1993	1994	Slope ± SE	*P* Value
Total (Females & Males), Occupation											
Administrative support occupations, including clerical	22,852	25.38 ± 0.39	27.87	26.09	25.22	25.24	26.09	23.46	23.87	−0.48 ± 0.14	0.02
Executive, administrative managerial	19,798	24.50 ± 0.43	28.43	26.71	22.42	24.93	24.25	24.15	21.43	−0.78 ± 0.26	0.03
Farming, forestry, fishing	3,666	26.56 ± 1.00	28.02	30.17	26.32	25.54	21.59	25.99	28.32	−0.70 ± 0.41	0.15
Handlers, equipment cleaners, helpers, laborers	4,470	36.49 ± 1.00	38.48	35.15	38.22	37.46	33.83	32.80	39.64	−0.15 ± 0.42	0.74
Machine operators, assemblers, inspectors	9,311	36.62 ± 0.60	38.47	39.79	35.74	37.01	35.67	33.68	35.66	−0.71 ± 0.22	0.02
Precision production, craft, repair	14,137	36.98 ± 0.50	40.37	38.27	34.55	35.05	37.28	33.53	40.06	−0.55 ± 0.43	0.26
Private household	1,241	23.84 ± 1.53	21.66	29.76	22.74	23.18	31.89	17.33	20.60	−0.68 ± 0.75	0.41
Professional specialty	21,942	15.33 ± 0.30	18.18	17.15	15.59	14.49	14.12	14.44	13.98	−0.64 ± 0.09	0.00
Protective service	2,299	30.35 ± 1.06	35.92	31.40	34.23	31.22	26.78	26.31	27.33	−1.23 ± 0.32	0.01
Sales	15,533	26.52 ± 0.45	28.91	27.90	25.13	27.13	27.72	25.29	24.08	−0.52 ± 0.20	0.05
Service occupations, except protective/household	15,426	34.53 ± 0.62	35.91	35.34	33.11	34.42	34.70	34.21	34.23	−0.23 ± 0.15	0.18
Technicians/related support	5,288	23.39 ± 0.61	22.43	26.81	22.53	24.51	22.06	24.10	21.69	−0.22 ± 0.31	0.51
Transportation/material moving	5,259	40.09 ± 0.85	42.43	42.20	38.14	38.42	41.83	37.31	40.54	−0.56 ± 0.31	0.13
Females, Occupation											
Administrative support occupations, including clerical	18,626	24.87 ± 0.41	27.63	25.56	24.66	24.81	25.27	23.28	23.08	−0.51 ± 0.13	0.01
Executive, administrative managerial	9,076	25.37 ± 0.61	27.93	26.99	23.84	26.08	28.48	24.26	21.16	−0.60 ± 0.34	0.14
Farming, forestry, fishing	735	20.24 ± 1.77	17.51	21.41	21.81	24.19	15.85	20.69	21.13	0.21 ± 0.48	0.68
Handlers, equipment cleaners, helpers, laborers	1,115	34.88 ± 2.03	35.38	30.37	35.49	37.45	27.68	29.45	45.75	0.35 ± 0.90	0.71
Machine operators, assemblers, inspectors	4,141	34.31 ± 1.01	37.17	36.81	33.15	33.94	32.96	35.17	29.96	−0.83 ± 0.22	0.01
Precision production, craft, repair	1,583	31.03 ± 1.51	35.27	27.89	26.47	30.89	35.66	29.35	32.31	0.04 ± 0.65	0.96
Private household	1,198	23.22 ± 1.51	22.44	28.27	21.91	21.84	30.94	16.71	21.02	−0.82 ± 0.66	0.27
Professional specialty	12,128	15.34 ± 0.40	19.84	17.93	14.05	14.56	14.42	14.02	13.65	−0.84 ± 0.23	0.01
Protective service	435	31.24 ± 2.45	26.26	36.82	28.20	47.23	27.92	25.56	26.17	−0.53 ± 1.39	0.72
Sales	8,268	26.96 ± 0.62	29.65	28.45	24.69	28.76	25.62	25.24	26.32	−0.52 ± 0.30	0.14
Service occupations, except protective/household	10,810	32.95 ± 0.62	36.22	35.31	31.09	31.67	32.84	30.49	33.48	−0.62 ± 0.29	0.08
Technicians/related support	2,810	24.39 ± 0.88	22.51	29.17	19.19	24.93	23.63	24.14	26.17	0.01 ± 0.62	0.99
Transportation/material moving	644	36.10 ± 2.39	34.16	37.50	31.80	34.35	45.11	30.48	39.21	0.17 ± 0.75	0.83
Males, Occupation											
Administrative support occupations, including clerical	4,226	27.18 ± 0.86	28.71	28.07	27.48	26.75	29.21	24.07	26.53	−0.38 ± 0.22	0.14
Executive, administrative managerial	10,722	23.92 ± 0.57	28.72	26.53	21.46	24.17	21.39	24.07	21.64	−0.94 ± 0.33	0.03
Farming, forestry, fishing	2,931	27.92 ± 1.11	30.45	32.06	27.34	25.78	22.86	27.27	29.78	−0.93 ± 0.45	0.09
Handlers, equipment cleaners, helpers, laborers	3,355	36.89 ± 1.06	39.21	36.33	38.84	37.47	35.10	33.72	37.82	−0.36 ± 0.30	0.29
Machine operators, assemblers, inspectors	5,170	38.05 ± 0.84	39.34	41.73	37.49	38.90	37.39	32.78	38.57	−0.71 ± 0.37	0.11
Precision production, craft, repair	12,554	37.58 ± 0.53	40.89	39.30	35.32	35.50	37.43	33.95	40.93	−0.60 ± 0.43	0.23
Private household	43	38.91 ± 8.13	6.74	57.81	37.69	48.23	70.87	64.48	0.00	‡	
Professional specialty	9,814	15.32 ± 0.44	16.54	16.39	17.08	14.43	13.80	14.87	14.33	−0.40 ± 0.16	0.06
Protective service	1,864	30.19 ± 1.20	37.36	30.35	35.37	28.36	26.60	26.46	27.54	−1.42 ± 0.47	0.03
Sales	7,265	26.10 ± 0.66	28.17	27.35	25.55	25.41	29.66	25.34	22.00	−0.56 ± 0.28	0.10
Service occupations, except protective/household	4,616	37.47 ± 1.07	35.31	35.42	36.87	39.49	38.12	41.19	35.60	0.58 ± 0.30	0.11
Technicians/related support	2,478	22.48 ± 0.9	22.37	24.37	25.53	24.14	20.67	24.05	18.16	−0.42 ± 0.39	0.32
Transportation/material moving	4,615	40.52 ± 0.89	43.19	42.77	38.88	38.78	41.43	38.07	40.68	−0.61 ± 0.28	0.08

* The National Health Interview Surveys: 1987–1988, 1990–1994.
† Overall prevalence based on responses collected in 1987, 1988, and 1990–1994.
‡ Trend not calculated as a result of small sample size.
SE, standard error.

females employed in several occupational categories; however, none of these trends was statistically significant. A significant trend of declining smoking rates was reported by females employed in "administrative, support occupations, including clerical" (yearly reduction = 0.51%; P = 0.01); "machine operators, assemblers, and inspectors" (0.83%; P = 0.01); and those employed in the "professional specialties" (0.84%; P = 0.01). Male workers in most occupational categories reported modest declines in smoking rates over the 8-year period (yearly reduction ranging from 0.36–1.42%). These trends were significant only for males employed in the "protective service" (yearly reduction = 1.42%; P = 0.03); and "executive, administrative and managerial professions" (yearly reduction = 0.94%; P = 0.03). Smoking rates in males employed in the service occupations increased by 0.58% per year, but this increase was not statistically significant (P = 0.11).

Table 2 presents the design-adjusted overall cigarette smoking prevalence rates and trend analyses in U.S. occupations with an estimated annual employment of 100,000 or more during the study period. The overall smoking rate (± SE) pooled across the 209 occupations was 27.9% ± 0.21. Occupations are ranked in descending order based on estimated overall smoking rates. The highest ranked occupations had overall smoking rates that exceeded 50% and included (in rank order): roofers, dry wall installers, bartenders, and brickmasons and stonemasons. The lowest ranked occupations (ranks 206–209) had overall smoking rates of 10% or less and included: elementary school teachers, dentists, clergy, and physicians.

Negative slopes presented on Table 2 indicate declining smoking rates from 1987–1994 for 72% of the listed occupations. The remaining occupations had positive slopes providing evidence of increasing smoking rates, although none of these increases was statistically significant. There were 19 statistically significant downward trends in smoking rates. The yearly reduction in smoking rates among these significant findings ranged from 0.82% in farmers (Table 2 smoking rate ranking 183) to 3.63% in personnel and labor relations managers (ranking 164). These statistically significant reductions in smoking rates were not randomly distributed in Table 2, which was sorted according to descending overall smoking rates. Rather, just over half of the statistically significant reductions in smoking rates occurred in the last 50 occupations listed in Table 2, which had the lowest overall smoking rates (ie, <22%).

Discussion

It is important to document the estimated smoking rates in various occupational groups along with corresponding trends in these rates for several reasons. Both the absolute smoking rate and the direction of trends reported in this article can be used to identify occupational groups in need of targeted smoking cessation programs. For example, occupations in Table 2 with high levels of smoking rates that also show some evidence of rising smoking rates include: drywall installers (smoking rate ranking 2), grinding and other machine operators (smoking rate ranking 10), timber cutters (smoking rate ranking 12), and sheet metal workers (smoking rate ranking 18). None of these trends were statistically significant in our analysis. However, their high background smoking rates, in combination with evidence of upward smoking trends and additional occupational exposures with respiratory illness implications,[27–29] indicate that these occupational groups are in need of targeted interventions.

Overall prevalence rates presented in Table 2 could help other investigators to address the possible confounding influence of smoking in occupational mortality studies that lack such data.[30] These data can also be used to identify occupational "control" groups that are matched on smoking rates in occupations under study during the same time period to identify excess risk of occupationally associated cancers.[31] Trend data also aid in the selection of control groups that not only match the background smoking rate of the occupational group of interest, but also trends in the smoking rates over the targeted study years. Correlation of trends in smoking rates in specific occupational groups with the level of smoke-free workplace regulations could help to evaluate the impact of these regulations on worker smoking behaviors in the 1980s and 1990s.[32,33]

The present findings not only convincingly show that there remains large differences in smoking rates across occupations, but also that significant reductions in these rates over the years 1987–1994 tended to be more common in occupations that have lower levels of smoking. Furthermore, these occupations can be classified as "white collar" as opposed to "blue collar" (see, for example, the last 50 occupations listed in Table 2). Differences in smoking rates in white collar versus blue collar workers have been observed for decades in the United States[34]; these differences were also noted in the first Surgeon General's 1964 Report on Smoking and Health.[35] Nelson and colleagues,[18] in their analysis of NHIS data from years 1978–1990, noted the growing disparity in smoking rates among white and blue collar workers. Blue collar workers are also exposed to more secondhand smoke than white collar workers, reflecting an additional tobacco-related burden.[36,37] Finally, selected blue collar groups are more likely to experience occupational exposures that interact with tobacco use to increase respiratory disease risk.[27–29]

One of the Nation's public health objectives is the elimination of health disparities.[38] It is clear from the present report, and the many that have preceded it, that smoking rates

TABLE 2
Estimated Overall Prevalence of Cigarette Smoking and Eight-Year Smoking Trends by Census Occupational Category Codes (COC)*

Smoking Rate Rank†	Occupation	COC	No.	Rate† ± SE	Slope ± SE	*P* Value	Estimated Annual Employment§
1	Roofers	595	161	58.06 ± 4.55	−1.72 ± 2.95	0.59	158,847
2	Drywall installers	573	125	56.41 ± 6.93	7.52 ± 3.66	0.10	137,655
3	Bartenders	434	440	55.49 ± 3.36	1.54 ± 1.35	0.31	344,383
4	Brick masons and stone masons	563	168	51.31 ± 4.56	0.38 ± 1.93	0.85	179,883
5	Molding and casting machine operators	719	123	49.31 ± 5.70	−3.91 ± 4.92	0.46	103,758
6	Waiters and waitresses	435	1629	45.56 ± 1.64	−1.11 ± 0.89	0.27	1,243,450
7	Painters, construction, and maintenance	579	528	45.23 ± 2.48	0.11 ± 1.63	0.95	495,214
8	Supervisors, related agricultural occupations	485	117	44.33 ± 5.37	1.56 ± 0.74	0.12	100,868
9	Garage and service station-related occupations	885	170	43.74 ± 5.04	1.54 ± 1.47	0.34	158,092
10	Grinding/abrading/buffing/polishing machine operators	709	143	43.68 ± 4.92	2.36 ± 2.45	0.38	121,344
11	Construction laborers	869	663	43.65 ± 2.44	−0.58 ± 0.80	0.50	697,191
12	Timber cutting and logging occupations	496	98	43.34 ± 5.52	3.02 ± 3.46	0.42	104,819
13	Truck drivers	804	2756	42.86 ± 1.09	0.14 ± 0.37	0.72	2,640,585
14	Carpenters	567	1451	42.79 ± 1.52	−1.15 ± 0.61	0.12	1,336,839
15	Slicing and cutting machine operators	769	244	42.75 ± 4.12	−3.74 ± 1.88	0.10	204,112
16	Operating engineers	844	264	42.70 ± 3.63	−1.63 ± 0.76	0.09	253,326
17	Punching and stamping press machine operators	706	175	42.51 ± 4.77	−0.95 ± 2.12	0.67	126,355
18	Sheet metal workers	653	157	42.43 ± 4.54	2.32 ± 1.06	0.08	143,964
19	Dispatchers	359	228	42.38 ± 3.84	−1.15 ± 1.26	0.40	180,789
20	Heavy equipment mechanics	516	184	41.77 ± 4.72	−1.95 ± 2.39	0.45	162,026
21	Heating, air conditioning, and refrigeration mechanics	534	234	41.29 ± 3.79	1.28 ± 1.58	0.45	225,091
22	Industrial truck and tractor equipment operators	856	536	40.64 ± 3.00	−1.26 ± 0.71	0.14	450,241
23	Welders and cutters	783	622	40.55 ± 2.49	−1.42 ± 1.27	0.32	597,287
24	Supervisors, mechanics, and repairers	503	301	40.09 ± 3.17	−1.39 ± 2.29	0.57	282,895
25	Machine operators, not specified	779	604	39.76 ± 2.32	−1.61 ± 0.70	0.07	528,820
26	Printing press operators	734	373	39.74 ± 4.04	−1.14 ± 0.88	0.25	323,661
27	Automobile mechanics	505	931	39.57 ± 2.24	−0.90 ± 1.07	0.44	924,831
28	Miscellaneous machine operators	777	1097	39.23 ± 1.77	−0.59 ± 0.40	0.21	912,207
29	Supervisors, cleaning and building service workers	448	216	39.08 ± 4.20	−0.27 ± 1.32	0.84	159,703
30	Sales workers, furniture and home furnishings	266	110	38.35 ± 5.69	1.52 ± 1.65	0.40	105,818
31	Automobile body and related repairers	514	205	38.25 ± 3.75	0.37 ± 1.38	0.80	194,183
32	Machinists	637	575	37.97 ± 2.33	−1.48 ± 1.14	0.25	522,513
33	Mixing and blending machine operators	756	142	37.75 ± 4.64	0.32 ± 1.55	0.84	123,593
34	Cooks	436	1903	37.65 ± 1.52	0.29 ± 0.31	0.39	1,587,227
35	Laborers, except construction	889	1347	36.78 ± 1.7	−0.37 ± 0.89	0.69	1,250,422
36	Supervisors, construction	558	543	36.40 ± 2.35	0.72 ± 0.89	0.46	509,017
37	Maids and housemen	449	778	36.34 ± 2.17	−0.01 ± 1.66	1.00	551,376
38	Painting and paint spraying machine operators	759	214	36.26 ± 3.98	−1.83 ± 0.88	0.09	184,736
39	Sales workers, motor vehicles and boats	263	276	36.10 ± 3.28	0.25 ± 0.62	0.71	255,606
40	Bus, truck, and stationary engine mechanics	507	338	35.99 ± 3.30	1.03 ± 1.17	0.42	312,281
41	Nursing aides, orderlies, and attendants	447	2193	35.93 ± 1.33	−0.47 ± 0.46	0.36	1,477,561
42	Aircraft engine mechanics	508	165	35.81 ± 4.64	−0.18 ± 1.95	0.93	139,849
43	Supervisors, food preparation and service occupations	433	331	35.78 ± 3.64	−0.86 ± 0.73	0.30	259,072
44	Attendants, amusement and recreation facilities	459	158	35.77 ± 5.45	2.59 ± 2.16	0.28	120,428
45	Industrial machinery repairers	518	449	35.43 ± 2.46	−1.47 ± 0.72	0.10	423,173
46	Specified mechanics and repairers	547	291	35.37 ± 3.12	0.56 ± 2.08	0.80	257,127
47	Taxicab drivers and chauffeurs	809	238	35.26 ± 4.07	−0.06 ± 2.08	0.98	198,640
48	Inspectors, testers, and graders	689	171	35.20 ± 4.29	0.67 ± 1.51	0.68	137,766
49	Groundskeepers and gardeners, except farm	486	661	35.19 ± 2.37	−1.12 ± 1.45	0.47	632,818
50	Not specified mechanics and repairers	549	253	35.18 ± 3.58	−1.67 ± 1.32	0.26	254,196
51	Food counter/fountain/related occupations	438	185	35.02 ± 4.23	−0.14 ± 0.90	0.88	176,859
52	Laundering and dry cleaning machine operators	748	249	34.83 ± 3.53	0.04 ± 1.89	0.99	174,095
53	Assemblers	785	1239	34.61 ± 1.70	−1.20 ± 0.78	0.19	1,026,023
54	Guards and police, except public service	426	770	34.58 ± 2.17	−1.44 ± 0.63	0.07	650,456
55	Electrical/electronic equipment assemblers	683	277	34.47 ± 3.63	−1.71 ± 0.99	0.15	230,284
56	Pressing machine operators	747	175	34.44 ± 4.89	−4.71 ± 2.01	0.07	131,707
57	Miscellaneous food preparation occupations	444	628	34.16 ± 2.42	1.41 ± 1.25	0.31	501,893
58	Janitors and cleaners	453	2644	34.12 ± 1.20	0.63 ± 0.55	0.30	2,067,101

TABLE 2
Continued

Smoking Rate Rank†	Occupation	COC	No.	Rate† ± SE	Slope ± SE	*P* Value	Estimated Annual Employment§
59	Butchers and meat cutters	686	246	34.08 ± 3.58	1.32 ± 1.01	0.25	213,405
60	Managers, food serving and lodging establishments	17	395	33.98 ± 2.59	‡		410,720
61	Freight, stock, and material handlers, nec.	883	654	33.94 ± 2.60	0.59 ± 1.42	0.69	571,810
62	Sales workers, parts	269	120	33.92 ± 5.02	−2.64 ± 3.51	0.49	138,870
63	Plumbers, pipefitters, and steamfitters	585	445	33.77 ± 2.60	−3.04 ± 0.98	0.03	419,839
64	Kitchen workers, food preparation	439	209	33.46 ± 4.26	−2.56 ± 1.59	0.17	192,563
65	Correctional institution officers	424	272	33.40 ± 3.06	−0.97 ± 1.14	0.43	219,927
66	Production coordinators	363	285	33.29 ± 3.28	−3.89 ± 1.99	0.11	204,210
67	Driver–sales workers	806	163	33.27 ± 4.51	1.18 ± 1.55	0.48	146,319
68	Hand packers and packagers	888	316	33.17 ± 3.32	−1.89 ± 1.88	0.36	245,670
69	Electricians	575	649	32.75 ± 2.39	0.40 ± 1.54	0.81	626,998
70	Supervisors, distribution, scheduling, and adjusting clerks	307	228	32.64 ± 3.63	−1.91 ± 1.93	0.37	177,953
71	Miscellaneous material moving equipment operators	859	136	32.58 ± 4.16	−5.25 ± 1.30	0.01	117,109
72	Vehicle washers and equipment cleaners	887	180	32.22 ± 4.46	−5.66 ± 4.00	0.22	167,519
73	Graders and sorters, except agricultural	799	157	32.20 ± 4.55	2.16 ± 1.86	0.30	125,068
74	Sheriffs/bailiffs/other law enforcement officers	423	144	32.13 ± 5.01	−0.89 ± 1.94	0.67	127,159
75	Construction trades, nec.	599	163	31.88 ± 5.30	−1.25 ± 1.86	0.53	169,750
76	Supervisors, production occupations	628	1261	31.28 ± 1.63	−0.96 ± 0.50	0.12	1,092,668
77	Production inspectors, checkers, and examiners	796	698	31.27 ± 2.20	−1.69 ± 0.87	0.11	571,665
78	Stock and inventory clerks	365	705	30.97 ± 2.38	1.69 ± 0.69	0.06	585,833
79	Hairdressers and cosmetologists	458	971	30.91 ± 1.78	−0.46 ± 0.37	0.27	741,546
80	Postal clerks, except mail carriers	354	425	30.90 ± 2.92	1.32 ± 1.64	0.46	310,003
81	Bus drivers	808	581	30.83 ± 2.27	−2.57 ± 1.18	0.08	437,321
82	Licensed practical nurses	207	662	30.78 ± 2.11	−1.30 ± 0.99	0.25	433,437
83	Cashiers	276	2513	30.78 ± 1.21	−0.48 ± 0.58	0.44	2,043,195
84	Traffic, shipping, and receiving clerks	364	582	30.74 ± 2.40	−2.64 ± 1.09	0.06	531,212
85	Bakers	687	144	30.66 ± 4.52	−0.66 ± 1.33	0.64	128,093
86	Expediters	373	201	30.44 ± 4.11	−2.10 ± 0.44	0.01	169,140
87	Farm workers	479	797	29.79 ± 1.86	−1.11 ± 0.85	0.25	686,987
88	Bill and account collectors	378	173	29.74 ± 4.45	−1.66 ± 1.64	0.36	133,916
89	Stock handlers and baggers	877	728	29.57 ± 2.27	−0.19 ± 0.73	0.80	650,044
90	Interviewers	316	187	29.49 ± 3.66	−0.84 ± 1.26	0.53	146,720
91	Managers, properties and real estate	18	572	29.42 ± 2.56	−0.48 ± 1.21	0.71	424,823
92	Packaging and filling machine operators	754	394	29.09 ± 2.85	−3.21 ± 1.05	0.03	381,818
93	Tool and die makers	634	158	28.66 ± 4.54	0.17 ± 0.82	0.84	143,231
94	Waiters/waitresses assistants	443	297	28.62 ± 3.69	−0.75 ± 1.04	0.50	264,739
95	Advertising and related sales occupations	256	180	28.40 ± 3.53	0.1 ± 2.20	0.97	142,145
96	Messengers	357	160	28.09 ± 4.44	0.01 ± 2.30	1.00	123,316
97	Buyers, wholesale/retail trade, except farm products	29	229	27.92 ± 3.80	0.75 ± 0.96	0.47	191,990
98	Telephone installers and repairers	529	189	27.7 ± 3.73	−1.24 ± 1.56	0.46	162,838
99	Billing clerks	339	217	27.62 ± 3.86	0.14 ± 1.73	0.94	165,608
100	Supervisors, general office	303	592	27.47 ± 2.27	−1.05 ± 1.12	0.39	456,019
101	Computer operators	308	845	27.26 ± 1.79	0.33 ± 0.96	0.74	659,841
102	Sales workers, hardware and building supplies	268	121	27.15 ± 5.24	−1.30 ± 2.05	0.56	116,569
103	Electronic repairers, communication equipment	523	196	27.10 ± 3.84	2.85 ± 1.61	0.14	169,027
104	Technicians	235	599	27.04 ± 2.09	0.66 ± 0.65	0.36	462,626
105	Painters/sculptors/craft-artists/artist printmakers	188	323	26.95 ± 3.23	−0.50 ± 0.61	0.45	243,308
106	Supervisors/proprietors, sales occupations	243	4115	26.94 ± 0.87	−0.77 ± 0.52	0.20	3,596,023
107	Firefighting occupations	417	233	26.93 ± 3.74	−3.27 ± 2.66	0.27	198,277
108	Legal assistants	234	323	26.92 ± 3.15	−2.38 ± 1.25	0.12	245,025
109	Street and door-to-door sales workers	277	382	26.70 ± 2.52	−1.61 ± 1.21	0.24	276,408
110	Mail carriers, postal service	355	355	26.69 ± 2.41	−0.71 ± 1.06	0.53	303,415
111	Payroll and timekeeping clerks	338	176	26.61 ± 3.57	−0.05 ± 2.20	0.98	150,511
112	Bookkeepers, accounting, and auditing clerks	337	2514	26.53 ± 1.09	0.10 ± 0.27	0.72	1,817,127
113	Managers and administrators	22	9837	26.52 ± 0.63	−1.03 ± 0.40	0.05	8,080,569
114	Sales counter clerks	275	200	26.50 ± 3.29	−1.00 ± 1.36	0.50	182,795
115	Dental assistants	445	236	26.50 ± 3.46	0.62 ± 1.48	0.69	176,208
116	Mail clerks, except postal service	356	233	26.22 ± 3.84	−1.12 ± 1.22	0.40	178,110

TABLE 2
Continued

Smoking Rate Rank†	Occupation	COC	No.	Rate† ± SE	Slope ± SE	*P* Value	Estimated Annual Employment§
117	Stationary engineers	696	178	26.14 ± 3.65	−2.78 ± 1.41	0.11	149,560
118	Administrative support occupations	389	949	26.08 ± 1.80	−1.52 ± 0.49	0.03	717,172
119	Insurance adjusters, examiners, and investigators	375	419	25.85 ± 2.76	−1.47 ± 1.49	0.37	304,227
120	Sales representatives, mining/manufacturing/wholesale	259	1559	25.62 ± 1.27	−0.35 ± 0.34	0.35	1,305,211
121	Sales workers, other commodities	274	2577	25.53 ± 1.06	−0.69 ± 0.37	0.12	2,118,672
122	Order clerks	327	253	25.47 ± 3.11	−0.93 ± 1.85	0.64	183,515
123	Telephone operators	348	288	25.27 ± 3.08	−1.30 ± 0.60	0.08	195,396
124	Police and detectives, public service	418	567	25.06 ± 2.87	−1.35 ± 0.78	0.14	481,710
125	Managers, medicine and health	15	314	25.04 ± 2.99	−0.18 ± 1.58	0.91	257,406
126	Social workers	174	845	24.94 ± 1.74	−1.49 ± 1.08	0.23	569,851
127	Personnel/training/labor relations specialists	27	601	24.85 ± 2.18	−2.50 ± 1.06	0.07	429,136
128	Transportation ticket and reservation agents	318	181	24.84 ± 3.91	−2.90 ± 1.41	0.10	164,670
129	Sales occupations, other business services	257	473	24.78 ± 2.58	−0.45 ± 1.75	0.81	393,028
130	Private household cleaners and servants	407	879	24.61 ± 1.85	0.15 ± 1.03	0.89	515,168
131	Managers/marketing/advertising/public relations	13	810	24.59 ± 1.74	0.56 ± 0.59	0.39	637,557
132	Investigators and adjusters, except insurance	376	839	24.38 ± 1.88	−1.25 ± 0.52	0.06	636,942
133	Dietitians	97	136	24.25 ± 5.83	0.29 ± 2.13	0.90	105,770
134	Personal service occupations, nec.	469	312	24.21 ± 2.88	−3.29 ± 1.54	0.09	222,426
135	Data-entry keyers	385	645	24.10 ± 2.12	−0.68 ± 0.63	0.33	485,635
136	Engineering technicians	216	339	24.00 ± 2.95	−0.75 ± 1.32	0.60	261,701
137	Sales workers, apparel	264	319	23.83 ± 2.88	−0.32 ± 0.78	0.70	296,930
138	Sales workers, radio, TV, hi-fi, and appliances	267	135	23.82 ± 4.59	−2.92 ± 0.99	0.03	119,117
139	Health aides, except nursing	446	467	23.82 ± 2.20	−1.92 ± 0.98	0.11	333,037
140	Secretaries	313	4970	23.61 ± 0.71	−0.89 ± 0.30	0.03	3,828,302
141	Radiologic technicians	206	182	23.56 ± 3.81	−2.19 ± 0.77	0.04	137,287
142	Financial managers	7	643	23.45 ± 1.95	−0.49 ± 0.58	0.44	516,489
143	Textile sewing machine operators	744	787	23.37 ± 2.00	−0.86 ± 0.96	0.42	656,092
144	Child care workers	468	916	23.34 ± 1.63	−0.62 ± 1.41	0.68	595,919
145	Electrical and electronic technicians	213	478	23.21 ± 2.21	0.09 ± 1.39	0.95	378,968
146	Industrial	56	318	23.14 ± 2.82	−1.14 ± 1.20	0.39	234,775
147	Drafting occupations	217	297	23.07 ± 2.70	−1.32 ± 1.55	0.43	265,437
148	File clerks	335	243	23.02 ± 2.95	−1.72 ± 1.61	0.34	193,069
149	Management related occupations	37	532	23.00 ± 2.36	−1.18 ± 1.05	0.31	371,203
150	Child care workers, private household	406	255	22.92 ± 3.48	−1.49 ± 1.23	0.28	184,736
151	Purchasing agents and buyers	33	327	22.85 ± 2.70	−1.24 ± 1.12	0.32	260,021
152	Insurance sales occupations	253	804	22.53 ± 1.55	−0.24 ± 0.47	0.63	654,951
153	Designers	185	698	22.40 ± 1.77	0.21 ± 0.97	0.83	526,843
154	Receptionists	319	961	22.24 ± 1.60	−0.28 ± 0.38	0.49	747,566
155	Typists	315	745	22.23 ± 2.38	0.45 ± 0.74	0.57	515,090
156	General office clerks	379	1546	22.00 ± 1.34	−0.58 ± 0.57	0.35	1,187,412
157	Health technologists and technicians	208	415	21.55 ± 2.36	−0.60 ± 0.62	0.38	330,504
158	Administrators/officials, public administration	5	595	21.05 ± 2.16	−0.19 ± 0.69	0.80	434,916
159	Other financial officers	25	968	20.84 ± 1.70	−0.06 ± 0.79	0.94	727,887
160	Real estate sales occupations	254	979	20.47 ± 1.56	−1.07 ± 0.41	0.05	788,281
161	Registered nurses	95	2538	20.19 ± 1.01	−1.04 ± 0.33	0.03	1,799,165
162	Musicians and composers	186	236	20.08 ± 2.86	−1.16 ± 1.45	0.46	171,362
163	Securities and financial services sales occupations	255	339	20.07 ± 2.17	0.92 ± 1.11	0.45	288,542
164	Personnel and labor relations managers	8	173	19.94 ± 3.09	−3.63 ± 0.88	0.01	145,879
165	Engineers	59	341	19.88 ± 2.58	−2.13 ± 1.70	0.27	285,379
166	Public relations specialists	197	231	19.88 ± 2.89	−3.19 ± 1.12	0.04	168,127
167	Operations/systems researchers and analysts	65	420	19.78 ± 2.28	0.71 ± 0.38	0.12	279,844
168	Clinical lab technologists and technicians	203	446	19.58 ± 2.20	0.25 ± 0.85	0.78	328,584
169	Records clerks	336	197	19.22 ± 3.10	−0.57 ± 0.92	0.57	159,184
170	Bank tellers	383	551	19.02 ± 2.27	−0.90 ± 1.00	0.41	452,802
171	Economists	166	233	19.01 ± 2.76	0.31 ± 1.47	0.84	166,170
172	Accountants and auditors	23	1845	18.98 ± 1.00	−0.29 ± 0.56	0.63	1,449,425
173	Inspectors/compliance officers, except construction	36	228	18.53 ± 2.90	−3.49 ± 1.51	0.07	183,364
174	Management analysts	26	273	18.41 ± 2.77	−1.50 ± 0.42	0.02	207,706
175	Managers, farms, except horticultural	475	205	18.07 ± 3.29	0.23 ± 1.49	0.88	167,631

TABLE 2
Continued

Smoking Rate Rank†	Occupation	COC	No.	Rate† ± SE	Slope ± SE	*P* Value	Estimated Annual Employment§
176	Managers, service organizations	21	121	17.90 ± 3.57	‡		119,002
177	Purchasing managers	9	161	17.85 ± 3.73	−2.50 ± 1.66	0.19	122,582
178	Teachers aides	387	513	17.66 ± 1.92	−0.69 ± 0.88	0.47	388,785
179	Editors and reporters	195	363	17.54 ± 2.49	−1.53 ± 1.04	0.20	247,967
180	Photographers	189	157	17.43 ± 3.58	−2.35 ± 1.07	0.08	134,989
181	Computer programmers	229	708	17.08 ± 1.67	0.26 ± 0.76	0.74	515,413
182	Counselors, educational and vocational	163	387	16.44 ± 2.83	−0.01 ± 0.65	0.99	262,756
183	Farmers, except horticultural	473	1405	16.43 ± 1.19	−0.82 ± 0.26	0.02	1,166,644
184	Actors and directors	187	154	16.17 ± 2.79	−3.12 ± 1.08	0.03	103,368
185	Mechanical	57	393	16.13 ± 2.03	−0.95 ± 1.15	0.45	330,773
186	Psychologists	167	267	16.05 ± 2.60	−0.81 ± 0.66	0.28	190,497
187	Family child care providers	466	170	15.81 ± 2.99	‡		161,876
188	Dressmakers	666	170	15.80 ± 3.17	−0.65 ± 1.39	0.66	123,787
189	Airplane pilots and navigators	226	127	15.42 ± 3.44	−2.09 ± 1.52	0.23	107,936
190	Library clerks	329	204	15.05 ± 3.03	−0.36 ± 1.21	0.78	125,725
191	Aerospace	44	131	14.95 ± 3.75	−0.33 ± 1.93	0.87	115,384
192	Chemists, except biochemists	73	167	14.85 ± 2.88	−2.40 ± 0.91	0.05	124,271
193	Electrical and electronic	55	750	14.73 ± 1.74	−0.05 ± 0.47	0.92	592,715
194	Administrators, education and related fields	14	716	14.68 ± 1.46	−0.70 ± 0.72	0.38	532,733
195	Teachers	159	696	14.35 ± 1.61	−1.04 ± 0.82	0.26	545,219
196	Teachers, special education	158	372	14.06 ± 1.91	−0.72 ± 0.68	0.34	252,519
197	Computer systems analysts and scientists	64	711	13.93 ± 1.45	−1.79 ± 0.46	0.01	564,743
198	Teachers, pre-Kindergarten and Kindergarten	155	535	13.86 ± 1.80	−1.23 ± 0.86	0.21	408,944
199	Civil	53	305	13.82 ± 2.33	−1.58 ± 1.06	0.20	264,614
200	Postsecondary teachers, subject unspecified	154	357	13.61 ± 2.04	0.79 ± 0.83	0.39	225,123
201	Lawyers	178	935	13.48 ± 1.09	−1.20 ± 0.41	0.03	747,311
202	Teachers, secondary school	157	1621	13.44 ± 1.14	−0.80 ± 0.40	0.10	1,207,921
203	Architects	43	218	12.13 ± 2.04	−1.62 ± 0.94	0.16	176,710
204	Librarians	164	258	11.51 ± 2.20	0.40 ± 0.74	0.62	185,788
205	Pharmacists	96	220	11.49 ± 2.41	0.29 ± 1.06	0.80	164,795
206	Teachers, elementary school	156	2152	10.13 ± 0.79	−0.50 ± 0.31	0.16	1,524,602
207	Dentists	85	162	7.42 ± 2.01	0.12 ± 0.74	0.88	139,120
208	Clergy	176	441	4.47 ± 0.93	−0.39 ± 0.41	0.41	330,405
209	Physicians	84	631	4.28 ± 0.80	−0.59 ± 0.41	0.21	564,555

* The National Health Interview Surveys: 1987–1988, 1990–1994.
† Overall prevalence based on responses collected in 1987, 1988, and 1990–1994.
‡ New occupational coding as of 1992—trend not calculated.
§ Calculated from total employment estimates derived from annual NHIS sampling; SE, standard error.

within blue collar occupations are unacceptably high. The need for targeted cessation programs in these populations has been known for years,[39] yet there exists only a limited literature on the effectiveness of smoking cessation interventions directed at occupational groups with high smoking rates.[40–43] Furthermore, the effectiveness of worksite-based smoking cessation programs in general has been inconsistent.[44] Additional work is needed to develop novel strategies for the delivery of smoking cessation services in blue collar populations; partnerships with labor unions in the delivery of such programs is one underused resource for such endeavors.[45,46] Such partnerships can also be used to pursue restrictive worksite smoking policies.[47] These policies have been shown to reduce both cigarette consumption levels and smoking prevalence rates among workers, although many of these studies were conducted in medical and white collar worksite settings.[48]

Investigators who do strive to design innovative new smoking cessation strategies will face unique challenges. For example, compared with white collar workers, blue collar workers are less likely to report both pressure to quit smoking and social support for quit attempts.[49] It is likely that the acceptability of smoking within the worksite varies considerably across blue collar occupations[39]; thus, both the occupational and social context within an organization must be considered when tailoring appropriate smoking cessation interventions. Finally, other measures of social class, including education and residential area deprivation, are independently associated with smoking status[50]; socieconomi-

cally deprived segments of society could be resistant to current smoking cessation programs because they see little likelihood of any gain in life expectancy, especially in the context of immediate environmental hazards and difficult day-to-day living and working conditions.[51] In short, appropriate and effective worksite smoking cessation strategies could be very different when targeting, for example, timber cutters versus unionized machine operators.

There are several advantages to the use of the NHIS to examine occupational trends in smoking rates. The NHIS is designed to be representative of the U.S. population; only institutionalized and military groups have been omitted from direct sampling. Survey participation rates have been excellent (ie, 95–98%). The ability to aggregate 7 years of data allowed for the examination of smoking trends in occupational groups with national employment levels as low as 100,000 persons. In fact, another important contribution of the NHIS is to provide estimates of the numbers of U.S. workers employed in particular industries and occupations within 2 weeks of the NHIS survey interview. These data are not readily available on an annual basis because the U.S. Census data are performed only every decade, and other surveys such as the National Occupational Exposure Survey Analysis[52] have not been updated recently. In Table 2, we have provided the average estimated annual numbers of U.S. workers by U.S. Census Occupation Codes for those occupations with greater than 100,000 workers. Finally, this information, in combination with the estimated smoking rate, can be used to estimate the number of smokers within a particular occupational group.

There are several study limitations that should be addressed. As indicated earlier, smoking status was not assessed each year of the NHIS. The exact wording and context in which smoking questions were asked varied somewhat across survey years depending on the supplement they were imbedded in. It is possible that these variations could have had some slight impact on the estimation of smoking prevalence rates. Although the accuracy of self-reported tobacco use in adults is generally considered good,[53] it is unknown if the accuracy of reported cigarette consumption varies across occupational groups. For example, it is possible that physicians and other healthcare providers would be more likely to underreport smoking than adults employed outside of the healthcare field.[19] NHIS smoking data used in the present analyses included 79% self-report versus 21% family member report. These proxy reports of smoking could have also led to systematic errors. To address this potential bias, we generated 209 logistic regression analyses for the COC occupational groups listed in Table 2. Each of these models included smoking status as the dependent variable and 3 independent variables: age (categorized as 18–44, 45–64, 65 or older), proxy status, and the interaction between proxy status and age group. In no case was the proxy variable statistically significant at <0.02, and in only 4 cases the P value was between 0.02 and 0.05. Given the number of comparisons made, we concluded that there was no evidence of systematic bias introduced by the inclusion of proxy reports of smoking status in the present analysis.

Finally, it should be noted that the timeframe in which we examined smoking trends was fairly short. There would have been greater statistical power to detect trends if we had included more survey years. However, for the sake of survey sampling and assessment continuity, we restricted analyses to the survey years that used similar sampling and assessment methods. The most recent redesign of the NHIS uses a consistent set of smoking questions.[54] Unfortunately, the redesigned NHIS only has 44 category occupational codes for current employment. Thus, the present findings represent the best and most recent information on smoking rates among U.S. adults employed in over 200 occupations with annual employment as low as 100,000 persons.

To summarize, analyses of the 1987–1994 NHIS data show that smoking rates declined in 72% of the occupational groups examined. Significant reductions were noted among 19 white collar occupational groups; none were found among blue collar workers who continue to smoke in large numbers. The development of effective smoking cessation strategies targeting blue collar groups is needed if this growing disparity in smoking rates is going to be addressed.

Acknowledgments

The data used in this publication were made available in part by the Inter-University Consortium for Political and Social Research. Data for the NHIS were originally collected and prepared by the U.S. Department of Health and Human Services and the National Center for Health Statistics. Neither the collector of the original data nor the Consortium bears any responsibility for the analyses or interpretations presented in this publication. This study was funded in part through the National Institute for Occupational Safety and Health (grant no. R01 OH03915).

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