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Prevalence of Cigarette Smoking by Occupation and Industry in the United States

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Background *This study was undertaken to estimate the most recent prevalence of cigarette smoking by occupation and industry in the US, using the data from the third National Health and Nutrition Examination Survey (NHANES III), 1988–1994.*
Methods *Included in NHANES III are data on the cigarette smoking status, occupation, industry, and other demographic information of US non-institutionalized civilians obtained through household interview surveys. The study population included 20,032 adults aged 17 years and older. To estimate the prevalence of cigarette smoking across occupation and industry groups, we used the Survey Data Analysis (SUDAAN) software.*
Results *The prevalence of cigarette smoking was highest among material moving occupations, construction laborers, and vehicle mechanics and repairers. The lowest smoking prevalence was found among teachers. Among industry groups, the construction industry had the highest prevalence of cigarette smoking.*
Conclusions *These findings provide information useful for targeting education activities focusing on adverse health effects of cigarette smoking and also for indirect adjustments in analysis of morbidity and mortality by occupation.* Am. J. Ind. Med. 40:233–239, 2001. *Published 2001 Wiley-Liss, Inc*†

KEY WORDS: cigarette; smoking; prevalence; occupation; industry

INTRODUCTION

Cigarette smoking has played a significant role in causing major personal and public health problems. It is the single leading preventable cause of death in the US. Smoking contributes to one of every six deaths including those from cancer, chronic obstructive pulmonary disease, coronary heart disease, and stroke [Arnett et al., 1998]. Smoking in the workplace is a serious public health problem. The US Environmental Protection Agency (USEPA) reported approximately 3,000 lung cancer deaths annually in the US due to environmental tobacco smoke [US Environmental Protection Agency, 1992]. Although smoking rates have undergone a general decline in the US in recent years, this is not true for all occupational groups. Blue-collar workers are more likely to smoke than more educated white-collar workers. In 1994, 39.2% of blue-collar workers smoked, compared to 24.2% of white-collar workers [Nelson et al., 1994].

Besides health effects from smoking, cigarette smoking affects job productivity from an excess of workdays lost. Current male and female smokers reported 33 and 45% excess workdays lost, respectively, compared with non-smokers. Excess workdays lost among smokers and former smokers accounted for 20% of all workdays lost in the US [Szczesny and Holbrook, 1992].

Recent information on cigarette smoking by occupation and industry is not available for occupational epidemiologic

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studies. Although Nelson et al. [1994] reported cigarette smoking prevalence based on data from 1987 to 1990, this study does not analyze prevalence of smoking by industry. The purpose of this paper is to present the most recent prevalence estimates of cigarette smoking by occupation and industry in the US. This information may be useful for indirect adjustment in analyses of morbidity and mortality by occupation when direct measures of smoking prevalence are not available [Beaumont et al., 1992].

MATERIALS AND METHODS

The third National Health and Nutrition Examination Survey (NHANES III) was conducted from 1988 to 1994 by the National Center for Health Statistics (NCHS) which is part of the Centers for Disease Control and Prevention (CDC). NHANES III was designed to examine the health and nutritional status of a nationally representative sample of the US civilian non-institutionalized population. The survey design and data collection methods in the NHANES III have been extensively described elsewhere [US Department of Health and Human Service, 1994]. The sample for the NHANES III was selected from households in 81 counties across the US. Approximately 40,000 persons of 2 months of age and older were selected and asked to complete extensive interview questionnaires and an examination in a mobile examination center. The household adult questionnaires, administered to adults 17 years of age and older, included questions on cigarette smoking, occupation/industry, and symptoms/conditions. Trained interviewers visited each person's home and the interview was conducted for approximately three and one half hours.

Persons aged 17 years and older were interviewed for cigarette smoking information. The categories of smoking status (current, former, non-smoker) were determined by the interview question, ''Have you smoked at least 100 cigarettes during your entire life? Do you smoke cigarettes now?'' A current cigarette smoker was defined as a person who had smoked 100 or more cigarettes in his/her life time and reported smoking at the time of interview. If someone smoked one cigarette a day, that person was classified as a current smoker. Former smokers were those who smoked at least 100 cigarettes during their life time but were not smoking at the time of interview. There was no information how long the former smokers had discontinued smoking. Non-smokers were those who never smoked or smoked less than 100 cigarettes during their life time. The overall response rate to these questionnaires in the NHANES III was about 86%.

Occupational information on current job and industry during the past 2 weeks was used to determine a person's employment status. Interview questions for occupations and industries are as follows: During the past 2 weeks, did you work at a job or business, not counting around the house? (1. Yes, 2. No). If yes to this question, what kind of work were you doing? (For example, electrical engineer, typist, farmer, etc.). What kind of business or industry is this? (For example, TV manufacturing, retail shoe store, farm, etc.). If no to the question, were you looking for work or on layoff from a job [US Department of Health and Human Service, 1994]? Occupation and industry were coded by the NCHS according to the 1980 Bureau of Census classification schemes. NCHS grouped the Bureau of Census occupations into 40 categories and the industries into 44 categories. To provide more stable estimates of smoking prevalence, we combined data for males and females by occupational and industrial groups. Additionally, we grouped three employment-status categories such as currently employed, currently unemployed, and not in the labor force. Persons not in the labor force included retired persons, housewives, students, and physically handicapped persons who were unable to work [Brackbill et al., 1988]. The 6-year pooled data were weighted to reflect national estimates, and the Survey Data Analysis (SUDAAN) software [Shah et al., 1991] was used to estimate variance for prevalence estimates of cigarette smoking. The overall smoking prevalence by gender and race was age-adjusted using the 1990 US population as the standard. Age-specific smoking prevalence by gender and occupation/industry could not be evaluated because of small sample size in each cell for an age-gender breakdown by occupation or industry. For 40 occupational groups and 44 industry groups, we calculated 95% confidence intervals for current cigarette smoking prevalence.

RESULTS

The overall prevalence of cigarette smoking was 28.3% (95% CI = 26.9–29.8) during the 1988–1994 period. Men (31.7%, 95% CI = 29.9–33.5) had significantly higher prevalence of cigarette smoking than women (25.1%, 95% CI = 23.5–26.7). Blacks (31.2%) had slightly higher prevalence of cigarette smoking than whites (28.2%). By employment status, currently unemployed persons (43.1%) had significantly higher smoking prevalence ($P < 0.05$) than currently employed (30%) or not in labor force groups (22.8%) (Table I).

Table II presents prevalence of current cigarette smoking by occupational group. The prevalence of cigarette smoking was highest among ''blue-collar'' occupations including material moving occupations (45.9%, 95% CI = 35.7–56.1), construction laborers (41.9%, 95% CI = 31.5–52.3), and vehicle mechanics and repairers (41.7%, 95% CI = 31.3–52.1). By comparison, teachers (12.2%, 95% CI = 8.5–15.9) and sales representatives (18.5%, 95% CI = 13.6–23.4) had the lowest prevalences of cigarette smoking.

TABLE I. Age-Adjusted Prevalence of Cigarette Smoking by Gender, Race, and Employment Status among US Residents Aged 17 and Older, 1988–1994

	No. of respondents	Prevalence (%)	95% CI
Gender			
Male	9,392	31.7	29.9–33.5
Female	10,640	25.1	23.5–26.7
Race			
White	13,725	28.2	26.5–29.9
Black	5,659	31.2	29.3–33.1
Employment Status			
Employed	10,492	30.0	28.3–31.7
Unemployed	852	43.1	37.2–49.0
Not in labor force	8,688	22.8	21.0–24.6
Total	20,032	28.3	26.9–29.8

Among 44 industry groups (Table III), the construction industry had the highest prevalence of cigarette smoking (42.2%, 95% CI = 37.1–47.3). Other top 10 industries with high cigarette smoking prevalence include repair services (40.9%, 95% CI = 31.5–50.3), lumber and wood products (39.7%, 95% CI = 27.8–51.6), eating and drinking places (39.3%, 95% CI = 35.6–43.0), vehicle dealers, supply and service stores (38.5%, 95% CI = 26.7–50.3), utilities (37.6%, 95% CI = 25.8–49.4), trucking service (37%, 95% CI = 27.8–46.2), agriculture services, forestry, and fishing (35.9%, 95% CI = 24.0–47.8), metal industries (33.8%, 95% CI = 24.0–43.6), and wholesale trade and durable goods (33%, 95% CI = 23.8–42.2). In contrast, educational services (14.4%, 95% CI = 11.1–17.7) and offices of health practitioners (14.4%, 95% CI = 8.9–24.9) had the lowest prevalences of cigarette smoking.

DISCUSSION

This analysis presents not only estimates of cigarette smoking prevalence based on data from the most recent national health survey in the US, but also shows the important value of using NHANES data in occupational epidemiologic studies. Specifically, this analysis incorporated smoking prevalence by occupational and industrial groups. Several previous reports have concentrated on smoking habits by occupation only [Stellman et al., 1988; Nelson et al., 1994].

This analysis indicated that smoking prevalence varied by employment status. Currently unemployed persons had a higher prevalence of cigarette smoking than did those currently employed or not in labor force. These results are similar with a previous report based on the 1979–1980 National Health Interview Survey (NHIS) data [Brackbill et al., 1988]. For most occupations/industries, men had higher smoking prevalence than women. Especially for male-dominated occupations, for example, the smoking prevalence in transportation and material moving occupations was 46.9% for men compared to 26% for women. In contrast, for female-dominated occupations, the prevalence in waitresses was 46.6% compared to 29.6% for male waiters.

Smoking prevalence was higher among blue-collar occupations than white-collar workers. Some blue-collar workers who smoke are at greater risk for certain chronic diseases. For example, workers who smoke and who are exposed to asbestos have greater relative risk for lung cancer than unexposed non-smokers, indicating multiplicative or synergistic relationship between smoking and asbestos exposure [Blot and Fraumeni, 1996]. Our study shows that construction industries and construction laborers, including asbestos workers, have over 40% smoking prevalence. These workers would have high risk of lung cancer in their lifetime. However, the prevalence of cigarette smoking among these workers declined substantially from 47% during the 1987–1990 period to 40% during the 1988–1994 period [Nelson et al., 1994]. Smoking prevalence among vehicle mechanics and repairers was stable between 1987 and 1994: 41.6% during the 1987–1990 period [Nelson et al., 1994] and 41.7% during the 1988–1994 period.

Among 40 different occupational groups, teachers had the lowest prevalence (12.2%). Previous study based on the 1987–1990 NHIS data reported 17.4% of smoking prevalence among teachers [Nelson et al., 1994]. Among teachers, the prevalence of former smokers was approximately 2-fold higher (22.2%) than that (12.2%) of current smokers. The reduced smoking prevalence among current smokers may be related to change in their smoking behavior because of restrictive work-site smoking policies or other personal reasons.

Prevalence of smoking among blue-collar workers has declined over the years: from 43.7% during the 1978–80 period to 39.2% during the 1987–1990 period [Nelson et al., 1994]. Our study shows that cigarette smoking prevalence among blue-collar workers is over 25% during the 1988–1994 period. The Healthy People 2000 objective on smoking for blue-collar workers is "*Reduce cigarette smoking to a prevalence of no more that 20% among blue-collar workers aged 18 and older*" [US Department of Health and Human Service, 1999]. To meet this goal, more intensive smoking cessation efforts should target this population.

Smoking in the workplace may affect not only human health but also employee performance. A recent study indicates that cigarette smoking is associated with physical and mental functional status [Woolf et al., 1999].

Another recent issue is a passive smoking effect. A recent report based on a meta-analysis of workplace data on lung cancer and passive smoking found a statistically

TABLE II. Estimated Prevalence of Current Cigarette Smoking by Occupation

Occupation	No. of respondents	Prevalence (%)	95% CI
Transportation and material moving occupations	263	45.9	35.7–56.1
Waiters and waitresses	314	44.5	35.9–53.1
Construction laborers	248	41.9	31.5–52.3
Vehicle and mobile equipment mechanics and repairers	281	41.7	31.3–52.1
Motor vehicle operators	573	41.5	35.0–48.0
Construction trades	679	40.2	33.3–47.1
Related agricultural, forestry, and fishing occupations	199	39.9	29.7–51.1
Laborers, except construction	221	38.8	28.0–49.6
Other handlers, equipment cleaners, and handlers	209	38.3	26.7–49.9
Fabricators, assemblers, inspectors, and samplers	657	37.4	30.5–44.3
Protective service occupations	212	36.6	24.3–48.9
Health service occupations	523	35.0	25.0–45.0
Cooks	524	34.6	27.0–42.2
Machine operators	960	34.2	29.9–38.5
Cleaning and building service occupations	616	33.7	26.6–40.8
Supervisors and proprietors, sales occupations	347	33.0	23.4–42.6
Other mechanics and repairers	322	32.3	25.0–39.6
Extractive and precision production occupations	759	32.1	26.2–38.0
Miscellaneous food preparations and service occupations	457	31.7	25.2–38.2
Material recording, and distributing clerks	275	30.2	21.8–38.6
Textile, apparel, furnishing machine operators	601	27.8	20.9–34.7
Farm and nursery workers	785	26.7	18.3–35.1
Sales workers, retail, and personal services	1,116	26.7	22.4–31.0
Record processing operators	461	26.6	20.3–32.9
Writers, artists, entertainers	210	25.2	17.9–32.5
Freight, stock, and material movers	290	25.2	18.5–31.9
Information clerks	169	24.1	19.0–29.2
Administrative support occupations	1,029	24.1	19.0–29.2
Executive, administrators, and managers	788	23.9	19.6–28.2
Personal service occupations	410	23.5	17.0–30.0
Farm operators, managers, and supervisors	364	22.9	13.7–32.1
Secretaries, typists	673	20.8	16.3–24.3
Technicians and related support occupations	337	20.7	15.0–26.4
Private household occupations	429	20.4	13.3–27.5
Management related occupations	313	19.7	13.4–26.0
Other professional specialist occupations	280	19.4	13.7–25.1
Health diagnosing, assessment, and treating occupations	324	19.3	13.2–25.4
Engineers and scientists	258	19.2	11.2–27.2
Sales representatives, finance, and business	276	18.5	13.6–23.4
Teachers	609	12.2	8.5–15.9

significant increase in lung cancer risk due to passive smoking [Wells, 1998]. This finding justifies the need to protect the workers' health. Knowledge concerning adverse health outcomes from workplace tobacco smoke is crucial in determining the need to protect workers' health [Breslow and Elashoff, 1998]. The 1985 Surgeon General's report [US Department of Health and Human Services, Office on Smoking and Health, 1985] focused on the interaction between occupational exposure and smoking: "*For the majority of American workers who smoke, cigarette smoking represents a greater cause of deaths and disability than the workplace environment.*" Since many researchers have reported that workplace smoking is a health hazard, interest in work-site smoking cessation programs may increase, and more restrictive work-site smoking policies should be implemented.

TABLE III. Estimated Prevalence of Current Cigarette Smoking by Industry

Industry	No. of respondent	Prevalence (%)	95% CI
Construction	1,007	42.2	37.1–47.3
Repair services	265	40.9	31.5–50.3
Lumber and wood products	194	39.7	27.8–51.6
Eating & drinking places	1,293	39.3	35.6–43.0
Vehicle dealers, supply and service stores	201	38.5	26.7–50.3
Utilities	196	37.6	25.8–49.4
Trucking service	254	37.0	27.8–46.2
Agricultural services, forestry, and fishing	170	35.9	24.0–47.8
Metal industries	386	33.8	24.0–43.6
Wholesale trade, durable goods	196	33.0	23.8–42.2
Other retail trade	702	32.5	26.6–38.4
Rubber, plastics and leather products	176	31.6	15.8–47.4
Machinery, except electrical	285	31.5	22.1–40.9
Food and kindred products	519	31.1	25.8–36.4
Transportation equipment	505	31.0	23.9–38.1
Paper products, printing, and publishing industries	355	30.8	23.0–38.6
Wholesale trade, non-durable goods	307	29.7	22.8–36.6
Entertainment & recreation services	187	29.6	19.8–39.4
Health services, not elsewhere classified	441	28.9	20.3–37.5
Electrical machinery, equipment and supplies	274	28.6	20.2–37.0
Transportation, except trucking	503	28.6	22.3–34.9
Business services	545	28.4	22.7–34.1
Mining	106	27.8	15.3–40.3
Lodging places	303	27.8	22.5–33.1
Food stores	492	27.7	21.8–33.6
Department stores	336	27.5	18.7–36.3
Apparel and other textile products	404	27.3	19.9–34.7
Personal services, except private households and lodging	383	27.2	20.5–33.9
Apparel and accessory stores	241	26.5	17.7–35.3
Miscellaneous and not specified manufacturing industries	364	26.8	20.5–33.1
Chemicals, petroleum and coal products	208	25.7	16.7–34.7
Textile mill products	304	25.1	15.9–34.3
Communications	260	24.6	16.2–33.0
Justice, public order, and safety	180	24.4	13.6–35.2
Agriculture production	1,186	24.3	16.9–31.7
Hospital	682	23.7	19.0–28.4
Public administration, except justice	718	22.6	15.9–29.3
Banking and other finance	356	21.6	15.5–27.7
Other profession and related services	375	20.8	15.3–26.3
Social services	271	20.1	14.0–26.2
Insurance and real estate	402	18.0	13.1–22.9
Private households	465	18.0	11.7–24.3
Offices of health practitioners	206	16.9	8.9–24.9
Educational services	1,134	14.4	11.1–17.7
All industries	20,030	28.3	26.9–29.7

In this study, occupations with very high smoking prevalence (over 40%) included transportation and material moving occupations, construction laborers, mechanics/repairers, motor vehicle operators, and construction trades. It is worthwhile to investigate why smoking prevalence is high among these groups of workers. High smoking prevalence in these occupations may be associated with job-related stress, socio-economic status, and other factors. There is some evidence that perceived high levels of occupational stress are associated with increased risk of smoking in the workplace [Conway et al., 1981]. Occupational stress may be more common among blue-collar workers. Schilling et al. (1985) found that smokers use cigarette smoking to reduce stress in their environment.

There are some limitations to this study. NHANES III excluded members of the non-civilian population, thus, these results may not be applicable to other populations such as military personnel. Since the smoking information is based on respondents' self-reporting, there was no biological verification of smoking status such as level of cotinine which is one of the major detoxication products of nicotine. However, self-reports are generally reliable for estimation of actual smoking behavior [US Department of Health, Education, and Welfare, 1979]. NCHS regrouped respondents' occupations or industries into 40 categories and 44 industries. Each occupation or industry was regrouped with similar occupation or industry when the sample size was small. Sample sizes in less than 30 of occupational and industrial groups were too small to evaluate age-gender-specific smoking prevalence. There was no detailed explanation to grouping procedures for occupation and industry categories in the data documentation. We assume that ''health diagnosing, assessment and treating occupations'' include physicians, and dentists. ''Health service occupations'' include registered nurse and nursing assistance.

Smoking information is important in occupational epidemiologic studies. Such information on smoking is necessary to describe potential interaction between smoking and occupational exposure in relation with disease [Steenland et al., 1984; Blair et al., 1988]. The absence of information on smoking complicates interpretations of the study results because smoking is associated with the etiology of certain chronic diseases including lung cancer, chronic obstructive pulmonary disease, and cardiovascular disease. Difference in smoking prevalence between specific occupations or industries and the comparison population may result in inaccurate evaluation of the relationship between disease and the occupational exposure of interest [Blair et al., 1988]. Public confidence in the results of occupational studies may suffer at the expense of missing information on smoking behavior.

An important consideration for applying smoking prevalences to epidemiologic studies is the time period upon which the survey is based. This study provides most recent smoking information by industry and occupation in the US for the 1988–1994 period. If someone were to assess the contribution of smoking as a risk factor for lung cancer, it needs to consider the latency period.

The findings from this study will be useful information in targeting groups who are in need of intervention to reduce smoking prevalence. Periodic estimates of smoking prevalence based on national health surveys as NHANES or NHIS are necessary to evaluate trends of smoking prevalence in the US.

REFERENCES

Arnett DK, Sprafka JM, McGovern PG, Jacobs DR, Shahar E, McCarty M, Luepker RV. 1998. Trends in cigarette smoking: the Minnesota Heart Survey, 1980 through 1992. Am J Pub Health 88:1230–1233.

Beaumont JJ, Singleton JA, Doebbert G, Riedmiller KR, Brackbill RM, Kizer KW. 1992. Adjustment for smoking, alcohol consumption, and socioeconomic status in the California occupational mortality study. Am J Ind Med 21:491–506.

Blair A, Steenland K, Shy C, O'Berg M, Halperin W, Thomas T. 1988. Control of smoking in occupational epidemiologic studies: methods and needs. Am J Ind Med 13:3–4.

Blot WJ, Fraumeni JF Jr. 1996. Cancer of the lung and pleura. In: Schottenfeld D, Fraumeni JF Jr., Editors. Cancer epidemiology and prevention. 2nd ed. New York: Oxford University Press. p 637–665.

Brackbill R, Frazier T, Shilling S. 1988. Smoking characteristics of US workers, 1978–1980. Am J Ind Med 13:5–41.

Breslow L, Elashoff R. 1998. Editorial: significance of workplace smoking. Am J Public Health 88:1011–1012.

Conway TL, Vickers RR, Ward HW, Rahe RH. 1981. Occupational stress and variation in cigarette, coffee, and alcohol consumption. J Health Soc Behav 22:155–165.

Nelson DE, Emont SL, Brackbill RM, Cameron LL, Peddicord J, Fiore MC. 1994. Cigarette smoking prevalence by occupation in the United States. J Occup Environ Med 36:516–525.

Schilling RF, Gilchrist LD, Schinke SP. 1985. Smoking in the workplace: review of critical issues. Public Health Reports 100:473–479.

Shah BV, Barnwell BG, Hunt PN, Lavange LM. 1991. SUDAAN user's manual. Research Triangle Park, NC: Research Triangle Institute.

Steenland K, Beaumont J, Halperin W. 1984. Methods of control for smoking in occupational cohort mortality studies. Scand J Work Environ Health 10:143–149.

Stellman SD, Boffetta P, Garfinkel L. 1988. Smoking habits of 800,000 American men and women in relation to their occupations. Am J Ind Med 13:43–58.

Szczesny LB, Holbrook JH. 1992. Cigarette smoking. In: Rom WV, Editor. Environmental and occupational medicine. Boston: Little, Brown and Company. p 1211–1222.

US Department of Health, Education, and Welfare. 1979. Smoking and health: a report of the Surgeon General Rockville, MD: Public health Service, 1979. DHEW Publication No. (PHS) 79–50065.

US Department of Health and Human Service. 1994. Plan and operation of the Third National Health and Nutrition Examination

Survey, 1988–94 National Center for Health Statistics. DHHS Publication No. (PHS) 94–1308.

US Department of Health and Human Service. 1999. Healthy People 2000 Review 1988–99 DHHS Publication No. (PHS) 99–1256.

US Department of Health and Human Services, Office on Smoking and Health. 1985. The health consequences of smoking: cancer and chronic lung disease in the workplace. A report of the Surgeon General. Washington, DC.

US Environmental Protection Agency. 1992. Respiratory health effects of passive smoking: lung cancer and other disorders. Washington, DC.

Wells AJ. 1998. Lung cancer from passive smoking at work. Am J Public Health 88:1025–1029.

Woolf SH, Rothemich SF, Johnson RE, Marsland DW. 1999. Is cigarette smoking associated with impaired physical and mental functional status? Am J Prev Med 17:134–137.