

Occupational Risks Associated with Cigarette Smoking: A Prospective Study

ABSTRACT

Background. Studies have indicated that cigarette smokers have more occupational accidents and injuries and use more sick time and health benefits than nonsmokers, thereby producing sizeable costs for employers. However, they usually have not controlled for other possible sources of these costs. We analyzed occupational costs associated with smoking while adjusting for a number of potential confounders.

Methods. We conducted a prospective, controlled study of the association between smoking and employment outcomes in 2537 postal employees, adjusting for age, gender, race, drug use, job category, and exercise habits.

Results. For smokers, the relative risk for turnover was 1.01 (95% confidence interval [CI], 0.83–1.21); for accidents 1.29 (CI, 1.07–1.55); for injuries 1.40 (CI, 1.11–1.77); for discipline 1.55 (CI, 1.19–2.02). Their mean absence rate was 5.43% compared with 4.06% for nonsmokers.

Conclusions. Our study shows that cigarette smoking is associated with adverse employment outcomes after controlling for a number of possible confounders. This finding has implications for companies formulating smoking policies and considering the establishment of smoking cessation programs. (*Am J Public Health.* 1992;82:29–32)

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Introduction

The social costs of cigarette smoking, including occupational risks, have been widely discussed since the original surgeon general's report on smoking and health.^{1,2} A 1986 study of public employees found that cigarette smokers use 23% more sick leave than nonsmokers.³ Studies of student nurses in 1983 and 1988 found smokers absent 77% more frequently than nonsmokers⁴ and a significant relationship ($P < .008$) between number of cigarettes smoked and days absent.⁵ Smokers have been reported to use more health benefits^{6,7} and have more occupational accidents and injuries. A 1966 study of machinists reported an injury rate of 18% for smokers compared with 10% for nonsmokers; 26% of injured smokers reported multiple injuries vs 13% of injured nonsmokers.⁸ A 1973 study involving ceramics workers⁹ found that 57% of smokers sustained occupational injuries and 20% lost time from work as a result of injury. Among nonsmokers, only 28% sustained injuries and 10% lost time. These associations account for sizable costs for employers of smokers.^{10,11}

Smoking rates vary with demographic variables, including age, sex, and race.² Smoking is also associated with use of drugs¹² and excessive alcohol.^{13,14} Since such factors may be associated with adverse health outcomes, studies of risks associated with smoking should control for these potential confounding variables.

We present a prospective examination of the association between cigarette smoking and rates of employee turnover, absenteeism, accidents, injuries, and discipline while controlling for age, gender, race, job category, exercise habits, and drug abuse. It represents a secondary

analysis of data collected in a previous study of the predictive value of preemployment drug testing.¹⁵

Methods

Cohort Definition

All Boston postal service applicants for permanent nonprofessional positions examined between September 24, 1986, and January 6, 1989, were potential study subjects. Candidates for temporary and professional positions were excluded, the latter because of their small number ($n = 11$) and different socioeconomic and educational backgrounds.

From September 24, 1986, to January 6, 1989, 4957 applicants received preemployment examinations. We excluded 56 applicants because data-entry errors made it impossible to track their outcome variables, 60 Hispanics (of whom 24 were hired) and 2 Native Americans (1 hired) because the numbers were too small for statistical analysis, and 42 applicants with a history of treatment for drug abuse and

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7 who tested positive for opiates under a prior agreement with postal service management to fully evaluate such persons. Thus, the study population was not entirely representative of all postal service employees hired during the study period. Persons removed from the study were excluded without consideration of their smoking status. Of the remaining 4797 applicants, 2 for whom data on smoking status were unavailable were excluded, leaving 4795 potential subjects for this study; 2537 applicants hired before January 28, 1989, were included. Both mean and median duration of follow-up were 406 days, with a range of 28 to 896 days.

Smoking Status

Smoking status was categorized as smoker or nonsmoker using self-reported data. Persons who had smoked three or more cigarettes per day over the previous month were classified as smokers. All other subjects were classified as nonsmokers. One tenth of 1% of subjects were smokers who smoked less than three cigarettes per day. Any misclassification bias introduced by this classification system would therefore be negligible and, in any case, toward the null.

Self-reported information on smoking status was used because of its convenience, simplicity, economy, and reliability. Self-reported data have been demonstrated to have sensitivity and specificity in excess of 90% when compared with objective measurements of saliva cotinine,¹⁶ serum thiocyanate,¹⁷ and expired carbon monoxide.^{17,18}

Confounding Factors

A number of confounding factors might be associated with both the risk variable (cigarette smoking) and the outcome variables (turnover, absenteeism, accidents, injuries, and discipline). We therefore collected data on age, gender, race, job classification, drug use, and exercise habits.

Race was classified by the examiner as White, Black, or Asian. Job classifications included letter carrier, special delivery messenger, motor vehicle operator, postal clerk, letter sorting machine clerk, computer forwarding system clerk, mail handler, and maintenance worker, divided into two or three categories according to endpoint. Applicants were divided into "aerobic exercisers" (strenuous exercise for 20 minutes, three times a week), "regular exercisers," and "nonexercisers" based on self-report. A urine drug screen was performed for marijuana, co-

caine, amphetamines, barbiturates, benzodiazepines, methadone, methaqualone, opiates, phencyclidine, and propoxyphene as reported elsewhere.¹⁵ In the analysis, drug test results were classified into four categories: negative for all drugs, positive for marijuana only, positive for cocaine only, and positive for other drugs or multiple drugs.

Endpoints

Five endpoints were considered in the analysis: absence rate, time to termination, time to first accident, time to first injury, and time to first discipline.

Absence rates. The absence variable was a function of sick leave (SL), leave without pay (LWOP), and work hours calculated according to the following formula:

$$\text{Absence rate} = \frac{\text{SL hours} + \text{LWOP hours}}{\text{SL hours} + \text{LWOP hours} + \text{work hours}}$$

Time to termination. Individuals whose employment with the postal service had terminated were defined as having turned over. Termination was subdivided into two categories, voluntary (death, resignation, or transfer to another federal agency) and involuntary (fired).

Time to first accident. Records of work-related accidents revealed a relatively low rate of multiple accidents. Of 502 employees reporting accidents, 76 had two accidents and 14 had three. We therefore analyzed time to first accident rather than accident rates.

Time to first injury. We found a relatively low rate of multiple injuries. Of 312 employees who reported occupational injuries, 41 had two injuries and 8 had three. We therefore analyzed time to first injury rather than injury rates.

Time to first report of disciplinary action. The postal service labor agreements provide for progressive levels of discipline up to removal. The time to first discipline was calculated from labor relations department records. All endpoints were followed through March 11, 1989.

Statistics

We used the Cox proportional hazards model¹⁹ from the SAS statistical package's SUGI supplement²⁰ with nonsmokers as the baseline group to assess whether cigarette smoking was associated with turnover, accidents, injuries, or discipline. Thus, a significantly positive Cox

regression coefficient for smokers indicates a significantly increased risk for that endpoint and a negative Cox regression coefficient indicates a decreased risk.

Because 25% of the subjects had a 0% absence rate, it was not possible to use linear regression with absence rate as the outcome variable. Subjects who were absent were divided into approximately equal quartiles according to their absence rates: 0% absence rate ($n = 646$), 0% to 1.52% ($n = 478$), 1.52% to 3.04% ($n = 468$), 3.04% to 5.60% ($n = 471$), and absence rate > 5.60% ($n = 474$). The SAS polychotomous logistic regression was used to determine whether smoking was associated with an increased risk of being in a high-absence category.

The potential confounding variables (age, sex, race, drug use, job classification, and exercise) were simultaneously entered into the Cox and logistic regression models, permitting adjustment for confounding with cigarette smoking.²¹ All P values were two sided and considered significant at a .05 level.

Results

Of the 4795 eligible applicants, 2537 were hired. There was no difference in smoking rate between those hired (32.5%) and not hired (33.2%; $P = .62$).

Table 1 presents the distribution of covariates. Smokers were more frequently older, female, nonexercisers, and drug users and less often Asian or letter carriers. Thus, these variables were potential confounders.

Table 2 shows measures related to the endpoints correlated with smoking status. Since the distribution for absence rate was skewed markedly to the right, both mean and median are provided. While this table does not include adjustments for covariates, inclusion of covariates in the Cox proportional hazards and polychotomous logistic regression models resulted in only small changes. Thus, these covariates were not major confounders in our data set.

Table 3 presents the results of the Cox proportional hazards models with inclusion of covariates. Cigarette smokers show increased risks of accidents, injuries, and discipline but no increased risk of termination.

A polychotomous logistic regression model was used to predict absence category with the covariates included. This analysis produced a beta for smokers of 0.264 with a P value of .0007. Interpretation of an odds ratio for absence is not

intuitive, as absence is divided into five leave-use categories. Mean absence rates provide a more easily interpreted estimate of the magnitude of the effect: 5.43% for smokers and 4.06% for nonsmokers.

Discussion

To our knowledge, this study presents the first prospective estimates of associations between cigarette smoking and adverse employment outcomes after adjustment for the potentially confounding covariates of age, sex, race, exercise, drug abuse, and job category. We found significant positive associations between cigarette smoking and absenteeism, industrial accidents, occupational injuries, and disciplinary action. Smokers had a 34% increase in mean absenteeism that remained significant after adjustment for covariates. Smokers had increased covariate-adjusted relative risks for industrial accidents (29%), occupational injuries (40%), and discipline (55%). We found no significant difference in turnover, voluntary or involuntary. Thus, our study confirms the previously reported elevated rates of absenteeism, accidents, and injuries for smokers.³⁻⁹

The mean age of our study population was 30.2 years. In our cohort of newly hired younger workers, any increase in absence from smoking-related illness is most likely due to acute, short-term illnesses such as respiratory infections. The more serious adverse health outcomes caused by cigarette smoking, cardiovascular and chronic pulmonary disease and cancers, probably would not develop until workers are several decades older. The increase in smoking-associated absenteeism in our cohort, therefore, probably underestimates the true magnitude of this effect for workers who smoke throughout their working lives. A similar analysis might be made for use of health insurance benefits, a factor that we did not assess but that has been reported to be increased in smokers.^{6,7}

In this study, we were unable to control for the possible confounding effect of alcoholism. Smoking is reported to be associated with alcoholism.^{13,14} Alcoholics are also known to have poor employment outcomes.²² We did not conduct any laboratory tests for alcohol abuse, as the methodologies available lack adequate sensitivity and specificity. We also did not use self-reports, as surveys of alcohol use have consistently demonstrated underreporting, even in settings where there would be no adverse consequences for

	Nonsmokers		Smokers		Total	
	No.	%	No.	%	No.	%
Sample size	1712	67.5	825	32.5	2537	100
Average time of follow-up (d)	407		404		406	
Mean age (y)	29.8		31.2		30.2	
Gender (<i>P</i> < .001)						
Male	1174	68.6	496	60.1	1670	65.8
Female	526	31.2	318	39.3	867	34.2
Race (<i>P</i> = .001)						
White	1521	88.8	757	91.8	2278	89.8
Black	107	6.3	53	6.4	160	6.3
Asian	84	4.9	15	1.8	99	3.9
Drug use (<i>P</i> < .001)						
None	1542	90.3	684	82.9	2226	87.9
Marijuana	103	6.0	94	11.4	197	7.8
Cocaine	33	1.9	22	2.7	55	2.2
Both	30	1.8	25	3.0	55	2.2
Exercise (<i>P</i> < .001)						
Aerobic	270	15.8	76	9.2	346	13.7
Nonaerobic	923	54.0	438	53.2	1361	53.8
None	516	30.2	310	37.6	824	32.6
Job classification (<i>P</i> < .001)						
Carrier	649	38.0	264	32.1	913	36.1
Clerk	121	7.1	44	5.4	165	6.5
LSM clerk	502	29.4	247	30.0	749	29.6
Mail handler	226	13.2	109	13.3	335	13.2
Mail processor	103	6.0	68	8.3	171	6.8
Other	109	6.4	90	10.9	199	7.9

Note. LSM = letter sorting machine. Since information on some covariates was not available for a few employees, sample sizes for some covariates may not add up to the overall totals. The "other" job classification includes special delivery messenger, motor vehicle operator, maintenance worker, computer forwarding system clerk, and electronic technician.

	Nonsmokers, %	Smokers, %
Turnover (%)	19.6	21.5
Voluntary	12.8	13.0
Involuntary	6.4	8.4
Accidents (%)	18.5	22.6
Injuries (%)	10.9	15.3
Discipline (%)	7.9	12.1
Mean absence rate (%)	4.1	5.4
Median absence rate (%)	1.8	2.3

Note. Reported percentages represent the simple overall proportion of employees for whom the endpoint occurred; time- and covariate-adjusted analyses are reported in Table 3.

positive reports.²³ The validity of self-reported data would be highly questionable in the preemployment examination setting.

Since we did not control for the effects of alcohol abuse, it is possible that some of the associations demonstrated are attributable to alcoholism rather than smoking. The degree of any confounding by alcoholism would be a function of the coincidence of alcohol and tobacco abuse in our study population. It might, therefore, affect the degree to which the results

of this research can be generalized to populations with different alcohol- and tobacco-abuse patterns.

Our study cannot distinguish adverse employment outcomes associated with cigarette smoking caused by the physiological effects of smoking from those caused by smoking behavior (e.g., decreased attention to driving) or by other social or personality characteristics associated with smoking. The postal service smoking policy in effect during the first 28 months of the study permitted either un-

TABLE 3—Covariate-Adjusted Risks for Smokers Relative to Nonsmokers

	Relative Risk	P Value	95% Confidence Interval
Turnover	1.01	.956	0.83, 1.21
Voluntary	0.94	.585	0.74, 1.19
Involuntary	1.17	.306	0.86, 1.60
Accidents	1.29	.008	1.07, 1.55
Injuries	1.40	.004	1.11, 1.77
Discipline	1.55	.001	1.19, 2.02

Note. The risk estimates have been adjusted for age, gender, race, drug use, exercise habits, and job classification.

limited smoking at work or regular smoking breaks. For the last 3 months of follow-up, smoking was permitted during breaks every 2 hours. Thus, the effects of nicotine withdrawal would not have contributed to accidents or injuries. Although we cannot determine the etiology of the adverse employment outcomes, our findings provide a basis for estimating the magnitude of the increase in costs to industry that results from hiring cigarette smokers.

The findings of this study may also be useful in assessing the cost-effectiveness of corporate smoking control and smoking cessation programs. To the degree that such programs decrease cigarette smoking in the work force, a health-related effect such as absenteeism might be expected to decrease. It is less clear whether there would be similar improvements in effects such as accidents, injuries, and discipline, as these may be linked to social and behavioral characteristics that might persist after cessation of, or a decrease in, smoking. A comparison of smokers, former smokers, and persons who have never smoked might begin to answer such questions. We hope, however, that the present study will contribute to the body of knowledge needed to evaluate some of

the complex ethical, legal, economic, and social issues related to smoking in the workplace. □

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