Cigarettes and Suicide: A Prospective Study of 50 000 Men

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A B S T R A C T

Objectives. This study examined the relation between smoking and suicide, controlling for various confounders.

Methods. More than 50 000 predominantly White, middle-aged and elderly male health professionals were followed up prospectively with biennial questionnaires from 1986 through 1994. The primary end point was suicide. Characteristics controlled for included age, marital status, body mass index, physical activity, alcohol intake, coffee consumption, and history of cancer.

Results. Eighty-two members of the cohort committed suicide during the 8-year follow-up period. In age-adjusted analyses with never smokers as the comparison group, the relative risk of suicide was 1.4 (95% confidence interval [CI] = 0.8, 2.3) among former smokers, 2.6 (95% CI = 0.9, 7.5) for light smokers (<15 cigarettes/day), and 4.5 (95% CI = 2.3, 8.8) among heavier smokers. After adjustment for potential confounders, the relative risks were 1.4 (95% CI = 0.9, 2.4), 2.5 (95% CI = 0.9, 7.3), and 4.3 (95% CI = 2.2, 8.5), respectively.

Conclusion. We found a positive, dose-related association between smoking and suicide among White men. Although inference about causality is not justified, our findings indicate that the smoking–suicide connection is not entirely due to the greater tendency among smokers to be unmarried, to be sedentary, to drink heavily, or to develop cancers. (*Am J Public Health*. 2000;90: 768–773)

Cigarette smoking is the leading cause of preventable death in the United States.[1] Although the nature of the relation between cigarette smoking and disease has been most convincingly demonstrated for physical illness, several researchers have linked smoking to mental illness, especially depression.[2–14]

Almost a dozen studies have shown a significant association between smoking and suicide. However, many of these studies were small and did not control for characteristics common to both smokers and persons who commit suicide.[13,15–25] For example, only 2 prospective studies with more than 20 suicides controlled for alcohol intake—and these yielded conflicting results.[18,22]

In this article, we present data on more than 50 000 men followed up prospectively for 8 years. Our analysis controlled for several potentially important behavioral, situational, and demographic factors that have been identified in the suicide, smoking, and depression literature. In addition, the investigation evaluated the relation between suicide and smoking, while taking into account changes in smoking status during follow-up. The study also examined prospectively the contribution of developing cancer to the association between smoking and suicide.

Methods

The Health Professionals Follow-Up Study Cohort

The Health Professionals Follow-Up Study is a longitudinal study of the risk factors for cardiovascular disease and cancer among 51 529 US men aged 40 to 75 years in 1986. The study population consists of 29 683 dentists, 10 098 veterinarians, 4185 pharmacists, 3745 optometrists, 2218 osteopathic physicians, and 1600 podiatrists. The study began in 1986, when cohort members completed a questionnaire on heart disease and cancer risk factors, including current and past smoking habits, medical history, and diet. Every 2 years, follow-up questionnaires have been sent out to update this information and to identify newly diagnosed diseases.

Ascertainment of Smoking Status

Men were characterized according to their smoking status as never smokers, current smokers, or former smokers. Current smokers were further characterized as smoking 1 to 14 or 15 or more cigarettes per day. On the baseline 1986 questionnaire, smokers were asked the age at which they started smoking. Respondents who had ever smoked (20 or more packs of cigarettes in their lifetime) were asked to indicate the average number of cigarettes they smoked per day for the following life periods: younger than 15 years, 15 to 19 years, 20 to 29 years, 30 to 39 years, 40 to 49 years, 50 to 59 years, and 60 years or older. One pack-year is defined as the amount smoked by an individual who smokes on average 20 cigarettes per day for 1 year. Cumulative (total) pack-years were calculated by summing the number of pack-years an individual smoked in each relevant life period.

For each of the four 2-year periods, respondents were divided into 4 smoking categories according to their status at the beginning of the period: (1) never smokers,

(2) former smokers, (3) current smokers of fewer than 15 cigarettes per day, and (4) current smokers of 15 or more cigarettes per day. Individuals who did not respond to the smoking question during a given follow-up period were assigned to the smoking category they occupied in the previous period.

Identification of Cases

Most deaths in the cohort were reported by next of kin, work associates, or postal authorities. Mortality surveillance also included systematic searches of the vital records in the National Death Index to identify deaths among participants who were persistent nonresponders to the questionnaire mailings. We estimated that more than 98% of the deaths were ascertained by these methods.[26]

Physicians reviewed death certificates and hospital or pathology reports to classify individual causes of death. Deaths caused by self-inflicted or external injury were classified according to the underlying causes listed on the death certificate. The end point of our study included all cases of suicide (*International Classification of Diseases, 8th Revision* [*ICD-8*] codes E950–E959)[27] that occurred between the return of the 1986 questionnaire and January 31, 1994.

Statistical Analysis

The primary analysis of follow-up data from 1986 to 1994 used suicide incidence rates with person-years of follow-up as the denominator. The relative risk (RR) was defined as the suicide incidence rate among men who reported a given history of smoking divided by the corresponding rate among men who were categorized as never smokers. Relative risks were adjusted for age with 5-year age groups,[28] and 95% confidence intervals (CIs) were calculated.[29] Pooled logistic regression, equivalent to Cox regression with time-dependent covariates, is used in multivariate analyses.[30] Multivariate relative risks adjust for age (in 5-year categories), marital status (married vs not married), body mass index (deciles), physical activity (quintiles), alcohol intake (0.0 g/d, 0.01–14.9 g/d, 15.0–29.9 g/d, 30.0–49.9 g/d, and 50.0 or more g/d), and coffee consumption (≤3 cups/month, ≤4 cups/week, ≤4 cups/day, ≥5 cups/day).

Because body mass index, physical activity, and coffee consumption did not affect our multivariate findings, results presented derive from a parsimonious model that does not include these factors. When appropriate, we performed the Mantel test for linear trend across levels of smoking and reported the 2-tailed *P* values.[28]

Updated analyses were performed and are presented. The magnitude of the association between current smoking status and suicide was greater in the updated analyses, as expected from improved classification of a time-varying exposure such as smoking status. For missing values of smoking status, analyses that assigned the previous smoking status for the current smoking status did not appreciably differ from analyses that assigned missing responses to a separate dummy variable. Results presented use the previous status for missing data on current smoking status.

In assessing the effect of cancer (i.e., all-cause cancer except nonmelanoma skin cancer) on the association between smoking status and suicide, we compared analyses using the entire cohort with analyses excluding individuals with a history of cancer at baseline (2018 individuals) and with analyses excluding individuals with cancer either at baseline or during follow-up (an additional 4188 individuals). We also evaluated the effect of developing cancer in general and lung cancer in particular (293 cases during follow-up) by entering overall cancer and lung cancer (separately) into our final model.

Results

Eighty-two members of the cohort committed suicide in the 8-year period. Smokers were more likely than nonsmokers to be unmarried, to be less physically active, to drink alcohol and drink heavily, to consume coffee, and to develop cancer (Table 1). These tendencies were most pronounced in heavy smokers and least pronounced in former smokers.

Compared with never smokers, heavy smokers were at increased risk for suicide (Table 2). The risk of suicide increased with the number of cigarettes smoked daily (*P* < .001 for trend). Current smokers of 15 or more cigarettes per day had more than 4 times the risk of suicide compared with never smokers (multivariate RR = 4.3, 95% CI = 2.2, 8.5) (Table 2). Suicide risk among former smokers was intermediate between the risks among never and current smokers.

Other measures of smoking exposure yielded similar trends. For example, cumulative pack-years also showed a strong, positive, and dose-related association with suicide: with never smokers as the comparison group, for every 10 pack-years of smoking, the relative risk of suicide increased by approximately 20% (*P* < .01 for trend; data not shown). The multivariate relative risks of suicide for smokers of less than 40, 40 to 60, and 80 or more pack-years, compared with never smokers, were 1.4, 1.8, and 4.0, respectively.

In the United States, the suicide rate among non-White Americans is approximately 60% of that among White Americans, and the rate among men in the United States is about 3 times that for women.[31] In our cohort, for each age stratum, the suicide rate was lower than that for the corresponding stratum in US White men. Overall, the suicide rate in our cohort (17 suicides per 100 000 person-years) was approximately half of the corresponding rate in the general US population of White men aged 40 to 84 years.[31] Suicide rates did not differ significantly by health professional specialty (data not shown). Our cohort was somewhat less likely than the general US male population to use guns to kill themselves (52% vs 65%) and somewhat more likely to use solid, liquid, or gas poisoning (30% vs 15%) (data not shown).[31]

Four of the 2018 individuals with cancer at baseline and 11 of the 4188 individuals who developed cancer during follow-up committed suicide during the 8-year follow-up period. Analyses of the relation between smoking and suicide were performed with the entire cohort; these were compared with analyses excluding individuals with a history of cancer at baseline and with analyses excluding individuals with cancer at baseline and/or during follow-up. The magnitude and statistical significance of the association between smoking and suicide were not materially affected by excluding individuals with cancer.

Individuals who developed lung cancer during follow-up were 7 times as likely (and those with cancer in general were twice as likely) to kill themselves as were those who did not develop cancer (RR = 7.0, 95% CI = 1.7, 29.2). Nevertheless, neither lung cancer nor cancer in general, when entered into our final multivariate model, appreciably diminished the magnitude or the significance of the association between smoking and suicide (e.g., the relative risk for heavy smokers remained significant at the *P* < .001 level, decreasing from 4.3 to 3.9 when lung cancer was added to the main model). Results presented derive from the entire cohort. Models do not include terms for cancer.

Discussion

Smokers and nonsmokers differ on many characteristics related to the risk of suicide. Depression,[2,6] schizophrenia,[32–34] alcohol and illicit drug use,[35,36] suicidal ideation and suicide attempts,[11] developing cancer,[37–39] not being married, and otherwise being socially isolated[40,41] are risk factors for suicide that are more common among smokers than among nonsmokers. Compared with nonsmokers, smokers also tend to act out hostility and have

TABLE 1—Population Characteristics, by Smoking Status: 1986[a]

	Never Smoker (n = 22 845)	Former Smoker (n = 21 652)	Current Smoker, 1–14 Cigarettes/Day (n = 1333)	Current Smoker, ≥15 Cigarettes/Day (n = 2241)
Alcohol intake, mean, g/d	8	14	16	18
Married, %	91	91	87	84
Cancer prevalence, %	8	9	11	12
Coffee intake, % drinking ≥3 cups/d	6	12	14	28
Physical activity, kcal/wk, % in top quintile	21	20	17	12

[a]Age-adjusted with respect to the entire cohort population.

TABLE 2—Age-Adjusted and Multivariate-Adjusted Relative Risks (RRs) of Suicide, According to Smoking History

	Never Smoker	Former Smoker	Current Smoker, 1–14 Cigarettes/Day	Current Smoker, ≥15 Cigarettes/Day
Number of cases	25	37	4	13
Crude incidence per 100 000 person-years	12	18	32	55
Age-adjusted RR[a] (95% CI)	1.0	1.4 (0.8, 2.3)	2.6 (0.9, 7.5)	4.5 (2.3, 8.8)*
Multivariate RR[a] (95% CI)	1.0	1.4 (0.9, 2.4)	2.5 (0.9, 7.3)	4.3 (2.2, 8.5)*

Note. Adjusted for time period (1986–1988, 1988–1990, 1990–1992, 1992–1994), age, alcohol intake (none, 0.01–14.9 g/d, 15–29.9 g/d, 30–49.9 g/d, ≥50 g/d), marital status (married vs divorced, widowed, or never married). Three cases are missing information on current smoking status.
[a]Test for trend among current smokers (compared with never smokers), $P < .05$.
*$P < .001$.

obsessional traits and anxiety.[42–46] Studies of smoking and reckless driving behavior suggest that those who smoke more than 1 pack per day are more likely than those who do not smoke to drive after drinking and are less likely to wear safety belts.[47–49] In our cohort, as in the general population, smokers were more likely to be unmarried, to drink alcohol and drink heavily, and to develop cancer (Table 1). We found a strong, positive, and dose-related association, independent of these factors, between various measures of smoking status and completed suicide. We lack data on depression, schizophrenia, hostility, anxiety, drinking and driving, and seat belt use.

Several epidemiologic studies have reported an association between cigarette smoking and depression, beginning in adolescence and persisting throughout adulthood.[2–8,50,51] The smoking–depression relation has been consistently observed, whether depression is conceptualized as a trait, a symptom, or a formal diagnosis of major depression; the formal diagnosis includes depressed mood but also requires that symptoms last at least 2 weeks and be sufficiently severe either to cause impaired functioning or to induce an individual to seek professional help.[12,52]

Compared with adolescents who are not depressed, depressed adolescents are more likely to smoke,[53] tend to smoke more,[54,55] and are more likely to continue to smoke as young adults.[50,51] Although some studies indicate that depressed adolescents are more likely than adolescents who are not depressed to begin smoking,[50,53,56] available data are generally weakest on the role that depression plays in smoking initiation.[13,57] In adults as well, the temporal relation between nicotine dependence and depression is unclear. For example, first-onset major depression has been associated with preexisting nicotine dependence, and, in the same population, a history of major depression at baseline increased the risk for progression to daily smoking.[13,14]

Four possible explanations for the smoking–suicide connection have been proposed[19]: (1) depression is a common antecedent of suicide and a condition that leads to smoking as a form of self-medication; (2) smoking alters brain chemistry, leading to depression, which increases the risk of suicide; (3) smoking leads to malignant disease, such as cancer, which increases the risk of suicide; and (4) smoking is associated with other characteristics that predispose individuals to suicide, such as low self-esteem (not because smoking physiologically exacerbates low self-esteem, but because in our culture they tend to occur together).

Several studies, summarized in the surgeon general's report[46] and elsewhere,[12] indi-

cate that nicotine has acute and chronic central nervous system effects, including potent influences on mood. Smoking is used, for example, to distract attention from emotionally painful stimuli, to positively enhance mood, and to reduce stress and negative mood.[12,46] Empiric evidence suggests that the heightened sensitivity of some depressed individuals to nicotine's positive mood-altering effects may lead to self-medication, which reinforces regular and heavy smoking.[57–63] Both survey and experimental studies report that nicotine reduces negative mood in smokers, that negative mood within 3 days of attempting to quit is one of the strongest predictors of relapse, that the benefits of nicotine gum are more apparent in depressed smokers,[9,46,64] and that persistent withdrawal symptoms predict major depression following smoking cessation.[65] Even though all retrospective studies indicate that negative mood is a precipitant of relapse,[12] and thereby might maintain an active smoking habit, recall bias may play an important role in the association.[62] One investigation examined a single cohort for relapse and found that negative mood was related to relapse when subjects were questioned after the relapse occurred but that the relation disappeared when the data were examined prospectively.[66]

Proposed mechanisms for a causal pathway in the other direction, from smoking to

depression, include (1) nicotine-related perturbations in neurotransmitter systems implicated in depression[63] and (2) depression-triggering effects of the low social status accorded smokers and of the difficulties encountered in trying to quit.[4,7,67]

Consistent with previous studies,[37–39] our results indicate that patients with cancer are at risk for taking their own lives. One route from smoking to suicide could be through the development of smoking-related malignant disease. As in the general population, smokers in our study were more likely to have cancer than were nonsmokers (Table 1). In a prospective study involving repeated measures of smoking status, nonfatal (and not immediately fatal) disease may act as a confounding factor and simultaneously as an intermediate variable in the pathway between smoking and mortality.

In assessing the effect of cancer on the association between smoking status and suicide, we compared analyses using the entire cohort with analyses excluding individuals with a history of cancer at baseline and with analyses excluding individuals with cancer either at baseline or during follow-up. We further explored the effect of cancer on the smoking–suicide connection by entering terms into our final model corresponding to cancer in general and to lung cancer specifically. Because there were no material differences in the smoking–suicide association among the various models, it appears that even if cancer were an intermediary between smoking and suicide in some people, the observed association between smoking and suicide cannot be accounted for solely by the increased risk of suicide in cancer patients. Our finding of a persistent association, despite taking into account malignant disease, is consistent with evidence linking smoking and suicidal behavior in teenagers, a group old enough to smoke but not old enough to develop smoking-related malignant disease.[68]

Smokers tend to drink, and heavy smokers tend to drink heavily.[36] Because heavy alcohol intake is a well-established risk factor for suicide,[35,69] we controlled for alcohol intake in our analyses. As in the general population, smokers in our cohort consumed more alcohol than did nonsmokers (Table 1). Even with alcohol in the model, former and current smokers were at significantly increased risk for suicide. Only 2 other large prospective studies have controlled for alcohol consumption. One continued to find an association between smoking and suicide[18]; the other did not.[22]

Smokers generally lead more sedentary lifestyles than do nonsmokers. In our cohort, fewer smokers exercised vigorously than did nonsmokers (Table 1). Although few prospective studies have examined the relation between physical activity and suicide, the literature suggests that sedentariness may induce depression and, alternatively, that depression may lead to sedentary habits.[18,70,71] In our study, the relation between smoking and suicide, although slightly attenuated by holding physical activity constant, remained strong and significant. This result is consistent with the findings of other studies.[18]

A primary limitation of our study is that although we have information about some risk factors for suicide, we have no information about others. For example, we lack good data on mental illness, illicit substance use, alcoholism (as distinct from alcohol intake itself), firearm availability, sexual orientation, risk taking, fatalism, hopelessness, and previous suicide attempts.[35–37,72,73]

Our cigarette consumption variable was based on self-report. Fortunately, smoking misclassification is small in the general population,[74] and the general accuracy of self-report responses among this sample of health professionals was corroborated by various validity checks.[19,75,76]

Suicides are generally considered to be underreported,[77] and the reporting process itself is variable.[78] Nevertheless, death certificates often provide the only available data on suicides and are generally used in epidemiologic research.[79,80] We have no reason to expect any reporting bias to correlate with smoking status.

Our study population of middle-aged, male, and almost entirely White health professionals limits the generalizability of the results. However, the rough homogeneity of our respondents improves the validity of our findings by effectively holding constant race, sex, income, education, and occupation, factors known to be associated with suicide.[73,81,82]

Our study did not allow us to determine causality. Our finding of a dose–response relationship between smoking and suicide is consistent with a causal effect or with higher doses' being better markers of some unidentified conceptual characteristic that predisposes individuals to both suicide and smoking (a third-variable explanation). Furthermore, because suicide is relatively infrequent and smoking is relatively common, the positive predictive value of smoking, even heavily, is quite low. It would be inappropriate to interpret smoking per se as a clinically important predictor of suicide.

The findings reported in this article help to establish the association of cigarettes with another major health problem. We present evidence of a positive and dose-related association between various measures of smoking status and completed suicide. Additionally, we controlled for various potential confounders. Our findings indicate that the smoking–suicide connection is not entirely due to the greater tendency among smokers to be unmarried, to be sedentary, to drink heavily, or to develop cancer. □

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