The Relationship between Cigarette Smoking and Education Revisited: Implications for Categorizing Persons' Educational Status

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ABSTRACT

Objective. This study sought to reassess the relationship between cigarette smoking and education.

Methods. Data from the 1983 to 1991 National Health Interview Survey for participants aged 25 years and older were used to plot the prevalence of current smoking, ever smoking, heavy smoking, and smoking cessation, as well as the adjusted log odds ratios, by years of education.

Results. The "less than high school graduate" category consisted of two groups with distinct smoking patterns: persons with 0 to 8 years and persons with 9 to 11 years of education. The latter were the most likely to be current, ever, and heavy smokers and the least likely to have quit smoking, whereas the former were similar to persons having 12 years of education. After 11 years of education, the likelihood of smoking decreased and that of smoking cessation increased with each successive year of education. These results persisted after the statistical adjustment for age, sex, ethnicity, poverty status, employment status, marital status, geographic region, and year of survey.

Conclusions. The relationship between smoking and education is not monotonic. Thus, when evaluating smoking in relation to education, researchers should categorize years of education as follows: 0 to 8, 9 to 11, 12, 13 to 15, and 16 or more years. (*Am J Public Health.* 1996;86:1582–1589)

Introduction

Although composite indices have often been created by combining variables such as education, occupation, and income to measure socioeconomic status, it is now increasingly common for epidemiologists to use these variables separately because studies suggest that each variable reflects a different dimension of socioeconomic status.[1–3] Among these variables, education is the most widely used in epidemiological research. This is because, unlike other measures of socioeconomic status such as occupation and income, education does not usually change during adulthood, it is not likely to be affected by poor health in adulthood, and its implications are generally not controversial. In addition, questions regarding education are not complex, so the nonresponse rate is usually low.[2] Moreover, researchers have shown that education is associated with various illnesses and health-related behaviors.[1–10]

The relationship between education and smoking has been extensively examined in both the United States[6–11] and other countries.[12–14] The 1989 US surgeon general's report, upon a thorough review of the literature, concluded that education is the best sociodemographic predictor of cigarette smoking patterns.[6] The general consensus has been that the fewer years of education one has, the more likely this person is to smoke. Upon our own review of the literature, we found that researchers who reached this conclusion typically categorized the education variable as follows: less than high school graduate (<12 years of education), high school graduate (12 years), some college (13 to 15 years), and college graduate (≥ 16 years).[6,7] When years of education are defined in this manner, smoking prevalence sometimes differs little between those who are less than high school graduates and those who are high school graduates and sometimes is even lower in the former group while the prevalence of smoking cessation is higher.[6,7] These seemingly counterintuitive results motivated us to scrutinize the relationship between smoking and education. The large and nationally representative samples of the US National Health Interview Survey (NHIS) provided us with superb data for reevaluating this relationship. This report presents our findings, based on data from the NHIS conducted between 1983 and 1991.

Subjects and Methods

Source of Data

The NHIS uses a probability sample of the US civilian, noninstitutionalized adult population. Most interviews are conducted in the home; when respondents cannot be interviewed in person, telephone interviews are conducted.[15–17]

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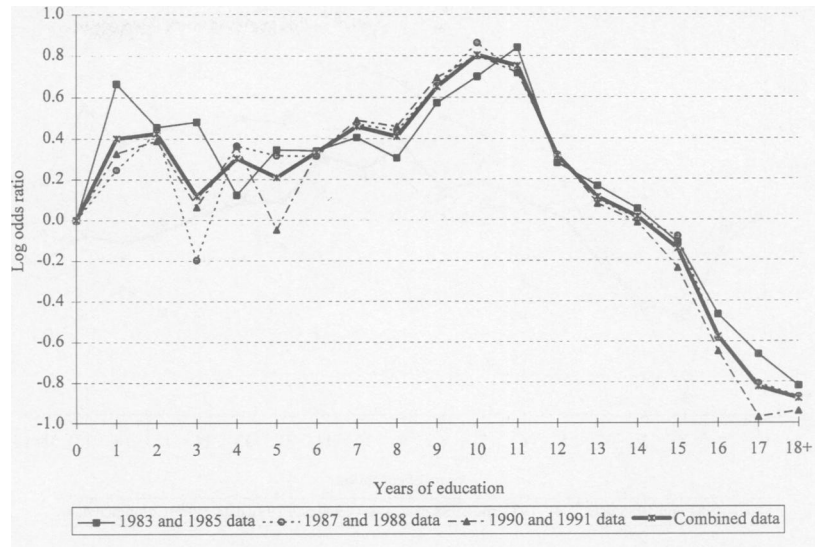
Data from 1983, 1985, 1987, 1988, 1990, and 1991 were used; the sample sizes for each of the survey years were 22 418, 33 630, 44 123, 44 233, 41 104, and 43 732, respectively. Data were then adjusted for nonresponse and weighted to reflect the US population of the corresponding survey year. After analysis was limited to respondents aged 25 years and older to exclude persons who had not yet graduated from college, the restricted sample sizes were 18 912, 28 986, 38 460, 38 896, 36 313, and 38 810, respectively, for a total sample size of 200 377.

Four widely used measures of smoking were examined[6]: the prevalence of current smoking, the prevalence of ever smoking, the prevalence of heavy smoking among current smokers, and the prevalence of smoking cessation among ever smokers. Current smokers are defined as persons who reported having smoked 100 or more cigarettes in their lives and who currently smoke. Former smokers are persons who had smoked 100 or more cigarettes in their lives but do not currently smoke. Ever smokers comprise current and former smokers. Never smokers have never smoked or have not smoked 100 cigarettes in their lives. Heavy smokers are current smokers who smoke 25 or more cigarettes per day. The prevalence of smoking cessation, also known as the quit ratio,[6,7,18,19] is defined as the percentage of former smokers among ever smokers. In each survey year except 1991, current smokers were asked to report the average number of cigarettes they smoked each day. In 1991, current smokers who reported smoking every day were asked to report the average number of cigarettes they smoked per day, while those who smoked only occasionally were asked to report the number of days in the past 30 days during which they had smoked cigarettes. These smokers were also asked to report the average number of cigarettes they had smoked on those days, after which the overall average number of cigarettes smoked was calculated.[11,20]

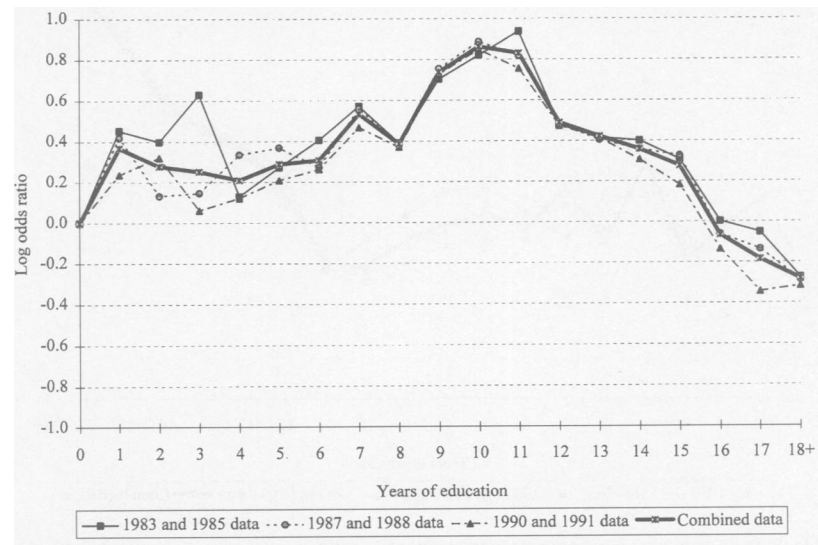
Statistical Analysis

The data were combined into three data sets (1983 and 1985, 1987 and 1988, 1990 and 1991) to increase the sample size for respondents with fewer than 8 years of education, and data from all six survey years were pooled to obtain averaged estimates. The crude prevalence of current, ever, and heavy smoking and of smoking cessation versus years of education were plotted, after which four logistic regression models were fit, corresponding to the four smoking measures. In these models, years of education were represented by 18 design variables corresponding to from 1 to 18 or more years of education. Eight covariates were included



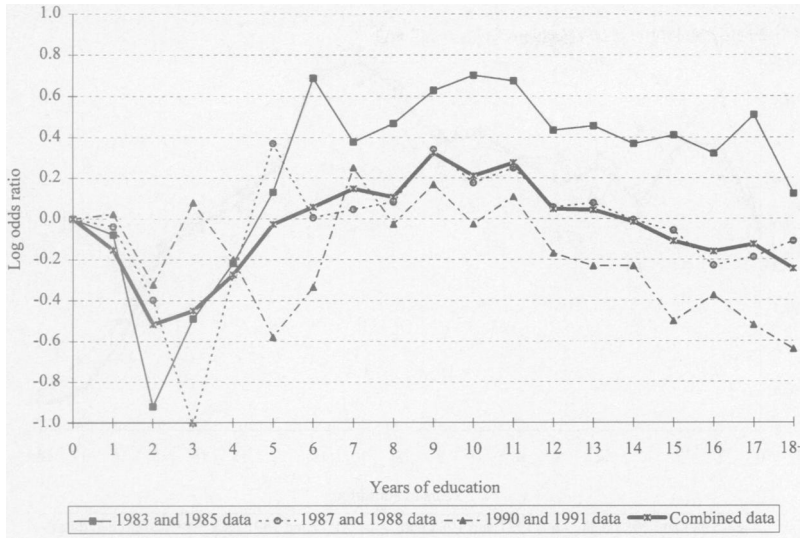
Note. Current smokers are persons who reported that they smoked ≥ 100 cigarettes in their lives and that they currently smoke.
Source. National Health Interview Survey for 1983, 1985, 1987, 1988, 1990, and 1991.

FIGURE 1—Current smoking vs years of education: log odds ratio among persons 25 years of age or older, controlled for age, sex, ethnicity, poverty status, employment status, marital status, geographic region, and year of survey—United States, 1983 through 1991.



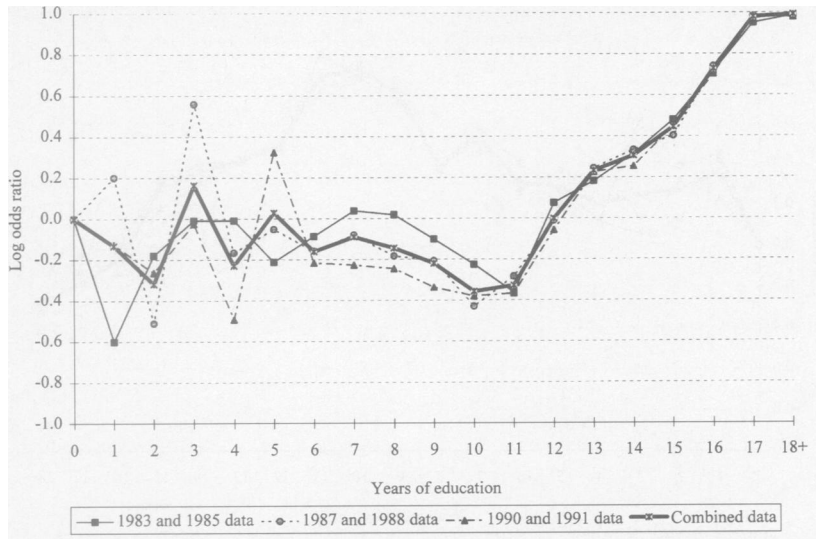
Note. Ever smokers are persons who reported that they smoked ≥ 100 cigarettes in their lives.
Source. National Health Interview Survey for 1983, 1985, 1987, 1988, 1990, and 1991.

FIGURE 2—Ever smoking vs years of education: log odds ratio among persons 25 years of age or older, controlled for age, sex, ethnicity, poverty status, employment status, marital status, geographic region, and year of survey—United States, 1983 through 1991.



Note. Heavy smokers are current smokers who smoke ≥ 25 cigarettes per day.
Source. National Health Interview Survey for 1983, 1985, 1987, 1988, 1990, and 1991.

FIGURE 3—Heavy smoking vs years of education: log odds ratio among persons 25 years of age or older, controlled for age, sex, ethnicity, poverty status, employment status, marital status, geographic region, and year of survey—United States, 1983 through 1991.



Note. Former smokers are persons who have smoked ≥ 100 cigarettes in their lives and do not currently smoke.
Source. National Health Interview Survey for 1983, 1985, 1987, 1988, 1990 and 1991.

FIGURE 4—Smoking cessation vs years of education: log odds ratio among persons 25 years of age or older, controlled for age, sex, ethnicity, poverty status, employment status, marital status, geographic region, and year of survey—United States, 1983 through 1991.

in the models as design variables: sex, age (25 to 44, 45 to 64, and 65 years and older), ethnicity (White non-Hispanic, African American non-Hispanic, Hispanic, Asian or Pacific Islander, American Indian or Alaska Native), marital status (married and living with spouse, married and not living with spouse, widowed, divorced, separated, never married), poverty status (at or above poverty level, below poverty level),[21] employment status during the past 2 weeks (employed, unemployed, not in labor force), geographic region (Northeast, Midwest, South, West), and year of survey. The coefficients for the 18 design variables representing education by years of education were plotted. This plot represents the relationship between the log odds ratio of smoking and the years of education, controlling for covariates.[22] In addition, the data were stratified, and the relationships within each of the sex, age, employment status, and ethnic subgroups were evaluated.

SAS[23] was used for the construction and diagnosis of the logistic regression models, and SUDAAN[24] was used for variance estimation that would account for the complex survey design of the NHIS. To assess their goodness of fit, the models were used to estimate the probability of positive outcomes (e.g., being a current smoker) for each subject, the probabilities were rank ordered, and the observations were classified into 25 approximately equal-sized "risk" groups. In each risk group, the observed and expected number of positive outcomes were compared. The Hosmer-Lemeshow test[22,23] was not used because it is sensitive to large sample sizes.

Results

The adjusted log odds ratio for current smoking varied little among persons who had attained between 0 and 8 years of education but increased sharply among those who had between 8 and 9 years of education (Figure 1). It then peaked for persons having 10 to 11 years of education, after which it declined steeply and steadily through each successively higher year. The plot for ever smoking is similar to that for current smoking except that there appears to be a positive slope between 0 and 8 years of education (Figure 2). The log odds ratio for heavy smoking increased between 0 and 9 years of education, after which it declined gradually (Figure 3). The plot for smoking cessation (Figure 4) practically mirrors that of current smoking: through 8 years of education, the log odds ratio of smoking cessation was fairly constant; then it dropped until 10 years of education, remained level for 11 years of education, and then increased sharply

TABLE 1—US Prevalences (%) of Smoking among Persons 25 Years of Age or Older, by Two Methods of Educational Categorization: Combined Data from the NHIS, 1983 through 1991

Educational Categorization			Current Smoking[a]		Heavy Smoking[a]		Ever Smoking[a]		Smoking Cessation[a]	
Four Categories	Five Categories	No.	%	95% CI	%	95% CI	%	95% CI	%	95% CI
	0–8 y	23 821	25.7	25.0, 26.4	24.8	23.4, 26.2	52.3	51.5, 53.1	50.5	49.4, 51.6
	9–11 y	24 218	39.7	39.0, 40.4	29.9	28.8, 31.0	64.5	63.8, 65.2	38.3	37.4, 39.2
< high school graduate		48 039	32.9	32.4, 33.4	27.9	27.1, 28.8	58.5	58.0, 59.0	43.6	42.8, 44.3
High school graduate	12 y	72 484	32.1	31.7, 32.5	27.2	26.5, 27.9	57.6	57.2, 58.0	44.0	43.4, 44.6
< college graduate	13–15 y	36 189	27.5	27.0, 28.0	26.4	25.3, 27.4	54.9	54.3, 55.5	49.6	48.9, 50.4
College graduate	≥ 16 y	39 943	16.1	15.7, 16.5	24.9	23.7, 26.1	44.5	44.0, 45.1	63.6	62.8, 64.4

Note. CI = confidence interval; NHIS = National Health Interview Survey.
Source. NHIS for 1983, 1985, 1987, 1988, 1990, and 1991 (combined data).
[a]Current smokers have smoked 100 cigarettes and smoke now; ever smokers are those who ever smoked 100 cigarettes; heavy smokers are current smokers who smoke at least 25 cigarettes per day; and the prevalence of smoking cessation is the proportion of ever smokers who do not currently smoke.

and steadily with each successive year of education.

The plots of the four crude prevalence measures of smoking (not shown) were very similar to those plots shown in Figures 1 to 4. In addition, analyses stratified by sex, age (25 to 44, 45 to 64 and 65 years and older), employment status, and ethnic groups showed that these patterns persisted among demographic subgroups whenever stable estimates could be obtained (not shown).

To understand why our results differed from those in the literature, we first computed the smoking prevalence when the education variable was categorized by the four standard groups. We then separated persons in the "less than high school graduate" category into two groups—0 to 8 years and 9 to 11 years of education—and computed the smoking prevalence for each group. When we categorized years of education by four groups, the prevalence measures of current, heavy, and ever smoking were highest for persons who did not complete high school, followed by high school graduates, persons who had some college education, and college graduates. The opposite trend was observed for the prevalence of smoking cessation. However, within the "less than high school graduate" group, the prevalence of smoking differed markedly between persons with 0 to 8 years of education and persons with 9 to 11 years of education (Table 1).

In examining the educational distribution among demographic subgroups, we found a high percentage of persons with 0 to 8 years of education among older persons, Hispanics, persons below the poverty level, persons who were not in the labor force, and persons who were widowed. Conversely, this percentage was low among younger persons, Whites, persons at or above the poverty level, persons who were employed, persons who were married and living with the spouse, persons who were divorced, and persons who had never married (data not shown; table available from the authors). Although the percentage of persons with 0 to 8 years of education decreased in younger age cohorts, overall this group is currently of similar size as the group of persons with 9 to 11 years of education: each represents more than 11% of the population. Also, when we examined the educational status of persons aged 18 to 29 years over time, we found that the percentage of persons with 0 to 8 years of education has remained at approximately 3% and has not declined since 1983, indicating that this group is not disappearing (not shown).

Based on the results described above, we classified years of education into five categories—0 to 8, 9 to 11, 12, 13 to 15, and 16 or more years—and fit four logistic regression models (corresponding to the four smoking measures) to the combined data set of all six survey years. The plots of observed vs expected values in each of the 25 risk groups indicated that these models fit the data well. After we controlled for age, sex, ethnicity, poverty status, employment status, marital status, geographic region, and year of survey, persons who had attained 9 to 11 years of education were the most likely to be current, ever, or heavy smokers and the least likely to have quit smoking (Table 2). Persons with 0 to 8 years of education were less likely to have ever smoked, less likely to be current or heavy smokers, and more likely to have quit smoking than were persons with 9 to 11 years of education. Compared with persons who had completed 12 years of education, persons with 0 to 8 years of education were less likely to have ever smoked, slightly less likely to have quit smoking, and about as likely to be current or heavy smokers. Almost all of these differences were statistically significant, as indicated by the non-overlapping 95% confidence intervals of the odds ratios.

The multivariable logistic regression models also helped to unveil the association between smoking patterns and other sociodemographic variables (Table 2). Men were more likely than women to be current, ever, and heavy smokers and to have quit smoking. Of the three age groups, persons aged 65 and older were the most likely to have quit smoking. Persons aged 25 to 44 years were the most likely to be current smokers, whereas persons aged 45 to 64 years were the most likely to be ever and heavy smokers. Among the five ethnic groups, Asians/Pacific Islanders and Hispanics were the least likely to be current or ever smokers, whereas Whites were the most likely to smoke heavily. Compared with Whites, Hispanics were more likely to have quit smoking whereas African Americans and Asians/Pacific Islanders were less likely to have quit smoking. The most notable patterns regarding smoking and marital status were that persons who were divorced or separated were the most likely to be current, ever, and heavy smokers and were the least likely to have quit smoking; whereas persons who were married and living with the spouse were the most likely to have quit smoking. Persons who were not employed were more likely to be current and ever smokers and were less likely to have quit smoking than were persons who were employed or were not in the labor force. Persons who were below the poverty line were more likely to

TABLE 2—Cigarette Smoking and Educational Attainment and Other Sociodemographic Variables in a Logistic Regression Analysis among Persons 25 Years of Age or Older: Combined Data from the NHIS, 1983 through 1991

	Current Smoking[a] (n = 196 655)		Ever Smoking[a] (n = 197 823)		Heavy Smoking[a] (n = 55 057)		Smoking Cessation[a] (n = 105 385)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Years of education								
0–8	2.9	2.7, 3.1	1.7	1.6, 1.7	1.3	1.1, 1.4	0.4	0.4, 0.4
9–11	4.2	4.0, 4.4	2.6	2.5, 2.7	1.6	1.4, 1.7	0.3	0.3, 0.3
12	2.8	2.7, 2.9	1.9	1.8, 2.0	1.3	1.2, 1.4	0.4	0.4, 0.5
13–15	2.1	2.0, 2.1	1.7	1.6, 1.7	1.2	1.1, 1.3	0.6	0.6, 0.6
≥16		referent		referent		referent		referent
Sex								
Male	1.5	1.4, 1.5	2.4	2.4, 2.5	2.1	2.0, 2.2	1.3	1.2, 1.3
Female		referent		referent		referent		referent
Age								
25–44 y	3.6	3.4, 3.8	1.2	1.1, 1.2	1.7	1.6, 1.9	0.2	0.2, 0.2
45–64 y	2.8	2.7, 2.9	1.6	1.6, 1.7	2.1	1.9, 2.3	0.4	0.4, 0.4
≥65 y		referent		referent		referent		referent
Race/ethnicity								
African American non-Hispanic	0.9	0.9, 1.0	0.8	0.7, 0.8	0.2	0.2, 0.2	0.8	0.7, 0.8
Hispanic	0.6	0.6, 0.6	0.6	0.5, 0.6	0.2	0.2, 0.3	1.1	1.1, 1.2
Asian/Pacific Islander	0.6	0.5, 0.7	0.4	0.4, 0.5	0.2	0.1, 0.3	0.8	0.7, 0.9
American Indian/Alaska Native	1.1	0.9, 1.3	1.0	0.9, 1.2	0.7	0.5, 0.9	0.8	0.6, 1.0
White non-Hispanic		referent		referent		referent		referent
Marital status								
Married, not living with spouse	1.5	1.3, 1.7	1.1	1.0, 1.3	1.0	0.8, 1.2	0.6	0.5, 0.7
Widowed	1.2	1.2, 1.3	0.8	0.8, 0.8	1.0	0.9, 1.1	0.7	0.6, 0.7
Divorced	1.9	1.8, 2.0	1.6	1.5, 1.6	1.2	1.2, 1.3	0.6	0.5, 0.6
Separated	1.9	1.8, 2.0	1.5	1.4, 1.6	1.1	1.0, 1.2	0.5	0.5, 0.6
Never married	1.1	1.1, 1.2	0.8	0.8, 0.8	0.8	0.7, 0.8	0.6	0.6, 0.7
Married, living with spouse		referent		referent		referent		referent
Employment status (past 2 weeks)								
Employed	1.0	1.0, 1.0	0.9	0.9, 0.9	1.0	0.9, 1.1	0.9	0.9, 1.0
Not employed	1.5	1.4, 1.6	1.3	1.2, 1.4	1.1	0.9, 1.2	0.7	0.6, 0.7
Not in labor force		referent		referent		referent		referent
Poverty status								
Below poverty level	1.3	1.3, 1.4	1.1	1.1, 1.2	1.0	0.9, 1.1	0.7	0.7, 0.7
At or above poverty level		referent		referent		referent		referent
Geographic region								
Northeast	1.0	1.0, 1.1	1.0	1.0, 1.1	1.1	1.0, 1.2	1.0	1.0, 1.1
Midwest	1.1	1.0, 1.1	1.0	0.9, 1.0	1.2	1.1, 1.3	0.9	0.9, 0.9
South	1.1	1.1, 1.1	1.0	0.9, 1.0	1.3	1.3, 1.4	0.8	0.8, 0.9
West		referent		referent		referent		referent
Year of survey								
1983	1.3	1.2, 1.3	1.1	1.0, 1.1	1.3	1.2, 1.4	0.8	0.7, 0.8
1985	1.2	1.1, 1.2	1.2	1.1, 1.2	1.4	1.2, 1.5	0.9	0.8, 0.9
1987	1.1	1.1, 1.2	1.1	1.1, 1.1	1.3	1.2, 1.5	0.9	0.8, 0.9
1988	1.1	1.1, 1.2	1.1	1.0, 1.1	1.3	1.2, 1.4	0.9	0.9, 1.0
1990	1.0	0.9, 1.0	1.0	1.0, 1.0	1.1	1.0, 1.2	1.0	1.0, 1.1
1991		referent		referent		referent		referent

Note. OR = odds ratio; CI = confidence interval; NHIS = National Health Interview Survey.
Source. NHIS for 1983, 1985, 1987, 1988, 1990, 1991 (combined data).
[a]Current smokers have smoked 100 cigarettes and smoke now; ever smokers are those who ever smoked 100 cigarettes; heavy smokers are current smokers who smoke at least 25 cigarettes per day; and the prevalence of smoking cessation is the proportion of ever smokers who do not currently smoke.

be current and ever smokers and were less likely to have quit smoking than were persons who were at or above the poverty line. With respect to geographic region, Midwestern and Southern residents were more likely to smoke heavily and less likely to have quit smoking. Finally, from 1983 to 1991, current smoking has become less prevalent while quitting smoking appears to have become increasingly popular.

Discussion

We found the prevalence measures of current smoking, ever smoking, heavy smoking, and smoking cessation to be markedly different between persons with 9 to 11 years of education and persons with 0 to 8 years of education. After statistically adjusting for age, sex, ethnicity, marital status, poverty status, employment status, geographic region, and year of survey, we found that persons who

attained 9 to 11 years of education were the most likely to be current, ever, and heavy smokers and the least likely to have quit smoking. In analyses stratified by age, sex, employment status, and ethnicity, these patterns persisted whenever stable estimates could be obtained. Therefore, when evaluating the relationship between smoking and education, we recommend separating persons with 0 to 8 years of education from persons with 9 to 11 years of education, and categorizing years of education into the five groups shown in Table 2.

The finding that persons who had attained 0 to 8 years of education are much less likely to smoke and more likely to have quit smoking than are persons with 9 to 11 years of education is rather perplexing. One possibility is that persons who never went to high school have not been influenced by its strong social influences that tend to reinforce the perceived value of smoking for adolescents who are striving for both independence and peer acceptance.[6,25] Another explanation is that some of the factors that cause adolescents to have difficulty in school—for example, the divorce of parents and the subsequent drop in family income[26–29]—may have a differential impact on the smoking behaviors of these young people when they are in senior high school. Also, persons who attained 0 to 8 years of education usually went to jobs, marriages, or farmwork after schooling, and their social environments may have discouraged or disallowed smoking. Finally, persons with 0 to 8 years of education may represent a distinct subgroup in the population. Further research is needed, then, to explain the phenomenon of their lesser likelihood of smoking and greater likelihood of quitting compared with persons with 9 to 11 years of education.

The finding that smoking was most prevalent among persons who had attained 9 to 11 years of education is consistent with the results of a follow-up study by Pirie and colleagues, who found that daily smoking prevalence among in-school students is substantially higher than that among persons of the same age who are not in school.[30] In another study, Johnston and colleagues showed that high school seniors who were not planning to go to college were much more likely to smoke than were students who were planning on higher education.[31] Similar findings have been observed in other US studies[6,25,32,33] and in other countries.[34–37]

Several hypotheses may explain the exceptionally high smoking prevalence among persons with 9 to 11 years of education. First, adolescents in grades 9 to 11 are typically 15 to 17 years of age and must cope with physical, cultural, and personal challenges. Failure to deal with these challenges may lead to depression; feelings of helplessness, aggressiveness, or pessimism; difficulty finishing high school; and smoking initiation.[25] Researchers have suggested that smoking, skipping or quitting school, and other risk behaviors (such as having multiple sexual partners and unprotected sex, not wearing seat belts when riding in a vehicle, engaging in violent behavior, attempting suicide, taking medicines without medical advice, and over- or undereating) are constituents of a "problem behavior syndrome" among adolescents.[25,37–40]

Second, it usually takes about 2 to 3 years from first try to regular smoking.[25] High school provides the social context for smoking to be learned and reinforced. This social context of reinforcement[41,42] may be particularly strong for high school students who are less attached to school.

Third, compared with those who complete high school and higher education, adolescents who are not able to finish high school have a lower self-image and self-esteem. Hence, they may be more likely to take up smoking as a self-enhancement mechanism.[25]

Fourth, cigarette advertising may have different effects on persons who do not finish high school compared with those who complete high school or higher education. The images of adventure, independence, rebelliousness, ruggedness, and social competence advertised by the tobacco industry may be especially appealing to the former group, who are generally more rebellious and are greater risk takers than the latter.[25]

Fifth, teenage smokers who are already addicted may be less likely to be able to complete high school than nonsmokers. Addicted teenage smokers may have difficulty refraining from smoking during school hours; many might smoke on school property even in violation of common prohibitions. Frequent infractions could lead to suspensions and eventually to their not being able to finish school. As we move to make our schools smokefree, this hypothesis, if proven true, calls for more attention to help teenagers who are already addicted to tobacco.

In studying a cohort of 1007 persons aged 21 to 30 years who were enrolled in a health maintenance organization in the Detroit area, Breslau and colleagues[43] found that persons who started smoking before age 14 and persons who delayed smoking until age 17 had a lower probability of developing nicotine dependence than did persons who initiated smoking between the ages of 14 and 17. Our study suggests that persons who went to high school but did not finish are the most likely to smoke and the least likely to have quit smoking. These findings suggest that the high school years may be a critical stage in the development of smoking behavior and that persons who start smoking at this stage may be more likely than others to become addicted. Therefore, school-based smoking prevention programs should be started early and repeated throughout the high school years[44] if we are to reduce the possibility of smoking initiation among high school students and thus decrease the prevalence of smoking and nicotine dependence in the population.

We have shown that, with respect to smoking behavior, the "less than high school graduate" group comprised two rather distinct groups, each constituting a significant portion of the current US population. Therefore, to describe the population of smokers accurately and to help identify target populations for smoking cessation programs, we recommend, whenever sample sizes allow, separating persons with 0 to 8 years of education from persons with 9 to 11 years of education and using five educational categories to evaluate the relationship between smoking and education. In studies where the sample of persons with 0 to 8 years of education is too small to permit such separation, attempts to generalize the estimates for the "less than high school graduates" to the general population should be made cautiously.

A limitation with this study is that it is based on cross-sectional data over a relatively short period of time. Available data on smoking among successive US birth cohorts suggest that both the adoption and the cessation of smoking appeared to have started with the higher social classes and diffused to the lower ones.[45,46] Therefore, the patterns of smoking in our data with respect to education may have been unstable during the entire history of the tobacco epidemic. Intriguingly, several researchers in the 1960s and 1970s also noticed in both sexes a lower smoking prevalence among persons with only grade school education compared with those with some high school.[47–50] Thus, it appears that the patterns we

observed in this study have existed for at least several decades.

The methodological implication of our study is that when describing the relationship between an outcome variable and a continuous explanatory variable, researchers should carefully examine the scale of the latter before categorizing it. In addition, when designing data collection forms, researchers should avoid precategorizing continuous variables whenever possible unless the relationships between all outcome and explanatory variables have been sufficiently established.

The findings of this study need to be replicated using other US data sets—for example, data from the National Household Survey on Drug Abuse, the Behavioral Risk Factor Surveillance System, and the Current Population Survey[6]—as well as data from other countries. In addition, the relationship between education and other substance use should be reassessed in a similar manner.

Although our study has focused on educational attainment, it is also one of the few studies that have examined smoking patterns in relation to several sociodemographic variables simultaneously. In general, our results support the findings by other researchers that smoking is more prevalent among persons of lower socioeconomic status and persons who are divorced or separated.[6] The smoking patterns among different age groups appear to reflect birth cohort effects that have been examined by other researchers.[45,46] □

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