

Tobacco smoking, cancer and social class

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Consumption of tobacco products, both by smoking and by other means, has long been causally connected with cancers of the lung, larynx, mouth and pharynx, oesophagus, bladder, and many other sites. Tobacco is the main specific contributor to total mortality in many developed countries and has become a major contributor in the developing countries as well. In most industrialized countries, prevalence of cigarette smoking is currently higher in low than in high social classes, although in some industrialized countries smoking was more frequent in high social classes during the first half of this century. The latter pattern of tobacco consumption is more likely to apply to developing countries. To formulate and carry out effective tobacco control activities it is essential to assess the relative incidence of tobacco-related cancers in different social strata and the prevalence of tobacco use across strata. Despite many years of data gathering the information base is far from complete, especially in developing countries where tobacco use is increasing rapidly, and where aggressive marketing by the transnational tobacco industry is occurring. A critical question is the extent to which tobacco usage can 'explain' the observed social class differences in cancer risk. Class differences in lung cancer are likely to be mostly related to the unequal distribution of tobacco smoking between social classes, and in some fairly simple situations this has been satisfactorily demonstrated. Nevertheless, there are many unresolved issues, especially with regard to the role of collateral exposures, such as hazardous occupations, poor diet, and limited access to health care. The question of whether tobacco use 'explains' socioeconomic differences in one or more of the cancers that it causes has rarely been directly addressed in epidemiological studies.

Consumption of tobacco products, both by smoking and by other means, has long been causally connected with cancers of the lung, larynx, mouth and pharynx, oesophagus, bladder, and many other sites (IARC, 1986). Tobacco is the main specific contributor to total mortality in many developed countries. Its consumption causes about 19% of all deaths in the United States of America (USA), including 11–30% of cancer deaths, in addition to substantial numbers of deaths from coronary heart disease and chronic obstructive pulmonary disease (COPD) (McGinnis & Foege, 1993). Tobacco use has become a major contributor to mortality in the developing countries as well (Boffetta & Parkin, 1994), and its role in such countries will increase in the coming years.

Tobacco use varies with social class in most countries. To formulate and carry out effective tobacco control activities it is essential to assess the relative incidence of tobacco-related cancers in different social strata and the prevalence of tobacco use across strata. Therefore, a goal of this chapter is

to show how tobacco use varies with some of the social class indicators in a number of countries. Despite many years of data gathering, however, the information base is far from complete, especially in developing countries where tobacco use is increasing rapidly, and where aggressive marketing by the transnational tobacco industry is occurring. The spread of tobacco use is a dynamic process that requires systematic monitoring. This spread to new, untapped markets is in part driven by a decline in smoking in developed countries, especially among the more affluent classes, as documented by increasing cessation rates. A second goal of this chapter is to present the risk of the principal tobacco-related cancers in several countries according to a variety of social class indicators and to evaluate the extent to which tobacco usage can 'explain' the observed social class differences in cancer risk. This is related to the more general question of what proportion of these differences can be explained by identifiable lifestyle and environmental factors, including other

Table 1. Smoking prevalence (percentage) by occupational category and sex in the USA during the periods 1978–1980 and 1987–1990^a

Occupation	Males		Females	
	1978–1980	1987–1990	1978–1980	1987–1990
White-collar	32.0	24.0	31.4	24.4
Blue-collar	45.3	40.2	36.9	34.8

^aNelson *et al.*, 1994a.

risk factors that affect the same cancers caused by smoking. These other risk factors, such as occupation and diet, can act independently or they may interact with smoking to increase risk, as is the case with alcohol consumption in some upper aerodigestive tract cancers. Risk factors other than tobacco are sometimes downplayed or even overlooked in programmes of smoking cessation. We therefore thought it important to present here some data on cofactors and correlates of smoking behaviour that also play a role in the etiology of tobacco-related cancers.

Throughout this chapter we make reference to the substantial literature on cancer rates and tobacco use in African-American (Black) and White populations in the USA. The large ethnic differences in both incidence and mortality for tobacco-related cancers are obviously related to cigarette smoking, but two significant questions remain: (1) do tobacco usage patterns satisfactorily explain these differences in a quantitative manner, and (2) is there a separately discernible role of social class that in turn 'explains' or underlies the tobacco usage patterns. The first question falls within the conventional role of epidemiology, whereas the second, with its socio-political overtones, may not necessarily fall within the traditional domain of biomedical science. The first may eventually be simpler to answer, but the second may be the more important because, as discussed in the section 'Intervention and prevention', serious attempts to prevent these cancers in economically disadvantaged populations must be guided by its solution.

Finally, a substantial body of experience has been developed in the application of smoking cessation methods, in which sensitivity to class and culture has come to play an important role. It is useful

to summarize some of the lessons learned from studies of knowledge and attitudes about smoking of members of different social strata, and to highlight successful intervention programmes that have targeted groups of individuals, especially ethnic minorities, that are often considered by public health specialists as difficult to reach.

Tobacco consumption by social class

The rate and extent to which different social classes have taken up tobacco smoking have varied markedly both within and between countries, and the distribution is constantly changing, especially in Western countries under pressure from anti-smoking organizations. Consequently, any relationship between social class and smoking that might be generally true in one country or society cannot necessarily be generalized to others. In the USA, for example, there is a strong inverse relation between social class (represented by occupational grouping or income) and smoking in men, but only a weak one in women (Stellman & Stellman, 1980). In countries where the great majority of men have been smokers at one time or other during their lives, but where widespread smoking by women may have occurred only recently, such as Japan (Wynder *et al.*, 1992) and France (Wynder *et al.*, 1981), even such weak generalizations may be inapplicable. Furthermore, in some Latin American countries there is a positive association between social class and tobacco use.

Prevalence of usage and cessation

Trends in tobacco consumption in the USA have been reported periodically by the National Center for Health Statistics through its annual National Health Interview Survey (NHIS) (Schoenborn &

Table 2. Distribution (percentage) of smoking habits of American women in selected occupations, 1982^a

Occupation	Never smoked regularly	Current smoker		Former smoker
		1-20 daily	21+ daily	
Farmer	78.7	8.6	2.3	10.5
Sewer, stitcher	69.4	14.7	3.6	12.3
Factory worker	63.1	16.8	5.6	14.5
Food preparation	62.5	16.0	4.7	16.8
Teacher	60.3	11.9	3.1	24.7
Domestic service	58.8	18.2	5.0	18.0
Office clerical	54.2	16.3	6.2	23.3
Sales	53.9	17.9	6.2	22.0
Beautician	53.1	20.9	5.2	20.8
Book-keeper	53.1	16.1	7.4	21.4
Assembler	52.7	18.7	7.1	21.9
Nurse	47.8	18.4	5.7	28.1
Doctor	46.9	15.7	5.7	31.7
Social worker	45.3	15.2	6.7	32.9
Lawyer	41.7	12.8	9.3	36.2
Waitress	40.6	27.8	12.6	19.0

^aStellman *et al.*, 1988.

Boyd, 1989). Trends in European tobacco usage were recently summarized by Hill (Hill, 1992). Total production and importation statistics for developing countries are sometimes available from industry sources (Mackay, 1992), but data on tobacco use within different population strata, especially with regard to income, education and other class variables, are usually available only from health surveys or epidemiological studies.

Occupation Epidemiological studies of occupational cancer have been among our most important tools for identifying environmental carcinogens, and occupational differences in cancer risks have been the subject of many investigations (Monson, 1990; Decoufle, 1982; Stellman & Stellman, 1996). Occupation itself can be used as an indicator of social class, so that clues to explain the impact of social class on cancer are often found in studies of differences in cancer rates between workers in different jobs or industries. The cancer sites most frequently affected by occupational carcinogens – those of the respiratory system and bladder – happen also to be strongly related to tobacco use. Therefore, it is

Table 3. Odds favouring current smoking in an Australian population^a

Socioeconomic variable	Rate ratio ^b	
	Men	Women
Employed^c	1.00	1.00
Unemployed	1.53*	1.43*
Not in labour force	1.40*	1.02
Professionals^c	1.00	1.00
Managers and administrators	1.52*	1.56*
Paraprofessionals	1.44*	1.50*
Tradespersons	1.97*	2.11*
Clerks	1.62*	1.51*
Sales and service	1.74*	1.84*
Plant and machinery operators	2.19*	1.94
Labourers and related workers	2.28*	2.18*

* $P < 0.01$ ^aI. Gordon, pers. commun.^bAge-standardized to the 1988 total Australian population.^cReference category.

essential to understand the role of tobacco in occupational carcinogenesis.

Few countries have tracked the evolution of smoking habits by occupation over time. Table 1 shows the estimated prevalence of smoking by occupational class and sex in 1978–1980 and 1987–1990 in the United States according to the NHIS (Nelson *et al.*, 1994a). The data show that during both periods blue-collar workers smoked more than white-collar workers, and that the range was wider for men than for women. The findings also show that the class differences in smoking prevalence over time have widened in the USA.

Other American studies have also shown that men's smoking habits strongly reflect their socio-economic levels as reflected in their occupations, with higher prevalence of smoking associated with lower occupational levels, although the association is weaker for women (Stellman & Stellman, 1980). Data from the American Cancer Society prospective study (Table 2) show the distribution of smoking habits in American women in occupations in which the majority of American working women are employed. The highest prevalence of smoking was found in two economically disparate occupations – waitresses and lawyers – while teachers and domestic service workers were among the least likely to smoke.

The relationship between occupational status and smoking in male and female Australian workers is far more uniform than in America (Table 3). These smoking trends are also different from those recently reported for France by Sasco *et al.* (1994, 1995). There, the non-working population had among the lowest smoking rates. During 1979–1991, the smoking prevalence among mid-level employees decreased from 57% to 47% among men, but increased sharply among women, from 33% to 47% (Sasco *et al.*, 1994).

For more than a century and a half the Registrar General for England and Wales has published periodic reports on mortality in relation to occupation. The Registrar General groups individuals into five broad social classes: I for professional occupations, II for managerial and lower professional occupations, III for skilled occupations (which may be further subdivided into manual and non-manual), IV for partly skilled occupations, and V for unskilled occupations (see, for instance, Registrar General for England and Wales, 1958). Using data from the Annual Consumer Survey of the Tobacco Advisory Council, Wald and Nicolaides-Bouman (1991) have examined the trends over time in smoking prevalence for each of the five classes for men and for women. In the late 1940s and early to mid-1950s cigarette smoking was more common among the

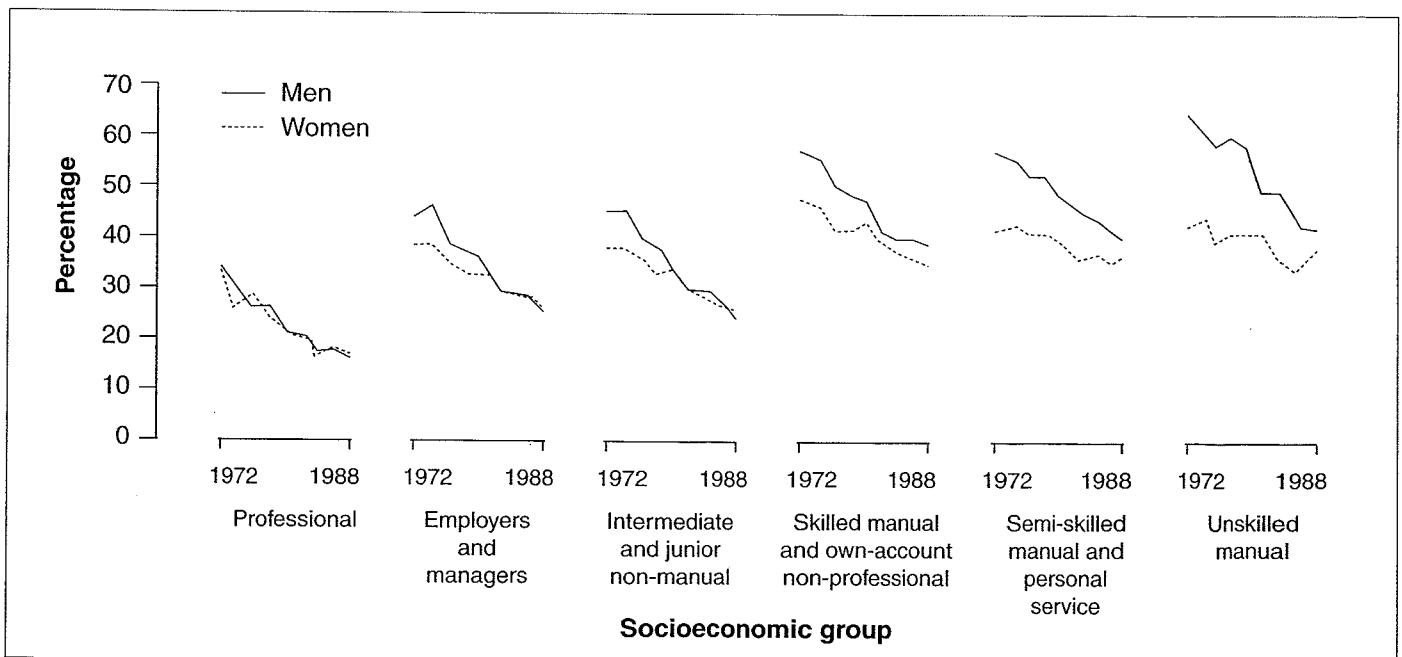


Figure 1. Percentages of men and women who smoke cigarettes (manufactured and hand-rolled) by socioeconomic group in Great Britain, 1972–1988 (men and women aged 16 and over). Data are from General Household Survey of the Office of Population Censuses and Surveys. Modified from Wald & Nicolaides-Bouman, 1991.

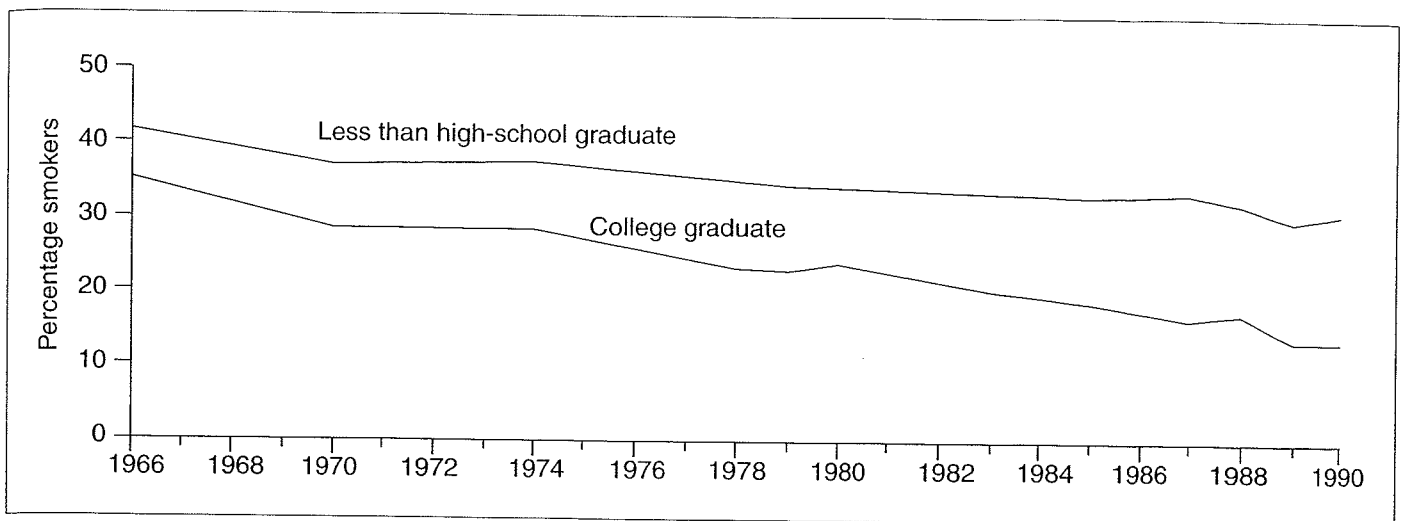


Figure 2. Prevalence of current smoking among adults by education in the United States, 1966–1990. Redrawn from Giovino *et al.*, 1994.

higher social classes. However, by the late 1950s the prevalence of smoking manufactured cigarettes was approximately the same in all social classes, with about 58% of British men and 42% of British women current smokers in 1958. Between 1958 and 1971 the percentage in men declined from 54% to 37% in social class I, but remained about 59% in class V, after which declines in prevalence occurred in all classes.

Trends in smoking for the more recent years of rapid change are illustrated in Figure 1, which uses a slightly different socioeconomic group classification, from the General Household Survey of the Office of Population Censuses and Surveys. In both this and the Registrar General's system, it can be observed that in the higher social classes smoking rates have been about the same in men and women throughout the recent past but in lower social classes the gap between men and women has gradually narrowed, while the overall prevalence of smoking has been declining in all classes. Wald and Nicolaides-Bouman have shown that there has been a long-term reversal of the smoking habit, from professionals once being most likely to smoke to the unskilled now being the most likely smokers. The decline in overall prevalence of smoking has continued into the 1990s: results of the 1992 General Household Survey showed that 28% of adults were cigarette smokers, compared with 30% in 1990. The already wide occupational differentials continued to expand: only 14% of men in the professional group were cigarette smokers, compared with 42% of men in the unskilled manual group (Thomas *et al.*, 1994)

Knowledge of smoking data for the occupational group of health professionals such as doctors and

nurses is particularly important. An American Cancer Society study that traced smoking in doctors, nurses and dentists over several decades found that by 1982 only 17% of doctors, 14% of dentists and 23% of female nurses were still smokers (Garfinkel & Stellman, 1986). In a more recent American study of a national sample, Nelson *et al.* (1994b) found that smoking among physicians had fallen to 3% and among registered nurses to 18%. In the British doctors study (Doll & Hill, 1954; Doll *et al.*, 1994) that followed doctors from 1951 to 1991, it was found that by 1991 18% of the doctors surviving were still smoking in comparison with 62% at the beginning of the study. In 1951, 85% of smokers consumed cigarettes (the remaining consuming only pipe and cigars) compared with 38% at 1991. These figures are important, because doctors and nurses serve as the only source of health information and counselling for many adults, and it is essential that they be role models if they are to function effectively.

These varying relationships between occupation and tobacco use make interpretation of epidemiological studies of occupational cohorts difficult if smoking data are not available at the individual level. Since this is frequently the case (Blair *et al.*, 1988), numerous authors have presented detailed data on smoking prevalence by occupation and industry (Stellman & Stellman, 1980; Brackbill *et al.*, 1988; Sterling & Weinkam, 1976, 1978; Weinkam & Sterling, 1987; Nelson *et al.*, 1994a) to aid interpretation of analytical studies that lack smoking data. Axelson and Steenland (1988) have proposed a method for indirectly adjusting risks for smoking

that utilizes prevalence data from industry-wide surveys.

Education There is considerable information available about tobacco use in relation to education for a number of countries. Data are available at frequent intervals for a probability sample of the USA (Resnicow *et al.*, 1991) and have been presented in detail by the National Center for Health Statistics (Schoenborn & Boyd, 1989). Figure 2 shows that in 1967 the proportion of current smokers among adult Americans ranged from 35–42%, but has since fallen by nearly two-thirds to about 14% among college graduates, and has dropped only modestly among those with less than a high-school education (Giovino *et al.*, 1994). As shown in Figure 3, there has been a rapidly increasing proportion of exsmokers among college graduates over time, compared with a much slower increase among the less educated. Out-of-school adolescents, who generally engage in more risky health behaviours than those who continue to attend, are also more likely to smoke (Centers for Disease Control, 1994a); smoking prevalence among high-school drop-outs has been reported to be as high as 70% (Pirie *et al.*, 1988).

These findings have been replicated in many studies, utilizing different sampling techniques in a variety of American subpopulations (Novotny *et al.*, 1988; Kabat, *et al.*, 1991; Shea *et al.*, 1991). In general, persons with less than high-school education are

more consistently likely to start smoking cigarettes during childhood and adolescence (Escobedo *et al.*, 1990), and among younger smokers of both sexes (age 18–30 years) those with only a high-school diploma smoke more cigarettes daily than those with at least some college education (Wagenknecht *et al.*, 1990).

Educational gradients have been observed during the past one or two decades in many industrialized countries, including the United Kingdom (Wald & Nicolaidis-Bouman, 1991), Italy (La Vecchia *et al.*, 1992), Australia (I. Gordon, pers. commun.) and France. In the late 1970s, Wynder *et al.* (1981) found choice of cigarette type by French men to be strongly dependent on education, with the least educated men preferring by far (71%) nonfilter cigarettes manufactured with black tobacco (Figure 4). In 1966–1967 the lung cancer death rate for males in France was 70% that of the rate for males in the USA (Segi & Kurihara, 1972), but today the rates are nearly equal (Leclerc *et al.*, 1990; Parkin *et al.*, 1992). This equalization was predicted (Wynder *et al.*, 1981) on the basis of a change towards American smoking habits in France: French smokers used to hold the lit cigarette in their mouths without inhaling; in addition, the protonated nicotine in black tobacco is absorbed through oral mucosa (Brunnemann & Hoffmann, 1974), leading smokers of black tobacco to inhale much less than smokers of blond (American-style) tobacco.

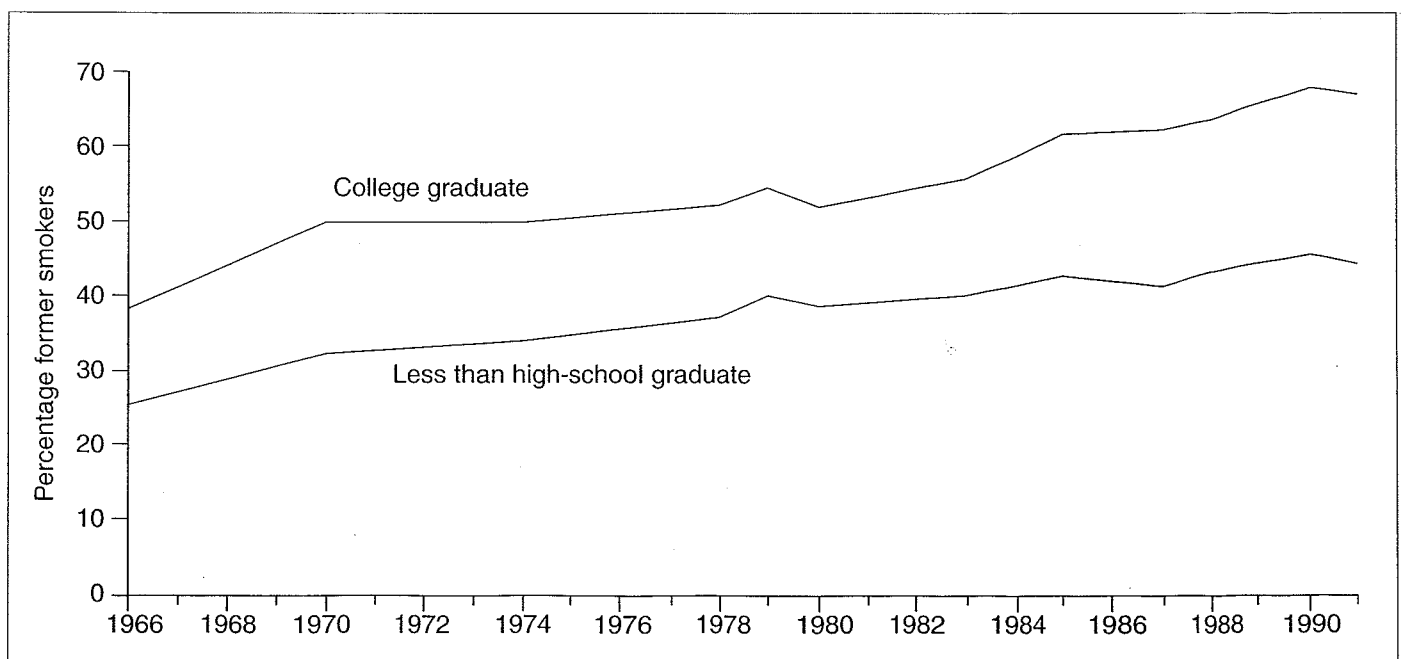


Figure 3. Prevalence of former smoking among adults by education in the United States, 1966–1990. Redrawn from Giovino *et al.*, 1994.

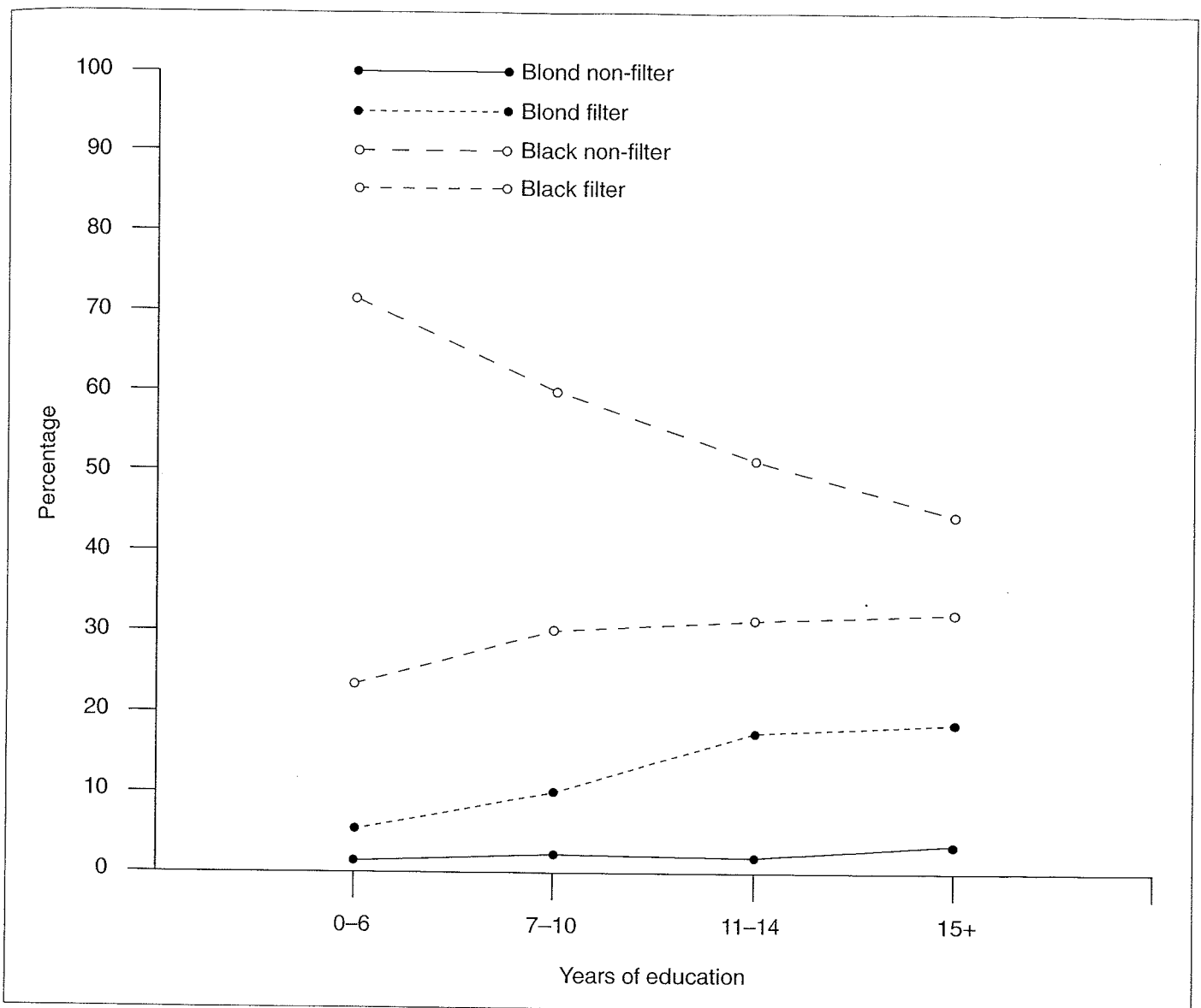


Figure 4. Tobacco type and filter preferences among French males by education. Redrawn from Wynder *et al.*, 1981.

Data from Spain have recently been published for a national random sample of the population taken in 1987 (Table 4) (Regidor *et al.*, 1994). These show that whereas smoking was more popular among college-educated men over 65 years old compared with poorly educated men of the same age, in younger cohorts the trend was reversed and more closely resembles the inverse association between cigarette smoking and education in the United Kingdom and the USA. While very few older Spanish women were cigarette smokers, the habit was very popular among young women, and showed a very strong association with higher levels of education, in sharp contrast to the data for men.

In most populations surveyed, the type of cigarette smoked is also related to education. Figure 5 shows a strong inverse relationship between education and the tar yield of cigarettes preferred by over 120 000 American men who were current smokers in 1982 (Stellman & Garfinkel, 1986). This is clearly a manifestation of the widespread belief among smokers that cigarettes with lower tar/nicotine yields carry reduced health risks.

Income, housing Cross-sectional studies of tobacco use frequently use income as a measure of social class. In Table 5, the smoking rates among Australian men and women relative to the most affluent quintile increase with decreasing income, reaching levels

43–47% greater for men and 32–53% greater for women aged 25 and older (I. Gordon, pers. commun.). Figure 6 shows the decline of never-smoking with increased income in the 1987 United States NHIS data, due principally to smoking cessation among the more affluent (Schoenborn & Boyd, 1989).

The British Office of Population Censuses and Surveys found smoking prevalence among women of ages 45–59 years was 48% for renters compared with 30% for owner-occupiers, and 50% for those without access to cars compared with 33% for those with access (Pugh *et al.*, 1991). Owner-occupiers who were once smokers were twice as likely to quit smoking over a 17-year period than were renters.

Ethnicity Table 6 shows estimates of smoking prevalence from a variety of American sources during the years 1980–1992 by ethnic group (White, Black and Hispanic) and sex. According to Novotny *et al.* (1988), 40 years ago smoking prevalence in Whites and Blacks was about equal, but since that time

Blacks have generally been more likely to smoke than Whites and less likely to quit.

However, Blacks who do smoke tend to consume fewer cigarettes per day than Whites do. In the NHIS, Blacks who smoked were far less likely to be heavy smokers (at least 15 per day) than Whites (odds ratio = 0.3; 95% confidence interval = 0.2–0.3); a similar odds ratio was reported by Kabat *et al.* (1991) among patients hospitalized for non-tobacco-related diseases. Using data from the 1987 NHIS and the National Hispanic Health and Nutrition Examination Survey (NHANES), Escobedo *et al.* (1990) reported that among men who started to smoke at 18 years of age or younger, Hispanic men had the highest smoking initiation rates, Whites had intermediate rates, and Blacks had the lowest rates. Furthermore, persons with less than a high-school education were consistently more likely to start smoking cigarettes during childhood and adolescence.

Population-based data on smoking among American Hispanics in San Francisco confirm their

Table 4. Prevalence of smoking (percentage) in adults according to age and education in Spain, 1987^a

Education	Age							
	16–24 years		25–44 years		45–64 years		65+ years	
	All smokers	Smokers of 20+ per day	All smokers	Smokers of 20+ per day	All smokers	Smokers of 20+ per day	All smokers	Smokers of 20+ per day
Males								
Less than primary school	67	34	64	41	55	30	34	14
Primary school	62	26	67	40	53	30	32	11
High school	51	18	68	40	55	26	39	13
University	53	29	54	31	51	25	37	10
Females								
Less than primary school	43	12	17	5	3	1	1	0
Primary school	46	11	28	7	6	2	4	1
High school	48	10	47	12	15	10	6	1
University	62	7	52	20	12	4	5	1

^aRegidor *et al.*, 1994.

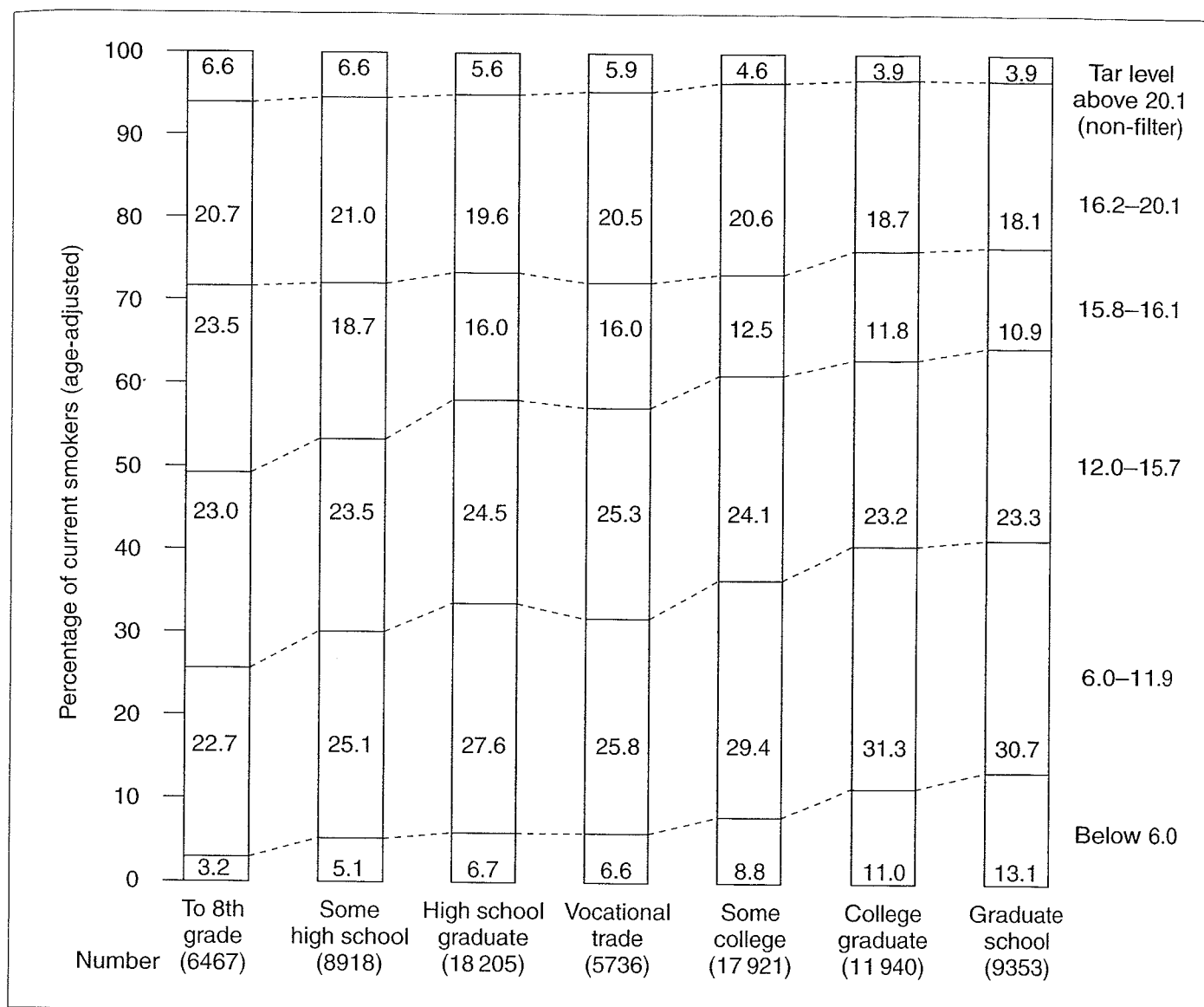


Figure 5. Age-adjusted distribution of tar yield of current cigarettes, by educational attainment, for males of age 40-89 years. Redrawn from Stellman & Garfinkel, 1986.

lower smoking prevalence especially among women. From telephone interviews conducted in 1989 with 652 randomly selected subjects, Perez-Stable *et al.* (1994) reported that 26% of Hispanic males and 8% of Hispanic females were current smokers, compared with 30% and 29% of White males and females, respectively. The corresponding figures for all Hispanics in the USA in 1987-1991 were 28.6% and 17.0% for males and females, respectively (Giovino *et al.*, 1994).

Published estimates of smoking prevalence, however, are not always comparable with each other because of changes in population coverage both with respect to geographical area and ages of eligible subjects. In order to understand the degree to which smoking patterns explain ethnic differences in rates

of lung cancer, much larger analytical studies will be required that account in a detailed way for individual smoking dosage histories, rather than simply recording whether or not individuals ever smoked. Few American studies have addressed this issue for lung cancer.

Cofactors and correlates of smoking behaviour

Much of the literature on tobacco and health treats cigarette smoking as if it were the only risk factor for cancer when in fact smokers are frequently exposed to other lifestyle and environmental factors that may affect cancer risk. Two of the most important of these correlated behaviours are occupation and diet. In epidemiological studies of these factors, cigarette smoking is often treated as

Table 5. Rate ratios for cigarette smoking, by sex, age and income in Australia, 1989–1990^a

Quintile of socioeconomic disadvantage	Age					
	18–24		25–64		65+	
	Males	Females	Males	Females	Males	Females
First	1.00	1.00	1.00	1.00	1.00	1.00
Second	1.16	1.16	1.13	1.25*	1.01	0.93
Third	1.04	1.08	1.27*	1.32*	1.53	1.13
Fourth	1.02	1.26	1.30*	1.42*	1.40	1.16
Fifth	1.24	1.22	1.43*	1.53*	1.47	1.32

* $P < 0.01$

^al. Gordon, pers. commun.

a confounding factor to be adjusted. For instance, in one American lung cancer study, after adjusting for smoking Morabia *et al.* (1992) computed a population attributable risk of 9.2% for occupation, independently of cigarette smoking. Comparative presentation of both smoking and occupationally related cancer risks within the same study is rare.

Occupation The 1986 Surgeon General's Report on Smoking and Health considered many occupational exposures, including those to petrochemicals, aromatic amines, pesticides, asbestos, radon daughters, and cotton dust, as factors in lung cancer and chronic lung disease (US Department of Health and Human Services, 1985).

Exposure to some substances, notably asbestos, increases the risk of smoking-related disease far above the amount expected if smoking and asbestos exerted their effects independently. This effect, called synergism, has important implications for predicting future numbers of cases of implicated diseases (Selikoff, 1981).

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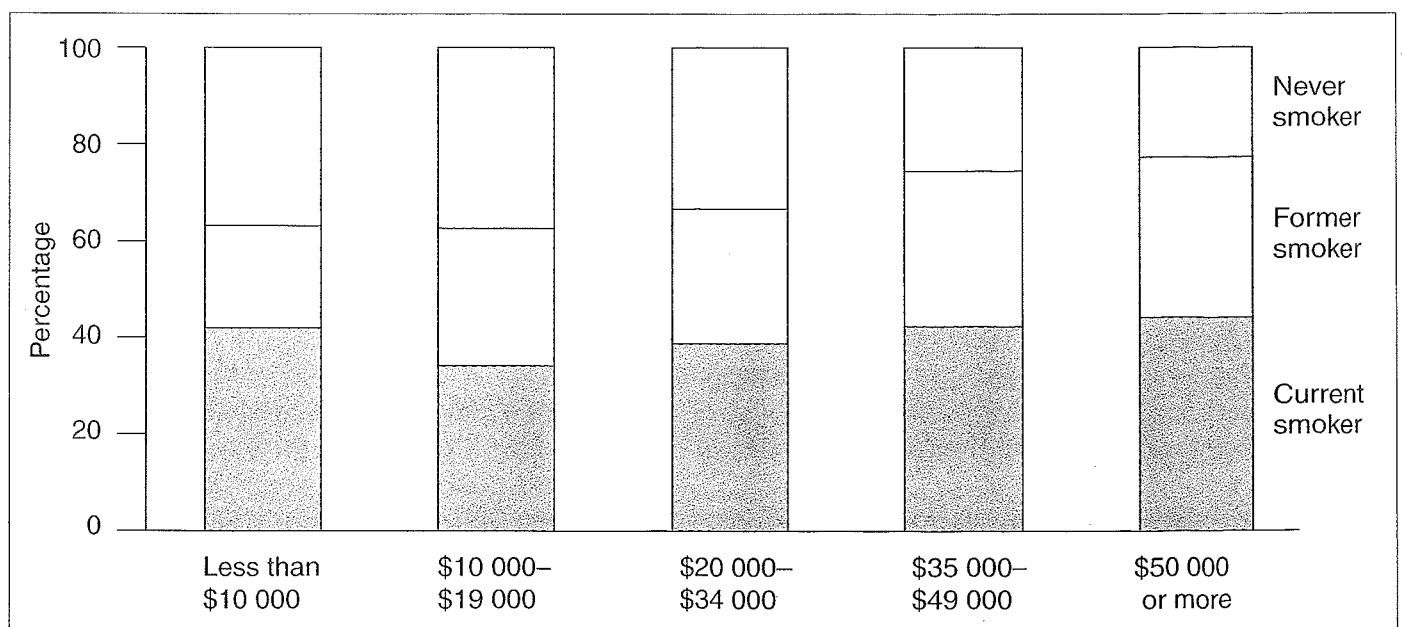


Figure 6. Distribution of smoking habits by annual income among males in the United States, 1987. Redrawn from Schoenborn & Boyd, 1989.

Table 6. Prevalence (percentage) of smoking by ethnic group and sex in the USA, 1980–1992

White, Black and Hispanic		White		Black		Hispanic		Year	Age	Reference
Males	Females	Males	Females	Males	Females	Males	Females			
–	–	35.1	30.8	45.6	36.3	–	–	1985	25–64	Novotny <i>et al.</i> , 1988
–	–	29.7	23.8	49.1	29.5	–	–	1980–1990	20+	Kabat <i>et al.</i> , 1991
–	–	29.3	23.7	32.5	25.1	–	–	1986	17+	Centers for Disease Control, 1987
31.2	26.5	30.6	27.5	38.9	28.2	30.0	18.0	1987	18+	American Cancer Society, 1991
31.2	26.5	30.5	26.7	39.0	28.0	30.0	18.0	1987	18+	Schoenborn & Boyd, 1989
–	–	27.4	23.8	35.1	24.4	25.2	15.5	1991	18+	Centers for Disease Control, 1993
28.6	24.6	28.6	25.9	32.3	24.1	23.6	18.0	1992	18+	Centers for Disease Control, 1994b

Synergism between asbestos-related occupations and smoking has been reported in both cohort and case-control studies. A classic example was reported for asbestos insulation workers by Hammond *et al.* (1979) who observed a lung death rate per 100 000 person-years of 11.3 in non-exposed nonsmokers, 122.6 in nonexposed smokers, 58.4 in nonsmoking asbestos-exposed workers, and 601.6 in smoking asbestos-exposed workers. An additive model would have predicted a rate in the latter of 170, while a multiplicative model predicted 633.6, which was close to the observed rate (Stellman, 1986).

A striking example of synergism in a case-control study is displayed in Figure 7, which shows the relative risk for lung cancer according to the number of cigarettes smoked per day and whether or not subjects worked in a shipyard, an occupation associated with heavy asbestos exposures (Blot & Fraumeni, 1981). Superimposed on the figure are theoretical risks that would be expected based upon both an additive and a multiplicative (synergistic) interaction. For heavy smokers, the multiplicative model closely predicted the observed lung cancer risk. Other examples of occupational exposures that may interact synergistically with smoking include exposure to radon daughters in underground

mining in Sweden (Damber & Larsson, 1985), exposure to a variety of industrial chemicals in Italy (Pastorino *et al.*, 1984), and working with metal materials in Japan (Hirayama, 1981).

Diet has long been known to play an important role in the development of many cancers, including those that are also caused by cigarette smoking. The association of smoking with various dietary factors, including those that may affect lung cancer risk, has been studied extensively. In the American Cancer Society follow-up study, Stellman showed that men with the lowest consumption of foods rich in vitamins A and C were twice as likely to smoke cigarettes than men with high consumption, as shown in Figure 8 (Stellman, 1985). This was confirmed by Hebert and Kabat (1990) in a hospital-based study and extended to a variety of other foods. Wang and Hammond (1985) found consistently higher standardized mortality ratios for lung cancer among men who consumed little or no fruits or juices compared with those who consumed them daily. In Japan, Gao *et al.* (1993) reported a strong protective effect against lung cancer in smokers who consumed fresh fruits and vegetables frequently. Willett has reviewed the role of vitamin A

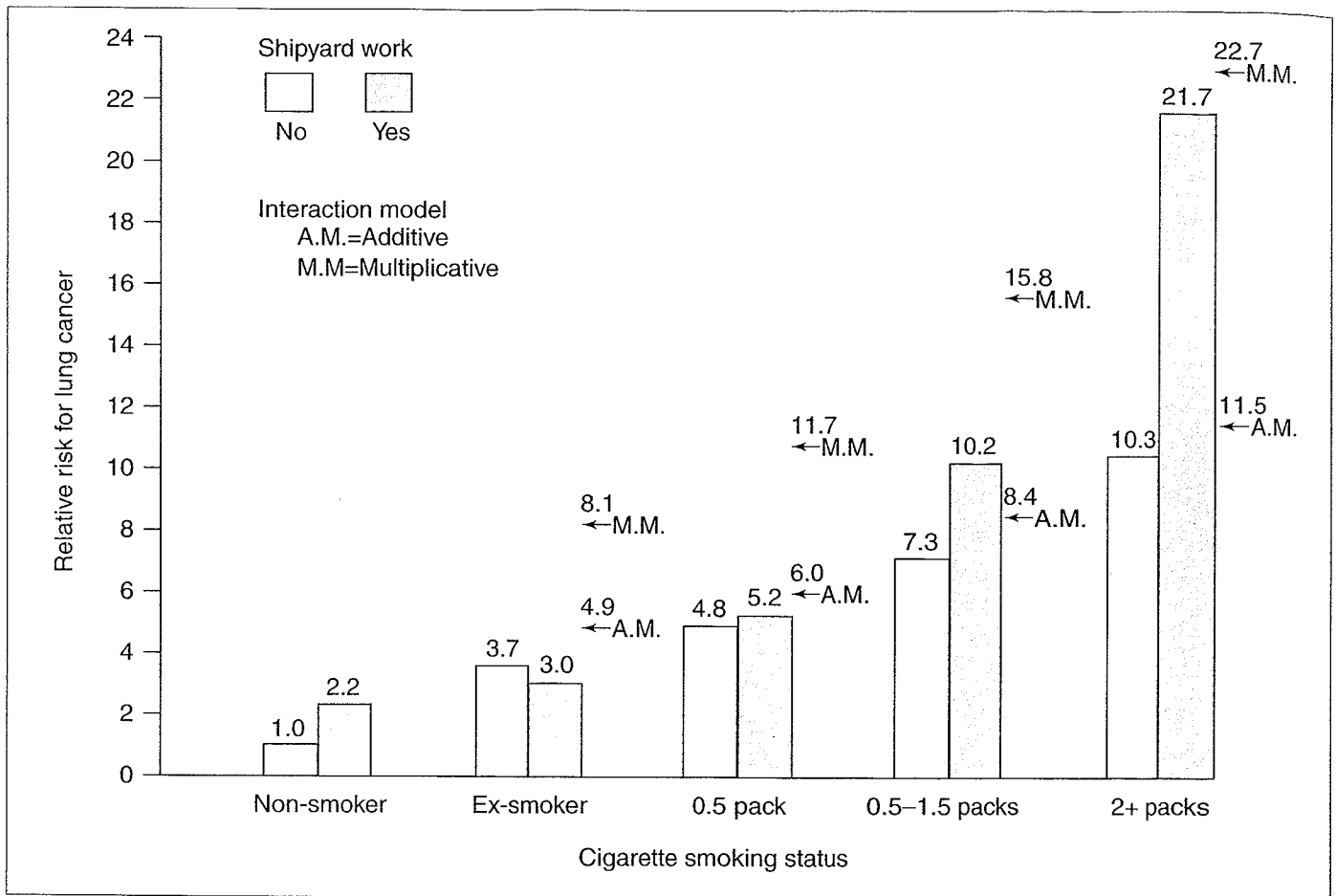


Figure 7. Relative risk for lung cancer according to number of cigarettes smoked per day, and whether or not subject worked in a shipyard. Redrawn from Stellman, 1986.

in lung cancer and concluded that dietary carotenoids are associated with reduced lung cancer risk (Willett, 1990).

However, the interplay of diet with tobacco usage patterns in different social strata and subsequent effect on cancer risk has not yet received adequate attention. For instance, as discussed above, it is difficult to explain the increased risk for lung cancer in American Blacks relative to Whites solely in terms of cigarette smoking. Hebert *et al.* (1991) reviewed Black-White differences in rates of lung, larynx and other cancers, and suggested that ethnic differences in diet are also important. Hebert and Kabat (1990) reported that total fat, meat consumption and cholesterol intake were positively associated with cigarette smoking, while total fruit, vitamin A and fibre consumption were negatively associated. Dorgan *et al.* (1993) found significant inverse smoking-adjusted associations of lung cancer with vegetables, fruit and carotenoids for White women, nonsignificant inverse associations for White men, but no inverse associations for Blacks.

In Japan, low consumption of green and yellow vegetables was associated with an increased risk of lung cancer in men and women independently of smoking (Hirayama, 1990). More generally, fruits and vegetables have been suggested to reduce the risk of lung cancer among smokers in Japan (Hirayama, 1986; Gao *et al.* 1993).

Alcohol plays an important etiological role alongside tobacco in cancers of the mouth, larynx, oral cavity, and oesophagus (Wynder & Stellman, 1977, 1979). It has been asserted that alcohol is not a carcinogen by itself but that it promotes the carcinogenic effects of tobacco smoke. However, the fact that most heavy drinkers are also heavy smokers makes it difficult to disentangle the two effects. In one of the few studies that addressed an indicator of socioeconomic status, Mashberg *et al.* (1993) found for oral cavity cancer a multiplicative effect of smoking and drinking in White United States veterans, with Blacks at lower risk than Whites. A recent Swedish case-control study of stomach cancer in relation to tobacco and alcohol use

observed a significant interaction between tobacco use and fruit intake, with the latter more protective among smokers than among nonsmokers, and showed that high alcohol intake was associated with increased stomach cancer risk (Hansson *et al.*, 1994).

Metabolic and genetic studies The development and application of novel molecular techniques to epidemiology (Shields & Harris, 1991) raises a number of new issues with respect to social factors and cancer, particularly concerning differences in cancer incidence between ethnic populations. Some population subgroups have been described as 'genetically high risk' for lung cancer (Kawajiri *et al.*, 1990). In a Japanese population the odds ratio for lung cancer among those with a cytochrome P450 polymorphism (*Msp1*) was 3 compared with those without the polymorphism. By contrast, in an American study the same allele was more prevalent in Blacks compared with Whites by the same odds ratio of 3, but there was no association between the allele and lung cancer after stratification by race (Sheilds *et al.*, 1993).

Metabolic and genetic studies of cancer incidence in different groups have so far been rather small and subject to wide variation, so no firm conclusions can yet be drawn. However, it is inevitable that refinements in laboratory techniques coupled with a reduction in testing costs will lead to an exponential proliferation of such studies in the near future. It is unclear whether inter-ethnic differences are derived from individuals' genetic inheritance, or whether they are acquired as a result of a long-term exposure or deficiency, which could conceivably be nutritional or occupational in origin. Findings from such studies might have unforeseeable social consequences. For instance, if it were determined that some ethnically identifiable segment of the population were inherently more 'susceptible' to lung cancer than another, this could affect availability of insurance and social services. The ethical questions associated with these possibilities are beyond the scope of this chapter.

Intervention and prevention

Cigarette smoking in most industrialized countries peaked after World War II and then gradually declined. Nevertheless, as there are still millions of smokers, and thousands of youths taking up the habit each year, concerted smoking control programmes

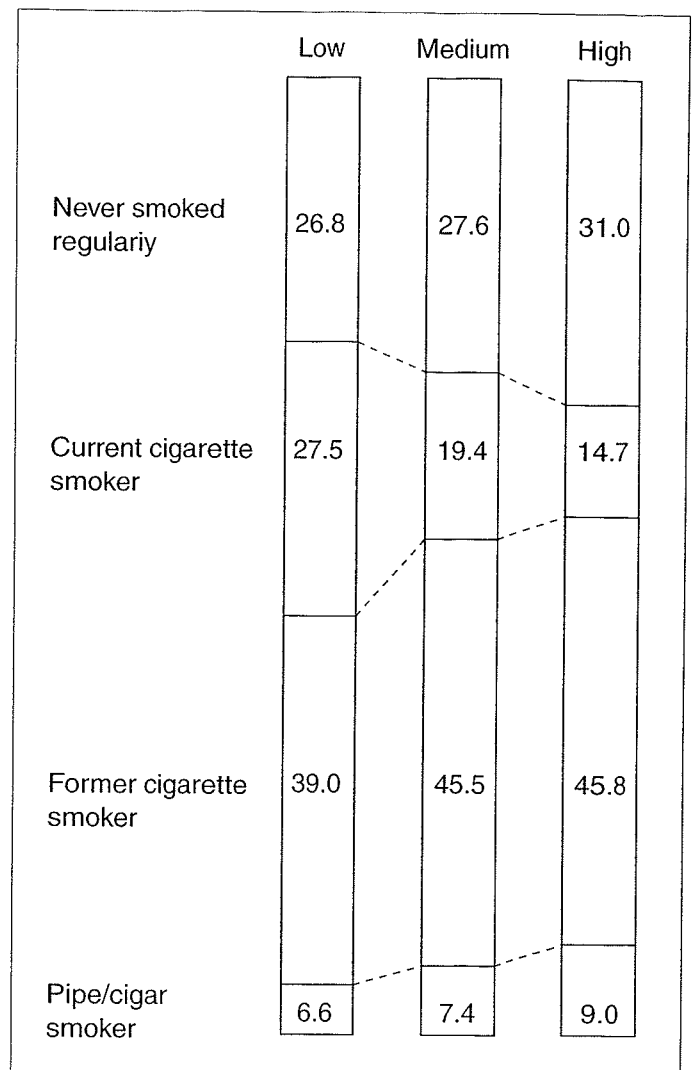


Figure 8. Distribution of smoking habits, adjusted for age, among 550 000 men surveyed in 1982 American Cancer Society follow-up study, according to whether they scored high, medium or low on a scale that measures frequency of consumption of foods rich in vitamins A and C. Redrawn from Stellman, 1986.

have become public policy in many countries. The United States in particular has invested heavily in controlled trials whose goals have included reduction in smoking prevalence in selected populations.

Two such trials recently concluded with results that have been termed disappointing by most observers. The Community Intervention Trial for Smoking Cessation (COMMIT) was a four-year randomized controlled trial in which one of each of 11 matched community pairs in the United States and Canada was randomly assigned to an intervention (COMMIT Research Group, 1995a, 1995b). There was a modest reduction in smoking levels for light-to-moderate smokers but not for heavy smokers. The Minnesota Heart Health Program was a research

and demonstration project in three pairs of communities in northern-central USA and was designed to reduce risk factors for heart disease, including cigarette smoking (Lando *et al.*, 1995). The programme had no effect on smoking prevalence in men, and positive effects were seen for women in cross-sectional but not longitudinal data. Susser and others have pointed out the inherent difficulties in measuring the 'true' impact of an intervention that is conducted while secular rates are already declining, stating that 'the very same changes aimed for in such matters as smoking, diet, and exercise are those that have been progressing apace in response to the social movement...' (Susser, 1995).

Efforts to reduce smoking in the poor and lower socioeconomic minorities have been far less successful than in the affluent (Romano *et al.*, 1991). To a large extent this failure relates to our inability to deliver health-related information to the former groups through 'standard' educational channels such as those used in the community trials just described. Minorities tend also to have a lower level of knowledge of basic health risks. Several American surveys have found Blacks to have lower levels of 'cancer knowledge' than Whites, such as knowledge of smoking-related risks, as well as symptoms, screening and treatment (Robinson *et al.*, 1991). In a study of inner city Blacks in Indianapolis, 40% did not know that smoking was related to cancer (Loehrer *et al.*, 1991), and Blacks nationally were less likely than Whites to know the health risks of smoking but more likely to believe that cancer was not preventable (Jepson *et al.*, 1991).

Nevertheless, lack of knowledge is only one component of the social environment that contributes to high-risk behaviours. The social processes connected with the higher smoking rates in Blacks in the United States and the implications for developing effective cancer prevention programmes have been extensively studied. In addition to the socioeconomic factors of poverty and ethnic discrimination, higher smoking rates are associated with psychological factors such as hostility, overcrowding, and low social support (Baquet *et al.*, 1991; Romano *et al.*, 1991; Manfredi *et al.*, 1992; Schweritz *et al.*, 1992), as well as targeted cigarette advertising in minority communities (Royce *et al.*, 1993).

Therefore, it is evident that a 'one size fits all' approach to smoking cessation and other interventions is impractical, and that there is a need to

develop culturally sensitive smoking cessation interventions consonant with the social and psychological characteristics of the target population. Cultural sensitivity comprises three dimensions. The first – surface structure – relates to the appearance of intervention materials. This can be achieved by using actors and settings recognized by the target audience. The second level – deep structure – may be more difficult to attain. It involves developing messages consistent with psychological, spiritual and emotional characteristics of the target audience. The third dimension – intragroup heterogeneity – recognizes that a large ethnic group, such as African-Americans, actually consists of individuals from many different cultural and social backgrounds. For example, among low-income, inner city Blacks there are varying levels of Afrocentricity (Cross, 1991). Some adopt African names and dress in Afrocentric clothing, but many do not. Moreover, a single African-American population may include immigrants from Haiti, Jamaica, and West Africa, in addition to Blacks born in the USA, and may contain groups with unique language, dress, food and norms. Failure to appreciate the significant variation within groups can result in so-called 'ethnic glossing' (Trimble, 1990–91).

Lack of culturally sensitive interventions may, at least in part, explain the lower success rate among Blacks who attempt to quit smoking. One programme tailored to a specific population in a culturally sensitive manner is the American Health Foundation's 'Harlem Health Connection', a community-based initiative to involve African-Americans in health promotion programmes with a special emphasis on reduction of cigarette smoking. Within this single community in one of the poorest neighbourhoods of New York City, smoking prevalence varied widely with the organizational 'channel' (recruitment milieu) – from 20% among those enrolled through church groups to 48% among those enrolled from (generally public) health care facilities and public housing (Resnicow *et al.*, 1996). Other intervention studies for Blacks have also worked through church groups (Stillman *et al.*, 1993).

The goal of the Harlem Health Connection was to develop and test a culturally sensitive self-help smoking cessation programme for low-income Blacks (Resnicow *et al.*, in press). The intervention comprised a video and accompanying cessation

guide, a single telephone counselling call, and several quit and win contests. Intervention materials employed culturally specific cessation messages and strategies. For example, characters representing Martin Luther King, Jr, Malcolm X and Marcus Garvey – key figures from United States Black history – were used to link cessation messages to cultural and historical themes; for instance, with slogans such as ‘break the chains of smoking addiction’, ‘be strong for your people’, and ‘there can be no progress without struggle’. Intervention results were mixed: there was a slight difference in self-reported point prevalence abstinence at six-month follow-up between the treatment and control groups (11.2% versus 7.9%; $P = 0.06$), but a significantly higher abstinence rate in the group that received both the materials and a booster call (16.4% versus 7.9%; $P < 0.05$).

This programme is one example of a nationwide effort, sponsored by the US National Cancer Institute (NCI) and other Federal health agencies, to develop and evaluate interventions aimed at stopping or preventing tobacco use in North America. The NCI Smoking, Tobacco, and Cancer Program has supported at least 49 intervention trials since 1984, with a total affected population of about ten million participants (Glynn *et al.*, 1993), and at least nine initiatives have been specifically targeted for reducing smoking in Blacks (Stotts *et al.*, 1991).

Risk of tobacco-related cancers in relation to indicators of social class

The relationship of social class to cancers of various sites has been reviewed comprehensively elsewhere in this book. Incidence, mortality and survival data are usually derived from official sources, such as tumour registries and vital statistics bureaus. These data sources frequently include social class indicators such as occupation, ethnic group, or education. Within many societies there is a strong gradient for each risk measure with respect to these social class variables. A large body of evidence confirms the inverse association of lung cancer with social class in many developed countries. Since this is the most common tobacco-related cancer in these countries, it is logical to ask whether risk within countries is associated with social class, and, if so, whether the association is explained by patterns of tobacco use. Unfortunately, most vital statistics sources contain no information on tobacco consumption, in which case the risk attributable to tobacco use must be inferred indirectly.

Incidence and mortality

Working with data from the Danish Cancer Registry and Central Population Register, Lynge and Thygesen (1990) reported a very strong gradient for lung and bladder cancers with respect to an occupational measure of social status in men and women (Table 7). Gradients were also observed for

Table 7. Relative risks for selected tobacco-related cancer sites for Danish men and women by occupational grouping^a

	Males			Females			
	Farmer	Academic	Building worker	Academic	Farmer	Clerk	Factory worker
Mouth	0.36	0.67	2.36	–	–	–	–
Pharynx	0.34	0.56	1.83	–	–	–	–
Oesophagus	0.47	0.65	1.42	–	–	–	–
Larynx	0.29	0.76	1.33	–	–	–	–
Lung	0.40	0.61	1.37	0.45	0.46	0.99	1.43
Bladder	0.51	0.88	1.15	0.61	0.83	1.05	1.19
Cervix	–	–	–	0.50	0.66	0.94	1.47

^aLynge and Thygesen, 1990.

several other tobacco-related sites for men but not women – mainly sites also associated with heavy alcohol consumption – and for cervical cancer in women. A similar pattern has been observed in England and Wales, indicating the predominant importance of tobacco smoking patterns for the occurrence of social class differences in cancer incidence and mortality in these societies. In an Italian case-control study, La Vecchia *et al.* (1992) reported a very strong inverse relation between education and several tobacco-related cancers, including oral cavity and pharynx (relative risk = 0.3 for highest versus lowest level), oesophagus (0.6), larynx (0.3) and cervix (0.7), but not lung.

An indirect estimation of the importance of smoking for the occurrence of social class differences in mortality in New Zealand (Pearce *et al.*, 1985) indicated that smoking patterns explained much of the increased risk for social classes III and IV but not the very high mortality for class V (unskilled manual workers).

The literature on cancer mortality with respect to social class includes many studies derived from vital records, which often contain education, occupation, ethnicity, and other data such as residence from which income can be inferred through linkage with census records. Besides the classic tabulation of British mortality data by Logan (1982), there are also numerous cohort mortality studies, especially those performed in selected industries or among specific occupational groups. While occupation is dealt with elsewhere in this book, it is useful to point out the comment of Blair *et al.*

(1988) that many occupational cohorts, such as those constructed through linkage with official death records in Denmark (Lynge, 1990–91), Switzerland (Minder & Beer-Porizek, 1992; Minder, 1993) and New Zealand (Firth *et al.*, 1993), lack smoking data and thus contribute only indirectly to the question of the relative roles of smoking and occupational exposures.

In the USA, Blacks constitute about one fifth of the total population but experience significantly higher cancer incidence rates than Whites for all sites combined (Baquet *et al.*, 1991), and particularly for lung cancer (Devesa *et al.*, 1991). Devesa *et al.* (1991) reported data from the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program that showed drastic and disproportionate increases in lung cancer rates occurring in both Whites and Blacks during the approximately 15 years between 1969–1971, (when regular geographically based incidence reporting was established) and 1984–1986.

Baquet *et al.* (1991) linked 1978–1982 SEER data for three urban populations with the corresponding 1980 United States census data on socioeconomic status within individual census tracts. They found nearly equal lung cancer rates for Blacks and Whites after adjustment for either income or education and population density (Table 8). They concluded that 'the disproportionate distribution of Blacks at lower socioeconomic levels accounts for much of the excess cancer burden' (Baquet *et al.*, 1991). These observations are extremely important because they show the existence of wide social class differences in cancer incidence in both races, but only minor race differences within each social class. They are also very important because they give rise to the testable hypothesis that patterns of tobacco use and other correlated lifestyle behaviours may 'explain' social class differences in cancer rates.

Bladder cancer is causally related to cigarette smoking, although the association is not as strong as for lung cancer (Wynder & Stellman, 1977). Anton-Culver *et al.* (1993) found the incidence of invasive bladder cancer in Hispanics to be half that in Whites in Orange County, California, and reported that after adjustment for smoking and occupational exposures, the risk of bladder cancer in Hispanics did not differ significantly from that

Table 8. Age-adjusted (1970-standard) rates for lung cancer by ethnic group and education in USA, 1978–1982^a

Education	White	Black
<12 years	79.7	78.4
High school graduate	64.1	59.3
Some college education	51.0	56.9
College graduate	44.7	16.4
Adjusted	59.7	56.7
Adjusted (age only)	58.6	70.8

^aBaquet *et al.*, 1991.

in Whites or Asians and Pacific Islanders. This suggested that ethnic differences in bladder cancer incidence could be due largely to differences in smoking and occupational exposures.

Although literature on ethnic differences in cancer tends to be dominated by North American studies, recently population-based data on lung cancer have become available in São Paulo, Brazil; these show that, except for cancer of the oesophagus, Blacks had lower rates of most tobacco-related cancers than did Whites, and in fact their rates for lung and bladder cancer were significantly lower (odds ratios = 0.7 and 0.5, respectively) (Bouchardy *et al.*, 1991).

Survival

The important question of social class differences in cancer survival and the reasons that underlie those differences are treated at length elsewhere in this book (see the chapters by Auvinen and Karjalainen, by Kogevinas and Porta and by Segnan). This literature, although voluminous, relates largely to differences in such prognostic factors as screening, barriers and access to medical treatment, quality of care, and host characteristics. It is possible that continued smoking might play a role as well in the occurrence of social class and race differences in cancer survival, but there have so far been relatively few studies of survival from tobacco-related cancers in which the role of tobacco use was explicitly accounted for (see, for example, Koh *et al.*, 1984).

Conclusions and generalizations

The complex relationships between tobacco use and social class throughout the world make a facile description of tobacco-cancer linkages exceptionally challenging. One would like to propose the hypothesis that class differences in lung cancer, say, are mostly related to the unequal distribution of tobacco smoking between social classes, and in some fairly simple situations this has been satisfactorily demonstrated. Nevertheless, there are many unresolved issues, especially with regard to the role of collateral exposures, such as hazardous occupations, poor diet, and limited access to health care. This makes it essential that careful epidemiological investigations in these areas be continued.

Despite an overall decline in death rates in the USA since 1960, poor and poorly educated people

have higher death rates than those with higher incomes or better educations, and this disparity increased between 1960 and 1986 (Pappas *et al.*, 1993). Whether tobacco use 'explains' socioeconomic differences in one or more of the cancers that it causes has rarely been directly addressed in epidemiological studies. Typically, socioeconomic status is treated as a nuisance factor whose effect one hopes to render invisible by statistical adjustment in order to focus on the etiological effects of tobacco use itself.

The difference in cancer incidence and mortality between Blacks and Whites in the USA has been a subject of considerable discussion. While the medical and epidemiological literature tends to focus narrowly on specific lifestyle and environmental agents, such as tobacco use and occupation, the social processes that underlie exposure to these agents are frequently neglected (Hurowitz, 1993). The most obvious such process is racism, which is a systematic set of social inequities. Freeman has written extensively on the relationship between racism, its associated poverty, and health (Freeman, 1993a, 1993b), while Cooper has attempted to construct a theoretical framework to define pathogenic mechanisms that also incorporate social processes (Cooper, 1993). This framework is not unique to the USA; Smith *et al.* (1991) have also shown in the United Kingdom that no single factor, such as differences in smoking behaviour or susceptibility, can entirely account for the association between tobacco use and cancer. The need for continuing research into these relationships has not diminished.

The changing rates in the tobacco-related cancer sites with the highest incidence (lung and oral cavity), along with shifting patterns of tobacco usage due to changing preferences abetted by aggressive marketing, make it increasingly important to maintain a flow of 'reliable data on prevalence of tobacco use and morbidity and mortality rates among minorities' (Chen, 1993). This includes support for ongoing population surveys and especially uniformity in recording race and ethnicity in surveys, vital records, and census data.

But as important as it is to continue to improve the information base on tobacco use and its health consequences, it is even more urgent to interpret and channel these findings into prevention strategies. If we are only now learning how best to do

this in the industrialized world, the struggle may be even more difficult in places like southern Europe, where smoking is on an upsurge (Hill, 1992), and in eastern Europe and the developing countries of South America, Asia and Africa, where the transnational tobacco companies have been aggressively expanding their markets (Connolly, 1992; Mackay, 1992). Perhaps health advocates can take a leaf from these companies and learn to export successful smoking and cessation programmes as well.

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