

Epidemiology of tobacco use in the United States

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Efforts to understand trends in and patterns of lung cancer are well served by studies of trends in and patterns of tobacco use. In the United States, the manufactured cigarette emerged as the tobacco product of choice shortly after the turn of the twentieth century. Lung cancer emerged after years of inhalation of cigarette smoke, first among men and then among women. The massive public health education campaign that began after scientists recognized the dangers of cigarette smoking has contributed to large reductions in cigarette use and subsequent smoking-attributable morbidity and mortality. Since 1965, the prevalence of cigarette smoking among US adults has declined by almost half, with positive trends observed among persons in almost all sociodemographic groups and efforts to reduce disparities recognized as an important goal in public health. An epidemiologic approach to understanding and controlling patterns of tobacco use is proposed. The model focuses on the agent (tobacco products), host (consumer or potential consumer), vector (tobacco companies and other users), and environment (with influences from families, social sources, culture, history, politics, law, and media). Accelerating progress in reducing tobacco use will accelerate reductions in tobacco-attributable morbidity and mortality.

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Introduction

Lung cancer is the leading cause of cancer death in the United States and throughout the world (Murray and Lopez 1997; Ries *et al.*, 2002; www://seer.cancer.gov/csr/1973_1999/). From 1995–1999, cigarette smoking and exposure to secondhand smoke accounted for approximately 440 000 annual deaths in the United States (CDC, 2002a). Each year 127 813 Americans die from smoking-attributable lung cancer deaths (i.e., deaths that would not have occurred in the absence of smoking and exposure to environmental tobacco smoke), representing approximately 84% of all lung

cancer deaths in the United States. In addition, cigar (NCI, 1998) and pipe (Nelson *et al.*, 1996) smoking each contribute, in a much smaller but substantial amount, to excess lung cancer mortality. Worldwide, approximately 4 million people die annually from tobacco-attributable diseases; the number of tobacco-attributable deaths is projected to rise to 8.4 million by 2020 (Murray and Lopez, 1996).

Since the smoking of tobacco products causes such a large percentage of all lung cancer deaths, understanding historical patterns of tobacco smoking will facilitate understanding of past and future patterns of lung cancer. Surveillance of selected tobacco use behaviors also aids in understanding the effects of activities that promote tobacco use, evaluating tobacco control interventions, identifying high-risk groups, and making cross-country comparisons. Lopez *et al.* (1994) have concluded that various countries of the world are in various stages of both the epidemics of tobacco use and tobacco-attributable diseases. Strategies designed to either slow the rate of increasing tobacco use or accelerate the reduction of declining use will lessen the eventual burden of lung and other cancers, heart disease, and other tobacco-attributable diseases. An epidemiologic model, which facilitates understanding of patterns of tobacco use and means to prevent disease, will be presented at the end of this review.

General patterns of use during the past 120 years

The emergence of the modern cigarette

This section will describe patterns of tobacco use in the 20th century, followed by a more detailed description of trends in prevalence since 1965. The work cited and presented here updates some of the findings presented in previous reviews (CDC, 1999a; Giovino, 1999; Giovino *et al.*, 1994, 1995; NCI, 2001b; Novotny and Giovino, 1998; Smith and Fiore, 1999; USDHHS, 1989, 1990, 1994, 1998, 2001). However, the reader is referred to those publications for additional details.

Per capita consumption of tobacco products in the United States has changed substantially since 1880. In the early 1880s, for example, each person aged 18 years and older consumed about six pounds of tobacco: 56% as chewing tobacco, 26% in cigars, 14% as smoking tobacco (pipe and hand-rolled), 2% as snuff, and 1% in manufactured cigarettes (Milmore and Conover, 1956). Per capita estimates from Milmore and Conover

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(1956), made for persons aged 15 years and older, are adjusted to represent persons aged 18 years and older. Unstemmed processing weights of tobacco products are used in calculations. Consumption peaked in the early 1950s at approximately 13 pounds of tobacco consumed per person: 80% in cigarettes, 10% in cigars, 4% as smoking tobacco, 4% as chewing tobacco, and 3% as snuff (Milmore and Conover, 1956). In 1999, 4.2 pounds of tobacco were consumed per person: 83% in cigarettes, 6% in cigars, 5% as snuff, 5% as chewing tobacco, and 1% as smoking tobacco (USDA, 2002).

USDA data show clearly that the shift to cigarettes produced an increase in the overall per capita consumption of tobacco products. About one-half of the increase in per capita cigarette consumption from 1900 to 1952 was additional tobacco consumption and not simply a shift from other forms of tobacco use (Milmore and Conover, 1956). The most likely explanation of the increase in overall consumption was that women became more likely to smoke cigarettes beginning in the 1920s, when cigarettes were more heavily marketed to them (Amos and Haglund, 2000; USDHHS, 2001).

The shift from the more common forms of tobacco used in 1880 (i.e., chewing tobacco, cigars, and smoking tobacco) to manufactured cigarettes over the next several decades occurred because of several factors. The tobacco used in chewing tobacco, cigars, snuff, and pipes delivers nicotine in a more alkaline state and the nicotine from them is absorbed through the oral or nasal mucosa (Slade, 1993). At the turn of the previous century, new tobacco blends (including sugared burley tobaccos) and curing processes (i.e., flue curing) were being developed for cigarettes and produced a mildly acidic smoke. This more acidic smoke allows substantially less nicotine to be absorbed in the mouth or nasal passages. Thus, the smoke from modern cigarettes needed to be inhaled into the lungs for optimal nicotine absorption to occur, unlike that for cigars and pipes. Pulmonary absorption is more efficient than oral or nasal absorption, because of the larger surface area of the lungs and because the nicotine can immediately (within 7–10 s) be transported to the brain via the carotid artery. The modern cigarette thus delivered nicotine more efficiently and became more dependence producing than other forms of tobacco; it also greatly increased the amount of carcinogens to which the lungs were directly exposed (Slade, 1993; USDHHS, 1988, 1989).

Other developments between 1880 and 1913 contributed to the rise of the modern cigarette. Machinery for mass-producing cigarettes was developed and used in factories by the end of the 19th century; the safety match was invented; a more efficient transportation system was developed; and state-of-the-art mass media marketing techniques were introduced to promote the use of cigarettes (Slade, 1989, 1993). In addition, the free distribution of cigarettes during the First World War likely contributed to increased use (Burns *et al.*, 1997).

Per capita consumption of cigarettes in the United States increased from 54 cigarettes per person (aged 18 years and older) in 1900 to 4345 per person in 1963, the year before the release of the first Surgeon General's report (Giovino *et al.*, 1994; USDA, 1987, 1994, 2002; USPHS, 1964). During that time period, the only major periods of decline were during the Great Depression, at the end of World War II, and in 1953 and 1954 concurrent with the reports linking smoking and cancer (Consumer Reports 1953, 1954; Miller and Monahan, 1954). Some have suggested that the cigarette companies' advertisements during 1952 and 1953 also contributed to the downturn in consumption. While promising protection via filters, these advertisements also reminded the consumer of the toxic chemicals in smoke, likely raising anxiety about cigarette smoking in general. When the companies changed their advertising strategies to make more subtle health claims, consumption rose again (Kozlowski, 2000; Stratton *et al.*, 2001; Swedrock *et al.*, 1999). The anti-smoking media campaign instituted following the release of the first Surgeon General's report contributed substantially to the subsequent drop in consumption (USDHHS, 1989; Warner, 1989). Other contributory factors include the implementation of the Fairness Doctrine ruling in 1968 that required anti-smoking advertisements be run on television and radio, the nonsmokers' rights movement, counter marketing and price increases following the 1998 Master Settlement Agreement, and other tax and price increases throughout the last 35 years (CDC, 1999a; USDHHS, 1989, 2000).

Changes in the types of cigarettes smoked

When initial scientific reports linking cigarette smoking with lung cancer (Doll and Hill, 1950, 1952; Wynder and Graham, 1950) were published and reported in the lay press (Consumer Reports, 1953, 1954; Miller and Monahan, 1954; Norr, 1952), the tobacco companies claimed that their products were safe, promised to cooperate fully with tobacco-related research efforts, pledged to protect the public's health, and introduced filtered cigarettes (in the 1950s) and low tar cigarettes (in the 1960s) (Cummings *et al.*, 2002b; Slade, 1993; USDHHS, 1989). The companies have failed to live up to their promises (Cummings *et al.*, 2002b) and thousands of scientific reports have continued to document the hazards of smoking tobacco (USDHHS, 1989). In addition, low tar cigarettes have not been shown to have any health benefits, in part because people compensate for lower nicotine yields by smoking more cigarettes; taking more puffs per cigarette; increasing puff volume, depth, and duration; and/or blocking ventilation holes (NCI, 2001a).

The market share of filter cigarettes increased from 0.3% in 1949 to 51% in 1960 (USDA, 1962) (Figure 1); the major initial jump in market share was from 3% in 1953 to 19% in 1955. By 1999, 98% of cigarettes consumed in the United States had filters (FTC, 2001). The percentage of cigarettes yielding, on standard

machine tests, less than 15 mg of tar increased from 2% in 1967 to 87% in 1999 (FTC, 2001). The market share of menthol cigarettes was 16% in 1963, peaked at 29% in 1979 and 1982, and was 26% in 1999 (FTC, 2001). The use of mentholated cigarettes is most common among African American smokers (USDHHS, 1998). The share of longer cigarettes (>94 mm) increased from 9% in 1967 to 44% in 1993 and was 40% in 1999 (FTC, 2001).

Retrospective birth cohort analyses of cigarette smoking in the twentieth century

Researchers have used the data from nationally representative surveys to reconstruct the prevalence of smoking for various birth cohorts covering much of the Twentieth century (Burns *et al.*, 1997; Harris, 1983; Tolley *et al.*, 1991). As shown in Figure 2, among US males the prevalence of cigarette smoking peaked during the 1940s and 1950s at about 67% for men born between 1911 and 1930 (Tolley *et al.*, 1991). Among US females, prevalence did not rise as high as among males and it peaked later in the century: at about 44% in the 1960s for women born between 1931 and 1940 (Tolley *et al.*, 1991) (Figure 3). According to Warner (1989), the peak prevalences for males would have dropped less rapidly and the peak prevalences for women would have eventually become higher than they actually did, had not the massive anti-smoking campaign been instituted in the 1960s (USDHHS, 1989). Lung cancer mortality rates reflect these population patterns of cigarette smoking, with mortality among US males peaking at approximately 91 out of 100 000 in 1990 (Ries *et al.*, 2002). As of 1999 among US females, the rise in lung cancer mortality was leveling at about 41 out of 100 000.

Birth cohort analyses can similarly help explain historical patterns of lung cancer mortality among African Americans and whites. White males born before 1915 started smoking and smoked at higher rates than did African American males born during the same time period (Shopland, 1995). Among males born after 1915, both the peak smoking rates and the duration of smoking were higher among African Americans than whites. In addition, white male smokers were more likely than African American male smokers to quit smoking during the 1950s (when the early scientific studies linking smoking with lung cancer were reported). Thus, African American males born after 1915 experienced greater cumulative exposure to cigarette smoke. Lung cancer mortality rates reflect these trends in smoking behavior, being higher among white males earlier in the century and higher among African American males during the second half of the century (USDHHS, 1998).

Lung cancer rates among white and African American females have been consistently lower than those for their male counterparts (again, reflecting lower rates of exposure to cigarette smoke among females). In addition, lung cancer mortality has been similar over the decades for African American and

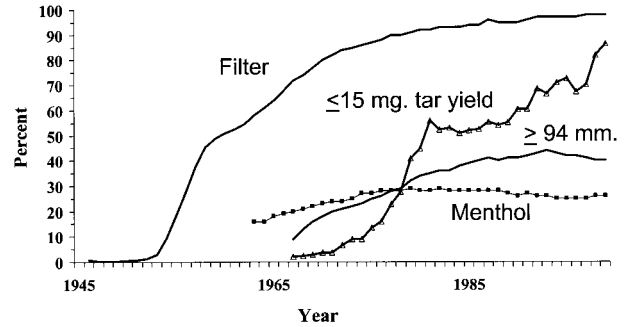


Figure 1 Domestic market share of cigarettes by tar yield, filter status, length and menthol status: United States, 1963–1999. Source: USDA 1962; FTC 2001

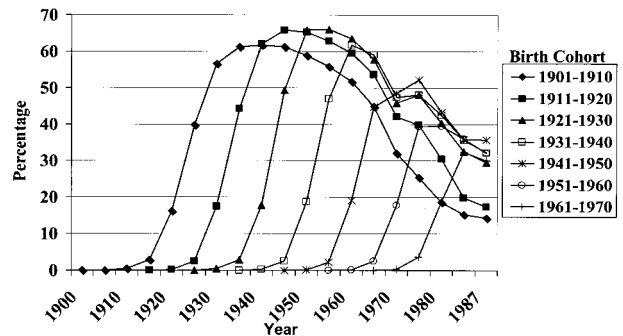


Figure 2 Prevalence (%) of cigarette smoking among successive birth cohorts of US males, 1900 to 1987. Source: 1970, 1978, 1979, 1980, 1987 (combined) National Health Interview Surveys (Tolley *et al.*, 1991)

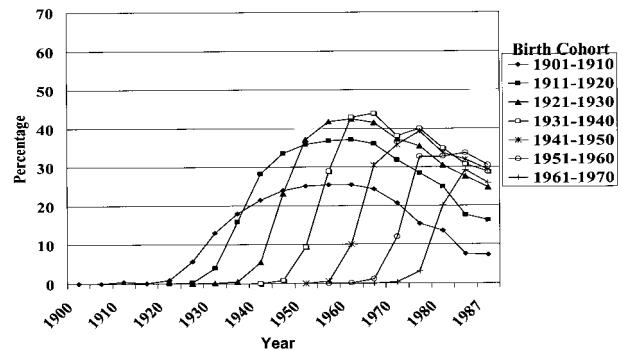


Figure 3 Prevalence (%) of cigarette smoking among successive birth cohorts of US females, 1900 to 1987. Source: 1970, 1978, 1979, 1980, 1987 (combined) National Health Interview Surveys. (Tolley *et al.*, 1991)

white females, reflecting similarities in their historical patterns of smoking (Shopland, 1995).

Patterns of tobacco use since 1965

Population-based surveys of trends and patterns of tobacco use provide estimates at the national, regional, and state levels (Yee and Schooley, 2001). Surveys of adults obtain data from personal (as in the National

Household Survey on Drug Abuse (NHSDA)) or telephone (as in the Behavioral Risk Factor Surveillance System) interviews, or combinations of the two methods (as in the National Health Interview Survey (NHIS) and the Current Population Survey Tobacco Control Supplements). For the NHSDA, personal household interviewing is being conducted by a system called Audio Computer-Assisted Self-Interviewing (A-CASI), in which the respondent is asked a few introductory questions by an interviewer and then is taught to use a laptop computer system. The respondent listens to questions through headphones and answers on the computer screen. A-CASI was designed to enhance privacy in household and other settings (SAMHSA, 2001). For further information on the surveys listed here, including web addresses, see the excellent summary by Yee and Schooley (2001). Population-based surveys such as these rely on personal disclosure of use for purposes of estimation. Self-reported data collected in surveys of adults provide reasonably valid estimates of cigarette smoking in the population (Caraballo *et al.*, 2001; Patrick *et al.*, 1994; Velicer *et al.*, 1992). Concerns about underreporting arise when there is a high demand for abstinence, as when cardiac patients (Sillet *et al.*, 1978) or pregnant women (Kendrick *et al.*, 1995) are advised to quit. However, the influence of these situations on survey estimates is small, in part because cardiac patients and pregnant women who have been recently advised to quit comprise a small proportion of representative survey samples. In addition, even though deception rates can be higher in some cessation studies, most smokers in these studies disclose smoking. Finally, the person administering the interview is not the person who has advised the smoker to quit, and the perceived demand for abstinence often stimulated by the receipt of advice to quit is likely lessened in a survey situation.

Under-reporting of use appears to be more common among adolescents than adults (Patrick *et al.*, 1994). Surveys of adolescents obtain data from personal interviews (as in the NHSDA), telephone interviews (as in California and Massachusetts), or in self-administered school-based surveys (as in the Monitoring the Future (MTF) surveys, the Youth Risk Behavior Survey (YRBS), and the Youth Tobacco Surveys (YTS). Prevalence estimates obtained from household surveys of younger adolescents were, in a major review, substantially lower than those obtained from school-based surveys (USDHHS, 1994), suggesting that increasing privacy may lead to greater disclosure of tobacco use (Turner *et al.*, 1992). However, in a recent methodological analysis of the NHSDA and MTF surveys privacy did not appear to influence the assessment of smoking prevalence in US adolescents (Gfroerer *et al.*, 1997). Further research on this topic is warranted.

Prevalence of cigarette smoking

Definitions From 1965 to 2001, the prevalence of cigarette smoking among US civilian noninstitutiona-

lized adults was measured during 23 administrations of the NHIS. The definitions used to define adult and adolescent smokers differ. For adults, ever smokers have been defined in the NHIS as those persons who have reported that they have smoked at least 100 lifetime cigarettes (conversely, never smokers are persons who have not smoked at least 100 cigarettes). From 1965–1991, current smokers were defined as ever smokers who reported currently smoking (i.e., that they ‘smoked now’). Since 1992, current smokers have been defined as ever smokers who reported that they currently smoked either every day or on some days (CDC, 1994a). For 1965 through 1991, former smokers were ever smokers who reported that they no longer smoked; since 1992, former smokers have been defined as ever smokers who reported that they did not smoke every day or on some days. A ‘dip-stick’ measure of quitting, known as the ‘quit ratio’ or the prevalence of cessation, is the percentage of ever smokers who are former smokers (USDHHS, 1989, 1990, 1998). Heavy smoking in the NHIS is the percentage of current smokers who smoke at least 25 cigarettes each day. Data for this measure are available since 1974.

For adolescents, ever smoking (also known as lifetime smoking) is defined in the MTF surveys as smoking even once or twice. The YRBS and YTS measure ever smoking, even one or two puffs. Current smoking among adolescents is defined as smoking on one or more days during the previous 30 days. MTF defines daily smoking as averaging one or more cigarettes per day during the previous 30 days; YRBS and YTS define frequent smoking as smoking on 20 or more of the previous 30 days. Published MTF measures permit calculation of a rate of discontinuance of regular smoking, which is the percentage of persons who smoked regularly in the past divided by the percentage of persons who report having smoked regularly (either currently or in the past). Heavy smoking among high school seniors is the per cent of seniors who smoked during the previous 30 days who smoked at least one-half pack per day.

Trends in the overall population

The prevalence of smoking among US adults was 42.4% in 1965 and 23.3% in 2000 (Table 1). In 2000, approximately 47 million US adults were current smokers. As was observed in 1993, about 18% of current smokers in 2000 smoked on some days (as opposed to every day) (CDC, 1994b, NHIS, 2000; public use data file).

The prevalence of cessation increased from 24.3% in 1965 to 49.6% in 1993; it then flattened and was 48.8% in 2000 (Table 1). The percentage of current smokers who were heavy smokers was 25.3% in 1974 and 15.3% in 2000. The prevalence of US adults who never smoked at least 100 cigarettes increased substantially from 1985 (45.8%) to 2000 (54.6%).

Most people try their first cigarette and become daily smokers as adolescents (SAMHSA, 2001; USDHHS, 1994). In the United States in 1998, 2.92 million persons

(7989 each day) tried a cigarette; 73% of these (5810 each day) were persons aged 12–17 years (SAMHSA, 2001). In 1999, 1.36 million persons (3737 each day) became daily smokers; 57.4% of these (2145 each day) were persons aged 12–17 years. Estimates of first use and of first daily use are presented for different years (1998 and 1999) because of technicalities involved in calculating estimates of incidence of initiation (see SAMHSA, 2001 for further details). Estimates for the most recent year with full data available are presented. In 1998, the mean age of first use was 15.4 years; in 1999, the mean age of becoming a daily smoker was 17.7 years (SAMHSA, 2001).

From 1965–1999, the incidence of first trying a cigarette was higher for persons aged 12–17 years than for persons aged 18–25 years (Figure 4); incidence increased substantially for persons aged 12–17 years in the early 1990s, peaking in 1997 and subsequently declining. A similar, but more attenuated pattern was seen for persons aged 18–25 years. As shown in Figure 5, from 1965 to the early 1970s, the incidence of first daily smoking was higher for persons aged 18–25 years than for persons aged 12–17 years; the rates for the two age groups were then similar for about a decade. Since 1984, however, first daily smoking was consistently higher among persons aged 12–17 years. The rate of increase of first daily use in the early 1990s was higher for persons aged 12–17 years than for persons aged 18–25 years.

Data from the MTF surveys (<http://www.monitoringthefuture.org>) show a similar pattern, with prevalence of past 30-day smoking among eighth, tenth, and twelfth grade students increasing in the early 1990s and declining after 1996 for eighth and tenth grade students and after 1997 for twelfth grade students (Figure 6). Among twelfth grade students, daily smoking also increased substantially from 1991–1997 and then declined (Table 2). Lifetime smoking among twelfth grade students, which declined substantially from 1976 (75.4%) to 1992 (61.8%), was 65.4% in 1997 and 61% in 2001.

According to YRBS data, lifetime smoking among US high school students was stable from 1991 (70.1%) to 1999 (70.4%) and then significantly declined to 63.9% in 2001 (CDC, 2002b). Similar to patterns observed in MTF, past 30-day smoking and frequent (use on at least 20 of the previous 30 days) smoking both increased significantly from 1991–1997 and then significantly declined through 2001.

Discontinuance among twelfth grade students generally varied inversely with current smoking prevalence (Table 2). For example, discontinuance increased from 1976–1980 and from 1997–2001, when current smoking prevalence was declining. Similarly, discontinuance decreased from 1992 through 1997, when the prevalence of current smoking was increasing.

Trends by sex

Among adult men, the prevalence of smoking in 2000 (25.7%) was half of what it was in 1965 (51.9%) (Table

1). Among women, little prevalence was 33.9% in 1965, 30.7% in 1978, and 21.0% in 2000. The prevalence of cessation appears to have leveled off among men, but not among women. This measure was about 10 percentage points higher for men than women in the 1970s; by 2000, the gap was only 2.7 percentage points. Men have been consistently more likely than women to smoke at least 25 cigarettes each day.

US women are substantially more likely than men to have never smoked at least 100 cigarettes (Table 1). Among US adolescents in the 1980s, smoking prevalence was generally higher among females than among males (USDHHS, 1994). More recently, however, smoking prevalence has been similar among US male and female adolescents (CDC, 2002b; SAMHSA, 2001; Table 2). For both males and females, prevalence increased early in the 1990s until 1997 or 1999, and then subsequently declined (CDC, 2002b; Table 2).

Trends by race/ethnicity

In 1999, the prevalence of cigarette smoking among US adults was highest for American Indians and Alaska Natives (41%), intermediate for African Americans and whites (both at 24%), and lowest among Hispanic Americans (18%) and Asian Americans/Pacific Islander Americans (15%) (CDC, 2001a). As shown in Figure 7, prevalence was high (41%) for both male and female American Indians and Alaska Natives. For each of the other racial/ethnic groups, males were more likely to smoke than females.

In 2000, African Americans (23.2%) and whites (23.7%) (regardless of Hispanic origin) smoked at essentially the same rate (Table 1). In the 1970s, current smoking prevalence was generally higher among African Americans than among whites. Among ever smokers, whites (50.4%) were more likely to be former smokers than African Americans (37.5%). In 2000, only 3.6% of African American smokers smoked heavily, compared with 17.5% of white smokers. In 2000, more African Americans (62.9%) than whites (52.3%) had never smoked at least 100 cigarettes.

Data on Hispanic origin are available since 1978. In 2000, 18.6% of Hispanics smoked, compared with 24% of persons not of Hispanic origin (Table 1). Among ever smokers, 42.9% of Hispanics and 48.7% of non-Hispanics were former smokers. In 2000, only 4.5% of Hispanic smokers smoked heavily, compared with 16.3% of non-Hispanic smokers. In all surveyed years, Hispanics were more likely to have never smoked.

The prevalence of smoking among African American high school seniors (Table 2), declined substantially from 1976–1992. This phenomenon is not explained by factors such as differential dropout rate, differential misclassification bias, differential use of other drugs, age of smoking initiation, or confounding from background or other lifestyle factors (USDHHS, 1998). Attitudes about smoking have shifted in a more positive direction among African American adolescents than among white adolescents (USDHHS, 1998).

Table 1 Percentage of adults who were current, former, or never smokers; percentage of ever smokers who are former smokers (prevalence of cessation); and percentage of current smokers who are heavy smokers; overall and by sex, race, Hispanic origin, age, and education, National Health Interview Surveys—United States, selected years from 1965–2000

<i>Smoking status</i>	1965	1970	1974	1978	1980	1985	1990	1992	1995	2000	<i>Percentage point change</i>	<i>Per cent change</i>	<i>Average annual change</i>
Total population													
Current	42.4	37.4	37.1	34.1	33.2	30.1	25.5	26.5	24.7	23.3	−19.1	−45.0	−0.55
Former	13.6	18.5	19.5	20.8	21.3	24.2	24.6	23.4	23.3	22.2	8.6	63.2	0.25
Never	44.0	44.2	43.4	45.0	45.5	45.8	49.9	50.1	52.0	54.6	10.6	24.1	0.30
Prevalence of cessation	24.3	33.1	34.5	37.9	39.0	44.5	49.1	46.9	48.6	48.8	24.5	100.8	0.70
Heavy smoking	NA	NA	25.3	28.0	28.8	26.6	22.9	21.3	20.1	15.3	−10.0	−39.5	−0.38
Sex													
<i>Male</i>													
Current	51.9	44.1	43.1	38.1	37.6	32.6	28.4	28.6	27.0	25.7	−26.2	−50.5	−0.75
Former	19.8	26.3	27.7	28.3	28.1	30.9	30.3	28.8	27.5	25.8	6.0	30.3	0.17
Never	28.3	29.6	29.2	33.6	34.4	36.5	41.3	42.6	45.5	48.5	20.2	71.4	0.58
Prevalence of cessation	27.6	37.4	39.2	42.7	42.8	48.7	51.6	50.1	50.5	50.0	22.4	81.2	0.64
Heavy smoking	NA	NA	31.1	34.5	33.7	32.4	28.5	27.0	25.5	19.4	−11.7	−37.6	−0.45
<i>Female</i>													
Current	33.9	31.5	32.1	30.7	29.3	27.9	22.8	24.6	22.6	21.0	−12.9	−38.1	−0.37
Former	8.0	11.6	12.7	14.2	15.1	18.1	19.5	18.5	19.5	18.9	10.9	136.3	0.31
Never	58.1	56.9	55.2	55.2	55.5	54.0	57.7	57.0	57.9	60.1	2.0	3.4	0.06
Prevalence of cessation	19.1	26.9	28.3	31.6	34.0	39.4	46.0	43.0	46.2	47.3	28.2	147.6	0.81
Heavy smoking	NA	NA	18.7	20.8	23.2	20.6	16.6	15.3	14.1	10.6	−8.21	−43.3	−0.31
Race													
<i>White</i>													
Current	42.1	37.0	36.4	33.9	32.9	29.6	25.6	26.6	24.8	23.7	−18.4	−43.7	−0.53
Former	14.2	19.4	20.5	21.9	22.2	25.5	25.9	24.9	24.0	24.0	9.8	69.0	0.28
Never	43.8	43.6	43.1	44.3	44.9	44.9	48.5	48.6	50.3	52.3	8.5	19.4	0.24
Prevalence of cessation	25.2	34.3	36.1	39.2	40.4	46.2	50.4	48.3	50.2	50.4	25.2	100.0	0.72
Heavy smoking	NA	NA	27.6	30.5	31.6	29.5	25.4	23.9	22.2	17.5	−10.1	−36.6	−0.39
<i>African American</i>													
Current	45.8	41.4	44.0	37.7	36.9	34.9	26.2	27.8	25.7	23.2	−22.6	−49.3	−0.65
Former	8.4	10.7	10.8	13.3	13.8	15.9	16.7	15.9	14.4	13.9	5.5	65.5	0.16
Never	45.8	47.8	45.3	49.0	49.4	49.2	57.1	56.3	59.9	62.9	17.1	37.3	0.49
Prevalence of cessation	15.5	20.6	19.7	26.1	27.2	31.3	38.9	36.4	35.9	37.5	22.0	141.9	0.63
Heavy smoking	NA	NA	8.7	9.7	9.4	9.3	6.0	5.4	7.7	3.6	−5.1	−58.6	−0.20
Hispanic origin													
<i>Hispanic</i>													
Current	NA	NA	NA	31.6	30.0	25.9	23.0	20.7	18.3	18.6	−13.0	−41.1	−0.59
Former	NA	NA	NA	15.6	15.1	17.2	17.0	16.4	16.5	14.0	−1.6	−10.3	−0.07
Never	NA	NA	NA	52.9	54.9	56.9	60.0	62.9	65.2	67.5	14.6	27.6	0.66
Prevalence of cessation	NA	NA	NA	33.0	33.5	40.0	42.5	44.2	47.3	42.9	9.9	30.0	0.45
Heavy smoking	NA	NA	NA	16.3	13.4	15.8	6.8	7.3	8.6	4.5	−11.8	−72.4	−0.54
<i>Non-Hispanic</i>													
Current	NA	NA	NA	34.3	33.4	30.3	25.7	27.0	25.4	23.8	−10.5	−30.6	−0.48
Former	NA	NA	NA	21.1	21.6	24.6	25.3	24.0	24.0	23.1	2.0	9.5	0.09
Never	NA	NA	NA	44.6	45.0	45.1	49.0	49.1	50.6	53.1	8.5	19.1	0.39
Prevalence of cessation	NA	NA	NA	38.2	39.3	44.8	49.5	47.1	48.7	49.3	11.1	29.1	0.50
Heavy smoking	NA	NA	NA	28.7	29.6	27.2	24.1	22.1	21.0	16.3	−12.4	−43.2	−0.56
Age (years)													
<i>18–24</i>													
Current	45.5	38.0	37.8	34.4	33.3	29.3	24.5	26.4	24.8	26.8	−18.7	−41.1	−0.53
Former	6.9	9.2	9.5	21.1	10.5	10.1	9.5	6.1	8.6	7.7	0.8	11.6	0.02
Never	47.6	52.8	52.7	44.6	56.2	60.6	66.0	67.4	66.6	65.5	17.9	37.6	0.51
Prevalence of cessation	13.1	19.6	20.2	21.1	23.9	25.7	28.0	18.8	25.8	22.4	9.3	71.0	0.27
Heavy smoking	NA	NA	15.1	17.8	17.0	13.6	9.1	11.1	10.5	5.8	−9.3	−61.6	−0.36
<i>25–44</i>													
Current	51.2	44.6	44.5	39.3	37.8	34.8	29.7	30.8	28.6	27.0	−24.2	−47.3	−0.69
Former	13.6	18.8	18.4	19.5	19.8	21.4	20.0	18.1	17.5	14.4	0.8	5.9	0.02
Never	35.3	36.6	37.1	41.2	42.5	43.8	50.3	51.1	53.8	58.6	23.3	66.0	0.67
Prevalence of cessation	21.0	29.7	29.2	33.2	34.3	38.1	40.3	37.1	38.0	34.8	13.8	65.7	0.39
Heavy smoking	NA	NA	29.2	30.5	31.5	29.5	22.9	21.0	18.1	15.1	−14.1	−48.3	−0.54

Continued

Table 1 (Continued)

Smoking status	1965	1970	1974	1978	1980	1985	1990	1992	1995	2000	Percentage point change	Per cent change	Average annual change
45-64													
Current	41.6	38.6	37.7	36.7	35.6	31.6	27.0	27.3	25.5	24.0	-17.6	-42.3	-0.50
Former	16.1	21.7	24.8	26.1	26.6	31.2	32.9	32.7	30.9	30.0	13.9	86.3	0.40
Never	42.3	39.7	37.5	37.3	37.9	37.3	40.1	40.1	43.5	46.1	3.8	9.0	0.11
Prevalence of cessation	27.9	36.0	39.7	41.6	42.8	49.7	55.0	54.5	54.8	55.6	27.7	99.3	0.79
Heavy smoking	NA	NA	27.3	32.5	34.5	31.1	30.8	27.1	27.5	20.5	-6.8	-24.9	-0.26
>65													
Current	17.9	16.1	17.3	16.3	17.2	16.0	12.8	14.0	13.0	9.7	-8.2	-45.8	-0.23
Former	15.0	21.3	23.3	28.1	27.9	34.0	36.6	36.5	37.7	38.9	23.9	159.3	0.68
Never	67.2	62.6	59.4	55.6	54.9	50.0	50.6	49.5	49.3	51.4	-15.8	-23.5	-0.45
Prevalence of cessation	45.5	56.9	57.5	63.4	61.8	68.1	74.1	72.4	74.4	80.1	34.6	76.0	0.99
Heavy smoking	NA	NA	17.7	19.5	18.2	19.4	18.9	20.9	22.6	14.3	-3.4	-19.2	-0.13
Education (years)^a													
<i>Less than 12</i>													
Current	41.7	37.5	37.8	35.7	35.1	34.2	30.8	30.9	30.4	28.6	-13.1	-31.4	-0.39
Former	14.1	18.6	19.8	21.0	21.7	26.3	26.3	27.0	25.3	22.0	7.9	56.0	0.23
Never	44.2	43.9	42.4	43.4	43.2	39.6	42.9	42.2	44.2	49.4	5.2	11.8	0.15
Prevalence of cessation	25.2	33.1	34.4	37.0	38.2	43.5	46.1	46.6	45.4	43.5	18.3	72.6	0.54
Heavy smoking	NA	NA	25.8	28.5	29.4	29.0	24.5	26.1	27.5	17.5	-8.3	-32.2	-0.32
<i>12</i>													
Current	44.7	39.3	38.8	37.0	35.4	33.4	30.1	31.3	29.5	29.5	-15.2	-34.0	-0.45
Former	14.3	19.9	20.9	23.0	22.8	25.1	26.2	25.1	24.7	21.5	7.2	50.3	0.21
Never	41.0	40.8	40.4	40.0	41.8	41.5	43.7	43.6	45.9	49.1	8.1	19.8	0.24
Prevalence of cessation	24.3	33.6	35.0	38.3	39.2	42.9	46.5	44.5	45.6	42.2	17.9	73.7	0.53
Heavy smoking	NA	NA	27.8	30.7	31.6	29.0	25.7	23.4	22.9	17.4	-10.4	-37.4	-0.40
<i>13-15</i>													
Current	44.8	38.7	37.9	34.3	33.9	30.6	24.6	25.5	23.6	22.6	-22.2	-49.6	-0.65
Former	17.0	22.1	24.1	26.9	24.9	27.5	27.5	27.7	27.1	22.1	5.1	30.0	0.15
Never	38.2	39.2	38.0	38.8	41.2	42.0	47.9	46.8	49.2	55.2	17.0	44.5	0.50
Prevalence of cessation	27.5	36.4	38.9	44.0	42.4	47.4	52.8	52.1	53.4	49.4	21.9	79.6	0.64
Heavy smoking	NA	NA	32.5	33.1	32.7	29.3	25.5	21.5	17.2	12.9	-19.6	-60.3	-0.75
<i>>16</i>													
Current	35.3	28.8	28.8	24.2	24.5	19.0	13.9	15.5	14.0	11.7	-23.6	-66.9	-0.69
Former	21.5	27.7	27.8	26.6	27.6	30.3	28.7	25.2	25.7	23.2	1.7	7.9	0.05
Never	43.2	43.5	43.4	49.2	47.9	50.7	57.4	59.3	60.3	65.2	22.0	50.9	0.65
Prevalence of cessation	37.9	49.1	49.1	52.4	52.9	56.2	67.3	61.8	64.7	66.6	28.7	75.7	0.84
Heavy smoking	NA	NA	27.3	30.9	33.3	28.7	22.6	16.6	13.5	9.6	-17.7	-64.8	-0.68

Source: National Health Interview Survey data presented on the CDC's Office on Smoking and Health's web site: <http://www.cdc.gov/tobacco/adstat1.htm>; 2000 NHIS public use data file. ^aData on education are presented for persons ≥ 25 years of age; since education data for the four categories used here were not available for 1965, estimates for 1966 were used instead. Definitions: Ever smokers have smoked at least 100 lifetime cigarettes. Prior to 1992, current smokers were defined as ever smokers who reported that they 'smoke now'. Since 1992, current smokers were ever smokers who reported that they now smoked every day or on some days. Prior to 1992, former smokers were ever smokers who reported that they didn't 'smoke now'. Since 1992, former smokers were ever smokers who reported that they didn't currently smoke either every day or on some days. The prevalence of cessation, also known as the quit ratio, is the percentage of ever smokers who are former smokers. Heavy smokers are current smokers who smoke, on average at least 25 cigarettes each day

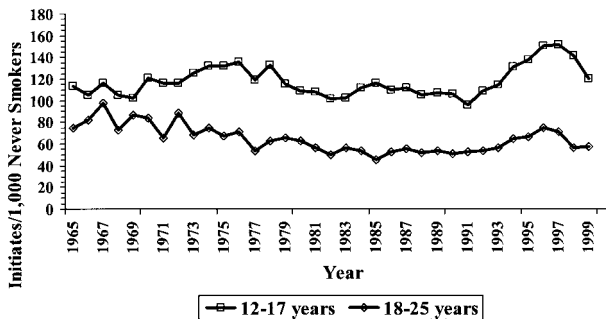


Figure 4 Trends in the incidence of initiation among young people of any cigarette use - United States, 1965-1999. Source: 1999 and 2000 (combined) National Household Surveys on Drug Abuse (SAMHSA, 2001)

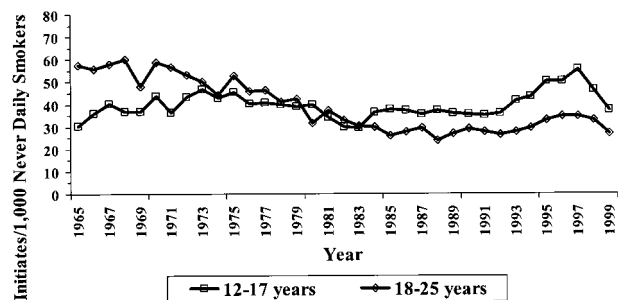


Figure 5 Trends in the incidence of initiation among young people of daily cigarette use - United States, 1965-1999. Source: 1999 and 2000 (combined). National Household Surveys on Drug Abuse (SAMHSA, 2001)

Table 2 Percentage of all 12th grade students who were lifetime smokers, 30-day smokers, daily smokers, discontinued smokers, and heavy smokers; and percentage of 30-day smokers by sex, race/ethnicity, and college plans; Monitoring the Future Surveys, United States, selected years, 1976–2001

	1976	1980	1985	1990	1992	1995	1997	2000	2001
<i>Smoking behaviors in the total population</i>									
Lifetime	75.4	71	68.8	64.4	61.8	64.2	65.4	62.5	61
Thirty-Day	38.8	30.5	30.1	29.4	27.8	33.5	36.5	31.4	29.5
Daily	28.8	21.3	19.5	19.1	17.2	21.6	24.6	20.6	19
Discontinuance	28.1	32.6	29.9	31.8	33.3	29.2	26.3	31.7	32.8
Heavy smoking	49.5	46.9	41.5	38.4	36	37	39.2	36	34.9
<i>Thirty-day smoking (gender)</i>									
Male	37.7	26.8	28.2	29.1	29.2	34.5	37.3	32.8	29.7
Female	39.1	33.4	31.4	29.2	26.1	32	35.2	29.7	28.7
<i>Race/ethnicity^a</i>									
White	38.8 ^b	33	31.3	32.3	31.8	36.6	40.7	37.9	35.3
African American	36.7 ^b	26.8	18.1	12.2	8.7	12.9	14.3	14.3	13.3
Hispanic	35.7 ^b	22.6	25.5	21.7	25	25.1	25.9	27.7	23.8
<i>College Plans</i>									
None or under 4 years	46.3	39.6	40.5	37.5	38.6	43.5	45.7	43.6	40.8
Complete 4 years	29.8	22.3	22.8	25.4	23.8	29.9	33.1	27.3	25.9

Source: Institute for Social Research, University of Michigan; <http://MonitoringtheFuture.org> web site; <http://www.monitoringthefuture.org/data/01data/pr01cig1.pdf> and <http://www.monitoringthefuture.org/data/01data/pr01cig3.pdf> accessed May 14, 2002; Bachman, Johnston, O'Malley (1980, 1981, 1993a,b, 2001); Johnston, Bachman, O'Malley (1986, 1997, 2001); Patrick O'Malley, personal communication, 5/16/02. ^aTo provide more stable estimates, MTF combines data for the specified year and the previous year for each racial/ethnic subgroup. ^bSince a point estimate for 1976 was not available, the 1997 estimate is presented. Definitions are based on responses to two questions: (1) Have you ever smoked cigarettes? Response categories are (1) Never, (2) Once or Twice (3) Occasionally but not regularly, (4) Regularly in the Past, and (5) Regularly now. (2) How frequently have you smoked cigarettes during the past 30 days? Response categories are: (1) Not at all, (2) Less than one cigarette per day, (3) One to five cigarettes per day, (4) About one-half pack per day, (5) About one pack per day, (6) About one and one-half packs per day, (7) Two packs or more per day. Lifetime smokers have ever smoked, at least once or twice. Thirty-day smokers smoked from less than one cigarette per day to two or more packs per day during the past 30 days. Daily smokers smoked from one to five cigarettes per day to two or more packs per day during the past 30 days. Discontinuance is the percentage of persons who have smoked regularly in the past divided by the percentage of persons who have smoked regularly, either in the past or currently. Heavy smoking is the percentage of persons who smoked during the past 30 days who smoked at least one-half pack per day

MTF twelfth grade data indicate that, 1996–2000 (data combined), past 30-day prevalence was 46.1% among American Indians, 39.6% among whites, 30.1% among Cuban Americans, 29.6% among Puerto Rican Americans, 25.7% among Mexican Americans, 25.2% among other Latin Americans, 20.4% among Asian Americans, and 14.3% among African Americans (Wallace *et al.*, 2002).

Trends by education

In 2000, the prevalence of cigarette smoking among US adults was 28.6% among persons with less than 12 years of formal education, 29.5% among high school graduates (12 years of education), 22.6% among persons with some college (13–15 years of education), and 11.7% among college graduates (16 or more years of education) (Table 1). Progress in reducing smoking has been most sustained among college graduates. Similarly, the prevalence of cessation has increased the most rapidly and is the highest (66.6%) among college graduates. Sixty-five per cent of college graduates have never smoked, compared with estimates ranging from 49–55% for persons in other educational categories.

Occupation and poverty are related indicators of socioeconomic status. In a study of smoking and occupational status in the United States covering the

years 1978–1997, progress in reducing smoking was slower among blue collar, service, and farm workers relative to progress in white collar workers (Giovino *et al.*, 2002). Current prevalence was highest among blue collar and service workers. Ever smokers in the blue collar, farm, and service categories were less likely to be former smokers. In addition, blue collar and farm workers who were current smokers were more likely to be heavy smokers (Giovino *et al.*, 2002). In 1999, persons who lived below the poverty line (33.1%) were more likely to smoke than those who lived at or above the poverty line (23.4%) (CDC, 2001a).

Among high school seniors, plans to graduate from college can be used as a marker of educational aspirations. From 1976–2001, seniors who had planned to complete college were much less likely to smoke (e.g., 25.9% in 2001), than seniors without such plans (40.8% in 2001). School performance is related to smoking prevalence, with those who do well in school being much less likely to smoke (USDHHS, 1994).

Trends by age

From 1965–2000, the prevalence of smoking declined in all age groups (Table 1). Current smoking was lowest and the prevalence of cessation was the highest

among persons aged 65 years and older. Since continuing smokers are less likely to live to an older age than persons who never smoked or who were former smokers (especially long-term former smokers), differential mortality influences these relationships (USDHHS, 1989, 1990). In addition, older persons may be more motivated to maintain abstinence once they quit (Hatziafreu *et al.*, 1990). The rate of increase in the prevalence of cessation slowed substantially during the 1990s for persons aged 25–44 years (from 37.1% in 1992 to 34.8% in 2000) and for persons aged 45–64 years (56.6% in 1993 and 55.6% in 2000).

From 1991–2001, past 30-day prevalence was highest among high school seniors, intermediate among tenth grade students, and lower among 8th grade students (Figure 6). The trends observed over time were similar for the three groups.

Smoking in geographic areas

Among adults in 2000, smoking prevalence was highest in Kentucky (30.5%), Nevada (29.1%), and Missouri (27.2%); prevalence was lowest in Utah (12.9%), Puerto Rico (13.1%), and California (17.2%) (CDC, 2001b). Tworek *et al.* have observed a direct, significant

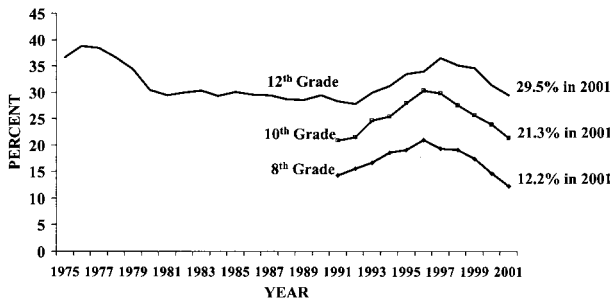


Figure 6 Trends in cigarette smoking anytime in the past 30 days by grade in school – United States, 1975–2001. Source: Institute for Social Research, University of Michigan, Monitoring the Future Surveys

relationship between state-specific adult and adolescent smoking prevalences (Tworek *et al.* unpublished manuscript). Among metropolitan statistical areas, adult prevalence was highest in Toledo, Ohio (31.2%); Knoxville, Tennessee (30.5%); and Indianapolis, Indiana (30.3%) and lowest in Orange County, California (13.0%); Salt Lake City-Ogden, Utah (14.7%); and San Diego, California (15.2%) (CDC, 2001c).

Other tobacco products

In 2000, 31.3% of men and 21.3% of women used tobacco in any form (NHIS; public use data file). Among men, 4.5% smoked cigars, 2.5% used snuff, 2.5% used chewing tobacco, 1.0% smoked tobacco in a pipe, and 0.1% smoked bidis (small cigarettes from India composed of tobacco wrapped in a temburni leaf and tied with a string). In 2000, current users were ever users who used each of these products every day or on some days. To be an ever user, a person had to have smoked cigars or pipes at least 50 times, bidis at least 20 times, and to have used snuff or chewing tobacco on at least 20 occasions. In 1987 and 1991, the measures of current use did not make the distinction of use on every day or on some days. NHIS data for 1987 and 1991 (combined) indicate that among men during that time period, 37.6% used tobacco in any form, 4.4% smoked cigars, 3.2% used snuff, 3.5% used chewing tobacco, and 2.7% smoked tobacco in a pipe.

Among women, prevalence of use of other tobacco products was very low, both in 2000 and in 1987–1991. Among women in 2000, 0.2% smoked cigars, 0.1% smoked tobacco in a pipe, 0.2% used snuff, 0.1% used chewing tobacco, and 0.1% smoked bidis; these prevalences were not substantially different from those observed a decade previously.

Among US high school students in 2000, past 30-day use of various products was 34.5% for any tobacco product, 28.0% for cigarettes, 14.8% for cigars, 6.6% for smokeless tobacco, 3.3% for pipes, 4.1% for bidis, and 4.2% for kreteks (clove cigarettes) (CDC, 2001d).

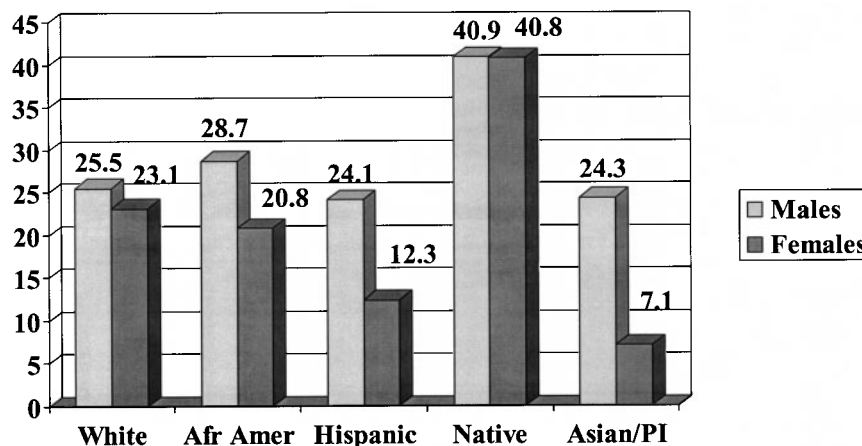


Figure 7 Percentage of adults who smoke cigarettes by race/ethnicity – United States, 1999. Source: 1999 National Health Interview Survey (CDC, 2001a)

The rates for high school students likely represent higher use of several products than for adults, but must be interpreted in light of the differences in definitions (i.e., the adolescent measure includes people who haven't smoked 50 cigars, 50 pipes, 20 bidis, or used smokeless tobacco or snuff on at least 20 occasions).

An epidemiologic model for understanding patterns of tobacco use

The traditional epidemiologic model of agent, host, vector, and environment is useful for studying the interplay of various influences on patterns of tobacco use in populations (Figure 8). Orleans and Slade (1993) first described the model in terms of tobacco prevention and control. Epidemiologists define the agent as the factor; such as a micro-organism, chemical substance, or form of radiation; that is required for a disease to occur (Last, 2001). Tobacco products and tobacco smoke cause addiction and disease (USDHHS, 1988, 1989). The host is the consumer or potential consumer (Orleans and Slade, 1993). The vector is the organism that distributes the agent (Last, 2001). The tobacco companies are the vectors of disease, along with other users. The agent, host, and vector all operate in an environment that includes familial, social, cultural, historical, economic, political, legal, and media influences.

Tobacco products have been changed over the years to influence both performance on standard machine tests (NCI, 2001a) and the bioavailability of nicotine (Fant *et al.*, 1999; Hurt and Robertson, 1998; US FDA, 1996). Products have been modified and marketed to provide the assurance of safety to concerned smokers (Glantz *et al.*, 1996; Pollay and Dewhirst, 2002), even while having defective components (Kozlowski and O'Connor, 2002; Pauly *et al.*, 2002). The cigarette companies have studied the smoothness of various brand formulations, striving to reduce harshness out of consideration of adolescents taste preferences (Cummings *et al.*, 2002a; Wayne and Connolly, 2002). Studies of traditional tobacco products and potential reduced-exposure products (PREPs) (Stratton *et al.*, 2001) are required

to determine if newly introduced products truly influence human biology in ways that lessen the risk of disease.

Another important consideration when considering the agent is the price of the product that the consumer pays. Increases in tobacco prices lead to reduced consumption, both by reducing the number of smokers and the number of cigarettes consumed by continuing smokers (Chaloupka *et al.*, 2001; USDHHS, 2000).

The host in this model is the person who uses the product, either someone who smokes tobacco or ingests (orally or nasally) one or more forms of smokeless tobacco. Host factors that can influence tobacco use include motivation to start or to quit, susceptibility to addiction, co-morbidities, misperceptions (e.g., optimism bias), self-efficacy, self-esteem, and personality (e.g., impulsiveness, sensation seeking, risk taking, and rebelliousness) (Crabbe, 2002; Giovino *et al.*, 1995; McMahon, 1999; Slovic, 2001; Tyas and Pederson, 1998; USDHHS, 1989, 1994, 1998, 2001; Weinstein, 1999). Host factors likely influence why some who experiment with tobacco readily discontinue use and while others who experiment quickly become dependent on the product (Pomerleau *et al.*, 1993).

This model also includes an incidental host, representing persons who are exposed to secondhand smoke and thus are at greater risk for lung cancer, heart disease, and respiratory illnesses (California EPA, 1997; Samet and Wang, 1999).

The vector is the organism that transports the agent to susceptible individuals (Last, 2001). Tobacco companies produce, distribute, and promote their products in ways that maximize appeal. Marketing efforts for cigarettes, for example, have been designed to appeal to young people and to allay health concerns among established smokers (Pollay, 2000; Pollay and Dewhirst, 2002; Slade, 2001; USDHHS, 1994; Warner, 1985). The vector also works to undermine public health efforts to limit use by resisting the implementation of health-promoting programs and policies (Begay *et al.*, 1993; Glantz and Begay, 1994; Kluger, 1996; Jamieson, 1998; Saloojee and Dagli, 2000; USDHHS, 2000). The companies have actively marketed products as being less hazardous, while simultaneously denying that their products cause disease and death (NCI, 2001a; Pollay, 2000; Pollay and Dewhirst, 2002). The industry sponsors cultural events and promotes youth prevention programs (Philip Morris Companies Inc., www.philipmorrisusa.com/DisplayPageWithTopic.asp?ID=75; Tobacco Institute, 1991; USDHHS, 1998), perhaps to gain cultural and political favor. Companies have used pricing strategies, such as discount coupons and multi-pack discounts, to offset the effects of tax increases (Chaloupka *et al.*, 2002).

In addition to the promotion and distribution of tobacco products by companies, other users serve to distribute the agent. Increasing numbers of adolescent smokers obtain cigarettes from social sources (vs purchasing cigarettes themselves in stores) as laws restricting sales to minors are better enforced (Everett-Jones *et al.*, 2002; SAMHSA, 2001).

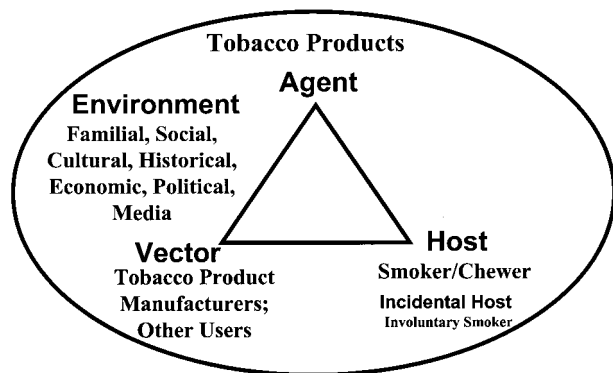


Figure 8 Tobacco control model of nicotine addiction. Adapted from Orleans and Slade, 1993

The environment involves familial, social, cultural, economic, historical, political, and media-based influences. Smoking by peers, siblings, and parents, as well as norms and policies regarding tobacco in the home, can influence adolescent patterns of use (USDHHS, 1994; Wakefield *et al.*, 2000). The quality of the relationship with parents may also influence adolescent use (Anda *et al.*, 1999; Tyas and Pederson, 1998; USDHHS, 1994, 2001). In many countries, tobacco growing and tobacco product manufacturing have become culturally established and economically powerful enterprises that greatly influence political decisions, as well as tobacco use and attitudes about tobacco (Kluger, 1996; Glantz and Begay, 1994; Jamieson, 1998; Noland, 1996; Saloojee and Dagli, 2000; von Gernet, 2000; World Bank, 1999). Environmental influences also include the media (e.g., appearances of smoking in television and movies, newspaper coverage and editorials, pro-tobacco advertising and promotion, health-promotion messages), smoke-free policies, access to cigarettes, and advice to quit from a health professional (Balbach and Glantz, 1995; Chapman *et al.*, 1999; Fiore *et al.*, 2000; Hazan and Glantz, 1995; Jacobson and Zapawa, 2002; Lantz *et al.*, 1999; National Cancer Policy Board, 2000; Rigotti, 2001; Slade, 2001; Teti and Glantz, 1998; USDHHS, 1989, 1994, 2000; Wakefield and Chaloupka, 2000). In 1999, the cigarette industry spent approximately \$8.2 billion on domestic marketing (FTC, 2001).

Research activities address different levels of a continuum – from cells to society (NCI, 1998). Most of the research conducted to date has been on host factors, with the number of studies on the genetics of smoking increasing in recent years. The number of research projects on policies has increased recently, as well (Rabin and Sugarman, 2001; USDHHS, 2000). The limited amount of work on product tracking and characterization needs to be expanded, especially because of needs to assess PREPs. Research on industry documents has increased our understanding of the vector (e.g., Cummings *et al.*, 2002a,b; Glantz *et al.*, 1996; Hurt and Robertson, 1998; Pauly *et al.*, 2002).

Public health interventions also occur at different levels, including the host (i.e., attempting to prevent smoking in people who have never smoked, attempting to prevent escalation of smoking in people who have recently experimented, and helping persons who smoke to quit), vector (e.g., raising excise taxes to raise prices), and environment (e.g., providing smoke-free indoor air, airing anti-tobacco advertisements). Interventions educate people about the dangers of tobacco use, the benefits of quitting, effective methods of quitting, and ways to resist pro-tobacco influences from peers and the media (CDC, 1999b; USDHHS, 1989, 1994, 2000). Large-scale interventions, such as those in Massachusetts and California, have had considerable success (CDC, 1999; National Cancer Policy Board, 1999; USDHHS, 2000; Wakefield and Chaloupka, 2000). In general, regulatory efforts attempt to control both the agent and activities of

the vector (Stratton *et al.*, 2001). The benefit of regulation vs free-market capitalism is a subject of ongoing debate (Cummings, 2002c).

Summary and conclusions

The emergence of the modern cigarette in the early 1900s changed smoking patterns and increased the exposures of millions of people's lungs to toxic and carcinogenic chemicals. Lung cancer patterns tracked population patterns of cigarette smoking in a dose-response manner. Once the dangers of cigarette smoking were recognized, the public health response has resulted in fewer smokers than there likely would have been.

Among adults, current smoking prevalence and the percentage of smokers who smoke heavily have both declined. The decreased prevalence of smoking during the past two decades among African American adolescents and adults will likely serve to reduce the disparities in lung cancer rates that currently exist between African Americans and whites. The percentage of the population that has never smoked has increased. Also encouraging was the progress from 1965–1993 in the per cent of ever smokers who were former smokers. However, the lack of progress in this important measure since 1993 for persons aged 25–64 years is disconcerting. The epidemiologic model described in this study suggests research topics. Has the product changed, perhaps in ways that make quitting more difficult? Have smokers become more recalcitrant about quitting? Have marketing strategies somehow served to undermine smokers's motivation to maintain abstinence? Why has the prevalence of cessation leveled off during a time in vastly increased use of pharmacological treatments for quitting (CDC, 2000)? These and other questions deserve researchers' attention.

An increase in the prevalence of smoking among US adolescents, as well as in the incidence of initiation of first use and daily smoking, were observed in the first two-thirds of the 1990s. Since then, both prevalence and the incidence of initiation have declined substantially. The increase may have been facilitated by increased promotion of brands that were attractive to adolescents and by increased positive portrayals of smoking in movies and on television (Hazan and Glantz, 1995; Slade, 2001; Teti and Glantz, 1998; USFDA, 1996); the downturn may have been facilitated by price increases and by increased exposure of adolescents to effective anti-smoking media campaigns (Chaloupka *et al.*, 2001; Farrelly *et al.*, 2002; US Department of Labor, 2002).

The epidemiologic model is a comprehensive approach for understanding and controlling the tobacco epidemic. It can stimulate research (especially in the search for interactions) and guide the decisions of program planners and regulators as they strive to implement optimal public health strategies for reducing the tobacco epidemic. It recognizes the need to

understand and measure both pro- and anti-tobacco forces when considering patterns of and trends in use. Reducing smoking further will require health-promoting decisions at the individual, family, community, state, and national levels. Optimal decisions could soon accelerate reductions in tobacco-attributable disease and death and perpetuate changes well into the 21st century.

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