

Chapter 13

Health Effects of Tobacco, Nicotine, and Exposure to Tobacco Smoke Pollution

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INTRODUCTION AND OVERVIEW

This chapter reviews the medical consequences of tobacco and nicotine use. This chapter focuses on the effects of chronic cigarette smoking (the most prevalent type of nicotine use) on specific diseases and overall mortality. It also discusses the effects of different types of tobacco, evidence for dose-response effects, the effects of reduction and cessation of cigarette use, the effects of passive exposure to tobacco smoke, and the psychiatric effects of tobacco use.

THE NATURE AND HISTORY OF TOBACCO USE

Tobacco use has been known since around the first century BC when Native Americans used it for ceremonial purposes, and was widespread in the

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American continent when Europeans first arrived there in the fifteenth century. However, it was the invention of the cigarette making machine and subsequently the mass manufacture and distribution of machine-made cigarettes that led to the massive rise in cigarette smoking as the predominant form of nicotine consumption at the end of the nineteenth century and throughout the twentieth century. During the 1990s approximately one billion people (47 percent of all adult men and 12 percent of all adult women in the world) were daily smokers (Collishaw and Lopez, 1996).

Part of the reason for the slowness of many countries to react to the “tobacco epidemic” is that for many tobacco-caused diseases there is a 30-year lag between the increase in smoking prevalence and the increase in deaths from smoking-caused diseases (e.g., lung cancer). This delayed effect means that for some decades after an increase in national smoking prevalence it is possible to have high smoking prevalence but low (if increasing) smoking-caused death rates. Figure 13.1 describes the recognized stages in the epidemic of smoking-caused deaths that follow the increase in smoking rates in a country, and also indicates examples of countries at each stage at the end of the twentieth century.

The pattern of tobacco consumption in the United States throughout the twentieth century is shown in Figure 13.2. This pattern is fairly typical of

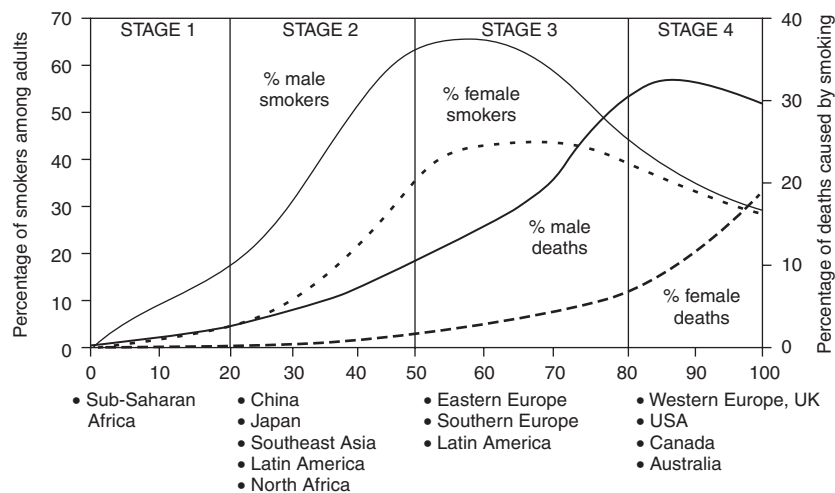


FIGURE 13.1. Four stages of the tobacco epidemic. A descriptive model of the cigarette epidemic in developed countries. *Tobacco Control*, 3, pp. 242-247. Source: From Lopez, A.D., Collishaw, N.E., and Piha, T. (1994). Reproduced with permission from the BMJ Publishing Group.

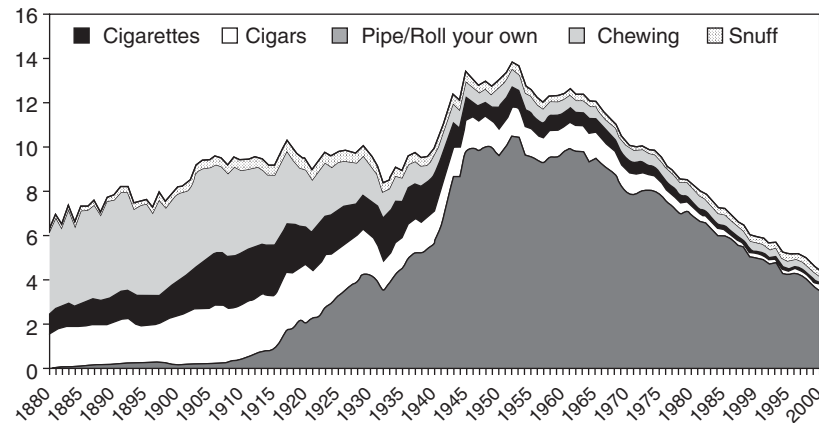


FIGURE 13.2. Per capita consumption of various tobacco products (in pounds)—United States, 1880-2000. *Source:* Tobacco Situation and Outlook Report, U.S. Department of Agriculture, U.S. Census. Adapted from Gerlach et al. (1998). Courtesy of Gary Giovino. *Note:* Among persons >18 years old. Beginning in 1982, fine-cut chewing tobacco was reclassified as snuff.

“mature” tobacco markets such as northern Europe, North America, and Australia, showing a mixed pattern of tobacco use, including significant amounts of smokeless tobacco until the beginning of the twentieth century, followed by the growing dominance of cigarettes by the 1930s and then a steady reduction in tobacco consumption overall since the 1960s, coinciding with increasing awareness of its harmful effects on health (Giovino, 2002).

Prior to the seminal publications on the effects of smoking on lung cancer risks in the 1950s (Doll and Hill, 1950; Wynder and Graham, 1950), relatively few people were aware that tobacco smoking caused serious illnesses. Medical consensus on the serious health effects of smoking was achieved and publicized during the early 1960s (Royal College of Physicians of London, 1962; U.S. Department of Health, Education and Welfare, 1964). However, the tobacco industry continued to deny or sow doubts about these health effects throughout the rest of the twentieth century (Cummings, Morley, and Hyland, 2002; Tobacco Industry Research Committee, 1954). For example, in 1971, Chairman of Philip Morris Joseph Cullman appeared on a TV news show (*Face the Nation*) and declared,

“we do not believe that cigarettes are hazardous; we don’t accept that.” Joseph Cullman, chairman, Philip Morris, 1971 (Herman et al., 1971).

In a 1972 interview with the *Wall Street Journal*, Philip Morris Vice President James Bowling repeated the company's promise to consumers two decades earlier that,

“if our product is harmful, we'll stop making it.” James Bowling, vice president, Philip Morris, 1972. (Kwitny, 1972)

He repeated the company's position in a 1976 interview when he noted:

“from our standpoint, if anyone ever identified any ingredient in tobacco smoke as being hazardous to human health or being something that shouldn't be there, we could eliminate it. But no one ever has.” James Bowling, vice president Philip Morris, 1976. (Bowling and Taylor, 1976)

As recently as 1998, Philip Morris Chairman Geoffrey Bible responded to the question “Has anyone died from smoking cigarettes?” in the following manner:

“I don't know if anyone dies from smoking tobacco. I just don't know.” Geoffrey Bible, chairman, Philip Morris, 1998. (Geyelin, 1998)

The tobacco industry also reacted to the evidence on the harmfulness of tobacco by providing consumers with a series of adapted products that were perceived by the public as being less harmful ways of continuing to smoke (primarily via addition of filters and reductions in the machine-measured tar and nicotine yields of cigarettes).

In 1963, Addison Yeaman, executive vice president of Brown and Williamson Tobacco Company, and president of the Committee for Tobacco Research, wrote thus:

Moreover nicotine is addictive. We are then in the business of selling nicotine, an addictive drug . . . But cigarettes . . . despite the beneficial effect of nicotine, have certain unattractive side effects:

1. They cause, or predispose to, lung cancer.
2. They contribute to certain cardiovascular diseases.
3. They may well be truly causative in emphysema etc.

However, these insights were not shared with the committee preparing the 1964 U.S. Surgeon General's Report on Tobacco and Health, and it was not until the late 1980s that scientific consensus was reached that tobacco use is addictive in the same way as heroin and cocaine, and that those who become addicted to tobacco are primarily addicted to nicotine (Royal Col-

lege of Physicians, 2000; U.S. Department of Health and Human Services [USDHHS], 1988). Although people primarily use tobacco for the psychological and dependence-forming effects of nicotine, it is the other components in tobacco—the “tar,” volatile oxidant gases and carbon-monoxide—that cause most (at least 90 percent) of the harm to health. The rest of this chapter reviews these health effects of tobacco use, before returning to discuss the addictiveness of tobacco.

DISEASES CAUSED BY TOBACCO

The recent review of the health effects of tobacco smoking published by the U.S. Surgeon General in 2004 (USDHHS, 2004) expanded the list of diseases known to be caused by smoking to include virtually every organ in the body. The conclusions about these causal relationships were made on the basis of the consistency, specificity, temporality, and strength of the observed associations, together with evidence on the biological plausibility, observed dose-response relationship, and results from experimental data (whether laboratory-based or “naturally occurring” experiments). Table 13.1 lists some of the deadly diseases known to be caused by tobacco smoking and the relative risks of death from each of these causes in continuing and former smokers compared with never smokers. It should be noted that in all of the diseases listed in the table, the evidence (which is thoroughly reviewed in the 2004 Surgeon General’s report and associated documents) has been judged to be sufficient to infer a causal relationship between tobacco smoking and

TABLE 13.1. Age-adjusted relative risk of death from smoking-related diseases from CPS-II, comparing continuing and former smokers to never smokers.

Disease category	CPS-II (1982-1988)			
	Males		Females	
	Continuing smokers	Former smokers	Continuing smokers	Former smokers
Neoplasms				
Lip, oral cavity, pharynx	10.9	3.4	5.1	2.3
Esophagus	6.8	4.5	7.8	2.8
Stomach	2	1.5	1.4	1.3
Pancreas	2.3	1.2	2.3	1.6
Larynx	14.6	6.3	13	5.2

TABLE 13.1 (continued)

Disease category	CPS-II (1982-1988)			
	Males		Females	
	Continuing smokers	Former smokers	Continuing smokers	Former smokers
Trachea, bronchus, lung	23.3	8.7	12.7	4.5
Cervix uteri			1.6	1.1
Urinary bladder	3.3	2.1	2.2	1.9
Kidney, other urinary diseases	2.7	1.7	1.3	1.1
Acute myeloid leukemia	1.9	1.3	1.1	1.4
Cardiovascular diseases				
Ischemic heart disease				
Aged 35-64 years	2.8	1.6	3.1	1.3
Aged \geq 65 years	1.5	1.2	1.6	1.2
Other heart disease	1.8	1.2	1.5	1.1
Cerebrovascular diseases				
Aged 35-64 years	3.3	1	4	1.3
Aged \geq 65 years	1.6	1	1.5	1
Atherosclerosis	2.4	1.3	1.8	1
Aortic aneurysm	6.2	3.1	7.1	2.1
Other arterial disease	2.1	1	2.2	1.1
Respiratory diseases				
Pneumonia, influenza	1.8	1.4	2.2	1.1
Bronchitis, emphysema	17.1	15.6	12	11.8
Chronic airway obstruction	10.6	6.8	13.1	6.8
Perinatal conditions				
Short gestation/low birth weight			1.8	
Respiratory distress syndrome			1.3	
Other respiratory conditions			1.4	
Sudden infant death syndrome			2.3	

Source: Adapted from Table 7-1.1, 2004 U.S. Surgeon General's Report (USDHHS, 2004).

Note: A relative risk of one implies no increased risk in smokers, and a relative risk of two implies a doubling of the risk of death due to that disease in smokers compared with never smokers.

that disease (rather than a noncausal statistical association or “risk factor”). Interestingly, the 2004 Surgeon General’s report did not list nicotine dependence as a smoking-caused illness, although that conclusion had been reached in a prior report (USDHHS, 1988).

Smoking is also the established cause of a number of other nonfatal diseases and conditions including cataracts, periodontitis, acute respiratory infections in people with COPD, acute respiratory symptoms in adults and children (e.g., coughing and wheezing), adverse surgical outcomes related to wound healing and respiratory complications, hip fractures, and peptic ulcer disease in persons who are *Helicobacter pylori* positive (USDHHS, 2004).

In addition, there is considerable evidence suggesting (but not yet conclusively) that numerous other conditions may be caused or exacerbated by tobacco smoking. These diseases include colorectal cancer, impaired lung function, ectopic pregnancy, spontaneous abortion, and oral clefts in children whose mothers smoked during pregnancy, childhood asthma, bronchial hyper-responsiveness, low bone density, root-surface caries, erectile dysfunction, age-related macular degeneration, Graves’ disease, and peptic ulcer disease (USDHHS, 2004).

It has been estimated that tobacco smoking causes around 400,000 premature deaths per year in the United States (Thun, Apicella, and Henley, 2000), and 4.9 million deaths per year worldwide (8.8 percent of all global deaths) (World Health Organization [WHO], 1997). In developed countries, the largest number of these deaths are due to cardiovascular diseases, followed by cancer (predominantly of the lung), and then chronic obstructive pulmonary disease (COPD). Tobacco smoking causes more premature deaths each year in the United States than alcohol, illegal drugs, AIDS, road traffic accidents, microbial infections, homicide and suicide all added together (McGinnus and Foege, 1993). However, for every smoking-caused death each year in the United States, there are approximately twenty cases of nonfatal serious smoking-caused illness (CDC, 2003). The vast majority (59 percent) of these are chronic respiratory diseases, which consequently comprise a large part of the estimated \$157 billion smoking-attributable economic costs per year in the United States. \$82 billion of these costs are due to lost productivity and \$75 billion are direct medical care to adults (USDHHS, 2004). The net effect of these smoking-caused diseases is that the continuing smoker is likely to die an average of ten years earlier than a never smoker, as reported by Doll et al. (2004) and shown in Figure 13.3. The approximate doubling of mortality risks for smokers is evident at age 50 (6 percent of smokers already died, versus 3 percent of never smokers) and continues past age 70 (by which 42 percent of smokers have died, versus 19 percent of never smokers).

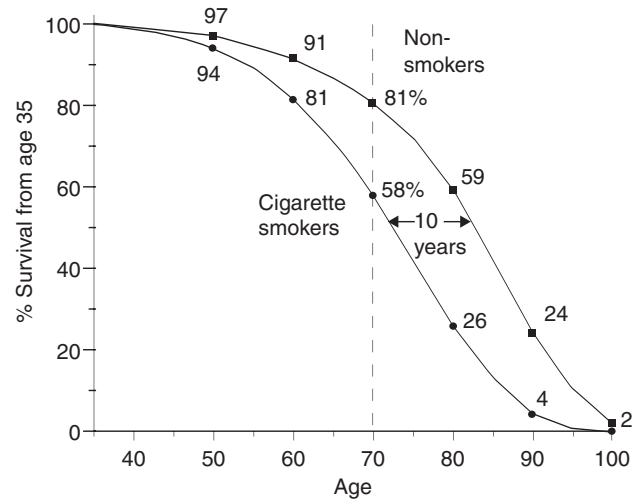


FIGURE 13.3. U.K. male doctors born 1900-1930: continuing cigarette versus never smokers. Fifty-year follow-up of mortality, 1951-2001. *Source:* Doll, Peto, et al. (2004). Mortality in relation to smoking: 50 years' observations on male British doctors. *British Medical Journal*, 328(7455):1519. Reproduced with permission from the BMJ Publishing Group.

DOSE-RESPONSE RELATIONSHIP BETWEEN CIGARETTE SMOKING AND DISEASE

For most of the smoking-caused diseases mentioned in previous text, there is also evidence of a significant dose-response relationship between the total amount of smoking and the risk of contracting the disease. The most striking dose-response relationship is typically found in lung cancer, as shown in Figure 13.4.

Thun et al. (1997) examined mortality from COPD in the second Cancer Prevention Study (CPS-II) and found that the relative risks increased from 5.9 in women smoking 1-9 cigarettes per day, to 25.2 for women smoking 40 or more cigarettes per day (relative to never-smoking women). Similarly, the Nurses Health Study (Stampfer et al., 2000) found adjusted relative risks of Coronary Heart Disease of 3.1 for women smoking up to 14 cigarettes per day and 5.5 for those smoking 15 or more per day.

However, it should be noted that reductions in some disease and mortality risks tend to be disappointingly small or nonexistent when smokers cut down their cigarette consumption per day (Godtfredsen et al., 2002). This is

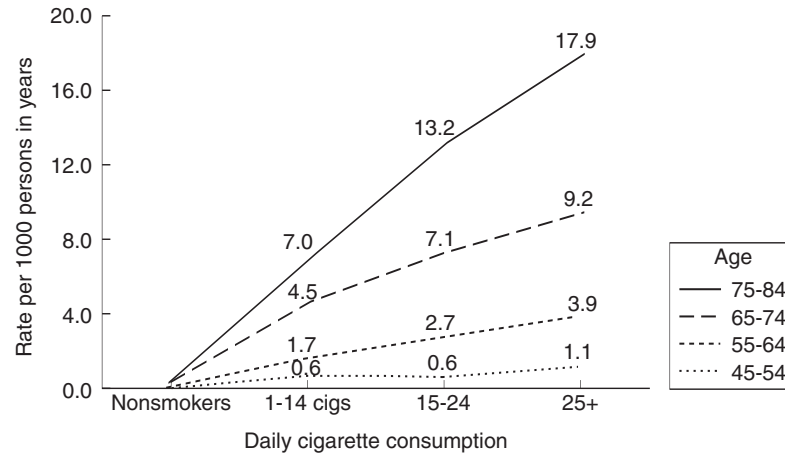


FIGURE 13.4. Lung cancer risk by age and cigarette consumption in CPS-II. Source: Thun et al., 1997.

likely because smokers who cut down cigarettes per day “compensate” by inhaling more from each cigarette in order to obtain their preferred dose of nicotine (Benowitz, 2001). It has also been established that the duration of smoking (i.e., number of years of smoking) is a much larger determinant of some disease risks (e.g., lung cancer) than the number of cigarettes smoked per day (Knoke et al., 2004). Thus, many epidemiological studies use the term “pack years” (packs of cigarettes per day multiplied by the number of years of smoking) as a crude measure of smoking “dose” and this measure is often significantly related to disease risk.

Although age itself is frequently a potent predictor of risk of many of the smoking-caused diseases, nonetheless it is clear that the earlier the smoker quits, the lower their risk of disease, independently of age. This relationship is shown in Figure 13.5, which indicates the cumulative risk of death from lung cancer by age for never smokers, continuing smokers, and smokers who quit at various ages.

**REDUCTIONS IN DISEASE
FOLLOWING SMOKING CESSATION**

The 1990 U.S. Surgeon General’s report reviewed the health benefits of ceasing tobacco use and concluded that smoking cessation has major health benefits, for men and women of all ages. For example, smokers who quit

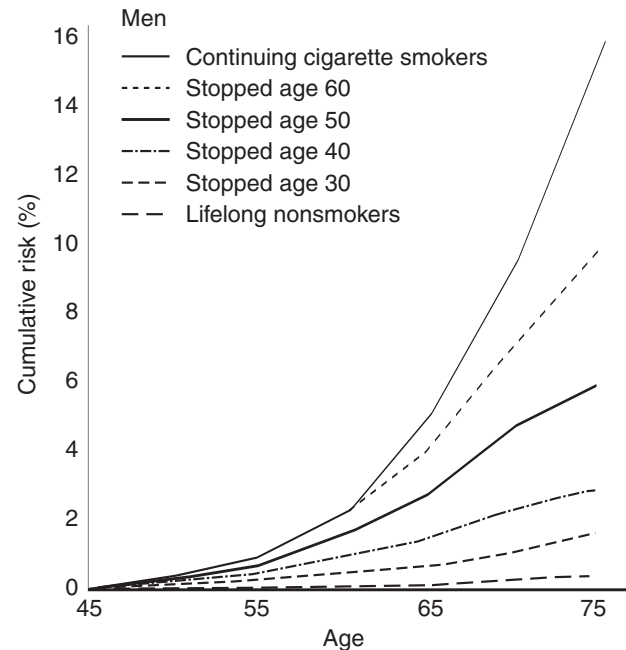


FIGURE 13.5. Effects of smoking cessation at various ages on the cumulative risk (%) of death from lung cancer up to age 75, at death rates for United Kingdom, 1990. *Source:* Peto et al. (2000). Smoking, smoking cessation, and lung cancer in the UK since 1950: Combination of national statistics with two case control studies. *British Medical Journal*, 321(7257):323-329. Reproduced with permission from the BMJ Publishing Group.

smoking by age 50 have one-half the risk of dying in the next 15 years, compared with continuing smokers (USDHHS, 1990).

The timescale for reduction in risks of disease after smoking cessation varies with each disease and even with the stage of the disease. Thus the excess risk of death from coronary heart disease will be cut in half within a year of stopping smoking, but the same level of risk reduction may take 10 to 15 years for lung cancer (USDHHS, 1990).

Lung function declines with age after reaching adulthood in nonsmokers, but it declines at a significantly faster rate for smokers. However, when a smoker stops smoking, the rate of decline of lung function normalizes to a rate similar to that for never-smokers. The effects of smoking cessation in the U.S. Lung Health Study were slightly better than described in previous text,

and produced an absolute improvement in lung function within the first year of stopping smoking, as shown in Figure 13.6.

**TOXINS IN CIGARETTE SMOKE
AND RELATIONSHIP TO DISEASE**

The cigarette itself typically contains a large number of ingredients, including the tobacco leaf, tobacco paper, and filter (fibers of which may be inhaled—Pauly et al., 2002), and over 500 potential additives (e.g., acetaldehyde, ammonia, cocoa, levulinic acid, and menthol). When the cigarette is lit, and the tip burns, it reaches extremely high temperatures (over 400 degrees centigrade), rising to over 600 degrees centigrade as air is sucked into the cone (White et al., 2001). The resulting smoke is composed of a complex mixture of over 4,000 chemicals resulting from pyrolysis. Many of these chemicals exist in very small quantities just above the detection limits of sensitive toxicology assays, but many highly toxic chemicals are present in large measurable concentrations in tobacco smoke and are known to be involved in causing a variety of diseases. Exhibit 13.1 provides a list of some of the main toxic smoke constituents (see also Hoffman and Hoffman, 1998).

Many of the mechanisms whereby this complex mixture of toxins contained in tobacco smoke leads to specific diseases have been identified. For example, a large number of these chemicals have been shown to cause can-

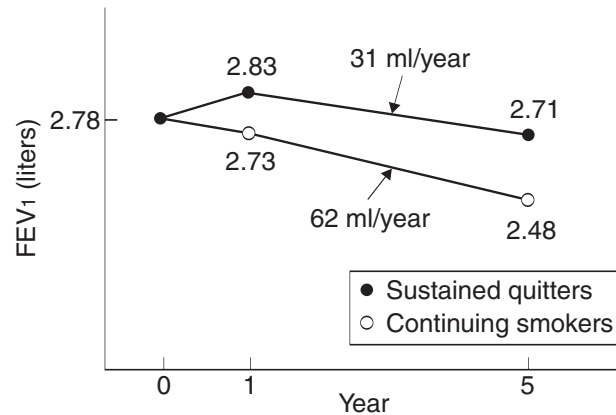


FIGURE 13.6. Change in lung function (FEV₁—forced expiratory volume in one second) in smokers who quit versus those continuing to smoke in the U.S. Lung Health Study. *Source:* Scanlon et al. (2000). Reprinted with permission from American Thoracic Society.

**EXHIBIT 13.1. Examples of Toxic Constituents
in Tobacco Smoke (from over 4,000 identified chemicals)**

<i>Volatile organic substances</i>	<i>Polycyclic aromatic hydrocarbons</i>
1,3-butadiene	Benzo(a)pyrene
Benzene	Pyrene
Toluene	Benz(a)anthracene
<i>Gaseous substances</i>	<i>Nitrosamines</i>
Ammonia	NNN
Hydrogen cyanide	NAB
Carbon monoxide	NNK
Nitrogen oxides	N-Nitrosodimethylamine
<i>Metals</i>	<i>Carbonyls</i>
Lead	Formaldehyde
Cadmium	Acetaldehyde
Arsenic	Acrolein
<i>Aromatic amines</i>	<i>Aza-arenes</i>
4-aminobiphenyl	Quinoline
1-aminoaphthalene	Dibenz(a,j)acridine

cer in animals and/or humans (e.g., benzo(a)pyrene, NNK, and NNN). These chemicals in the smoke cause DNA damage, inflammation, and oxidative stress, which promote the initiation and growth of tumors (Hecht, 1999).

The deposition of particles of tar in the lungs and upper airways leads to the blocking of airways and COPD. The toxic chemicals stimulate oxidative stress, inflammation, and a reduction in elastin, inhibiting the elasticity of the lungs and hence the ability to inhale and exhale normally. Irritants such as nitric oxide cause hypersecretion of mucus and substances such as acrolein, acetone, and acetaldehyde damage the cilia (inhibiting the ability of the cilia to clear mucus) which also contributes to chronic decrements in respiratory function. Years of smoking and daily coating of the lungs and airways in tar leads to irreversible lung damage and ultimately death from COPD (Barnes, 1999).

The carbon monoxide in smoke replaces oxygen in the hemoglobin, adversely affecting oxygen transport and energy supply, and requiring the heart to do more work to supply the same amount of oxygen to the body. A large number of smoke constituents, and particularly the volatile components of the gaseous phase of tobacco smoke, cause oxidative stress, immunologic

responses, and inflammation in the endothelial cells (Powell, 1998). The resultant platelet aggregation, plaque formation, and inhibition of vasorelaxation contribute to endothelial malfunction and thrombosis. These processes increase the likelihood of a myocardial infarction, stroke, or other problems with the cardiovascular system. Acute nicotine administration increases heart rate, blood pressure, and causes peripheral vasoconstriction (i.e., impairs peripheral circulation and thus exacerbates Raynaud's disease and erectile dysfunction). However, studies of smokeless tobacco users (who have high nicotine exposure like smokers, but without the smoke) compared with smokers, suggest that most of the cardiovascular problems are not caused by nicotine. For example, smoking but not snuff use is associated with femoral artery intima-media thickness (Wallenfeldt et al., 2001), and snuff users have consistently been found to have lower risks of myocardial infarction than smokers (Critchley and Unal, 2003). It therefore appears that it is the thrombogenic effects of tobacco smoke exposure (primarily oxidant gases), combined with reduced oxygen supply (carbon monoxide), and increased myocardial oxygen demand (nicotine) that cause cardiovascular harm from smoking (USDHHS, 2004).

TAR AND NICOTINE DELIVERY FROM "LIGHT" CIGARETTES

In 1967, the U.S. Federal Trade Commission (FTC) began the systematic measurement of the yields of tar, nicotine, and carbon monoxide from cigarettes marketed in the United States using a standardized smoking-machine test, now referred to as the "FTC method" in the United States and the "ISO method" (International Organization for Standardization) in most other countries (National Cancer Institute, 1996). In the United States, this procedure measures the amount of toxins that are absorbed when the machine takes a two-second, 35 ml puff per minute until the cigarette has reached a specified distance from the butt (23 mm or overwrap plus 3 mm), with the number of puffs being variable. Tar is the term used for all of the particulate matter collected on the filter of a smoking machine, minus the moisture and alkaloids (e.g., nicotine). Since the 1950s, it has become widely known that a number of chemicals contained in the tar from cigarettes are carcinogenic and so there has been an effort to reduce exposure to cigarette tar. However, the FTC machine-smoked yields of tar and nicotine are typically very highly correlated (e.g., the correlation between FTC tar and FTC nicotine yield in a range of U.S. cigarette brands reported by Kozlowski et al., 1998,

was 0.98), meaning that as one increases, the other typically increases in a direct linear relationship.

Although tar category cut-points are somewhat arbitrary and can vary over time and across countries, in the United States cigarette brands yielding 15 mg tar or greater using the FTC method are often referred to as “regular” or “full flavor,” whereas brands yielding 6.5 mg to 14.5 mg tar have frequently been referred to by manufacturers as “lights,” and those yielding less than 6.5 mg tar are often called “ultra-lights.”

In order to exemplify some of the differences and similarities between a full flavor and a same-brand light cigarette, this discussion will focus on the Marlboro brand. Marlboro Reds is the name often given to the leading regular length full-flavor brand within the Marlboro portfolio, reflecting the distinctive red Marlboro logo on the pack (*note*: there can be over 20 different varieties of “Marlboros” available in the United States at any one time). In 1971, Philip Morris launched “Marlboro Lights.” The pack and advertising were markedly different from Marlboro Reds, using a gold colored logo instead of red, and stating “*LOWERED TAR & NICOTINE*” on the pack. The advertising at that time stated,

For the smokers of America who prefer low tar and nicotine cigarettes
... Marlboro Lights: 14 mg “tar,” 1.1 mg Nicotine av. Per cigarette by
FTC method.

By 1995, Marlboro Reds (full flavor, soft pack) had FTC method yields of 16 mg tar and 1.1 mg nicotine, whereas Marlboro Lights (soft pack) had FTC method yields of 10 mg tar and 0.8 mg nicotine (Kozlowski et al., 1998).

Interestingly, however, the nicotine content of light and regular cigarettes bear little relation to their FTC yields and some lights actually contain more nicotine than their full-flavor same-brand counterparts. In the case of Marlboro, Kozlowski et al. reported in 1998 that Marlboro Lights contained only 2.8 percent less nicotine than regular Marlboros (10.6 mg versus 10.9 mg).

Unfortunately, however, the FTC yields also bare very little relation to the amount of nicotine or tar absorbed by a smoker. The reason for this is that unlike machines, humans can adjust their smoking behavior in a variety of ways that alter the amount of smoke, nicotine, and tar they absorb from each cigarette. Although a number of factors can potentially influence the FTC yields for different cigarettes (e.g., the amount and type of tobacco in the cigarette column, or the type, porosity, and burn characteristics of the cigarette paper), it has become clear that the main factor used by cigarette manufacturers to reduce the FTC measured nicotine and tar yields has been by adding ventilation holes to the filter design. These vents are typically small

holes that are added to the filter (using laser or electrostatic technology) to enable air to be drawn into and through the filter with the main effect being to dilute the smoke drawn out of the filter. Percentage air dilution/filter ventilation is defined as the percentage of a standard puff (35 ml in two seconds) that is air taken into the puff through filter vents. Thus the “light” cigarettes are able to “trick” the FTC method by enabling the machine (and the smoker) to easily draw air out of the filter that was not drawn through the cigarette column. Kozlowski et al. (1998) reported that full flavor Marlboros had 10.2 percent filter ventilation whereas lights had 22.5 percent filter ventilation. Therefore the reason Marlboro Lights get lower FTC machine-smoked tar and nicotine yields is primarily that they have more vents added to the filter to dilute the smoke sucked out by the machine.

There are a number of reasons why the FTC machine-smoked yields bear little resemblance to the amounts inhaled by a smoker. One reason is that it is possible and indeed likely that some of the vent holes will be blocked by the smoker in the act of smoking (e.g., by covering with the fingers or lips (Martin and Dunn, 1967)). In addition, unlike a smoking machine, human smokers do not smoke in a standardized way, taking one 35 ml puff per minute. Rather, human smoking behavior is highly variable and is primarily determined by the smokers’ need for nicotine (which tends to be rather consistent). Smokers primarily smoke cigarettes for the psychopharmacological and addictive effects of nicotine. Smokers therefore smoke in order to get a sufficient dose of nicotine to provide the desired psychological effects. When a smoker switches from regular to light cigarettes, they typically adjust their smoking behavior (often without being aware of it) to inhale more smoke in order to absorb their usual (preferred) dose of nicotine—a phenomenon often referred to as “compensation” (Benowitz, 2001).

Filter ventilation makes it easy to “compensate” by facilitating the inhalation of larger puffs (Goodman, 1975; Kozlowski and O’Connor, 2002). This is often referred to in the tobacco industry literature as a decreased “resistance to draw (RTD).” The ventilated cigarette requires a lower amount of pressure to be exerted against the filter to initiate inhalation, meaning that the smoker can easily take a larger puff without extra effort and so receives more smoke from the cigarette. Other methods of “compensatory” smoking behavior include taking more puffs per cigarette, blocking the vents in the filters, smoking more cigarettes, or simply removing the filter.

As a result of the fact that smokers regulate their intake of nicotine and that Lights (via filter vents) facilitate “elastic” nicotine (and therefore tar) dosing by smokers (if not by machines), there is often no reduction in nicotine or tar absorption when a smoker switches from regular to light cigarettes (Benowitz, 2001).

**HEALTH EFFECTS OF “LIGHT”
VERSUS REGULAR CIGARETTES**

A large number of epidemiological studies have now been conducted to assess the health effects of smoking “lights” as opposed to regular cigarettes. Such studies require careful analysis and interpretation because there is good evidence that smokers who choose or switch to “lights” differ in a number of ways from those smoking “regular” cigarettes (e.g., Light smokers tend to more likely to be women, older, better educated, have a higher income, and have a higher interest in smoking cessation and other health behaviors than smokers of regular cigarettes.). Another issue for such studies is whether or not to statistically “control for” the number of cigarettes smoked in the two comparison groups (i.e., those smoking regular cigarettes and those smoking “low-tar” cigarettes). Given the evidence that “light” smokers may increase the number of cigarettes smoked in order obtain their usual nicotine dose, such adjustments may unintentionally reduce the disease risk that should properly be attributed to switching to “lights.”

Burns et al. (2001) reviewed the evidence to date on health risks from cigarettes with differing tar yields. Although there are some published studies finding reduced lung cancer risks for smokers of lower tar yielding cigarettes (using FTC method), these have typically not been able to measure and control for all potential confounding variables, or properly assess whether those using lower yielding cigarettes had increased their daily cigarette consumption. Other studies found no reduction in cancer risk among smokers of lower yielding cigarettes and some found increased lung cancer risks. Burns et al. (2001) analyzed a subsample of participants in the American Cancer Society Cancer Prevention Study I (CPS-I), who kept their cigarettes per day and FTC tar category constant throughout the follow-up period of the study. In this group, there was no significant reduction in lung cancer among those smoking cigarettes with lower tar yields.

The mortality risks from coronary heart disease and chronic respiratory disease was also reviewed by Burns et al., again finding no convincing evidence that switching to lower FTC-method tar or nicotine yielding cigarettes reduces disease risks. Burns et al. concluded:

Existing disease risk data do not support making a recommendation that smokers switch cigarette brands . . .

Widespread adoption of lower yield cigarettes by smokers in the United States has not prevented the sustained increase in lung cancer among older smokers . . .

Epidemiological studies have not consistently found lesser risk of diseases, other than lung cancer, among smokers of reduced yield cigarettes. Some studies have found lesser risks of lung cancer among smokers of reduced yield cigarettes. Some or all of this reduction in lung cancer risk may reflect differing characteristics of smokers of reduced-yield compared with higher-yield cigarettes.

A review of the epidemiological evidence on lower machine-yielding cigarettes published by the Royal College of Physicians in 2000, concluded:

Smokers of low yield cigarettes actually achieve little, if any, reduction in intake of nicotine and tar, and the health benefit accrued from switching to such cigarettes is, if anything, small. (RCP, 2000, “Key Points”)

Harris et al. (2004) recently reported on the six-year follow-up of CPS-II participants and found that the lung cancer risk among smokers of very low tar cigarettes (machine-measured tar <7 mg/cig) was no different from the risks of smokers of low tar (8-14 mg/cig) and medium tar (15-21 mg/cig.) cigarettes. The main results from this study are shown in the Figure 13.7, demonstrating that those smoking cigarettes in the “light” category were no less likely to suffer lung cancer, than those smoking regular cigarettes.

As mentioned previously, smokers smoke light and regular cigarettes differently, and generally take larger puff volumes from cigarettes with lower machine-measured tar and nicotine yields. However, the changed inhalation pattern also alters the burn characteristics of the cigarette and hence also the precise mixture of toxic chemicals in the smoke. Harris (2004) has used data from the 1999 Massachusetts Benchmark Study to demonstrate that even if nicotine compensation is not 100 percent (even if smokers does not increase their puff volume sufficiently to absorb precisely the same amount of nicotine from the Light as the regular cigarette), the smoker may actually obtain a higher dosage of certain smoke toxins from the light cigarette. Overall, it is clear that light or “low-tar” cigarettes are not less harmful to health.

NONCIGARETTE TOBACCO PRODUCTS

Cigars

U.S. federal regulations define a cigar as “any roll of tobacco wrapped in leaf tobacco or in any substance containing tobacco” (26 USC Sec. 5702a).

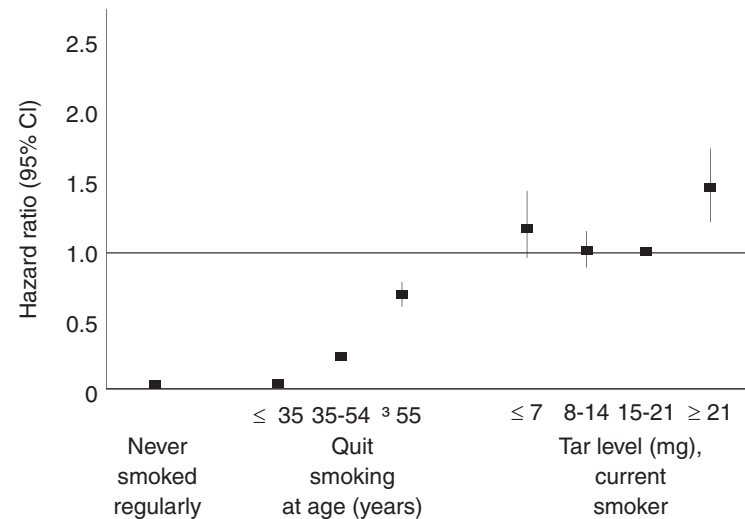


FIGURE 13.7. Hazard ratios for lung cancer in men, 1982-1988, by smoking status and tar yield of brand smoked relative to current smokers of 15-21 mg tar cigarettes. *Source:* Harris, J.E.; Thun, M.J.; Mondul, A.M.; Calle, E.E. (2004). Cigarette tar yields in relation to mortality from lung cancer in the Cancer Prevention Study II prospective cohort, 1982-8. *British Medical Journal*, 328(7431):72. Reproduced with permission from the BMJ Publishing Group.

In contrast, a cigarette is defined as “any roll of tobacco wrapped in paper or in any substance *not* containing tobacco” (26 USC Sec. 5702b). There are many different types of cigars, including large premium cigars, cigarillos, and small or little cigars. Despite the wide variety of cigar products, there is no universally accepted classification system (Baker et al., 2000). Alternatively, Hoffman and Hoffman (1998) classify cigars into four groups (see Table 13.2). This classification system is useful because it illustrates the fact that little and small cigars have characteristics other than weight that set them apart from large cigars. Most notably these cigars have features common to cigarettes, such as shape, size (length 70 to 100 mm), and frequent use of filter tips. In addition, a little or small cigar is sometimes wrapped in paper that contains tobacco or tobacco extract.

Cigar use is often dismissed as a health issue. Indeed, former cigarette smokers incorrectly perceive cigars as safe alternatives to cigarettes (Nyman, Taylor, and Biener, 2002). However, even moderate cigar use carries significant health risks, including increased risk for heart and lung disease, and cancer, including but not limited to oral, esophageal, larynx, and lung,

TABLE 13.2. Cigar types by weight, length, and description.

Classification	Weight in grams	Length in millimeters	Description
Little	0.9-1.3	70-100	Shaped like a cigarette, some with filter tip
Small	1.3-2.5	70-120	Also known as cigarillo, some with wood/plastic mouthpiece
Regular	5-17	110-150	Rolled to a tip, banded, machine, or handmade
Premium	≤ 22	127-214	Most handrolled

Source: Adapted from Hoffman and Hoffman (1998).

compared with nonsmokers. Although the risks for lung and laryngeal cancers are lower for cigar smokers compared with cigarette smokers, oral and esophageal cancer risks are similar in both cigar smokers and cigarette smokers. Like other carcinogenic products, risk increases with consumption (i.e., number of cigars smoked) and depth of inhalation (Baker et al., 2000). Smokers who quit cigarettes but substitute cigars will continue to face risks for tobacco-caused diseases. Of particular concern is that former cigarette smokers typically inhale when smoking cigars (Ockene et al., 1987) and thus are at higher risk for tobacco-caused diseases than cigar smokers who have never smoked cigarettes (National Cancer Institute, 1998). Indeed, cigar smokers who inhale have increased risk for chronic obstructive pulmonary disease and coronary heart disease compared with nonsmokers (Baker et al., 2000). Last, cigars have higher total nicotine content than cigarettes and can deliver nicotine both through smoke and/or direct oral contact with the tobacco wrapper. The potential for cigars to create nicotine addiction is unquestionable (Henningfield et al., 1999).

Pipe Smoking

Pipe smoking carries significant health risks, similar to that of cigar smoking. Compared with no tobacco use, pipe smoking is associated with increased risk for cancer (oral, esophageal, larynx, and lung), coronary heart disease, stroke, and chronic obstructive pulmonary disease (Henley et al., 2004; Shaper, Wannamethee, and Walker, 2003). Like other smoked tobacco products, risk increases with depth of inhalation and consumption

(i.e., number of pipes smoked and years of smoking). Pipe smoke is more alkaline than cigarettes, dissolving more easily in saliva, thus reducing inhalation. Thus, pipes deliver nicotine without the need to inhale and are capable of providing levels of nicotine high enough to produce addiction and dependence. Pipe smokers, who formerly smoked cigarettes and continue their cigarette inhalation behaviors, are at greater risk for tobacco-caused disease than pipe cigar smokers who have never smoked cigarettes (Ockene et al., 1987).

Bidis

Bidis are small, brown, hand-rolled unfiltered cigarettes, consisting of tobacco flakes rolled in a tendu leaf and tied with a small string. Manufactured primarily in India and other Southeast Asian countries, bidis have been imported into the United States for the past 20 years. Bidis are frequently enhanced with appealing flavors like cherry, root beer, and vanilla.

Much of the available toxicological and epidemiological data on bidis are derived from research in India, where bidis are referred to as the “poor man’s cigarette.” Bidis must be puffed more often than regular cigarettes to keep the product lit. Consequently, the smoke from a bidi produces greater amounts of nicotine and tar than a regular cigarette (Pakhale and Maru, 1998). Owing to the higher concentration of nicotine, bidi smokers are at risk for nicotine dependence (Malson, Sims, and Murty, 2001). Bidi smokers also have increased risks for cancers of the throat, oral cavity, pharynx, larynx, lungs, esophagus, stomach, and liver, compared with nonsmokers (Gupta, Hamner, and Murti, 1992).

Kreteks

Kreteks are clove cigarettes, produced primarily in Indonesia, that blend tobacco and ground clove buds. It is believed that the name kretek comes from the crackling sound the cloves make when they are burned. Eugenol, an analgesic, naturally occurs in cloves and thus is present in kretek cigarettes. It is believed that eugenol (like menthol) may minimize the harshness of cigarette smoke (Malson et al., 2003). Kreteks seem to carry tobacco-related health risks similar to conventional cigarettes (Anonymous, 1988). Although the health effects above and beyond normal cigarette smoking are unclear, it is plausible that the eugenol in the kreteks may introduce additional risks (e.g., facilitate initiation or inhibit quitting).

Smokeless Tobacco

The use of smokeless tobacco of various varieties is common throughout the world, with chewing tobacco and snuff being commonly used in North America, snus (a form of moist snuff that is low in nitrosamines and other toxins) is common in Sweden, and paan and Gutka are common in South-east Asia. All of the commonly used varieties deliver pharmacologically active doses of nicotine, primarily via the lining of the mouth (with nasal snuff occasionally used in Europe). These different varieties vary as much as 130-fold in their content and delivery of tobacco toxins (McNeill et al., 2006). Some (primarily the Asian varieties) have very high concentrations of nitrosamines and are therefore a significant cause of oral cancer (Stepanov et al., 2005), whereas others, including the snus used in Sweden have relatively low concentrations of nitrosamines and appear not to cause cancer. Given the harmful effects of nicotine on the fetus, all of these products are potentially harmful in pregnancy. It has been proposed that the low-nitrosamine variety in Sweden is around 90 percent less harmful to health than smoking (Levy et al., 2005) and has had a net beneficial effect on the health of men in Sweden by helping to reduce the number of daily smokers (Foulds et al., 2003).

EFFECTS OF SMOKING ON THE FETUS AND EARLY CHILD DEVELOPMENT

One of the most dramatic and emotional impacts that tobacco smoke can have is the effect on fetal and child development. Unfortunately, with the stigma associated with smoking in pregnancy, current estimates of maternal tobacco use and their effects on health may not be accurate (and more likely to underestimate the health effects) unless combined with biochemical measures of smoke intake (Webb et al., 2003). Although the majority of women who continue to smoke in pregnancy report decreasing their cigarette consumption, it is likely that compensatory inhalation patterns may serve to maintain the exposure of the mother and fetus to nicotine and the multitude of toxins in tobacco smoke.

The general effects that smoke has on pregnancy are through several mechanisms. Vascular effects, such as constriction of blood vessels, lead to decreased blood supply and thus oxygen to the fetus via the placenta. Decreased delivery of oxygen to the fetus also occurs because carbon monoxide replaces oxygen in the maternal circulation. Through its effects as an appetite suppressant, maternal smoking can lead to decreased nutritional intake

and relative maternal malnutrition, which can impact on fetal development. Finally, direct cellular damage can result from exposure to such chemicals as arsenic, cadmium, cyanide, and lead.

Based on the 2004 U.S. Surgeon General's report, there is evidence sufficient to conclude that there is a causal relationship between maternal smoking in pregnancy and low birth weight, preterm labor, premature rupture of membranes, placental abnormalities (e.g., abruption) as well as a reduced risk of preeclampsia. The protective effect of smoking on preeclampsia appears to be mediated via components of tobacco smoke other than nicotine because it does not occur in women using smokeless tobacco during pregnancy, who have an increased risk of preeclampsia (England et al., 2003). In addition, there is evidence that is suggestive of an increased risk of miscarriage/spontaneous abortion, ectopic pregnancy, and birth defects such as cleft lip (USDHHS, 2004).

These and many other risks continue after birth and are borne by the new infant and child. Many other linked conditions have been suggested, including SIDS, childhood respiratory infections, childhood ear infections, asthma, learning difficulties and behavior problems, childhood cancers, and higher blood pressure (through age six) (Castles et al., 1999; Higgins, 2002; USDHHS, 2004). Other effects influence the mother's body and subsequently the child such as toxins in breast milk and reduction of breast milk production.

Based on the wide range of the effects of smoking during and after pregnancy, it is critical to encourage women to quit at all stages of pregnancy. Whether they quit smoking in early pregnancy during organogenesis, mid-pregnancy during fetal growth and development, late in pregnancy prior to delivery, or even following delivery, the benefit of cessation to the mother and fetus/child is a large one. The earlier the woman can stop smoking, the greater the magnitude of harm reduction.

The health effects listed are related to the 4,000 toxins found in tobacco smoke. A difficult issue related to maternal smoking is consideration of the use of pharmacological treatments for tobacco dependence in pregnancy. Nicotine itself has been shown to have detrimental effects to the developing fetus, and therefore its use as a cessation aid has been limited in pregnancy. However, in deciding how to most appropriately treat pregnant smokers, most clinical practice guidelines and professional organizations recognize the potential benefit of pharmacotherapy, and recommend consideration of medications if other treatments have not been successful (American College of Obstetricians and Gynecologists, 2000; Benowitz et al., 2000; Fiore et al., 2000).

**EXPOSURE TO TOBACCO SMOKE POLLUTION
(ENVIRONMENTAL TOBACCO
SMOKE/SECONDHAND SMOKE)**

Despite continued claims from the tobacco industry, environmental tobacco smoke (ETS) has emerged as a major preventable health hazard in our society. As with other major pollutants, ETS exposure is often involuntary and frequently unavoidable. Smoke that is produced by combustion of tobacco and is inhaled directly by the smoker is referred to as mainstream smoke. Mainstream smoke is 92 percent gaseous compounds and 8 percent tar (Pryor and Stone, 1993). ETS is mostly sidestream smoke but also contains some exhaled mainstream smoke. The sidestream smoke contains higher concentrations of certain toxins as they are produced by tobacco burning at lower temperatures. This composition may influence the types and rates of health effects caused by ETS.

Much of the evidence relating ETS to health effects comes from large epidemiological studies and determining a causal link between the two frequently requires the combination of data sets in meta-analyses. A point of contention in recent analyses of certain studies is the accuracy of exposure assessment. Some studies include residential exposures, such as living with a spouse who smokes or having parents that had smoked, while others include occupational exposures. The “misclassification” of exposure can potentially have a significant impact on the interpretation of ETS exposure data (Johnson and Letzel, 1984), and should be considered in reviewing the evidence.

As tobacco smoke is one of the most potent toxic compounds, ETS pollution can impact on many health problems, even at low levels of exposure. It is estimated that at least 50,000 deaths are attributable to secondhand smoke each year in the United States (California Air Resources Board [CAR], 2005). Exhibit 13.2 lists some of the most common health effects of those that have been causally linked to ETS.

Exposure to ETS can increase the relative risks of the diseases listed in Exhibit 13.2 in the range of 1.2 to 1.7 for heart disease to as high as a relative risk of 1.7 to 3 for nasal sinus cancer, and 3.5 for sudden infant death syndrome (CAR, 2005). The range of diseases influenced by ETS is related to the vast array of toxic compounds found in this pollutant. The causal relationship between ETS and breast cancer may appear surprising, given that some prior reports had not found active smoking to be causally related to breast cancer. The California Air Resources Board came to their conclusion primarily by focusing on the studies with the most careful measurement of lifetime ETS exposure, so as to avoid diluting the effect by including exposed

EXHIBIT 13.2. Effects Causally Associated with Exposure to Environmental Tobacco Smoke

Developmental Effects

Low birthweight
Sudden infant death syndrome (SIDS)
Preterm delivery

Respiratory Effects

Acute lower respiratory tract infections in children (e.g., bronchitis and pneumonia)
Asthma induction and exacerbation in children and adults
Chronic respiratory symptoms in children
Middle ear infections in children

Carcinogenic Effects

Lung cancer
Nasal sinus cancer
Breast cancer in younger, primarily premenopausal women

Cardiovascular Effects

Coronary artery disease

Source: California Air Resources Board (2005).

individuals in the “unexposed” control group. They also restricted their finding to premenopausal breast cancer.

With cardiovascular diseases representing such a high proportion of deaths, factors that increase risk of cardiovascular mortality have a substantial societal impact. ETS results in smoke exposure of about 1 percent to mainstream smoking, but increases cardiovascular risk by 30 percent (Glantz and Parmley, 1991; Law, Morris, and Wald, 1997; Law et al., 1997). Exposure to ETS has numerous effects on the cardiovascular system, including activating platelets and causing endothelial dysfunction via exposure to oxidant gases (Knight-Lozano et al., 2002; Law and Wald, 2003; Valkonen and Kussi, 1998). Some of these effects occur at relatively low levels of exposure, with a nonlinear dose-response curve (Barnoya and Glantz, 2005).

Recent evidence suggests that policy regarding ETS can have substantial effects on cardiovascular events. A study conducted in Helena, Montana, found that implementation of a comprehensive local ordinance on clean air was related to a 40 percent reduction in admissions for acute myocardial infarction, which subsequently rebounded after the ordinance was suspended (Sargent, Shephard, and Glantz, 2004). This study demonstrates the potential health benefit of establishing smoke-free environments.

Exposure to ETS has also been linked to increased risk of cancer, listed as a carcinogen by the U.S. Environmental Protection Agency and the U.S. Department of Health and Human Services. It is understandable that as there appears to be no safe threshold level above which carcinogens need to reach to induce genetic damage and subsequent abnormal cell cycle growth, relatively high increases in risk can be seen with low levels of exposure. However, it is often difficult to demonstrate causal effects for cancer-related exposures as there is often a long latency period (i.e., 20-30 years) between the exposure and the diagnosis of a malignancy. It has been demonstrated that nonsmokers have statistically greater risk of lung cancer if their spouses are smokers. Meta-analyses show the increased risk of lung cancer was about 25 percent greater than expected in women and 35 percent greater in men if their spouses smoked (National Cancer Institute, 1999). Although acute exposure may be variable in these settings, it is clear that the cumulative exposure over years of living in a smoke-exposed environment can lead to malignant transformation.

The evidence currently available demonstrates that ETS exposure poses a serious public health problem and policies designed to protect the public from secondhand smoke need to be continued to limit its deadly impact.

PSYCHIATRIC AND PSYCHOLOGICAL EFFECTS OF TOBACCO/NICOTINE USE

Nicotine dependence is one of the first tobacco-caused disorders experienced by most people who start regular tobacco use. Unsuccessful attempts to stop smoking, difficulty controlling use, and previous experience of withdrawal symptoms during a period of abstinence are criteria for nicotine dependence in both the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition) (DSM-IV) and the World Health Organization's *International Classification of Diseases and Related Health Problems* (Tenth Revision) (ICD-10) (American Psychiatric Association, 2000; World Health Organization, 1992). The Fagerstrom Test for Nicotine Dependence (FTND) is a six-item scale that has been

shown to predict withdrawal symptom and craving severity, and is the most widely used questionnaire measure of tobacco dependence (Heatherton et al., 1991). The items and scoring for the FTND are shown in Exhibit 13.3.

Epidemiological studies using research diagnostic criteria suggest that between 50 percent and 90 percent of current tobacco users meet diagnostic criteria for nicotine dependence, and 21 to 46 percent meet criteria for nicotine withdrawal when abstaining for at least 24 hours (Grant et al., 2004; Hughes, Gust, and Pechacek, 1987). Clinicians frequently view nicotine dependence in dimensional rather than categorical terms and there has been a general consensus that smokers of at least 10 cigarettes per day (or those smoking within 60 minutes of waking) are moderately nicotine dependent and those smoking over 20 cigarettes per day (or within 30 minutes of waking) are highly nicotine dependent. More recent studies of the development

EXHIBIT 13.3. The Fagerstrom Test for Nicotine Dependence

Question	Answer	Score
How soon after you wake up do you smoke your first cigarette?	Within 5 minutes	3
	6-30 minutes	2
	31-60 minutes	1
	>60 minutes	0
Do you find it difficult to refrain from smoking in places where it is forbidden?	Yes	1
	No	0
Which cigarette would you hate to give up most?	The first one in the morning	1
	Others	0
How many cigarettes per day do you smoke?	<10	0
	11-20	1
	21-30	2
	>31	3
Do you smoke more frequently during the first hours after waking than during the rest of the day?	Yes	1
	No	0
Do you smoke if you are so ill that you are in bed most of the day?	Yes	1
	No	0

Scores are totaled to yield a single value, with scores of 6 or more indicating high nicotine dependence.

Source: Heatherton et al. (1991).

of dependence in young people have suggested that loss of autonomy over one's smoking (as a central criteria for dependence) develops at much lower levels of smoking, including less than one cigarette per day. DiFranza et al. have developed a scale called the "Hooked on Nicotine Checklist" (HONC) that is particularly useful in predicting the development of dependence in young people and may potentially be a useful index of dependence in adults as well (see Exhibit 13.4; DiFranza et al., 2002; O'Loughlin et al., 2002; Wellman et al., 2005).

Nicotine withdrawal symptoms are believed to be a key factor making it hard for smokers to abstain and are an important medical consequence of tobacco use. The DSM-IV criteria for nicotine withdrawal are shown in Exhibit 13.5 (American Psychiatric Association, 2000).

Smoking is banned from many workplaces and other indoor areas in order protect against passive exposure to secondhand smoke, and so many smokers may be forced into a state of nicotine withdrawal on an almost daily basis.

EXHIBIT 13.4 The Hooked on Nicotine Checklist (HONC)

1. Have you ever tried to quit but couldn't?
2. Do you smoke *now* because it is really hard to quit?
3. Have you ever felt like you were addicted to tobacco?
4. Do you ever have strong cravings to smoke?
5. Have you ever felt like you really needed a cigarette?
6. Is it hard to keep from smoking in places where you are not supposed to?

When you tried to stop smoking or when you haven't used tobacco for a while . . .

7. Did you find it hard to concentrate because you couldn't smoke?
8. Did you feel more irritable because you couldn't smoke?
9. Did you feel a strong need or urge to smoke?
10. Did you feel nervous, restless, or anxious because you couldn't smoke?

The number of items checked "yes" give a total score with zero indicating no dependence, 1 = low dependence, and 10 = high dependence.

Source: DiFranza et al. (2002).

EXHIBIT 13.5. DSM-IV Criteria for Nicotine Withdrawal

- A. Daily use of nicotine for at least several weeks.
- B. Abrupt cessation of nicotine use, or reduction in the amount of nicotine used, followed within 24 hours by four (or more) of the following:
 - (1) dysphoric or depressed mood
 - (2) insomnia
 - (3) irritability, frustration, or anger
 - (4) anxiety
 - (5) difficulty concentrating
 - (6) restlessness
 - (7) decreased heart rate
 - (8) increased appetite or weight gain.
- C. The symptoms in criterion B cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.
- D. The symptoms are not due to a general medical condition and are not better accounted for by another mental disorder.
 - Associated features:
 - Craving for nicotine
 - Desire for sweets
 - Impaired performance on tasks requiring vigilance
 - EEG slowing
 - Decrease in catecholamine and cortisol levels
 - Decreased metabolism of medications and other substances

Source: American Psychiatric Association (2000).

Mental health professionals in particular, should assess and treat nicotine dependence and withdrawal in their patients, to ensure that these symptoms are not exacerbating or being mistaken for other mental health problems.

There remains considerable debate over the extent to which tobacco use may be a form of self-medication for people with a range of psychiatric disorders. It is clear that once an individual becomes dependent on nicotine, then continued tobacco use is partly motivated by the need to medicate nicotine withdrawal symptoms (many of which overlap with symptoms of psy-

chiatric disorders). However, it is less clear that nicotine and/or tobacco use does not provide any direct and primary beneficial effects (other than mild stimulant and appetite suppressant effects) or worsening effects (e.g., other than via nicotine withdrawal or as secondary to other tobacco caused illness) in any psychiatric condition.

To take just one disorder, there is evidence that people with a history of depression are more likely to smoke. Smokers are also more likely to have an episode of major depression after stopping smoking, as compared with similar individuals who keep smoking (Glassman et al., 2001). There is also evidence that chemicals in tobacco other than nicotine may reduce depressive symptoms through their effect on reducing the monoamine oxidase enzyme (MAO B) in a manner similar to MAO inhibitor antidepressant medications. Reducing MAO B enzyme levels, which is a goal of some antidepressants, slows the breakdown of catecholamines. Studies have shown that the brains of living smokers had 40 percent less MAO B compared with nonsmokers or former smokers (Fowler et al., 1996). These kinds of studies appear to lay a foundation for concluding that smoking may have beneficial effects on depression. However, a number of studies have also demonstrated that smoking frequently predates the onset of psychiatric illnesses such as depression. For example, the National Longitudinal Study of Adolescent Health revealed that current cigarette smoking was the strongest predictor of developing depressive symptoms at follow-up (Goodman and Capitman, 2000). Nondepressed teens who smoked at least one pack per week during the study were four times more likely to develop depression than their non-smoking peers. The relationship between tobacco use and mental health clearly warrants further study. What is very clear, however, is that tobacco use is particularly common among people with psychiatric comorbidity or chemical dependence, with around 44 percent of all the cigarettes smoked in the United States being consumed by people who have suffered from a psychiatric problem within the past 30 days (Lasser et al., 2000).

Health Consequences of Tobacco Use in Psychiatric Patients

In some categories of behavioral health provision (e.g., inpatient substance abuse services) patients are more likely to ultimately be killed by their tobacco use than by the problem being presented for treatment (Hurt et al., 1996).

The rates of cancer, cardiovascular, and respiratory diseases among individuals with severe mental illness (SMI) are double those of age-matched controls, due to the two to three times increased rate of tobacco addiction (Brown, Inskip, and Barraclough, 2000; Stroup, Gilmore, and Jarskog, 2000). In addition to increased medical comorbidity, smokers with SMI

experience increased psychiatric symptoms, hospitalizations, and need for higher medication doses compared with non-smokers with SMI. Heavy smokers with SMI have increased positive symptoms (hallucinations and delusions) and reduced negative symptoms (anhedonia, alogia, flat affect, low motivation, and poor social skills) compared with nonsmokers and light smokers (Goff, Henderson, and Amico, 1992).

Effects of Tobacco Smoking on Metabolism of Psychiatric Medications

Some researchers speculate that the high rates of tobacco dependence in those suffering from another mental illness may be secondary to some patients managing medication side effects by changing their intake of cigarettes. The tars of tobacco are metabolized in the liver and are very potent inducers of the CYP 1A2 cytochrome isoenzyme in the P450 liver enzymes. The induction of the 1A2 isoenzyme has a clinically significant impact on increasing the metabolism of many antipsychotics and some antidepressants and antianxiety medications (e.g., oxazepam, desipramine, haloperidol, clozapine, and olanzapine). The medications are metabolized quicker in smokers and so smokers typically need twice the dosage of medications as non-smokers. When smokers initially abstain from tobacco, medication blood levels increase, and there is a risk for increased side-effects if the medication dosage is not adjusted (Desai, Seabolt, and Jann, 2001). Of note, nicotine is not metabolized through the 1A2 isoenzyme, but has a small clinically insignificant effect on the 2D6 isoenzyme.

SUMMARY AND CONCLUSIONS

Tobacco remains the only legal consumer product that is lethal when used as intended. It causes serious damage to practically every organ in the body, but is particularly harmful to the lungs and the cardiovascular system. Approximately half of long-term smokers are killed prematurely by their smoking (Peto et al., 1994), and on average, the continuing smoker will lose ten years of life (Doll et al., 2004). However, there is a one in four chance of losing a much larger part of one's life (e.g., 30 years). It has been estimated that, on average, each cigarette will reduce life expectancy by around 11 minutes (Shaw, Mitchell, and Dorling, 2000). Thus, time spent smoking translates almost one minute for one minute into premature death. It is important for smokers to know that those years of life lost are healthy years, as smokers have fewer years in health (free from disability) and more years in

sickness/disability (Nusselder et al., 2000). In addition to these dramatic health effects, tobacco is highly addictive, and has a complex relationship with mental health. For all of these reasons, it is important that society, the health care system and behavioral health professionals in particular, start to address tobacco use with the seriousness its lethal nature deserves.

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