



## REVIEW

# Smoking and Passive Smoking

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## Abstract

**Objective:** To review the literature on associations between cardiovascular diseases and tobacco use, including recent trends in smoking behaviors and clinical approaches for cessation of smoking.

**Methods:** A literature review of recent scientific findings for smoking and cardiovascular diseases and recommendations for obtaining cessation.

**Results:** Tobacco smoking is causally related to cardiovascular disease, with nearly a half million deaths annually attributed to cigarette smoking in the United States. The human, economic, medical, and indirect costs are enormous. Secondhand smoke as inhaled from the environment also plays an important role in the genesis of cardiovascular diseases. A recent trend in the use of e-cigarettes is noted particularly among youth. For children, prevention is the best strategy. For adult smokers, behavioral treatments, self-help approaches, and pharmacologic therapies are readily available. Clinicians can have a significant impact on patients' smoking habits. Adding to individual strategies, regulatory community and public health approaches provide the potential for eliminating the use of tobacco.

**Conclusion:** Tobacco smoke causes cardiovascular morbidity and death. Clinicians can play a role in preventing smoking and promoting cessation.

**Keywords:** tobacco; cigarettes; smoking cessation; e-cigarettes; secondhand smoke; myocardial infarction; stroke

## Introduction

The addictive cigarette smoking habit is a leading cause of death and disability from chronic diseases around the world. In industrialized countries, tobacco use contributes the largest number of years of life lost [1]. In the United States it is estimated that more than 480,000 deaths annually are associated with smoking, and cardiovascular diseases are a leading cause [2] (Figure 1). Although smoking rates have declined in wealthy countries,

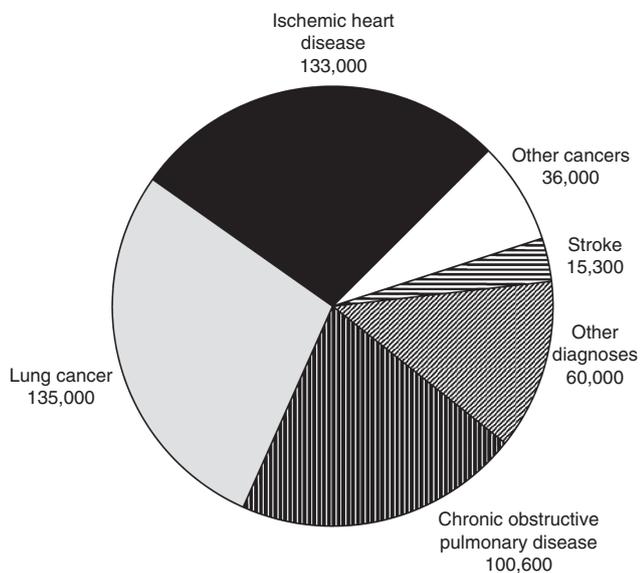
there are increasing rates of smoking in low- and middle-income countries [3] (Figure 2). Many people have quit smoking, but younger smokers are recruited; those who remain are addicted and are particularly difficult to treat [4]. Cigarette smoking also affects nonsmokers through passive or secondhand smoke [5]. The scientific evidence underlying the dangers of cigarette smoking and tobacco use are described herein along with trends in cigarette use and strategies for prevention and cessation of the cigarette-smoking habit.

## Cigarette Smoking and Cardiovascular Disease

The causal relationship of lung cancer with cigarette smoking has been known for many decades. Cardiovascular diseases were first suggested as an

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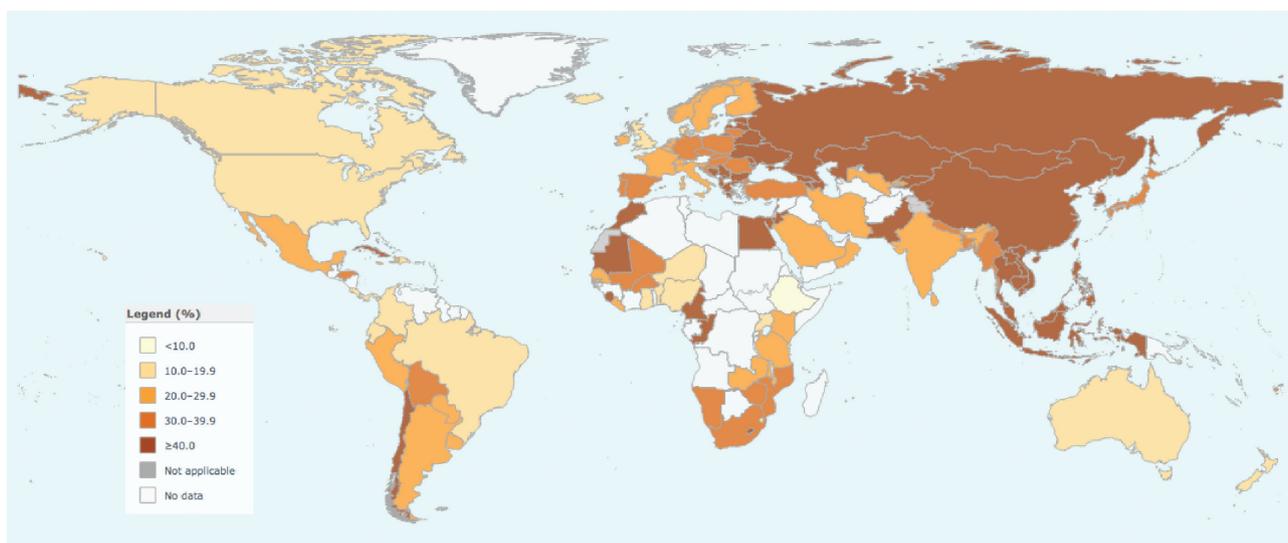
**Figure 1:** More than 480,000 US Deaths Each Year From Cigarette Smoking, Including Secondhand Smoke. Source: <http://www.surgeongeneral.gov/library/reports/50-years-of-progress/sgr50-chap-12.pdf> (accessed 2016 May 30).

outcome of cigarette smoking in the early 1960s. In 1962, epidemiologic studies from Framingham, Massachusetts, and Albany, New York, found an association between coronary heart disease and smoking among men [6, 7]. Further studies found a similar association among women and included other cardiovascular diseases [7]. It is now known

that smoking is associated with all the major cardiovascular diseases, including coronary artery disease, myocardial infarction, sudden death, stroke, and peripheral artery disease [7]. These associations are found in all sex, age, ethnic, and racial groups. Smoking cessation can have a profound impact on reducing the incidence of these diseases [8, 9].

The Multiple Risk Factor Intervention Trial screened 316,099 men and demonstrated a graded relationship between the number of cigarettes smoked daily and the relative risk of death from coronary heart disease [10]. The relative risk is 2.1 for consumption of 1–25 cigarettes per day, rising to 2.9 for more than 25 cigarettes per day. The Multiple Risk Factor Intervention Trial and many other studies demonstrate that quitting smoking reduces incident cardiovascular disease morbidity and mortality [9, 11]. It is also known that those who quit smoking following an acute event such as a myocardial infarction have a significantly improved prognosis [12].

The interaction of cigarette smoking with other established risk factors is also well described, with some suggesting the outcome is additive, whereas others argue there is a multiplier effect (Figure 2). Smoking adds to cardiovascular risk with hypertension, lipid abnormalities, diabetes, obesity, oral contraception use, and electrocardiogram



**Figure 2:** Prevalence of Tobacco Smoking. Age-Standardized Prevalence of Current Tobacco Smoking Among Males Aged 15 Years or Older (%), 2015. Source: [http://gamapserv.who.int/gho/interactive\\_charts/tobacco/use/atlas.html](http://gamapserv.who.int/gho/interactive_charts/tobacco/use/atlas.html).

abnormality [13–16]. Experiments in laboratory animals and humans have advanced our understanding of the mechanisms by which cigarette smoking can influence cardiovascular disease both acutely and chronically. The pharmacologic effects of nicotine are many, including sympathetic stimulation and coronary vasoconstriction [15]. Carbon monoxide in cigarette smoke binds to hemoglobin and reduces the oxygen-carrying ability of the blood. Other components of cigarette smoke increase platelet activation and other thrombotic factors. The many toxic chemicals found in cigarette smoke are associated with increased inflammation, endothelial dysfunction, and a prothrombotic state [16].

## Secondhand Smoke

A 2006 US Surgeon General report entitled “Health consequences of involuntary exposure to tobacco smoke” is focused on environmental exposure [5]. It describes significant increases in the incidence of cardiovascular and other diseases among those exposed to secondhand tobacco smoke.

A subsequent review by the Institute of Medicine came to similar conclusions [17]. Exposure to secondhand smoke increases the risk of coronary heart disease by 25–30%. Other studies demonstrate that the incidence of myocardial infarctions decreased after a smoking ban was implemented, with decreases ranging from 6% to 47%. In addition to cardiovascular diseases, secondhand smoke is also associated with cancer and respiratory diseases [17]. A comparison of home-based and worksite studies reported an overall increased risk of cardiovascular diseases associated with environmental smoke but found no differences between smoke exposure in the home or at work [18].

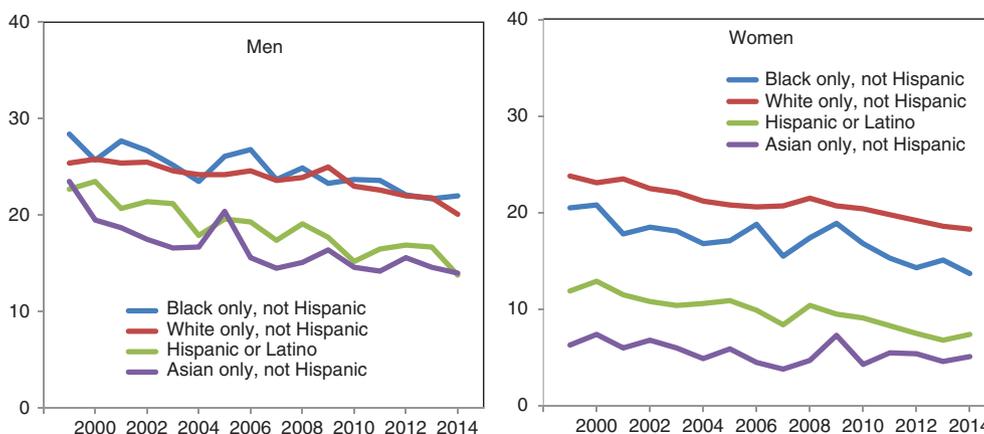
The mechanisms by which secondhand smoke affects others is debated; they probably resemble the pathway in the primary smoker but may have other effects. Mainstream smoke, which is inhaled by the primary smoker, differs from sidestream smoke, which is released into the environment [5]. It is possible that sidestream smoke may be more toxic, and physiologic changes among nonsmokers who are regularly exposed to cigarette smoke could have widespread effects. These include lower levels

of high-density lipoprotein cholesterol, increased atrial fibrillation, and platelet abnormality [5]. Also observed are endothelial dysfunction and lower exercise tolerance. All these factors are associated with increased incidence of cardiovascular disease and, coupled with the positive effects of smoking bans on nonsmokers, reinforce the importance of reducing exposure to secondhand smoke.

## Trends in Cigarette Smoking

Following World War II, cigarette smoking became common in the United States with the return of soldiers [6]. Cigarettes were provided as part of food rations (K-rations) used by the military [6]. Women gradually attained equivalency with men in smoking rates. By 1965 cigarette smoking was a habit of 42.4% of adults [19]. Since that peak in 1965, cigarette smoking has steadily declined nationally with smokers quitting and many never acquiring the habit [19]. By 2014, 17% of the adult population aged 18 years or older were regular smokers. Trends in smoking by sex and race are depicted in Figure 3. Declines in smoking have been observed in all groups but higher rates continue to be observed in white and black men and white women. The rates for Hispanics/Latinos and Asians are the lowest [20]. The trend of decline is likely to continue as most smokers describe an interest in quitting and approximately half attempted to quit during the previous year [19]; however, only 6% were successful.

Historically, smoking begins in middle school and becomes regular in high school [4]. Smokers became addicted as they grew older and more liberated from the constraints of home and school. However, more recent data show cigarette smoking among those aged 12–17 years has fallen significantly, with the percentage of adolescents using tobacco products decreasing from 15.2% in 2003 to 7.8% in 2013. New regulations led the tobacco industry to focus more on young adults who are able to legally smoke and have the economic resources to buy cigarettes. This approach has had some success, with men and women aged 18–44 years having higher smoking rates than the general population [20]. Many in this group are certain that they will not become addicted and can quit later in life.



**Figure 3:** Current Cigarette Smoking Among Adults Aged 18 Years or Older, by Sex and Race and Hispanic Origin: United States, 1999–2014.

Source: Centers for Disease Control and Prevention/National Center for Health Statistics, National Health Interview Survey.

## Lowering Tobacco Use Among Youth

The tobacco smoking habit begins among youth and young adults. Research was initially described in the 1994 Surgeon General's report on preventing tobacco use among young people, and more recent research is summarized in the Surgeon General's report of 2012 [4]. Use of mass media is one approach, with messages presented multiple times over media channels viewed by this age group. These messages are mainly on television and radio [4]. Media strategies that are aimed at adults also have an effect on youth.

Regulatory approaches are also useful in reducing tobacco use among youth. Youth are particularly sensitive to increased cigarette prices resulting from tobacco taxes. Increased costs reduce the likelihood of youth starting smoking and reduce the number of cigarettes smoked. Young smokers are affected by regulations eliminating tobacco use in public places. A combination of increased taxation, use of mass media, restriction of public smoking, and prevention programs in schools has been shown to be effective in reducing cigarette smoking among youth as shown by the steady decline of cigarette use in this age group [21].

Although the smoking of cigarettes among youth is falling, a new trend is emerging to take its place, the use of electronic cigarettes (e-cigarettes) among middle and high school students [22]. In 2015, e-cigarettes became the most commonly

used tobacco product among middle (5.3%) and high (16%) school students. The use of hookahs also increased in this age group. Although marketed as a safe cigarette and a way to quit smoking, e-cigarettes are a path to addiction. The use of fruit and other flavors suggests that youth are the targeted audience. Unfortunately, these products are new and less is known about the long-term health effects or conversion rates to regular tobacco use. Many have called for increasing regulation of these new alternatives [23].

## Smoking Cessation Approaches

Most current smokers report a desire to quit the habit. In 2013 approximately two-thirds of adult smokers reported they had attempted to quit in the previous year [24]. Unfortunately only a small proportion (6%) reported a successful quit attempt. Numerous programs are available in communities to aid in quit attempts. These include behavioral approaches, pharmacologic intervention, and other strategies. Many resources are available to help individuals who wish to quit smoking. They include the Centers for Disease Control and Prevention Helping Quit Smoking Program ([http://www.cdc.gov/tobacco/quit\\_smoking/how\\_to\\_quit/index.htm](http://www.cdc.gov/tobacco/quit_smoking/how_to_quit/index.htm)), resources from the American Heart Association (<http://www.heart.org/HEARTORG/HealthyLiving/QuitSmoking/QuittingResources/>

Resources-to-Help-You-Quit-Smoking\_UCM\_307934\_Article.jsp#.V1rWfdddQ4t), and resources from the National Institutes of Health (<https://www.nlm.nih.gov/medlineplus/healthtopics.html>).

## Behavioral Strategies

Nicotine is an addictive substance, and behavioral approaches to smoking cessation are critical tools. Successful programs, including those using nicotine replacement or other pharmaceuticals, are best when combined with behavioral treatment components. Many behavioral approaches have been tested alone with differing degrees of success. Specific behavioral components include aversive smoking, intratreatment social support, problem solving skills training, quit date setting, specific social support, weight control, nutrition, exercise, contingency contracts, relaxation techniques, and cigarette fading. Although many of these strategies are not very effective alone, they may work in combination.

## Pharmacologic Interventions

Environmental cues and triggers encourage smoking for all smokers. These can be addressed in behavioral programs; however, nicotine addiction is a common theme in many patients [25]. A number of pharmacologic agents are recognized as effective by the Food and Drug Administration (FDA), and these will be discussed below. There are also agents that have been used “off label” or without FDA approval. These will not be discussed here. Many of the agents involve some form of nicotine replacement: nicotine gum, nicotine inhaler, nicotine lozenges, nicotine nasal spray, and nicotine patches. Each has its advantages and disadvantages. All may result in a new dependency among some smokers.

The nicotine patch is convenient and needs to be applied once each day. It allows flexible dosing, and once it has been placed on the skin, the delivery of nicotine is consistent but slow. Nicotine gum allows flexible dosing but can be more difficult to use correctly. Many gum users do not adequately dose themselves with this medication. Nicotine nasal spray has the advantage of flexible

dosing plus it provides faster delivery of the drug. For many users, nasal and eye irritation is a problem as frequent use may be necessary to build an adequate nicotine dose. The nicotine inhaler allows more flexible dosing and mimics the hand-to-mouth behavior of smoking. The inhaler also has fewer side effects. The nicotine lozenge is convenient and allows flexible dosing. Nicotine replacement therapy has been found to be effective in randomized trials [26]. Some nicotine replacement therapies are available without a prescription, whereas others require a physician’s approval.

Bupropion hydrochloride is approved by the FDA for smoking cessation and is available in tablet form. It appears to act on brain chemistry to mimic the effects of nicotine among smokers. There is evidence to suggest that a combination of a nicotine patch and bupropion use may be more effective than use of either alone [27]. Bupropion has been available for many years as an antidepressant, however, it works well in smokers without the symptoms of depression. It has the potential side effects of all antidepressants, including suicidality, depression, anxiety, panic attacks, insomnia, and irritability. Monitoring patients for these symptoms is recommended, along with social support for cessation of smoking.

Several nicotine receptor partial agonists are used for smoking cessation. These stimulate nicotine receptors and help to reduce the craving. Only varenicline is approved by the FDA in the United States. It is a pill available by a prescription. Varenicline should not be used with other quit smoking products. Common side effects include nausea and insomnia but serious behavioral side effects have also been observed. Varenicline received a black box warning in 2009 because of side effects including agitation, depression, and suicidality [28].

## Clinical Approaches

Clinicians have many opportunities to advocate smoking cessation. The hospital, where nonsmoking is mandated, can be a good place to begin the cessation program. An acute illness such as myocardial infarction may provide that unique opportunity. A recent Cochrane review of interventions for smoking cessation in hospitalized patients revealed a number of important observations [29]. High-intensity

behavioral interventions beginning during the hospital stay and continuing for at least one month after discharge were successful in achieving smoking cessation. Other interventions with lower intensity have little effect. The addition of nicotine replacement therapy to counseling significantly increased cessation rates compared with those achieved by counseling alone. No data were found to suggest that addition of bupropion or varenicline treatment to intensive counseling increases cessation rates over those achieved by counseling alone [29].

The outpatient clinic visit is also an opportunity to advocate smoking cessation. Many clinics ask about smoking and other behaviors along with allergies at every patient visit. The answer is usually the same, but this emphasizes the importance of smoking cessation to an individual's health. It also provides an opportunity for the clinician to advocate smoking cessation and referral to cessation resources.

The overall strategy is as follows:

1. Tobacco dependence is a chronic disease that often requires repeated intervention and multiple attempts to quit. Effective treatments exist, however, that can significantly increase rates of long-term abstinence.
2. It is essential that clinicians and health care delivery systems consistently identify and document tobacco use status and treat every tobacco user seen in a health care setting.
3. Tobacco dependence treatments are effective across a broad range of populations. Clinicians should encourage every patient willing to make a quit attempt to use the counseling treatments and medication recommended.
4. Brief tobacco dependence treatment is effective. Clinicians should offer every patient who uses tobacco treatments shown to be effective.
5. Individual, group, and telephone counseling are effective, and their effectiveness increases with treatment intensity. Two components of counseling are especially effective, and clinicians should use these when counseling patients making a quit attempt:
  - a. Practical counseling (problem solving/skills training)
  - b. Social support delivered as part of treatment

6. Numerous effective medications are available for tobacco dependence, and clinicians should encourage their use by all patients attempting to quit smoking – except when their use is medically contraindicated or with a specific population for which there is insufficient evidence of effectiveness (i.e. pregnant women, smokeless tobacco users, light smokers, and adolescents):
  - a. Seven first-line medications (five nicotine and two non-nicotine) reliably increase long-term smoking abstinence rates:
    - i. Bupropion
    - ii. Nicotine gum
    - iii. Nicotine inhaler
    - iv. Nicotine lozenge
    - v. Nicotine nasal spray
    - vi. Nicotine patch
    - vii. Varenicline
  - b. Clinicians also should consider the use of certain combinations of medications identified as effective.
7. Counseling and medication are effective when used by themselves for treating tobacco dependence. The combination of counseling and medication, however, is more effective than use of either alone. Thus clinicians should encourage all individuals attempting to quit smoking to use both counseling and medication.
8. Telephone quitline counseling is effective with diverse populations and has a broad reach. Therefore clinicians and health care delivery systems should both ensure patient access to quitlines and promote quitline use.
9. Tobacco dependence treatments are both clinically effective and highly cost-effective relative to interventions for other clinical disorders. Providing coverage for these treatments increases quit rates. Insurers and purchasers should ensure that all insurance plans include the counseling and medication identified as effective as covered benefits.

Clinicians have greater success in achieving smoking cessation in patients than most believe. The five hints for smoking cessation counseling by physicians are as follows:

1. Ask: systematically identify all tobacco users at every visit.
2. Advise: strongly urge all smokers to quit.
3. Attempt: identify smokers willing to try to quit.
4. Assist: aid the patient in quitting.
5. Arrange: schedule follow-up contact.

The amount of time required to do this is minimal and the potential for health improvement great [30].

## Conclusions

Tobacco smoking is causally related to cardiovascular disease. Nearly a half million deaths annually are attributed to tobacco smoking in the United States. The economic cost, medical expenses, and

indirect costs are enormous. The human cost in suffering exceeds the economic costs. Environmental smoke as inhaled as secondhand smoke is also an important cause of up to 40,000 deaths annually from cardiovascular disease. For adults, behavioral treatments, self-help approaches, and pharmacologic therapy are readily available. These measures, in combination with regulatory, community, and public health approaches, provide the potential for eliminating use of tobacco, one of the greatest health-impairing behaviors affecting humans.

## Conflict of Interest

The author declare no conflict of interest.

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