Tobacco

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The term *tobacco* refers to plants of the genus *Nicotiana*, which may be consumed in various ways. Because cigarette smoking is the predominant method of tobacco consumption in the United States, in public health the term tobacco use is often used as a synonym for cigarette smoking without consideration of the different modes of tobacco consumption and differing health risks posed by them. This entry describes the health risks associated with cigarette smoking, other tobacco smoking, and environmental tobacco smoke, and contrasts these to the effect of nicotine in itself and to the use of smokeless tobacco. It also explores the importance of tobacco research in the history of epidemiology and the potential of epidemiological studies in reducing the health impacts of smoking. Tobacco is native to the Americas, where it was cultivated by indigenous populations from about 4000 B.C and used in smoked and smokeless forms, largely for ceremonial purposes. Less than 100 years after its discovery by European explorers around 1500 A.D., tobacco was being used throughout the world, a testimony to the powerful psychoactive properties it delivers to human brains. Cigarette smoking started to become popular only around 1900 with the introduction of efficient mass-production, and wide distribution of cigarettes during the 20th century's two

world wars made it the dominant form of tobacco use globally.

Ochsner and Debakey recognized a link between smoking and lung cancer as early as 1936. Schairer and Schöniger published one of the first epidemiologic studies of this relationship, in German during World War II (it was not widely distributed or indexed at the time, but was resurrected in English in 2001). But it was not until the studies of cigarette smoking and lung cancer by Doll, Hill, Wynder, and others a half century ago that the dangers of smoking were clearly established. While difficult to imagine today, the medical community that then dominated public health was sufficiently conservative that these results were not immediately accepted despite previous evidence. These early studies of the relationship between smoking and health risks also played an important role in establishing the merits of observational epidemiologic studies.

Today, it is well-established that regular moderate or heavy cigarette smoking (and to a lesser extent, smoking of tobacco in other forms) causes well-known morbidity and mortality risks, with total attributable risk far exceeding that from any other voluntary exposure in wealthy countries. Cigarette smoke also creates an environmental exposure, labeled "second-hand smoke" or "environmental tobacco smoke" (ETS). Because smoking has been so prevalent for so long, and causes high relative risks for many diseases, and because it offers little opportunity for experimental intervention, smoking stands as a near-perfect demonstration of what can be done with observational epidemiology (though perhaps also as a rarely-attainable archetype).

In contrast, nicotine, the primary reason people smoke or otherwise use tobacco, is a relatively benign mild stimulant, similar to caffeine. Nicotine causes transient changes in cardiovascular physiology, as do many mild stimulants, which might cause a small risk for cardiovascular disease. There is general agreement that nicotine is addictive for many people (the term addictive is not well-defined, but nicotine consumption fits most proposed definitions, at least for a portion of the population). But nicotine by itself does not appear to cause a substantial risk of any life-threatening disease; the epidemiologic evidence on nicotine in the absence of smoking is sufficiently limited that it is impossible to distinguish small risks from zero risk. Although not extensively studied, research suggests that nicotine may have psychological and neurological health benefits, protecting against Parkinson's disease and possibly dementia, and providing acute relief from schizophrenia and other psychological morbidities.

Substantial research shows that the use of modern smokeless tobacco (ST) products is associated with very small health risks, similar to those from nicotine alone. There has been little research on the health effects of very light smoking or long-term pharmaceutical nicotine use, in part because it is difficult to find populations with such long-term usage patterns (not interrupted by periods of heavier smoking), and in part because most tobacco and nicotine research funding is driven by an prohibitionist agenda, and so there is limited support for quantifying these practices' presumably modest health effects.

Cigarette smoking probably remains the most researched exposure in epidemiology. However, the set of exposures related to tobacco also generate a great deal of advocacy and rhetoric, often making it a challenge to sort out the epidemiology from the politics. Epidemiology related to tobacco suffers from publication bias against studies that show no increased risk (which is particularly relevant to harm reduction and to smokeless tobacco), from over-interpretation of results of a few favored studies, and from a "ratchet effect," where any association found in one study is treated as established, regardless of what other evidence shows. For example, many studies of ETS have shown very small or undetectable health effects for all but extreme exposure levels, but these studies are widely ignored, or even vilified, in the popular discourse. Similarly, a few studies have found positive associations of ST use and oral or pancreatic cancer, but most studies have not; nevertheless, these positive associations are discussed as if they are indisputably established.

Perhaps these problems are no worse than in other subject matter areas, but they pose a potentially greater threat to epidemiology as an honest science because of the high stakes and high profile of tobacco issues, and are less excusable given the overwhelming amount of epidemiologic evidence that exists.

The greatest confusion comes from treating exposures to tobacco as homogeneous, despite the very different pathways and different levels of health risk. Using the term tobacco is particularly misleading when referring only to the health effects of smoking, since the major health impact is from inhaling smoke, which is quite unhealthy no matter what is burning; thus, emphasizing the plant rather than using the term "smoking" confuses people about the cause of the health effects.

Cigarette Smoking

Smoking prevalence peaked at about 50% in most Western countries, reaching a maximum in the 1950s and 1960s in most male populations, though often continuing to rise among women. But the health risks of smoking, highlighted in reports from the Royal College of Physicians (United Kingdom, 1962) and the United States Surgeon General (1964) and in thousands of studies since, resulted in a steady decline over about two decades, to the prevalences in the twenty-some percent range (similar for men and women) found in most Western countries today. However, despite near-universal knowledge of the health risks and aggressive anti-smoking advocacy and policies in many places, the rate of the decline has slowed or stopped over the past several decades. National average prevalence has dropped substantially below 20% only in Sweden where smokeless tobacco use has largely replaced smoking. Outside the West, prevalence is increasing in many countries; male prevalence remains above 50% in many countries in Eastern Europe, the former Soviet Union, Africa and Asia, while prevalence among women varies from negligible to quite high.

Since the lung cancer link was established, smoking has been shown to cause other cancer mortality and an even greater absolute risk of fatal cardiovascular disease. Popular claims attribute about 1/5th of all current

mortality in wealthy countries to smoking, or in excess of 150 deaths per 100,000 person years. Extrapolations of present worldwide trends predict dramatically increasing smoking-attributable mortality in the future, predominantly in developing countries.

It should be noted that some of the most widely cited statistics about tobacco and health are produced primarily by anti-tobacco advocates using proprietary data and methods, and thus cannot be validated. For example, estimates of smoking-attributable deaths released by the U.S. Center for Disease Control and Prevention (CDC) are based on relative risks derived from the American Cancer Society's (ACS) Second Cancer Prevention Study (CPS-II). Nearly everyone has heard the CDC estimate of about 400,000 annual smoking-attributable deaths in the U.S. But few realize that this and other findings from the CDC relating to health consequences of tobacco use, the basis of tobacco policies at all levels of American government, are based on data and analyses that are kept secret from investigators outside the CDC or ACS.

However, few would doubt that the true mortality from smoking is at least half of what is usually claimed, so there is no serious question that among behavioral health exposures, smoking is among the most important at the individual and social levels. In the world's healthier countries it has a greater impact on mortality and morbidity than any other behavioral exposure. Smoking is often called the greatest or most important preventable source of disease; while such phrasing belongs to advocacy rhetoric and is scientifically meaningless (most notably, it strains the definition of "preventable" to apply it to an exposure that remains very prevalent despite massive efforts to eliminate it), the epidemiologic evidence makes clear that if we could substantially reduce the rate of smoking, it would result in greater health improvement in wealthy countries than any other change imaginable within the bounds of current technology and budgets.

By exposing the lungs, airway, and mouth to concentrated combustion products, smoking causes a still-increasing majority of the world's lung cancer. In Western men, smoking is estimated to cause as much as 90% of lung cancer and 75% of the oral, pharyngeal, esophageal, and laryngeal cancers; attributable risk for women, historically lower due to a lag in smoking uptake in the 20th century, is largely equivalent today. Smoking has also been convincingly linked to cancers of the stomach, pancreas, and urinary bladder, as well as leukemia. It is sometimes also linked to cancers of the breast and colon, but these associations are less well established. Smoking is responsible for reversing what otherwise would have been a steep decline in overall cancer mortality in Western countries during the last half of the 20th century.

The relative risks for cardiovascular diseases are much lower than those for the sentinel cancers, but because of the greater baseline risk the absolute total risk is higher. In the West, smoking is estimated to cause about 40% of coronary heart disease and stroke deaths under age 65 and over 50% of deaths from aortic aneurysms. In addition, smoking is considered the proximate cause of about 20% of pneumonia and

influenza deaths, and about 80% of deaths related to bronchitis, emphysema and chronic airway obstruction.

Other Tobacco Smoking

Smoking of tobacco in various types of pipes and cigars is an exposure similar to smoking cigarettes, though many (but not all) smokers of these products have lower consumption and do not draw smoke into the lungs, both of which result in lower risks. Because of the great heterogeneity of usage patterns, it is difficult to generalize about these exposures. But epidemiologic studies generally show these exposures, as practiced in the West, to cause substantially less risk than regular cigarette smoking on average, though the total risk of serious disease associated with their use is still high compared to almost every other common voluntary exposure.

Environmental Tobacco Smoke (ETS)

There is fierce debate about the magnitude of the health risk to nonsmokers from ETS exposure. ETS has been linked to various acute changes in respiratory and cardiovascular physiology, but the epidemiologic evidence is only suggestive of a small risk of lung cancer and cardiovascular disease after concentrated long-term exposure such as that experienced by the nonsmoking spouses of smokers, or by people who work in very smoky environments. Popular claims attribute about 2 deaths per 100,000 person years to ETS in wealthy countries, with claimed relative risks for lung cancer and heart disease as high as about 1.3, but these numbers come from anti-smoking advocates and selective citation of the research, and are not widely accepted by non-advocates. For example, the scientific literature contains competing summary analyses of studies of ETS and cardiovascular disease, with a widely-cited study written by employees of an anti-tobacco advocacy group finding a relative risk in excess of 1.2, while a recent study of that literature produces a summary estimate of approximately 1.05. While it stands to reason that ETS creates some of the same risks as active smoking (since it involves exposure to the same chemicals that harm smokers, via the same pathway, albeit in much lower doses), the absolute risk appears to be lower than what can be accurately measured by available epidemiologic methods.

Smokeless Tobacco (ST)

Since most of the health risk from smoking comes not from the tobacco plant, but from inhaling concentrated smoke, oral use of modern Western ST products (e.g., snuff dipping) has little in common with smoking, other than nicotine absorption. This exposure has become popular in Sweden and Norway, and seems to be gaining popularity in parts of North America, due in part to the low health risks and to availability of modern products that can be used invisibly and without spitting, in contrast to traditional chewing tobacco.

The epidemiologic evidence does not definitively demonstrate an association between ST use and any life-threatening disease. There is a widespread misunderstanding, among both health professionals and the general population, that ST use creates substantial risk of oral cancer, but this is based on erroneous conclusions from early research. Extensive modern epidemiology has consistently shown that ST use causes very little or no risk

of oral cancer (clearly much less than the substantial risk of oral cancer from smoking), or of any other life-threatening disease.

In contrast to studies of smoking, epidemiologic studies of smokeless tobacco use face considerable challenges because the prevalence of ST use in Western countries is very low (for example, no more than 5% among adult men and well under 1% among women in the U.S.), the diseases putatively linked to ST use (such as oral cancer) are rare, and the relative risks, even among long-term users, are very low. Despite these challenges, there has been sufficient epidemiologic research on the subject, most usefully from the last 15 years, to conclude that Western ST use causes only a tiny fraction of the total mortality risk of smoking; calculated estimates put it at 1 to 2%, and clearly less than 5%. A recent meta-analysis of epidemiologic studies of ST use and oral cancer found that the use of modern American and Swedish products (moist snuff and chewing tobacco) was associated with undetectably low risks for cancers of the oral cavity and other upper respiratory sites (relative risks ranging from 0.6 to 1.7); older studies of American dry snuff showed substantially elevated risk (RRs from 4 to 13), with the contrast due to an unknown combination of the archaic products causing measurable risk and improved study methods (e.g., better control for smoking).

Smokeless tobacco use in South Asia and Africa may cause substantially greater disease risks. The products used are quite different from Western ST, because they use different manufacturing processes and typically include other ingredients that have their own psychoactive and health effects (indeed, sometimes these products do not even contain tobacco, but are classified in analyses as being tobacco products). The epidemiology suggests that these products are associated with a substantially increased risk of oral cancer, with relative risks for this disease similar to or higher than those from smoking. Since oral cancer is much more common outside the West, this represents a greater absolute risk than it would in the West. Little is known about other mortality risks from these products, though there is no reason to doubt that total risk is greater than that from Western ST, but still only a small fraction of that from smoking.

Epidemiology and Reducing the Health Impacts of Smoking

Beyond showing that smoking is unhealthy, epidemiologic research also contributes to identifying predictors of smoking behavior, assessing smoking cessation interventions (generally finding them to provide very little or no benefit), and measuring the effects of anti-smoking regulations. Important unanswered epidemiologic questions with practical implications for health policy include the health effects of very low levels of smoking (in the range of 1 cigarette per day), the nature of the benefits of nicotine for some users and its effect on their quality of life, and whether smokers derive important benefits from smoking apart from the nicotine.

Epidemiologic research has revealed the potential of tobacco harm reduction (the substitution of less harmful sources of nicotine for smoking) as an important public health intervention. The

effectiveness of traditional anti-smoking efforts has plateaued in the Western world. But since other products (particularly ST, which has similar pharmacokinetics to smoking) contain the nicotine that smokers seek, and those products have been shown to cause very little of the health risk associated with smoking, encouraging smokers to switch products is a promising intervention. Swedish men substantially replaced smoking with ST use over the last several decades, and descriptive epidemiology confirmed that the predicted reduction in disease occurred. Swedish women and Norwegians are making a similar substitution and the approach is increasingly considered a promising option in North America and elsewhere.

Further Readings

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