

Environmental Influences on Tobacco Use: Evidence from Societal and Community Influences on Tobacco Use and Dependence

K. Michael Cummings,¹ Geoffrey T. Fong,²
and Ron Borland³

¹Department of Health Behavior, Roswell Park Cancer Institute, Buffalo, New York 14263; email: michael.cummings@roswellpark.org

²Department of Psychology, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1, and Ontario Institute for Cancer Research, Toronto, Ontario, Canada; email: gfong@uwaterloo.ca

³VicHealth Center for Tobacco Control, The Cancer Council Victoria, Melbourne, Australia 3053; email: ron.borland@accv.org.au

Annu. Rev. Clin. Psychol. 2009. 5:433–58

First published online as a Review in Advance on January 13, 2009

The *Annual Review of Clinical Psychology* is online at clinpsy.annualreviews.org

This article's doi:
10.1146/annurev.clinpsy.032408.153607

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1548-5943/09/0427-0433\$20.00

Key Words

tobacco control, normative beliefs, policy research, marketing controls

Abstract

There is little doubt that nicotine addiction sustains tobacco use in most people and that individual variation in response to tobacco has a strong biological basis. However, the great diversity in tobacco use behaviors observed between countries and within countries over time suggests that biology alone cannot fully explain these variations. This review examines the role of the social environment in understanding tobacco use behaviors and efforts to curb tobacco use at the population level. We conclude that the social environment plays a critical role in determining how innate biological factors involved in nicotine dependency actually get expressed at the population level. Tobacco use as reflected in population trends is seen as the product of the interaction of agent, host, and environmental factors. Government policies are seen as an important modifiable environmental influence that can alter how tobacco products are designed and marketed (agent factors) and how consumers perceive the risks and benefits of smoking (host factors). Evidence suggests that synergy is gained when tobacco control interventions directed at agent, host, and environmental factors are implemented together.

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TOBACCO USE AND DISEASE RISK

Tobacco use is the most prevalent cause of premature morbidity and mortality in the world. The statistics supporting this contention are staggering in magnitude. Currently, an estimated 5.4 million people die each year, and future predictions are even more ominous: It is estimated that 8 million deaths per year will be caused by tobacco by the year 2030 (Ezzati & Lopez 2003, Lopez et al. 1994, Murray & Lopez 1997, World Health Org. 2008).

Tobacco use varies around the world, although factory-made cigarettes are the predominant form of tobacco used worldwide and are by far the most lethal type of tobacco (Corrao et al. 2000, Euromonitor 2006). In 2006, manufactured cigarettes accounted for 95% of total smoked-tobacco sales, with cigars and other smoked tobacco, such as roll-your-own cigarettes, pipes, bidis, and kreteks, accounting for the remainder (Euromonitor 2006). Oral smokeless tobacco is common in

Southeast Asia and regionally is popular in parts of Europe (particularly Sweden) and the United States.

The proportion of the population who use tobacco also varies greatly, from approximately 20% to 60% (Corrao et al. 2000, Euromonitor 2006, World Health Org. 2008). In many of the countries where few women smoke, smoking rates are often high in males (e.g., in Asia). By contrast, in most developed countries, female smoking rates are typically only a few percentage points below those of males. Over the past 50 years, smoking prevalence has fallen markedly in high-income countries such as the United States while it has increased in other, mainly low-income, countries. The descriptive model of the global tobacco epidemic by Lopez et al. (1994) groups countries into four categories based upon tobacco use trends along a roughly century-long timeline. The typical pattern of tobacco use observed among countries well into the epidemic begins with a slow and then rapid acceleration of prevalence rates among males, followed by a lag of perhaps 20 years and then by a similarly shaped though lower-peaked trajectory of prevalence rates among females. The inevitable health consequences of tobacco-related health outcomes lag tobacco use rates by 30–40 years. Thus, in the United States and other high-income countries, smoking prevalence has decreased, but because of the prevalence-impact lag, an enormous level of morbidity and mortality due to smoking still exists (Dept. Health Human Serv. 2004). For example, currently in the United States about 20% of all deaths annually are attributed to smoking even though smoking rates have been declining for 50 years (Dept. Health Human Serv. 2004). However, Lopez et al. (1994) also note that the vast majority of the world's population, which is dominated by low- and middle-income countries and includes the most populous countries of the world, such as China and India, is in the early stages of the epidemic. Male smoking prevalence rates in these countries are high and have yet to peak, and female prevalence is still very low but may be starting to climb, in the absence

of effective countering interventions. The great diversity both between countries and within countries over time creates opportunities for advancing scientific understanding of the factors that influence tobacco use behaviors (Fong et al. 2006a, Intl. Agency Res. Cancer 2008, Thompson et al. 2006).

DETERMINANTS OF TOBACCO USE

Little doubt exists today that nicotine in tobacco is the primary reason why most smokers continue to expose themselves on a daily basis to known toxins (Dept. Health Human Serv. 1988, Dunn 1972, Fiore et al. 2008, Hurt & Robertson 1998). As acknowledged by one Philip Morris scientist who stated the importance of nicotine bluntly, “No one has ever become a cigarette smoker by smoking cigarettes without nicotine” (Dunn 1972).

Most people begin smoking during their teenage years and struggle to quit as adults (Dept. Health Human Serv. 1988). Regret among smokers for having started to smoke is nearly universal (about 90%) in high income countries such as the United States, Canada, United Kingdom, and Australia (Fong et al. 2004). Most smokers in high-income countries say they want to quit, and many attempt to stop smoking annually without success (Cokkinides et al. 2005; Hyland et al. 2006a; Siahpush et al. 2006a, 2007). Quit attempts are typically unplanned and usually last only a few days or weeks owing to the smoker’s dependency on nicotine (West & Sohal 2006). Studies indicate that difficulty quitting is best predicted by how much one smokes on a daily basis and by smoking within 30 minutes of waking up each day, both of which are measures of nicotine dependency (Hyland et al. 2006a, Piper et al. 2006).

Although little doubt exists that nicotine addiction sustains tobacco use in most people, there is also individual variation in how different people respond to tobacco, with many individuals becoming hopelessly addicted whereas others seemingly are able to quit with little difficulty (Dept. Health Human Serv. 1988,

Hyland et al. 2006a). Evidence from studies of twins, siblings, and related family members makes it clear that genetic factors play an important role explaining individual variation in nicotine dependency (Lerman et al. 1999; Lessov et al. 2004; Swan 1999; Swan et al. 2003, 2004, 2005). However, on a population-wide basis, the great diversity in tobacco use behaviors observed both between countries and within countries over time demonstrates that biology alone cannot fully explain these variations (Corrao et al. 2000, Euromonitor 2006, Hosking et al. 2009, Siahpush et al. 2006a, World Health Org. 2008).

Declining cigarette consumption in the United States since the 1960s corresponds to increased public awareness of the dangers of tobacco use, changing social norms about tobacco, and increased governmental actions to regulate the use, sale, and advertising of tobacco products (Cummings 2002; Warner 1986, 1989). The most comprehensive change has been in attitudes and rules about smoking in enclosed public places. As recently as 20 years ago, smoking was permitted nearly everywhere and was effectively ubiquitous (except where there was a danger of fires or damage to equipment). Over time, the environment that had supported smoking indoors has transformed. Several countries now prohibit smoking in all public places and workplaces, and other countries are following rapidly (Fong et al. 2006b; Hyland et al. 2008b, 2009; World Health Org. 2008). Limiting where people can smoke has contributed to the social marginalization of smoking as an accepted behavior.

The social environment undoubtedly plays a critical role in determining how innate biological factors that are involved in nicotine dependency actually get expressed at the population level. In other words, having a genetic profile that makes one susceptible to nicotine dependency does not automatically guarantee that an individual will become a smoker or will be unable to stop smoking, unless the social environment is also such that tobacco use is supported. The importance of the social environment in influencing trends in tobacco use behaviors was

Nicotine

dependency: a cluster of physiological, behavioral, and cognitive phenomena in which the use of nicotine-containing products (e.g., tobacco) takes on a much higher priority for a given individual than other behaviors that once had greater value. A central descriptive characteristic of the dependency syndrome is the desire (often strong, sometimes overpowering) to use nicotine

Advertising: a form of communication that typically attempts to persuade potential customers to purchase or to consume more of a particular brand of product or service

Socioeconomic

status (SES): one's social class; typically measured by a combination of educational attainment, occupation, and household income

Marketing: an ongoing process of planning and executing the marketing mix (product, price, place, promotion; often referred to as the four Ps) for products, services, or ideas to create exchange between individuals and organizations

illustrated nicely in a recent study that monitored the smoking habits of 12,067 people over a 30-year period as part of the Framingham Heart Study (Christakis & Fowler 2008). In this study, trends in smoking behavior were strongly linked to an individual's social ties. Smokers whose social network included an increasing share of nonsmokers or former smokers were much more likely to stop smoking over time, whereas those whose social ties were mainly among smokers continued to smoke.

Socioeconomic status (SES) has also been found to be a strong predictor of tobacco use status (Cokkinides et al. 2005; Farrelly et al. 2001; Hyland et al. 2005; Jarvis & Wardle 1999; Jarvis et al. 2003; Pierce et al. 1989; Siahpush et al. 2006a,b, 2007; Townsend et al. 1994; Young et al. 2006). The association is so strong that smoking is regarded as a marker for deprivation, and one can identify disadvantaged groups by simply observing their smoking prevalence (Jarvis 1994). Not only are social inequalities in smoking prevalence pervasive, but they also have been widening in many countries, such as United States and the United Kingdom, over the past few decades (Jarvis & Wardle 1999; Pierce et al. 1989; Siahpush et al. 2006a,b). In the United Kingdom, this is to a large extent due to differential cessation rates between socioeconomic groups. Jarvis (1994, 1997) reported that although cessation rate doubled among the most affluent groups, there was very little change among the poor between 1973 and 1996. The mechanism of the link between SES and cessation has not been adequately explored. Nicotine dependency, self-efficacy, and intention to quit are strong predictors of the propensity to quit and/or successful cessation, and research has shown that lower SES is associated with higher levels of nicotine dependency, having low self-efficacy to quit, and having no intention to quit across four different countries (i.e., the United States, Canada, the United Kingdom, and Australia) (Siahpush et al. 2006b, 2007). Higher levels of dependency among lower-SES groups may be due to the association of social disadvantage with financial and psychological stress on the

one hand, and the fact that most smokers attribute their smoking to its alleged anxiolytic properties on the other (Cohen & Williamson 1988, Parrott 1999). To the extent that lower-SES smokers are more addicted, they are likely to need more intensive support if they are to be successful in their attempts to quit (Fiore et al. 2008, Jarvis et al. 2003, Siahpush et al. 2006a).

Another critical component of the environment that can influence tobacco use behaviors is how tobacco products are manufactured and marketed (Ashare et al. 2007; Carpenter et al. 2005; Cummings et al. 2002, 2006a; Hurt & Robertson 1998; Kreslake et al. 2008; Leavell 1999; Megerdichian et al. 2007; O'Connor et al. 2007a; Stevenson & Proctor 2008; Wayne & Connolly 2002; Wayne et al. 2006). Evidence from previously secret internal tobacco industry research makes it clear that the modern cigarette has been engineered to promote and sustain addiction (Cummings et al. 2002, Hurt & Robertson 1998, King & Borland 2005, Kreslake et al. 2008, Megerdichian et al. 2007, Stevenson & Proctor 2008, Wayne & Connolly 2002, Wayne et al. 2006). In low-income countries, where the use of factory-made cigarettes has been far less common than it has been in high-income countries, tobacco use patterns differ. For example, in parts of India and Indonesia, it is not uncommon to find people who use tobacco infrequently, perhaps just a few times per day. In contrast, smoking every hour is the norm in high-income countries (Ganiwijaya et al. 1995, Rani et al. 2003).

It is not just trends in tobacco use and tobacco-related knowledge that are likely to affect tobacco use behaviors. Broader societal issues may also play a key role. For example, international trade agreements have had a major impact on the price and marketing of tobacco products. Over the past decade, there has been a trend toward dismantling state-owned tobacco monopolies in favor of allowing privately owned tobacco companies to compete for market share in a country (Connolly 1992, Euromonitor 2006). The result of this trend has been to fuel a greater demand for tobacco

through lower prices and increased marketing. The rapid emergence of China and other low-income countries as economic powerhouses is also likely to affect tobacco use as more and more people have money to spend on consumer products such as tobacco, which will increasingly be marketed to appeal to modern sensibilities. The rising costs of gasoline and food, which compete with tobacco for a share of disposable income, will also likely have an impact on tobacco use behaviors (Chaloupka et al. 2002). Finally, religious beliefs in some jurisdictions are also likely to have effects on tobacco use behaviors. For example, Utah—which has a large concentration of Mormons—has the lowest rates of tobacco use in the United States (Cent. Disease Control 2007). In 2004, Bhutan implemented a law prohibiting the sale of cigarettes, and more recently, several small villages in Bahrain have banned the sale of all tobacco products (smoked and smokeless), mainly for religious reasons (Cummings & O'Connor 2009). It is beyond the scope of this review to speculate as to all the social forces that might impact tobacco use. However, it is important to recognize that tobacco control efforts are not isolated; rather, they fit within the broader context of social changes that are likely to have a strong influence on the use of tobacco.

Interaction Between Agent, Host, and Environment

The agent-host-environment model used in epidemiology provides a useful framework for understanding the multitude of factors that combine to influence tobacco use behaviors (Lilienfeld & Lilienfeld 1980). As illustrated in **Figure 1**, government policies are seen as an important environmental influence that can alter how tobacco products are designed and marketed (agent factors) and how consumers perceive the risks and benefits of smoking (host factors). This figure also makes it clear that policy and sociocultural influences have indirect effects on use and that the most proximal determinants of use are the product; cues in the environment; and the characteristics of

the individual, including cognitions about the products and the individual's biology (both conditioned and innate). Furthermore, the behavior and the product jointly determine exposures, which in turn interact with existing biology to determine harm. The role of a systematic science of tobacco control is to analyze and clarify the components of this system and their interrelationships over time, with the aim of introducing interventions that will minimize the harms.

Conceptual Framework for Tobacco Control Interventions

The solution to the tobacco problem lies in changing the tobacco use behavior of individuals, in changing the social contexts that affect the pattern of incentives for tobacco use, and in changing the behavior of the tobacco industry to prevent it from acting in ways that counter the goals of tobacco control (Fiore et al. 2004, Intl. Agency Res. Cancer 2008, Inst. Med. 2007). Tobacco control interventions that have the greatest chance of reducing tobacco use in the population are those that reach the most smokers (Cummings 2002). Highly efficacious interventions that reach only a tiny fraction of the target population will not have a sizeable impact on rates of tobacco use in the population at large. This is one of the reasons that past research has shown that the most potent demand-reducing influences on tobacco use have been interventions that affect virtually all smokers repeatedly, such as higher taxes on tobacco products, comprehensive advertising bans, package warnings, mass media campaigns, and smoke-free policies (Chaloupka et al. 2000, 2002; Cummings 2002; Cummings & O'Connor 2009; Hammond et al. 2007; O'Keefe 1971; Sweanor 2000; Tauras & Chaloupka 2001, 2004; Wakefield et al. 2008; Warner 1986, 1989; Wasserman et al. 1991; World Health Org. 2003, 2008). Similarly, despite the promising evidence on the efficacy of different stop-smoking treatments, little evidence exists to support the idea that any of these therapies have dramatically influenced rates of

Agent: agent factors, such as the manufacture and design of cigarettes, include those things whose presence is essential for tobacco use

Host: host factors include the characteristics of individuals (e.g., age, gender, occupation, living arrangements, risk perceptions, biology) that influence tobacco use

Environment: environmental factors include all factors that are external to the individual (host) and agent that influence tobacco use (e.g., government policies, access to stop-smoking services)

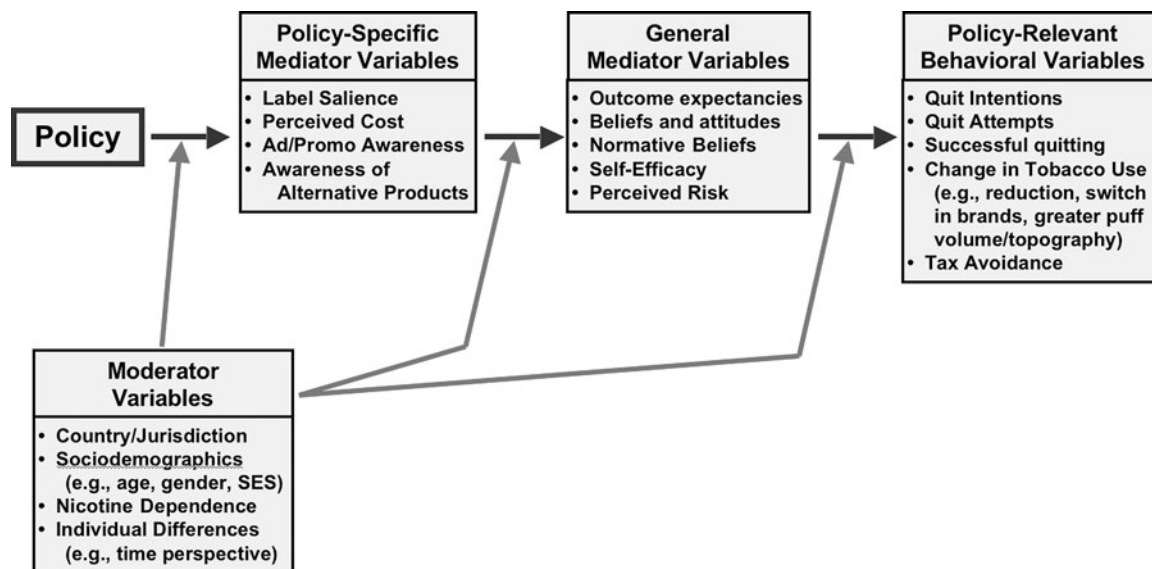


Figure 2

Conceptual model illustrating the hypothesized causal chain of how tobacco control policies influence on tobacco use behaviors (after Fong et al. 2006a).

tobacco use in the population at large because too few smokers use them when they try to quit (Cokkinides et al. 2005; Cummings & Hyland 2005; Cummings & Mahoney 2008; Cummings & O'Connor 2009; Zhu et al. 2000).

An understanding of the mechanisms by which tobacco control interventions are likely to exert their influence is important for several reasons: (a) it can help to differentiate the effects of a specific intervention from other possible causes; (b) it can help explain differential effects across groups or situations (i.e., clarify why moderation occurs); (c) it can be used to diagnose problems when the intended effects did not occur; and (d) it can potentially facilitate the development of new, and hopefully improved, strategies, including ways to better reach more resistant or needy groups (Intl. Agency Res. Cancer 2008). **Figure 2** presents the general causal chain model of the processes by which tobacco control policies affect individuals (Fong et al. 2006a, Intl. Agency Res. Cancer 2008). In this model, tobacco control policies are seen as affecting a variety of psychosocial and behavioral variables. The most immediate effects

are those variables that are connected most directly with the policy itself. For example, new graphic warning labels would be expected to increase salience and noticeability; price adjustments should affect perceived expense or costs of cigarettes (e.g., belief that cigarettes have become too expensive), and lifting restrictions on alternative nicotine products should lead to increased awareness of the availability of those products. These in turn may increase the likelihood of discrete behaviors, such as smokers hesitating before smoking, or even forgoing cigarettes.

Further down the causal chain are more general mediator variables that are more distant from the policy itself. These variables have been demonstrated to predict smoking behavior and changes in smoking behavior (e.g., quitting). They include variables such as attitudes, normative beliefs, and intentions, and are taken from well-known psychosocial models of health behavior such as the Theory of Planned Behavior (Ajzen 1991), Social Cognitive Theory (Bandura 1986), the Health Belief Model (Becker 1974), and Protection Motivation

Theory (Rogers & Prentice-Dunn 1997). In this conceptual model, policies affect these general mediator variables indirectly, via their prior effects on the more policy-specific variables.

In this model, the tobacco-specific behaviors include not only those that confer benefits (e.g., quitting), but also important compensatory behaviors that the persons may engage in that, although responsive to the policy, may not lead to the economic and public health benefits that are ultimately the goal of such policies. For example, in response to price increases, smokers may switch to discount brands, which would confer no public health benefit.

Finally, moderator variables include those factors that change the magnitude of the effects of an intervention without necessarily being changed by the intervention. They often include sociodemographic characteristics (e.g., age, gender, SES, cultural background) and psychological factors that are assumed to be stable or that the intervention is not designed to change (e.g., stress).

TOBACCO CONTROL INTERVENTIONS

Tobacco control interventions can be grouped into three categories that describe the primary intent of the intervention. These include (a) interventions designed to directly influence tobacco users and potential users, such as educational campaigns, product warnings, and provision of stop-smoking services; (b) interventions that indirectly influence the tobacco user by changing the social contexts that affect incentives for tobacco use, such as taxes and rules about where tobacco can be used; and (c) interventions that indirectly influence the tobacco user by constraining the marketing practices of the tobacco industry (Intl. Agency Res. Cancer 2008). Interventions are needed to influence all three of these general domains to act in ways more consonant with health promotion. The challenge is to apply rigorous science to ensure that the most appropriate and effective

mix of strategies for controlling tobacco use is adopted. The following sections of this review attempt to summarize the evidence regarding the effectiveness of each of these approaches in controlling tobacco use.

Interventions to Directly Influence Tobacco Users and Potential Users

Consumer education. The extent to which smokers understand the magnitude of the health risks associated with using tobacco affects the strength of the influence that this knowledge has on behavior (Cummings 2002; Warner 1986, 1989). At present, most smokers concede that tobacco use is a health risk; however, important gaps remain in their understanding of these risks, and the level of knowledge is not uniform across the globe (Ayanian & Cleary 1999, Borland et al. 2004, Cummings et al. 2004, Shiffman et al. 2001, Siahpush et al. 2006b, Weinstein et al. 2004). For example, many smokers fail to appreciate that switching to a low-tar and/or filtered cigarette does not make smoking less hazardous (Shiffman et al. 2001). Also, smokers tend to be overly optimistic about their personal risk of illness (Ayanian & Cleary 1999).

Communicating the health effects of smoking remains a primary goal of tobacco control policy (Fiore et al. 2004, Frieden et al. 2005, Inst. Med. 2007, World Health Org. 2008). Government efforts to warn the public about the dangers of tobacco use have included (a) requiring information about the health risks of tobacco to be present in advertising and on tobacco packages, (b) sponsoring antismoking campaigns through the mass media, and (c) issuing reports summarizing information on the health risks of using tobacco. The impact of each of these efforts on cigarette smoking behavior is described below.

Pack warnings. The provision of health warnings and/or product information on tobacco packages is an important means of informing consumers about the health risks of

smoking as a first step toward changing behavior. Nearly all countries throughout the world require package warning labels on cigarettes, although the content and size of the warnings vary widely (Hammond 2008a,b). Several countries (e.g., Australia, Brazil, Canada, Singapore, and Thailand) have mandated picture-based warnings that cover at least half of cigarette packages. **Figure 3** provides an example of a graphic pack warning used in Australia.

Research indicates that warning labels on cigarette packs are a salient means of communicating with smokers, although their effectiveness depends upon their size and comprehensiveness: Obscure text-only messages are unlikely to be noticed, whereas large pictorial warnings are effective in engaging smokers and promoting message recall (Borland & Hill 1997; Hammond et al. 2006b, 2007; Thrasher et al. 2007a,b). A recent study comparing reports of adult smokers in Canada, Australia, the United Kingdom, and the United States found that two-thirds of smokers cited cigarette packages as a source of health information, with a significant association between the strength of package health warnings and the likelihood of citing packages as a source of health information (Hammond et al. 2006b, 2007). In short, larger, more comprehensive warnings were more likely to be cited as a source of health information. Not only were health warnings self-identified as an important source of health information about smoking, but they also were identified as an effective means of communicating health information. The results provide evidence at both the individual and country-level that health warnings on cigarette packages are strongly associated with health knowledge. Health knowledge was found to be strongly associated with intentions to quit among smokers in all four countries. Deeper cognitive processing of warnings and behavioral reactions to them (e.g., forgoing a cigarette after noticing the warning) are prospectively predictive of making quit attempts but are not related to success among those who try (Borland et al. 2009). This finding supports previous evidence that

warnings serve as an important source of motivation for quitting (Hammond et al. 2006b, 2007).

Informational campaigns. Research indicates that antitobacco mass media campaigns, when adequately funded, can be effective in reducing cigarette consumption (Fichtenberg & Glantz 2000; Hamilton 1972; Hyland et al. 2006; O’Keefe 1971; Siegel & Biener 2000; Wakefield et al. 2008; Warner 1986, 1989). The first large-scale national counteradvertising campaign to educate the public about the health risks of tobacco use occurred in the United States between 1967 and 1970, when the Federal Communications Commission required licensees who broadcast cigarette commercials to provide free media time for antismoking public service announcements under the Fairness Doctrine (Hamilton 1972; O’Keefe 1971; Simonich 1991; Warner 1986, 1989). Between 1967 and 1970, cigarette consumption in the United States dropped at a much faster rate than during the period immediately before or after the time when the Fairness Doctrine antismoking campaign was operational (Warner 1986, 1989). Subsequent studies in several states and other countries have confirmed that adequately resourced mass media campaigns that have the objective of educating the public about the risks of smoking lead reductions in cigarette consumption (Fichtenberg & Glantz 2000, Frieden et al. 2005, Harris et al. 1997, Hyland et al. 2006, Siegel & Biener 2000, Stillman et al. 2003, Wakefield et al. 2008). Pierce & Gilpin (2001) have shown that the level of news media coverage of smoking and health in the United States from 1950 to the early 1980s mirrored population trends in awareness about smoking as a cause of lung cancer and in rates of smoking cessation.

Official reports. The publication and dissemination of scientific information on the health consequences of tobacco use represent the least coercive of government interventions to combat tobacco (Pierce & Gilpin 2001, Simonich 1991). Because these reports

frequently receive extensive media coverage and are widely disseminated, they have helped educate the public about the health risks of tobacco (Cummings 2002; Pierce & Gilpin 2001; Simonich 1991; Warner 1986, 1989).

Several studies suggest that the first U.S. Surgeon General's Report in 1964 contributed to a drop in cigarette consumption (Hamilton 1972, Simonich 1991, Warner 1989). Recent reports have helped influence policy development on such issues as secondhand smoke exposure, nicotine addiction, and youth tobacco use (Pierce & Gilpin 2001). The impact of this effort on tobacco use behavior is impossible to measure precisely; however, information dissemination is essential to the formulation of other policy initiatives. Without appropriate information, it is difficult to form the popular consensus necessary to create and enforce more restrictive policies.

Tobacco cessation interventions. Historically, the vast majority (>90%) of former smokers have reported that they stopped smoking without receiving formal assistance or help from anyone (Fiore et al. 1990). However, in high-income countries, this statistic is changing with the introduction and wide availability of effective drug therapies to help smokers alleviate withdrawal symptoms commonly associated with cessation (Cummings & Hyland 2005, Cummings et al. 2006b). First-line pharmacotherapy to support a quit attempt includes nicotine replacement (i.e., gum, patch, lozenge, nasal spray, or inhaler), bupropion, or varenicline; the use of these agents can increase quit rates by 1.5- to three-fold (Brunnhuber et al. 2007, Cummings & Mahoney 2008, Fiore et al. 2008). Several studies have shown that combining the nicotine patch with either gum or nasal spray can increase quit rates over a single-modality therapy (Cummings & Mahoney 2008).

Recent comprehensive reviews of the efficacy of different stop-smoking treatments indicate that providing both pharmacotherapy and counseling support for all quit attempts helps to optimize rates of cessation (Brunnhuber

et al. 2007, Cummings & Mahoney 2008, Fiore et al. 2008). However, the potential impact of current and emerging treatments for tobacco dependency will depend not only on their efficacy, but also on the extent to which these treatments reach those who might benefit from them. Even in high-income countries where access to pharmacotherapy would be expected to be reasonably high, evidence is lacking to support the idea that therapies for treating nicotine dependency have dramatically influenced rates of tobacco use on a population level (Cokkinides et al. 2005, Cummings & Hyland 2005, Cummings & Mahoney 2008, Orleans et al. 2006, Zhu et al. 2000). The main reason for this failure is the generally low utilization of these therapies, which may be due in part to the failure of health-care workers to aggressively assist their tobacco-using patients in quitting (Brunnhuber et al. 2007, Cokkinides et al. 2005, Fiore et al. 2004, Inst. Med. 2007, Orleans et al. 2006). Policies that can increase the reach, appeal, and use of effective cessation treatments, such as promotion of a national quitline number on cigarette packs, the development and marketing of stop-smoking treatments that are more appealing to consumers, and the creation of health care systems that require cessation treatment to be offered as routine care, hold great untapped potential to reduce overall adult smoking prevalence and growing disparities in tobacco use in the future (Brunnhuber et al. 2007, Cummings & Mahoney 2008, Fiore et al. 2004, Inst. Med. 2007, Orleans et al. 2006).

Interventions to Alter Incentives to Use Tobacco

It is well recognized in economic theory, as well as in everyday life, that incentives can influence behavior (Watson 1972). As the costs (both financial and psychological) of obtaining and using tobacco increase, consumption would be expected to decrease. Thus, policies that make it more costly to use tobacco, such as taxes and limitations on where one can smoke, would logically be expected to discourage tobacco use (Chaloupka et al. 2002; Farrelly et al.

Price elasticity: in economics, price elasticity is the ratio of the change in one variable with respect to change in another variable, such as the responsiveness of the price of a commodity to changes in market demand or vice versa

2001; Jha & Chaloupka 1999; Jha et al. 2006; Simonich 1991; Tauras & Chaloupka 2001, 2004; Townsend et al. 1994).

Taxation. The price of tobacco products is determined by the manufacturer's price, wholesale and retail markups, and tobacco taxes. Significant increases in cigarette and other tobacco product taxes are widely considered a highly effective policy in reducing tobacco use (Jha & Chaloupka 1999, Jha et al. 2006). Tax increases are effective in inducing current tobacco users to quit, preventing youth from becoming regular users, keeping former users from restarting, and reducing the amount consumed by continuing users (Chaloupka et al. 2000). When the revenues from these taxes are used to support other tobacco control efforts (e.g., enforcement of tobacco control policies, mass media information campaigns, and increased access to cessation services and products), the impact is increased.

Considerable economic research over the past three decades has clearly demonstrated that increases in tobacco taxes and prices are effective in reducing tobacco use (Chaloupka et al. 2000; Frieden et al. 2005; Hyland et al. 2006; Jha & Chaloupka 1999; Jha et al. 2006; Ross & Chaloupka 2006; Simonich 1991; Tauras & Chaloupka 2001, 2004; Townsend et al. 1994). The price elasticity of demand is defined as the percentage change in consumption resulting from a 1% increase in price. Well over 100 studies from high-income countries consistently have found that a 10% increase in cigarette prices will lead to relatively immediate reductions in overall tobacco use of between 2.5% and 5% (Chaloupka et al. 2000). About half of the impact on aggregate consumption results from reductions in the prevalence of smoking; the other half results from reductions in cigarette consumption among continuing smokers (Chaloupka et al. 2000). Growing evidence from low- and middle-income countries suggests that a 1% price increase reduces overall smoking by up to twice as much as in high-income countries (Jha & Chaloupka 1999, Ross & Chaloupka 2006). Given the addictive nature

of tobacco use, the impact of a permanent price increase will take several years to fully appear as addicted users respond to the increase in price; estimates from the United States suggest that the long-run reductions in use resulting from a permanent price increase are about double the short-run effects (Chaloupka et al. 2000).

The reductions in prevalence caused by tax and price increases are largely the result of increased cessation among current tobacco users. Higher taxes and prices lead numerous users to try to quit; although many eventually relapse, a significant number are successful in the long term (Tauras & Chaloupka 2001, 2004). In addition, key populations such as youth and those on low incomes are particularly sensitive to price. Growing evidence indicates that higher taxes and prices are particularly effective in reducing the number of youth who initiate regular smoking (Tauras & Chaloupka 2001). Similarly, as implied by economic theory, tax and price increases lead to greater reductions in tobacco use among low-income, less-educated populations than among higher-income, more-educated persons (Farrelly et al. 2001, Townsend et al. 1994).

Although tobacco taxation is a fairly direct means of influencing consumption, it can also have adverse effects that actually do harm to tobacco control efforts. For example, in parts of Africa (e.g., Malawi) and rural China, government officials have become so dependent on tobacco sales that there is little incentive for them to support programs and policies that would discourage people from using tobacco (Cummings & O'Connor 2009). Even in high-income countries, tobacco taxation is a double-edged sword because it may prevent government officials from enacting truly effective tobacco control policies for fear that tax revenues would decline. Also, higher taxes on tobacco products bring the real threat of illegal enterprises taking advantage of opportunities for tax evasion. Cigarettes are the world's most widely smuggled legal consumer product (Euromonitor 2006, Joossens & Raw 1998).

Taxing tobacco is not the only way to influence the price of tobacco products. For

example, policies that affect the marketing of tobacco products, such as rules dictating minimum package size, banning product sampling, or restricting the use of coupons and price promotions, all can affect consumer demand (Chaloupka et al. 2002, Wakefield et al. 2002a). Differential tax policies on different forms of tobacco can also influence demand (Chaloupka et al. 2000, Hyland et al. 2005, Young et al. 2006). For example, in Western Europe, the impact of rising taxes on cigarettes may have caused some smokers to switch to roll-your-own cigarettes because loose tobacco is taxed at a lower rate, making it a cheaper substitute for factory-made cigarettes (Young et al. 2006).

Restriction on where tobacco can be used.

Fifty years ago, virtually no laws regulated smoking in public locations such as schools, public transportation, government buildings, elevators, and restaurants. However, as scientific studies regarding the health consequences of secondhand smoke exposure began to emerge in the 1980s, attitudes about smoking began to shift, and policies limiting where people could smoke increased (Hyland et al. 2008a,b, 2009). Today, nearly all countries have laws restricting smoking in at least some public places and workplaces, and more than 20 countries have adopted and implemented comprehensive smoke-free laws that prohibit smoking in nearly all public venues including bars and restaurants (Borland et al. 2006b; Fong et al. 2006b; Hyland et al. 2008a,b, 2009; Simonich 1991; Wasserman et al. 1991).

Although rules limiting the locations where people can smoke are intended to protect the health of nonsmokers, these rules have helped redefine the social context for smoking, making it less acceptable, less convenient, and less pleasurable, thereby encouraging cessation and discouraging uptake of smoking (Bauer et al. 2005; Borland et al. 2006a,b; Chapman & Freeman 2008; Fong et al. 2006b; Hyland et al. 2008a, 2009). Smoke-free policies reduce overall cigarette consumption and increase quitting activity (Bauer et al. 2005, Borland et al. 2006a, Frieden et al. 2005, Hyland et al. 2006,

Simonich 1991, Wasserman et al. 1991). The theorized mechanism of action is that smoke-free laws increase the likelihood of quitting by decreasing the number of opportunities to smoke and reducing cues for smoking; this also reduces the likelihood of relapse after a quit attempt (Bauer et al. 2005, Fong et al. 2006a).

Interventions to Constrain Tobacco Product Marketing

Tobacco industry controls are achieved through a mix of laws and agreements that generally target manufacturers/distributors but in some cases are aimed at other points in the supply chain (e.g., retailers) (Intl. Agency Res. Cancer 2008, Inst. Med. 2007, World Health Org. 2003). Evaluation of tobacco industry controls also requires an analysis of possible industry actions to counter the intended effects or to otherwise minimize adverse effects on their business. Tobacco industry control typically falls into the four P's of marketing: price, product, promotion, and place.

Price controls. Price controls include policies designed to affect price-related marketing, such as setting values for minimum and/or maximum prices to prevent discounting and to limit smuggling and counterfeiting (Chaloupka et al. 2000). Policies that affect the structure of the tobacco product market and the costs of producing tobacco products and that prevent tax avoidance and smuggling can change prices in ways that influence tobacco use behaviors (Chaloupka et al. 2000). In countries where the tobacco product markets are dominated by one firm and/or where the costs of production rise rapidly with output, it is likely that an increase in tobacco product taxes will result in less-than-comparable increases in tobacco product prices, particularly when tobacco use is relatively responsive to changes in price (Jha & Chaloupka 1999, Jha et al. 2006, Ross & Chaloupka 2006). In contrast, in countries where the tobacco product markets are highly competitive and where per-unit production costs are independent of output, increases in

tobacco taxes are likely to result in comparable increases in the prices of tobacco products.

International trade agreements can also have a major impact on the price and marketing of tobacco products (Cummings & O'Connor 2009). Over the past decade, there has been a trend toward dismantling state-owned tobacco monopolies in favor of allowing privately owned tobacco companies to compete for market share in a country (Connolly 1992, Euromonitor 2006). The result of this trend has been an increased demand for tobacco fueled by lower prices and increased marketing. Future trends in tobacco consumption, especially in Southeast Asia, the Middle East, and parts of the African continent where manufacturing monopolies remain, are likely to be influenced by trade agreements that permit private multinational tobacco corporations to enter a market and compete with state-owned tobacco companies (Connolly 1992, Cummings & O'Connor 2009, Euromonitor 2006, World Health Org. 2008).

Industry consolidation is another trend that is likely to influence tobacco marketing and pricing. Between 1990 and the end of 2003, there were more than 50 major changes of ownership of privately owned tobacco companies (Euromonitor 2006). The result of these acquisitions has been a smaller number of companies controlling a larger share of the worldwide cigarette market, the emergence of global superbrands, and cost savings obtained through consolidation of marketing and distribution channels.

Cross-border discrepancies in prices brought about by tax increases or other reasons promote tax avoidance and smuggling (Chaloupka et al. 2000; Euromonitor 2006; Hyland et al. 2005, 2006b; Jha & Chaloupka 1999; Jha et al. 2006; Joossens & Raw 1998; Young et al. 2006). It is estimated that approximately one-third of all legally exported cigarettes end up illegally smuggled across international borders (Euromonitor 2006). Cigarette smuggling has the effect of increasing the number of smokers by providing a less-expensive supply of cigarettes (Joossens

& Raw 1998). Cigarette smuggling also has an indirect impact on the adoption of demand-reducing policies such as cigarette taxation because the threat of smuggling can discourage governments from raising cigarette and other tobacco taxes or can lead others to reduce their taxes, resulting in lower prices than would exist in the absence of smuggling (Chaloupka et al. 2000, Jha & Chaloupka 1999, Jha et al. 2006, Joossens & Raw 1998).

Counterfeiting involves illegally manufacturing and distributing tobacco products without a license, often imitating an established brand. The market for counterfeit cigarettes has grown in recent years as cigarette prices have increased and the distribution system for contraband cigarettes has expanded due in part to Internet sales (Euromonitor 2006, VanderBeken et al. 2008). Increasingly, countries are adopting strong antismuggling policies that include marking cigarettes to allow better tracking and identification of smuggled products, mandatory licensing of all parties involved in cigarette distribution, chain-of-custody record keeping to allow for tracking of cigarettes from the factory to the final country of sale, and the elimination of duty-free sales, which have in the past served as a major source of smuggled cigarettes (World Health Org. 2003, 2008). Regional agreements between countries, such as that governing the European Union, have begun to evolve on issues such as taxation and systems for tracking the distribution of tobacco products to reduce incentives for smuggling and counterfeiting. In the United States, credit card companies and major private shippers have recently agreed to not accept charges for cigarettes from Internet retailers and to not deliver cigarettes to individuals in an effort to stem the flow of low-taxed and counterfeit cigarettes. These agreements resulted in a 50% reduction in Internet sales of tobacco products (Li et al. 2008).

Product controls. Product controls include rules about what types of products can be sold (e.g., smokeless tobacco is banned from sale in some jurisdictions), disclosure of information

about products (e.g., tar and nicotine levels), requirements for testing products, and mandated performance standards for products (Intl. Agency Res. Cancer 2008, Inst. Med. 2007, World Health Org. 2003). The evidence suggests that product controls can have a major impact on consumer behavior, although the effects are not always beneficial in terms of public health outcomes.

Product bans. Legal bans on the sale of tobacco products have not been widely used by governments as a means to control the harm caused by tobacco, and as a result there is little experience available to evaluate the impact of such bans on tobacco use and population health (Cummings & O'Connor 2009). Bhutan is the only country that has adopted a law banning the sale of cigarettes. A small number of countries have adopted laws limiting the sale of several forms of smokeless tobacco, and several countries have prohibited the sale of certain classes of tobacco products, such as high-tar cigarettes (Cummings & O'Connor 2009, Masironi 1993).

Most experts suggest that a complete prohibition on the sale of cigarettes is infeasible given the large number of smokers present in most countries, the economic benefit that many countries derive from tobacco (albeit illusory in most cases), and the ease of access to cigarettes across borders (Ferrence 2003). Even so, some governments have attempted to control the distribution of tobacco products by enacting laws that restrict how tobacco products are distributed and to whom they may be sold. For example, many governments have laws that prohibit the sale of tobacco products to minors (Cummings 2002). A smaller number of governments have enacted laws designed to control the distribution of tobacco products, such as bans on sampling, retail licensing, vending machines, mail delivery of tobacco products, and cross-border sales. The impact of these laws on tobacco product consumption has not been fully determined (Cummings 2002). Emerging evidence suggests that the regulations on the purchase, use, and possession of tobacco prod-

ucts by minors have little effect on youth smoking prevalence (Ling et al. 2002).

Some countries have tried to prohibit the sale of specific types of tobacco products, such as smokeless tobacco and high-tar cigarettes, usually with the intention of removing products perceived as particularly risky from the market. For example, in 2004, the European Commission implemented new maximal values for tar (10 mg), nicotine (1 mg), and carbon monoxide (10 mg) per cigarette as measured using the International Organization for Standardization method (O'Connor et al. 2006c). A similar policy has recently been adopted in China, which issued a regulation banning the sale of cigarettes above 15 mg/stick after July 2004 (O'Connor et al. 2008). In effect, these policies act as a ban on products that do not meet these standards.

Government bans on the sale of certain forms of smokeless tobacco products exist in several places including Australia, the member countries of the European Union except for Sweden, and in Israel, Hong Kong, New Zealand, Singapore, Taiwan, Saudi Arabia, and Bahrain (Masironi 1993). The main basis for banning the sale of smokeless tobacco was concern about health risks and increases in oral snuff usage, particularly among young people, following large-scale advertising and promotion campaigns as had occurred in the United States and elsewhere in the 1980s. The impact of these laws on tobacco use behaviors and health risks is unknown, and some evidence suggests compliance may not be complete. For example, in Taiwan, betel nut quid with loose-leaf tobacco is widely sold and used. A recent study in Australia found that smokeless tobacco was sold in 94% of South Asian grocery shops in Sydney (Sachdev & Chapman 2005).

Product reporting and disclosure policies. Tobacco product reporting and disclosure are closely related, although they represent distinct activities (Hammond 2008b, Intl. Agency Res. Cancer 2008, World Health Org. 2003). Whereas reporting guidelines dictate what information must be reported to regulatory authorities, disclosure guidelines establish how

this information is disseminated and to whom. Without explicit disclosure guidelines, the information reported by tobacco companies proves difficult or impossible to access and adds little value to tobacco control efforts.

Reporting requirements for cigarettes are significantly more advanced than for other tobacco products (Hammond 2008b). In the United States, the ingredients and nicotine content of smokeless tobacco products must be reported under federal law; however, no such requirements exist for “fine-cut” or loose tobacco, cigars, or other tobacco products (Hammond 2008b). At present, reporting guidelines vary considerably across jurisdictions. In the United States, the Federal Cigarette Labeling and Advertising Act requires tobacco companies to report a full list of cigarette ingredients, including “additives” and flavorings (Cummings 2002). More comprehensive ingredient reporting has been implemented in jurisdictions outside the United States, including Canada, Brazil, Thailand, and the European Union (Hammond 2008b). In Canada, for example, companies must report the quantity of all ingredients in each brand, including the ingredients used in the cigarette paper and filler. Companies must also report the level of 26 chemical constituents found in the tobacco. Before 1987, the United States Federal Trade Commission (FTC) tested the levels of tar, nicotine, and CO emissions in its own laboratory using the FTC smoking method (Cummings 2002). Since the closure of the FTC laboratories in 1987, the Tobacco Institute Testing Laboratory has been required to provide annual reports on tar, nicotine, and CO emissions pursuant to an FTC subpoena. Massachusetts and Texas require disclosure of nicotine yield using a more intensive machine-smoking method. Minnesota and Utah also require tobacco manufacturers to report the presence—though not the amount—of the following emissions for each brand: arsenic, cadmium, formaldehyde, lead, and ammonia or any ammonia compound. More comprehensive emission reports are required in other countries such as Canada and Brazil (Hammond 2008a,b).

In Canada, manufacturers are required to report the level of 41 chemical emissions found in tobacco smoke. The emissions must be reported for both mainstream and side-stream smoke, and they must be generated using different machine-smoking methods, a requirement that is intended to give a range of emissions.

Without explicit disclosure guidelines, the information reported by tobacco companies proves difficult or impossible to access and adds little value to tobacco control efforts. This is the case with many of the reporting guidelines described above. In the United States, there are no requirements to print emission levels on packages (Hammond 2008a,b). However, a number of manufacturers do so voluntarily, albeit in a highly selective fashion. In 2004 and 2005, tar levels were printed on more than 90% of U.S. brands with less than 3 mg of tar, compared to fewer than 2% of brands with 8–11 mg of tar (O'Connor et al. 2006b). Similar practices have occurred in other jurisdictions, such as Brazil, where regulators have removed the requirement to print numbers but have not prohibited manufactures from doing so (Hammond 2008a,b).

Other jurisdictions, including the European Union and China, require manufacturers to print levels of three emissions: tar, nicotine, and carbon monoxide on packages (Hammond 2008a,b). Research has repeatedly shown that although many smokers are not able to recall the specific tar level of their brand, a substantial proportion nevertheless equate lower numbers with a reduction in exposure and risk, and many use these numbers to guide their choice of brands (O'Connor et al. 2006b). These findings are consistent with the ways in which smokers have been shown to perceive emission numbers when conveyed through advertising (Borland et al. 2004, 2008; Cummings et al. 2004, 2006a; Hammond 2008a,b; King & Borland 2005; O'Connor et al. 2006b, 2007; Shiffman et al. 2001). Given the current scientific consensus that emissions data do not accurately reflect meaningful differences in risk between conventional cigarette brands, the World Health Organization (WHO) has called

for the removal of emission numbers from packages (Hammond 2008a,b; World Health Org. 2003).

Product performance standards. Because cigarettes are an important cause of residential fires, some governments have recently implemented standards for cigarette ignition propensity (Connolly et al. 2005). In 2004, New York State became the first jurisdiction to mandate fire safety standards for cigarettes (O'Connor et al. 2006a). In 2005, Canada became the first country to adopt a fire safety standard for cigarettes (O'Connor et al. 2007b). Both the New York and Canadian law require cigarette brands licensed for sale to meet a performance standard whereby the cigarettes self-extinguish on a standardized test. Preliminary data from New York State suggest that the law has reduced smoking materials fires—however, what remains unknown is whether design changes engineered into the cigarette in order to meet the fire safety standard has altered smoking behavior in ways that might potentially lead smokers to smoke differently (Connolly et al. 2005, 2006a, 2007b; O'Connor et al. 2007b).

Concern over the fire safe cigarette standard raises the larger question of how product modification designed to reduce harm in one regard might inadvertently increase harm in areas that were unintended. Many countries have established emission limits pertaining to cigarette smoke-generated tar, nicotine, and in some cases, carbon monoxide levels (Hammond 2008a; O'Connor et al. 2006c, 2009). The concept of establishing tobacco smoke emission ceilings as a means of lowering toxicants in cigarette smoke is not new and is analogous to other regulatory approaches applied to automobiles, factories, and power plants. However, as public health officials now know, mandating emissions limits using a flawed performance standard can inadvertently result in communicating meaningless distinctions among brands (O'Connor et al. 2006c). For example, in 2004 the European Commission implemented new maximal values for tar (10 mg), nicotine (1 mg) and carbon monoxide (10 mg) per cigarette, as

measured by machines using the International Organization for Standardization method. Unfortunately, cigarette manufacturers merely increased filter ventilation in their brands to meet the performance standard (O'Connor et al. 2006c). Studies reveal that increasing filter ventilation allows smokers to take bigger puffs meaning that actual exposures to smoke toxicants would remain essentially unchanged, although some smokers may believe this not to be the case (Hammond et al. 2005, 2006a; Kozlowski et al. 2006).

Promotional controls. Controls on promotion are the most prominent form of control on the industry (Saffer 2001, Simonich 1991, World Health Org. 2008). These include bans on paid advertising, sponsorships, restrictions on packaging (including controls on the use of trademarks—e.g., generic packaging) (Hamilton 1972; Harris et al. 2006; King & Siegel 2001; Saffer 2001; Simonich 1991; Warner 1986, 1989; Wasserman et al. 1991). The impact of voluntary and government restrictions on tobacco advertising and promotion has been the subject of many research studies (Borland et al. 2008; Farrelly et al. 2001; Hamilton 1972; Harris et al. 2006; Kessler 2006; King & Borland 2005; Saffer 2001; Simonich 1991; Wakefield et al. 2002a,b; Warner 1986, 1989; Wasserman et al. 1991). In a recent review of the evidence on the effectiveness of advertising bans, Saffer (2001) concluded that cigarette consumption is reduced when a comprehensive advertising ban is implemented. Saffer (2001) noted that in countries that have enacted partial advertising bans, the industry has typically found ways to get around the restrictions by increasing advertising expenditures in alternative venues. For example, following the 1971 broadcast advertising ban in the United States, cigarette marketing expenditures increased and were redirected into print and billboard advertising and promotions (Simonich 1991; Warner 1986, 1989). Evidence suggests that the same thing occurred following the 1998 master settlement agreement, when advertising revenue shifted from billboards and

magazines to point-of-sale and retail marketing incentives (King & Siegel 2001, Wakefield et al. 2002b).

Packaging provides a direct link between consumers and manufacturers, and serves as a vital channel for product communications (Goldberg et al. 1999, Hammond 2008b, Wakefield et al. 2002a). Packaging controls include rules related to the use of product descriptors, colors and package size. For example, jurisdictions have prohibited the sale of single cigarettes or have established a minimum pack size to stop the use of packs with small numbers of sticks, which are known to appeal primarily to young people and to counteract tax policies (Hammond 2008b).

Tobacco manufacturers incorporate a variety of common terms into the names of their cigarette brands. Words such as “light” and “mild” are ostensibly used to denote flavor and taste; however, light and mild brands are often promoted as “healthier” products and are typically applied to brands with filter ventilation that generates lower machine levels of tar. Not surprisingly, light and mild brands are perceived by many consumers to deliver less tar and to lower risk compared with regular or full-flavor varieties, despite evidence to the contrary. Research suggests the marketing of such brands can forestall quitting among health-concerned smokers (Borland et al. 2004; Cummings et al. 2004; Hammond 2008b; King & Borland 2005; Kozlowski et al. 2006; Leavell 1999; O’Connor et al. 2007a,c; Shiffman et al. 2001).

In 2006, a U.S. Federal District Court ruled that the terms “low tar,” “light,” “ultra light,” and “mild” are deceptive, and a court order prohibited their use (Cummings & O’Connor 2007, Kessler 2006). These terms have already been removed in a number of jurisdictions, including Brazil, the EU member countries (i.e., United Kingdom, France, Germany, etc.), and Australia (Borland et al. 2008, Hammond 2008b). Although the terms light, mild, and low tar are the most notable examples of misleading brand descriptors, they are by no means the only ones. Indeed, a wide variety of other descriptors has been designed to reinforce the

same beliefs and perceptions. For example, the term “smooth” has been used as a replacement for light and mild in a number of jurisdictions with prohibitions. Recent findings suggest that smooth conveys the same misleading perceptions of reduced risk as light and mild (Hammond 2008b). Other common substitutes for light and mild include the names of colors, such as silver and blue, which capitalize on the perceptions of these colors as being lighter (Hammond 2008b, King & Borland 2005, Wakefield et al. 2002a).

Research has shown that consumers associate the “lightness” and “strength” of a brand with different colors (Wakefield et al. 2002a). For example, blue tones are perceived as “lighter” than red, while products in gray and white packages are perceived to be the “lightest.” Different shades of the same color can also be used to manipulate perceptions of strength, as well as the proportion of white space on the package. Even the color of the tipping paper is altered according to the “strength” profile of a cigarette. The variety of brand descriptors and other design elements that are used to communicate risk represents a considerable challenge for regulators. In theory, all misleading information should be prohibited, which is what has prompted some experts to advocate for plain packaging (Hammond 2008a,b). Plain packaging would standardize the appearance of cigarette packages by requiring the removal of all brand imagery, including corporate logos and trademarks. In this scenario, packages would display a standard background color and manufacturers would be permitted only to print the brand name in a mandated size, font and position. At present, plain packaging for tobacco products has yet to be introduced in any jurisdiction. Research to date suggests that plain packaging is less attractive and engaging, particularly to young people, and may increase salience and believability of package health warnings (Goldberg et al. 1999, Hammond 2008b).

Place controls. Place or availability controls refer to efforts to reduce the availability of

the products and include restrictions on the number or types of outlets and who they can be sold to (e.g., age limits and bans on vending machines) (Intl. Agency Res. Cancer 2008, Inst. Med. 2007, World Health Org. 2003). Many of the existing rules have been put in place to discourage use by young people, but restrictions could also be used to reduce impulsive purchases and/or to discourage use in certain venues (e.g., bans on vending machines and sales in bars). Industry documents reveal a strategic interest in placing marketing in locations where young people congregate (Cummings et al. 2002). One Philip Morris report describes product sampling and promotion activities at ski resorts and different beach locations selected because these were places where young people hang out (Philip Morris Co. Inc. 1984). R.J. Reynolds sales representatives in the 1990s discussed placing marketing for Camel cigarettes in high volume cigarette outlets in close proximity to colleges and high schools where large numbers of young adults are likely to frequent (McMahon 1990, Warlick 1990). Other studies have documented how the tobacco industry used product placements in movies and other entertainment media to boost sales, and the impact of product placements on youth smoking behavior (Mekemson & Glantz 2002). Research by Sargent (e.g., Dalton et al. 2003; Sargent et al. 2005, 2007) shows that an association exists between exposure to depictions of smoking in the movies and smoking status, initiation, and established smoking among youth.

In the United States, the 1998 Master Settlement Agreement limited the placement of advertising on billboards and in youth oriented magazines (King & Siegel 2001, Wakefield et al. 2002b). However, distribution of tobacco products remains largely unregulated with the exception of a few jurisdictions have enacted laws preventing the free distribution of tobacco product samples and the sale of tobacco products in selected locations such as pharmacies (Cummings 2002, Cummings et al. 2002, Cummings & O'Connor 2009, World Health Org. 2008).

SUMMARY

This review has focused attention on the role of the environment in understanding tobacco use and tobacco control. Tobacco use as reflected in population trends are seen as the product of the interaction of agent, host, environment factors. Government policies are seen as an important modifiable environmental influence that can alter how tobacco products are designed and marketed and how consumers perceive the risks and benefits of smoking. Our analysis has focused attention on three categories of interventions: (a) those intended to directly influence tobacco users and potential users, (b) those intended to change incentives for using tobacco, and (c) those intended to influence the way tobacco products are marketed. Evidence from evaluation studies that are population based suggests that there is synergy when interventions from multiple domains are implemented together (Fichtenberg & Glantz 2000, Frieden et al. 2005, Harris et al. 1997, Hyland et al. 2006, Wakefield et al. 2008).

In the past decade, significant advances have been made in public health policies designed to reduce the health, economic, and societal costs of tobacco use throughout the world. At present, a number of countries have enacted or are on the verge of enacting tobacco control policies that would have been difficult to imagine 10 years ago (Fong et al. 2006a, Hammond 2008a, World Health Org. 2008). The global effort to reduce the burden of tobacco use has been stimulated by the Framework Convention on Tobacco Control (FCTC), which is the first global health treaty negotiated under the auspices of the World Health Organization (Intl. Agency Res. Cancer 2008, World Health Org. 2003). The FCTC was adopted by 192 countries of the World Health Assembly in 2003 and has been ratified by more than 160 countries. Ratification of the treaty obligates countries to implement a comprehensive set of tobacco control policies as shown in **Table 1**.

A fundamental premise of the FCTC is that scientific evidence can identify effective methods for reducing the global burden of tobacco

Population based: pertaining to a population defined by geopolitical boundaries (e.g., community, state, country)

Framework Convention on Tobacco Control (FCTC): World Health Organization health treaty. The treaty was adopted in 2003 and obligates ratifying countries to implement policies and programs to reduce tobacco use

Table 1 Key policy provisions of the Framework Convention on Tobacco Control

• Increase tobacco taxes
• Protect citizens from exposure to tobacco smoke in workplaces, public transport and indoor public places
• Enact comprehensive bans on tobacco advertising, promotion and sponsorship
• Regulate the packaging and labeling of tobacco products to prevent the use of misleading and deceptive terms such as “light” and “mild”
• Regulate the packaging and labeling of tobacco products to ensure appropriate product warnings are communicated to consumers. For example, obligate the placement of rotating health warnings on tobacco packaging that cover at least 30% (but ideally 50% or more) of the principal display areas and can include pictures or pictograms
• Regulate the testing and disclosure of the content and emissions of tobacco products
• Promote public awareness of tobacco control issues by ensuring broad access to effective comprehensive educational and public awareness programs on the health risks of tobacco and exposure to tobacco smoke
• Promote and implement effective programs aimed at promoting the cessation of tobacco use
• Combat smuggling, including the placing of final destination markings on packs
• Implement legislation and programs to prohibit the sale of tobacco products to minors
• Implement policies to support economically viable alternative sources of income for tobacco workers, growers, and individual sellers

use, as captured in the Foreword of the treaty, which states, “The FCTC is an evidence-based treaty that reaffirms the right of all people to the highest standard of health” (World Health Org. 2003). The text of the treaty, however, is not specific with respect to precisely what these methods are.

As tobacco control policies are formulated and implemented, it is important that they be rigorously evaluated (Fong et al. 2006a, Intl. Agency Res. Cancer 2008, Thompson et al. 2006). As intuitively appealing as it may be to put graphic photographs on warning labels or to restrict sponsorship activities of tobacco companies, it is imperative that we conduct high-quality evaluation research to provide concrete evidence for the effects of such policies. Do these policies reduce smoking frequency and increase quitting among smokers? Do different levels of intensity of a policy lead to different levels of impact? To what extent does the same policy lead to different effects in different countries?

It can be assumed that the tobacco industry is working to counteract the FCTC by using its economic power and influence to lead governments to adopt policies that, although compliant with the FCTC, are actually ineffective (Schick & Glantz 2007, Sebríe & Glantz 2007). Thus, it is more critical than ever that

researchers work to amass a strong body of evidence from methodologically sound evaluation to provide true evidence-based guidance to governments regarding the kinds of policies and programs that will be effective in reducing tobacco use.

Measuring Success

The first issue is determining the extent to which the target population is aware of the intervention, which is a function of its implementation, its dissemination, and the publicity about it (Intl. Agency Res. Cancer 2008). The second issue to evaluate is acceptance of the policy by the target population. Policies that are unpopular are more likely to be resisted. For example, a smoker who objects to smoke-free rules is more likely to ignore the rules or to seek convenient alternatives, whereas a smoker who approves and views the rules as an opportunity to gain greater control over his or her smoking, may not only comply but may also use the opportunity to either quit altogether or to reduce consumption. The third issue is evaluating both intended and unintended effects that result as a consequence of the policy. Although individually focused interventions typically restrict evaluation to measuring outcomes among those who are

encouraged to use the interventions, this is not a useful restriction for policy interventions because the goal typically is to see the overall impact on the target population. Of interest are three broad types of outcomes: improvements in knowledge, changes to attitudes and related normative beliefs, and changes to behavior patterns. Mechanisms for behavior change can be through rules and restrictions, making available alternatives or substitutes, and/or providing resources and/or skills that facilitate behavior change.

Another key aspect of policy evaluations concerns their proposed onset effects, sustainability, and the conditions under which sustained effects might be achieved. For example, provision of knowledge might be expected to have an onset effect, but we might also want a sustained effect. For example, warning labels on packs might continue to have an effect (once the information is gained) by keeping the information accessible to thought and thus be more likely to affect decision-making processes. Sustained, intended effects generally are desired. It is important to understand what, if anything, is required to sustain potential enduring effects of an intervention; that is, what endures without further intervention and what requires regular updating. Similarly, across cultures, interventions may need to be framed differently to ensure cultural relevance whereas the underlying intervention may remain stable.

Interventions need to change to maintain their relevance, in particular because the tobacco industry is very good at adapting to policy changes. For example, in response to marketing restrictions, cigarette makers shifted their advertising to direct consumer marketing and an increased emphasis on point-of-sale promo-

tions. It is important for policy researchers not only to study how policies affect consumers, but also to learn how the industry adapts its products and marketing efforts to maximize sales so that tobacco control interventions can also be modified to maintain potency. Within the host-agent-environment model, this means that tobacco control practitioners may well need to develop models for creating new immunizations for emerging strains of tobacco industry products and marketing efforts in much the same way as infectious disease experts develop models for creating new immunizations against emerging strains of influenza.

Changes to interventions may also be required as a society progresses through the innovation cycle for adopting new sets of values and behavioral options for tobacco use. Take, for example, encouraging the adoption of smoke-free homes. This happens first in the face of social disapproval or at least a lack of understanding. Somebody instituting a ban will often be asked to justify it, and some might see it as unreasonable. However, as such bans become more common, there comes a tipping point, where smoke-free environments become the norm (Borland et al. 2006b, Chapman & Freeman 2008, Hyland et al. 2009). Because justification is no longer necessary, smokers often just don't smoke when inside, and those without such bans feel a need to justify their positions. Before the tipping point, even quite intense interventions may have limited impact, as has been the case for implementing smoke-free homes. In contrast, after the tipping point, people may be readily able to change without help (as evidenced by rapid adoption of the practice in some countries (Borland et al. 2006a).

SUMMARY POINTS

1. The social environment plays a critical role in determining how innate biological factors that are involved in nicotine dependency actually are expressed at the population level.
2. Tobacco use as reflected in population trends are seen as the product of the interaction of agent, host, and environmental factors.

3. Government policies are seen as an important modifiable environmental influence that can alter how tobacco products are designed and marketed (agent factors) and how consumers perceive the risks and benefits of smoking (host factors).
4. Evidence suggests that synergy is gained when tobacco control interventions directed at agent, host, and environmental factors are implemented together.

DISCLOSURE STATEMENT

K.M. Cummings has served as a paid witness for plaintiffs in litigation against the tobacco industry; over the past two years, he has received payment from Novartis (manufacturer of nicotine replacement products) to attend two Novartis-sponsored meetings on smoking cessation as well as payment from Pfizer Corp. (manufacturer of Chantix, an FDA-approved stop-smoking drug) to talk to professional groups about smoking cessation.

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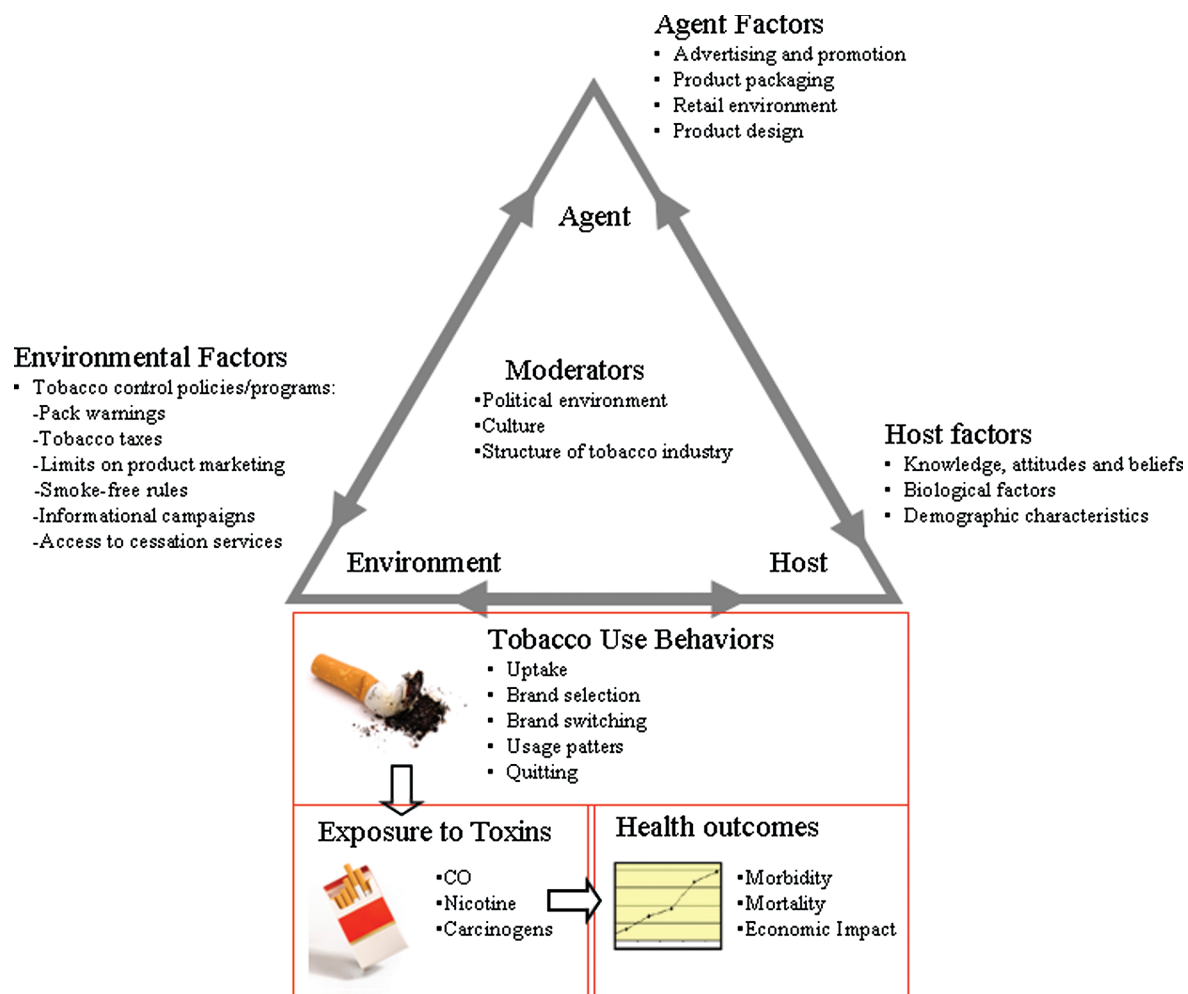


Figure 1

Agent, host, and environmental factors influencing tobacco use.



Figure 3

Example of a new graphic pack warning from Australia.