

# Smokers Who Have Not Quit: Is Cessation More Difficult and Should We Change Our Strategies?

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**INTRODUCTION** In the early 1950s, recognition that cigarette smoking is a cause of disease led to substantial and sustained efforts to persuade smokers to quit smoking and to assist them in their attempts to achieve abstinence (U.S. DHHS 2000). Approximately half of those who have ever smoked have currently quit smoking (CDC 1999b), demonstrating that successful smoking cessation is both possible and has been widely achieved.

Increasing costs of smoking, changing social norms, more successful cessation methods, and persistent and inescapable messages to quit, coupled with support for cessation, have all likely contributed to these changes in smoking behavior (CDC 1999a; U.S. DHHS 2000). However, even in the face of all of these efforts, 45 million Americans remain cigarette smokers, and the rate of decline in smoking prevalence appeared to stall during much of the 1990s (CDC 1999b; see Chapters 7 and 8). Part of this stabilization of smoking prevalence is due to a recent increase in rates of smoking initiation among adolescents (Johnston et al. in press), but there also appears to have been a decline in rates of cessation among adult smokers between the periods covered by the 1992/93 and 1995/96 Current Population Survey (CPS) (Burns et al. 2000a). The most recent CPS (1998/99) shows a rise in rates of cessation back to the levels recorded in the 1992/93 CPS. However, the slowing in the rate of decline in smoking prevalence and the fall in rates of cessation in the mid-1990s raise a question whether those smokers who are left behind by not having quit are substantively different in their ability to achieve abstinence compared with those who have quit (see Chapter 2; Warner and Burns in press 2003); that is, does the population of smokers currently targeted with cessation efforts have more difficulty in achieving long-term abstinence than previous generations of smokers, are they less likely to achieve abstinence, and have they become more resistant to existing interventions?

There are two parts to these questions. First, have those smokers who could easily quit done so, leaving behind a residual group of smokers who cannot achieve abstinence, do not want to quit, or have much more difficulty quitting? Second, are the smokers who remain less likely to be reached by existing cessation interventions or less likely to respond to them? The answers to these questions define where programmatic tobacco control efforts should invest their resources. In particular, fundamental to planning for the delivery of tobacco control activities is the question

whether we should shift resources away from current comprehensive tobacco control interventions, with their focus on media, changing social norms, and implementing public policy changes, and move resources toward more individualized and intensive cessation assistance. This monograph takes some initial steps toward answering these questions, with particular emphasis on the first of them: is there evidence that the residual population of smokers is having more difficulty achieving successful abstinence?

The chapter begins with a discussion of how hardening of the smoking population over time might be defined and what changes in a population of smokers could lead to the remaining smokers' having more difficulty achieving abstinence. We then explore the evidence for trends over time in the characteristics of smokers that reflect these changes and for trends in whether they are influencing cessation. Finally, we attempt to integrate these data to form an understanding of how the population of residual smokers has changed and what it may mean for tobacco control. While a definitive conclusion is premature, there is little evidence that cessation rates are falling due to hardening of the residual smoking population or that the residual population of smokers has become resistant to cessation or unresponsive to current tobacco control approaches.

We use the term hardening in this volume as a convenient shorthand to describe changes in difficulty of quitting, in measures of smoking behavior and cessation, in the characteristics of the smoking population, and in the smoking population's becoming more resistant to cessation interventions. There is a reasonable concern that use of this term may be demeaning to continuing smokers who cannot quit or dismissive of their cessation efforts (J. Slade, personal communication). That is not the intent of this monograph. The term is in widespread use as a description of the changing trends in smoking cessation and therefore, rather than substituting a new term, it is used here too.

**DEFINITION OF THE QUESTION** On an abstract level, the question whether, on average, the population of residual smokers has more personal difficulty achieving successful abstinence than a population who has already quit can only be answered in the affirmative. It is logically compelling that those who have successfully quit must, as a group, have had less difficulty achieving abstinence than those who, having tried to quit unsuccessfully, continue to smoke in the face of great pressure not to. These residual smokers should, as a group, also find achieving abstinence more difficult than those who have already quit successfully. This greater difficulty in achieving abstinence, and the lower rate of successful quitting that should result, could leave behind a population of smokers which is hardening over time (see Chapter 2). This definition of hardening refers to an increasing population mean in the difficulty of achieving abstinence among those who continue to smoke.

Whether this increasing difficulty in quitting over time lowers actual abstinence would depend on changes in the availability and effectiveness of cessation methods, social support for abstinence, and environmental norms

encouraging cessation. Among the forces influencing cessation rates and successful abstinence are individual characteristics of the smoker (U.S. DHHS 1990) and factors in the environment in which smoking takes place (NCI 2000). Rates of successful cessation in the population of residual smokers are likely determined by a balance between increases in the difficulty of achieving abstinence and increases in the forces and resources promoting cessation. Environmental influences promoting cessation and supporting abstinence may be increasing over time, thus counterbalancing the greater individual difficulty in achieving cessation (see Chapter 3).

This abstract definition of hardening offers little assistance in defining which characteristics of the smoking population have changed or how we might adjust our interventions to respond to these changes. To move from the abstract to the pragmatic, measures and characteristics of the smoking population associated with difficulty in achieving abstinence need to be identified. Changes over time in these measures or in characteristics of the population of residual smokers can then be examined to see how tobacco control programs can respond. In forcing the discussion of hardening toward objective and quantitative measures of smokers and their behavior, we lose the ability to consider difficulty in achieving abstinence as a qualitative reality. However, these qualitative considerations do little but lead us back to the compelling logic that those who have not quit must have more difficulty achieving abstinence than those who are already abstinent. Objective and quantifiable measures of hardening may lack the richness of qualitative measures in describing hardening, but they offer an opportunity to examine changes in the measures over time as a test of whether hardening is occurring.

In addition, the changes in personal difficulty of achieving abstinence occurred over the same interval of time that the changes that motivate and support cessation also occurred in the general environment. Actions taken by smokers are the net result of these competing trends. Examining trends over time in specific smoking actions (cessation attempts and success, number of cigarettes smoked, and time to first cigarette as a measure of addiction) quantifies the net effect of the qualitative changes occurring among smokers and in the environment in which they smoke in order to determine which is exerting the larger influence on current smokers' behavior. The implications of these net effects for current tobacco control programs can then be considered. In choosing quantitative measures to examine whether hardening is occurring, we are able to define the presence or absence of net changes in smoking behavior consistent with hardening, but not whether qualitative differences in the difficulty of successful cessation are occurring.

It may be important to differentiate between cessation attempts and long-term abstinence in considering whether cessation rates are declining in the residual population of smokers. One can describe reduced cessation as a decline in quit attempts, a decline in the fraction of quit attempts that result in long-term abstinence, or a decline in the rate of long-term abstinence. Individual characteristics of smokers or particular tobacco

control interventions may influence quit attempts without affecting long-term abstinence, and the reverse may be true as well: cessation success may be influenced without increasing quit attempts. Data on both quit attempts and cessation success are presented in this monograph. However, as a general approach, the term hardening is used in this monograph to describe an effect on the difficulty or probability of achieving long-term abstinence among smokers, rather than the rate at which smokers try to quit or the fraction of quit attempts that are successful.

**MEASURES OF HARDENING** One central measure of hardening is a fall in long-term abstinence rates for all current smokers as a group. Falling abstinence rates are perhaps the most direct outcome measure of hardening and, on one level, are by definition a hardening of the residual smokers. Abstinence rates suffer from two principal limitations as a measure of hardening, however.

First, cessation rates have changed over the past several decades (U.S. DHHS 1990, Burns et al.1997), both rising and falling over time. A decline in cessation may be due to changes in the external environment (e.g., reduction in the price of cigarettes) that may influence cessation activity and interest, or the decline may be due to the residual population of smokers having more difficulty achieving abstinence once those who could easily quit have dropped out of the smoking population. Over a short time interval, or if global changes in cessation are the only measure used, it may not be possible to distinguish between temporal trends in cessation activity and changes in the characteristics of smokers being targeted by tobacco control efforts, or, if both are occurring, to define their relative contributions. A short-term rise in global cessation rates due, for example, to an increase in taxes on cigarettes, may mask or overwhelm the appearance of hardening among residual smokers. Improved abstinence rates may also be due to improvements in the effectiveness of cessation interventions even if the residual smokers have more difficulty, on an individual level, in achieving cessation.

A second limitation of using global abstinence rates as a measure of hardening is that it offers little information as to how that hardening has occurred or what we might do to respond to it.

An alternative to a global fall in abstinence rates is the possibility that those demographic groups in which cumulative abstinence has been higher—for example, in the most highly educated—are now composed of individuals who are strongly resistant to cessation messages. Those smokers with greater than a college education who continue to smoke in spite of strong social disapproval, diminishing locations where they can smoke, and repetitive information and advice to quit could represent a hardcore, highly resistant group of smokers; one would expect to see cessation and abstinence rates fall for that group. If abstinence rates for more educated smokers fall, the historical gradient in cessation activity and success by level of education should also diminish. For example, if the higher rates of abstinence among smokers with a college education means that those left behind are a more highly resistant group of residual smokers, then the ratio of cessation rates for smokers with more education compared with those

smokers with less education would diminish over time, as would the magnitude of the effect of education as an independent positive predictor of abstinence. The hallmark of this form of hardening would be diminishing cessation and abstinence rates among those groups with the lowest smoking prevalences.

Countering the trend toward diminishing cessation among the most highly educated might, potentially, be greater availability of, or these individuals' increased willingness to participate in, effective tobacco interventions. Those individuals with high levels of education who continue to smoke may also encounter substantially greater negative social reinforcement for their smoking, and negative social norms may be increasing more rapidly over time for that group of smokers. However, if the magnitude of the differential in abstinence by level of education persists for those with greater education, it is difficult to argue that existing tobacco control approaches are not working. The same line of reasoning can be applied to examining trends for other subgroups of the population among whom smoking prevalence rates have fallen more rapidly than among the general population.

Hardening can also be conceptualized to mean less intense or less-addicted smokers have quit, leaving behind a heavier-smoking and more heavily addicted group of smokers. This conceptualization could be measured by increases in intensity of smoking or in measures of addiction among the residual population of smokers. Once again, it would seem to be logically inescapable that higher rates of cessation success among lighter or less-addicted smokers must leave behind a population who, on average, smokes more heavily and is more addicted. However, changes in self-reported number of cigarettes smoked per day are likely to be influenced by factors other than differential cessation rates across levels of intensity of smoking. These influences include, among others, restrictions on where smoking is allowed and increases in the price of cigarettes. Many of these factors have changed over the past several decades, confounding the use of temporal trends in intensity of smoking as a measure of hardening. It is also possible that as smokers age or experience more restrictions on their smoking behavior, their level of addiction may decline, leading, over time, to a fall in measures of the strength of addiction. However, if selective cessation by lighter and less-addicted smokers reduces rates of successful abstinence among the remaining smokers, some increase in intensity of smoking or in measures of addiction should be evident over time, or we should see dramatic declines in abstinence rates among more intense and addicted smokers. Again, this decline in cessation success could be blunted if these addicted smokers increasingly use new or more effective tobacco intervention resources.

A more complex concept of hardening is that residual smokers are not necessarily more addicted but that they have fewer resources on a personal level to overcome their addiction or have greater barriers to any behavioral change. For example, comorbidity with alcohol or drug use, depression, or other psychiatric illness can make cessation success less likely. If the

smoking population were increasingly concentrated among individuals with these comorbidities, then it would be a population with much greater difficulty in quitting.

A final concept of hardening focuses less on the individual smoking behavior of the smoker and more on where they are concentrated demographically in the population. Higher rates of successful smoking cessation among those with greater levels of education, income, and other characteristics have concentrated the residual smoking population among the poor and the less educated (U.S. DHHS 1990, 2000). These individuals may well need more assistance to quit smoking for a variety of reasons, but they are also the groups that have the least exposure to cessation messages and assistance. This concept of hardening allows for the possibility that a fall in cessation rates may not be due to an intrinsically more difficult target, but rather to a target that is less exposed to existing cessation interventions and has received less intervention.

This monograph presents evidence for each of these concepts of hardening in an effort to clarify what is known about changes in the characteristics of the smoking population over time and their implications for tobacco control interventions.

**HAVE CESSATION AND  
ABSTINENCE RATES  
FALLEN OVERALL?**

The fraction of those who have ever smoked but have successfully quit increased dramatically over the last half-century (U.S. DHHS 2000) to the point at which approximately one-half of those who have ever smoked are currently former smokers (CDC 1999b). However, declines in per capita consumption slowed dramatically during the midpart of the 1990s, and the CPS data show a decline in cessation attempts and abstinence between the 1992/93 and 1995/96 surveys (see Chapter 8). These observations raise a concern that those smokers who could easily quit, or who could be influenced by existing tobacco control approaches to quit, have done so, leaving behind a residual population of smokers who are more heavily addicted and who need new or more individualized cessation interventions (see Chapter 2). Both anecdotal and systematic observations of contemporary smokers participating in smoking cessation clinical interventions suggest that these smokers are less successful in achieving long-term abstinence than were smokers in prior years (Irvin and Brandon 2000; see Chapters 4 and 9).

In contrast, following the price increases that resulted from the Master Settlement Agreement (MSA), per capita cigarette consumption began declining (see Chapter 8). Data from the 1998/99 CPS show that cessation measures (both quit attempts and prevalence of 3-plus-month abstinence among those who were daily smokers one year prior to the survey) have returned to the 1992/93 levels (see Chapter 8). This increase in measures of cessation was evident even before the increase in the price of cigarettes triggered by the MSA, suggesting that it was at least in part a temporal trend rather than simply a response to price. Changes in per capita consumption and measures of cessation in California following a greater increase in price due to a combination of the MSA plus an increase in the tax on cigarettes demonstrate that price increases maintain their ability to change smoking



behavior (see Chapter 8). The magnitudes of the per capita consumption changes observed nationally and in California are similar to those predicted based on changes in the price of cigarettes that occurred in previous decades, showing that the impact of price as a tobacco control intervention has not diminished.

These recent observations suggest that the absence of a decline in per capita consumption and the fall in cessation observed during the mid-1990s may be due to temporal variations in cessation activity and smoking behavior rather than the result of hardening of the smoking population. However, it remains to be demonstrated whether the recent improvements in per capita consumption and cessation can be sustained by interventions other than price increases, or whether cessation activity will again fall once the effect of the price increases dissipates.

Compared with past generations of new smokers, if smokers who began smoking in recent years are less interested in quitting or less able to achieve abstinence, then the population of current smokers could be hardening due to changes in the characteristics of those who initiate smoking rather than those who quit. However, there is little evidence that the new generation of young smokers is more heavily addicted or less likely to quit than earlier generations of smokers. Data from the Monitoring the Future Study (Johnston, O'Malley, and Bachman 2000) for high school seniors in the United States show a decline from the late 1970s to the present in the percentage of adolescent smokers who are daily smokers and who are daily smokers who smoke 10 or more cigarettes per day.

It seems clear that the residual population of smokers who generated concerns about hardening by its decline in cessation rates during the mid-1990s remains responsive to tobacco control interventions, at least with respect to increasing price.

**HAVE RECENT CESSATION RATES FALLEN AMONG POPULATIONS THAT HAVE ACHIEVED LOW SMOKING PREVALENCE?**

Low smoking prevalence rates by geographic area or by demographic subgroup are achieved, in part, by increased cessation. Variability in the difficulty of achieving sustained abstinence among individual smokers should result in the population of remaining smokers containing a higher fraction of those who have difficulty quitting, unless changes in other factors affecting the difficulty of successful cessation are occurring simultaneously. This trend should occur for subgroups of the population as well as for the population as a whole. In particular, one might expect the greatest hardening among those geographic and demographic subgroups that have a higher fraction of ever-smokers who have quit and therefore a lower prevalence of current smokers.

Lower smoking prevalence by geographic area is likely to be associated with increased environmental and social pressure to quit as well as with the presence of successful tobacco control programs. Individuals who continue to smoke in those locations do so despite strong pressure to quit. They may represent a group less interested in cessation or less able to achieve abstinence than smokers in areas without these influences. Conversely, the

factors that produced the lower rates of smoking prevalence may influence cessation strongly enough to overwhelm the increased average difficulty in quitting among residual smokers. If this were to happen, the increased motivation and resources available to the smoker to promote cessation could more than counterbalance the inherently greater difficulty many of these residual smokers have in achieving abstinence. Thus individual smokers might have more difficulty quitting on a personal level without having a reduced likelihood of achieving abstinence.

On an individual level, smokers with higher levels of education and income may bring greater personal resources to a cessation effort and have historically had higher rates of cessation (U.S. DHHS 1990, 2000). As the prevalence of smoking in these groups falls, the negative social reinforcement for smoking likely increases. Those who continue to smoke do so in the face of increased social pressure to stop. The larger fraction of smokers who have quit, and the greater social pressure to quit, make it likely that the remaining smokers are highly resistant to cessation or have great difficulty in achieving abstinence. Once again, the converse may also be true: increases in the external motivation and support for cessation among these groups may overwhelm the effect of differential quitting by smokers who can easily do so.

The likelihood that populations with a low prevalence of current smoking or in which a large fraction of ever-smokers have quit contain more smokers who are unwilling or unable to quit makes them fertile ground for examining cessation and abstinence trends for evidence of hardening. If a true hard core of smokers exists due to biological or behavioral factors, as opposed to demographic characteristics, then that hard core should be more evident among populations where smoking prevalence has fallen the most. Current cessation rates among those groups in which cessation has been high historically should also fall over time if the remaining smokers are predominantly hardcore smokers unwilling or unable to quit. The absence of a fall in cessation over time would suggest either that the group is not hardening or that changes in environmental factors are able to counterbalance the hardening at the individual level.

Fagerström and colleagues (1996) reported a correlation between mean scores on a nicotine dependence scale and the prevalence of cigarette smoking for six countries, with a lower smoking prevalence being associated with a higher score on the dependence scale (a higher level of addiction). They suggest that successful tobacco control efforts may result in higher dependence among the remaining smokers due to successful quitting by low dependence smokers. However, as the authors acknowledge, the relationship weakens considerably when data for both male and female smokers in Finland are included. (Finnish females have both a low prevalence of smoking and a low dependence score.) When the data for both sexes combined are examined, the middle four of the six countries studied show no obvious relationship between prevalence and dependence score.

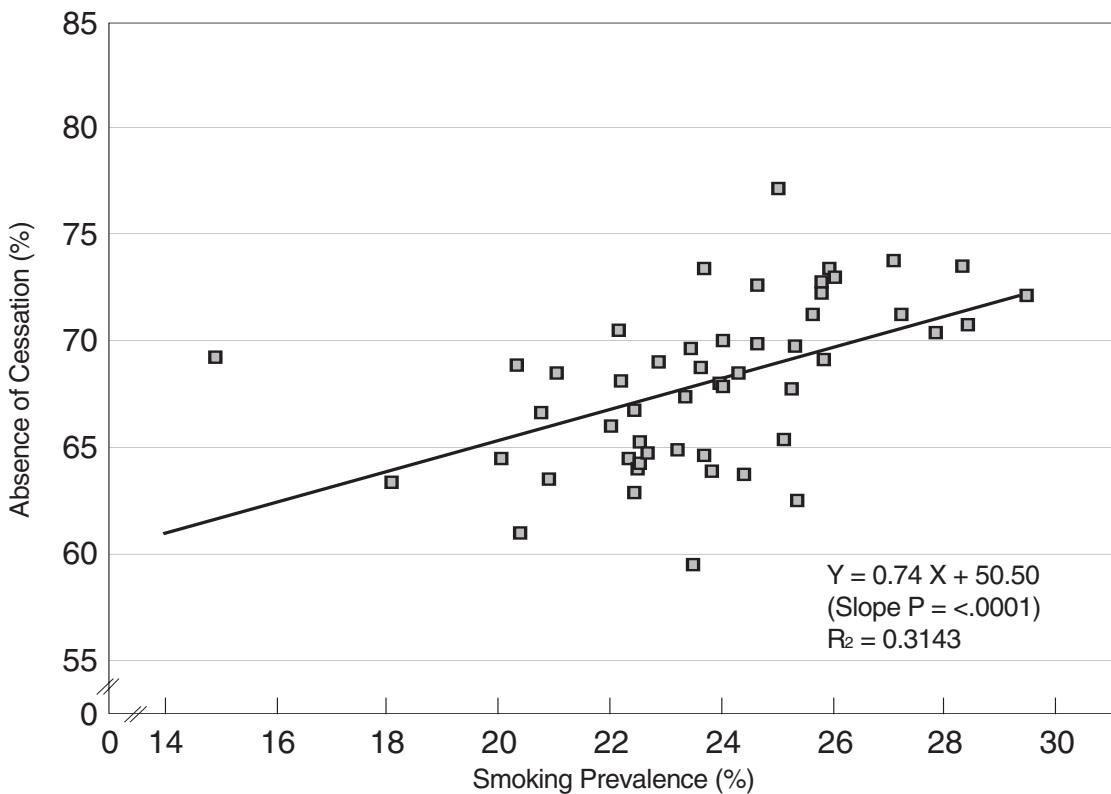


There is substantial variability in the prevalence of smoking among the 50 states as measured by the 1995/96 CPS. Figure 1-1 presents the state-specific percentage of those who were daily cigarette smokers one year prior to the survey who made no attempt to quit smoking and who did not become an occasional smoker prior to the survey (see Chapter 8). These fractions are paired with state-specific smoking prevalences to generate the graph in Figure 1-1.

There is a significant positive association between the absence of cessation activity and the prevalence of smoking. States with a high smoking prevalence have high fractions of the population who made no attempt to quit. Conversely, states with a low smoking prevalence have high levels of cessation activity. This relationship of greater cessation with lower smoking prevalence is present when either cessation activity or 3-plus-month abstinence is examined, and the effect is evident for smoking prevalence measured as a percentage of the population smoking or as the fraction of ever-smokers who have quit (see Chapter 8). The effect is significant even when the state-specific price of cigarettes is included in the analysis. At least at the level of state-specific data, having achieved a lower

Figure 1-1

**State-Specific Percentage of Smokers Age 25 and Older Who Made No Attempt to Change Their Smoking Behavior in the Last Year Compared to State-Specific Smoking Prevalence—1995/96 CPS**



smoking prevalence is not accompanied by hardening as measured by falling cessation rates. This observation does not imply that increased cessation is produced by a low smoking prevalence, but it does suggest that changes in environmental factors that occur as smoking prevalence falls, and which promote cessation at the state level, may more than compensate for the increase in average level of difficulty in achieving abstinence among residual smokers.

High educational attainment is correlated with both low smoking prevalence and high rates of successful abstinence (U.S. DHHS 1990). Smoking prevalence among those with 16 or more years of education is 11.7% for the 1995/96 CPS and 10.3% for the 1999 California Tobacco Survey (CTS) (see Chapter 8). The effect of educational level on cessation activity and abstinence is also evident in multivariate logistic regression analyses of these data sets in which the odds ratios for cessation activity and success increase with increasing level of education, controlling for age, gender, race/ethnicity, income, and number of cigarettes smoked per day (Tables 8-1 and 8-2). If high rates of abstinence result in a residual population that is less willing or less able to quit, smokers in the better-educated segments of the population should become more hardened than smokers in the less-educated groups over time. One would then expect them to have fewer cessation attempts and less cessation success over time, reflected in lower odds ratios with increasing level of education for cessation attempts and abstinence in sequential surveys.

Cessation activity and abstinence measures fell between the 1992/93 and 1995/96 CPS. If this decline reflects hardening of the residual population of smokers, one manifestation might be a decline in the magnitude of the odds ratios for measures of cessation with increasing level of education between the two surveys. The odds ratios for the effect of educational attainment on cessation activity and abstinence did not fall between the 1992/93 and 1995/96 CPS, even though the rates of cessation activity and cessation success declined significantly for the total population between these two surveys. Similarly, in California, where a substantial fall in smoking prevalence occurred between 1990 and 1999, there was no decline in the magnitude of the odds ratios comparing the highest and lowest educational categories for cessation activity or abstinence across the period of decline in smoking prevalence (see Chapter 8). High education level is a demographic measure of a population of smokers who has had a large fraction of the group already quit and in which the residual smokers have arguably experienced greater social stigma and therefore should be highly resistant to cessation. Yet there is no evident decline in the strength of educational attainment as a predictor of the likelihood of attempting to quit or achieving abstinence. Either the individual smokers who remain change in ways that make it easier for them to quit (e.g., reduced levels of addiction) or, over time, there is an increased level of motivation or support for cessation provided in the environment.

Income, highly correlated with education, is another demographic characteristic associated with low smoking prevalence. Current smoking prevalence among those making more than \$75,000 per year was 13.2% for

the 1995/96 CPS and 13.1% for the 1999 CTS. The magnitude of the increase in odds ratios with increasing level of income in multivariate logistic regression analyses is smaller than that for increasing level of education (see Chapter 8). In contrast with the changes seen for education, the odds ratios for cessation activity and abstinence among the highest income group compared with the lowest was smaller for the 1995/96 CPS than for the 1992/93 CPS. The effect of income on cessation also diminished across the three CTS surveys (1990 to 1999). These data provide some support for a diminished response of upper income groups to existing tobacco control interventions, controlling for education. However, price increases are one of the interventions occurring during this period, and the likelihood that price increases may affect smokers in the lower income groups more heavily makes attribution of these shifts to hardening of the residual smoking population difficult (Townsend, Roderick, and Cooper 1994).

In summary, with the exception of the income data, there is little evidence to suggest that demographic or geographic subgroups with low smoking prevalences are seeing declines in cessation activity or lower rates of cessation success consistent with hardening.

**ARE RESIDUAL SMOKERS HEAVIER SMOKERS OR MORE ADDICTED?** More heavily addicted smokers have difficulty achieving abstinence (U.S. DHHS 1990; see Chapter 2). As less-addicted smokers quit, the remaining population of smokers should become composed of smokers who are, on average, more heavily addicted. While the number of cigarettes smoked per day is not a precise measure of level of addiction, heavily addicted smokers are on average also smokers who consume more cigarettes per day (CPD), and there is a modest correlation between CPD and level of addiction (see Chapter 2).

Time to first cigarette after waking is a measure incorporated into scales used to measure level of addiction (Fagerström and Schneider 1989). As a single question, time to first cigarette is the most powerful predictor of level of addiction of the questions used in the addiction scales (Kozlowski et al. 1994).

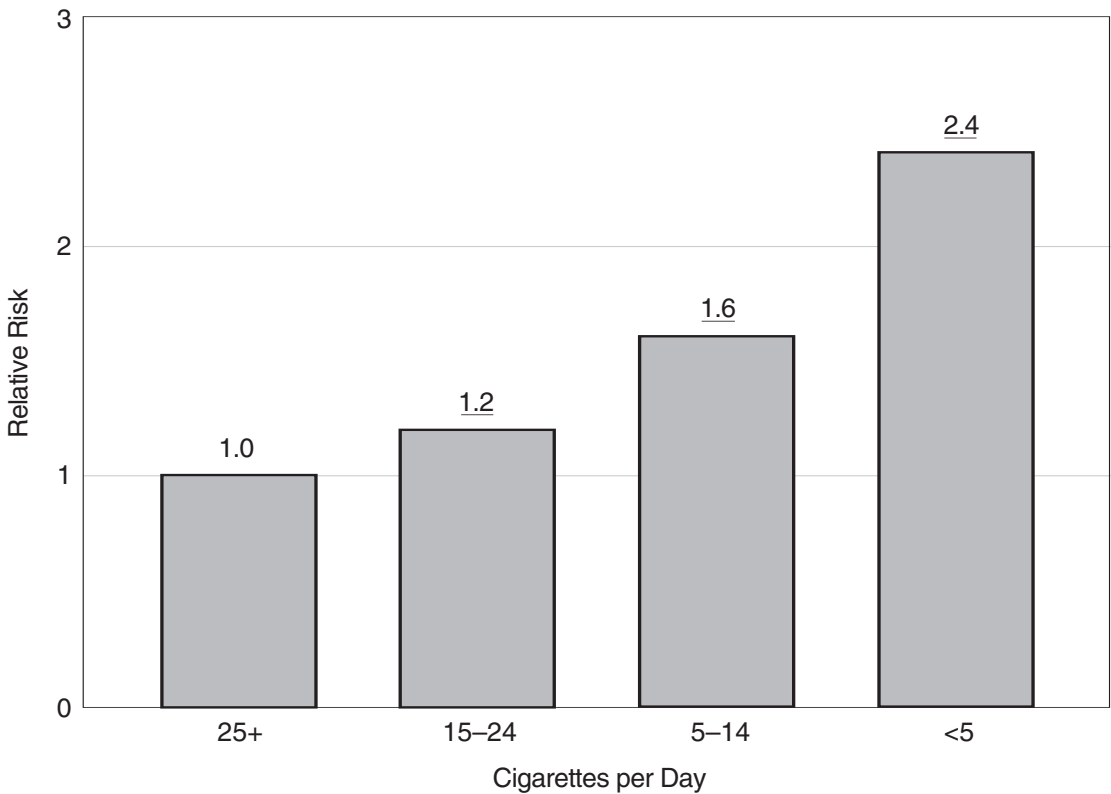
If less-addicted smokers are more likely to quit, remaining smokers should smoke more cigarettes per day and be more likely to have their first cigarette within 30 minutes of waking. If so, trends over time in number of cigarettes smoked per day and time to first cigarette should be good measures of whether the population is increasingly composed of more heavily addicted smokers. Both of these measures, especially CPD, may be influenced by trends in social norms and environmental restrictions on smoking. These influences may be large enough to obscure the expected increase due to the differential cessation success of lighter and less-addicted smokers. However, trends in these measures could strongly support the position that the residual population of smokers has hardened.

In a population of current smokers drawn from the American Cancer Society Cancer Prevention Study I (CPS I) that participated in all of the follow-up evaluations, heavy smokers were substantially less likely to

achieve abstinence (see Chapter 6). This effect is also demonstrated by a multiple logistic regression of abstinence in the long-term follow-up of a cohort of smokers in the Community Intervention Trial for Smoking Cessation (COMMIT) trial (Figure 5-2; see Chapter 5). Other things being equal, the effect of greater cessation success by smokers of fewer cigarettes per day should lead to an increase in the average number of cigarettes smoked per day by the remaining population of smokers, and this effect is observed among the smokers in the CPS I trial (see Chapter 6).

There was also an increase in the mean number of cigarettes smoked per day for the National Health Interview Survey (NHIS) data between 1965 and 1980, extending the period of observation of the CPS I study (1959 to 1972) (Figure 3-1). However, since that time, the mean number of cigarettes smoked per day has declined substantially in national data (see Chapter 7). This decline is also evident over the shorter intervals covered by surveys conducted in Massachusetts (see Chapter 9) and California (see Chapter 8),

Figure 1-2  
**Average Daily Amount Smoked as a Predictor of Future Cessation, 1988 to 1993\***



\*Data from the COMMIT Endpoint Cohort,  $N = 13,415$ . Adjusted for sex, age, race/ethnicity, income, education, alcohol consumption, age started smoking, time to first cigarette, use of a noncigarette tobacco product, price category of cigarette smoked, past quit attempts, desire to quit, and number of other smokers in the household. See Chapter 5.

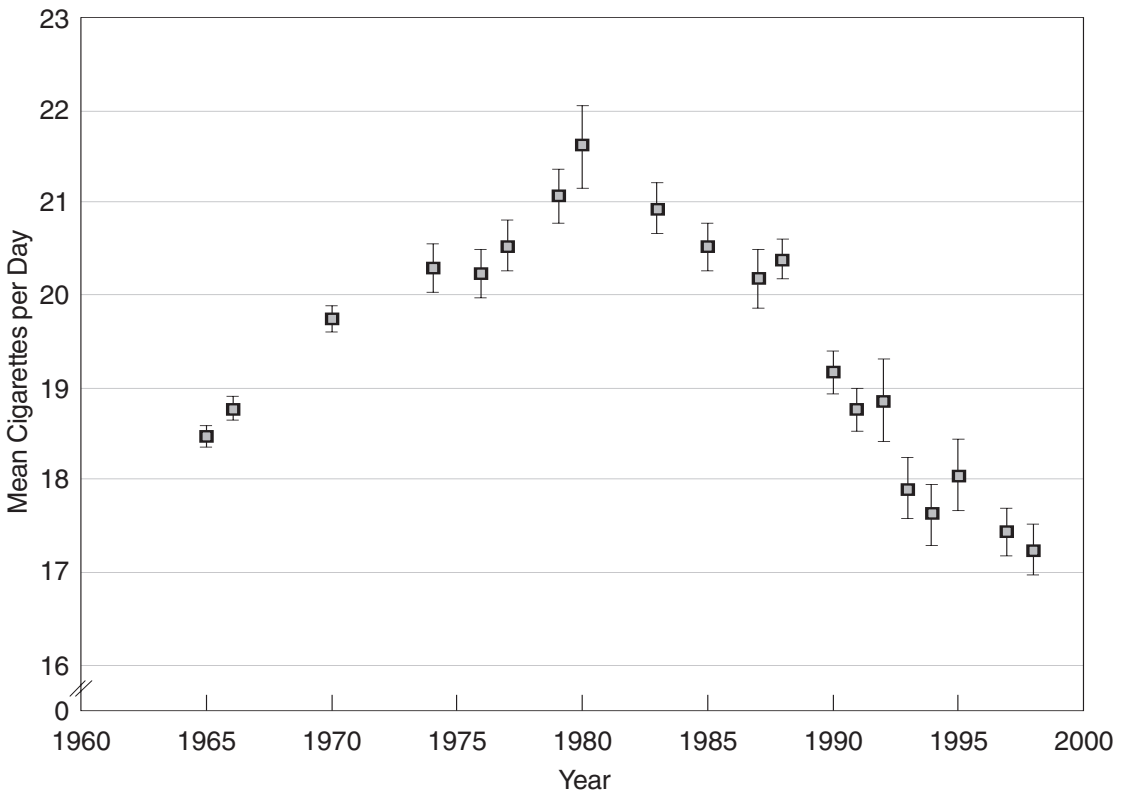
NOTE: Underlined relative risks are statistically significant at the 5% level.

as well as in the cross-sectional surveys conducted at the start and the end of the COMMIT trial (see Chapter 5).

Rates of successful cessation were also lower in the COMMIT data for those who reported smoking within the first 30 minutes of waking (Figure 4-1; see Chapter 5). This effect would lead one to expect that there would be an increase in the fraction of smokers who smoke within the first 30 minutes of waking between the cross-sectional samples of smokers collected at the start and end of COMMIT. However, the fraction of the smoking population reporting a time to first cigarette of less than 30 minutes, instead of increasing, remained constant.

In the California tobacco surveys (1990 to 1999), the fraction of smokers reporting smoking within the first 30 minutes of waking increased with increasing number of cigarettes smoked per day, but the percent reporting smoking within 30 minutes of waking remained constant for smokers when

Figure 1-3  
**Standardized Mean Cigarettes per Day Among Current Smokers**

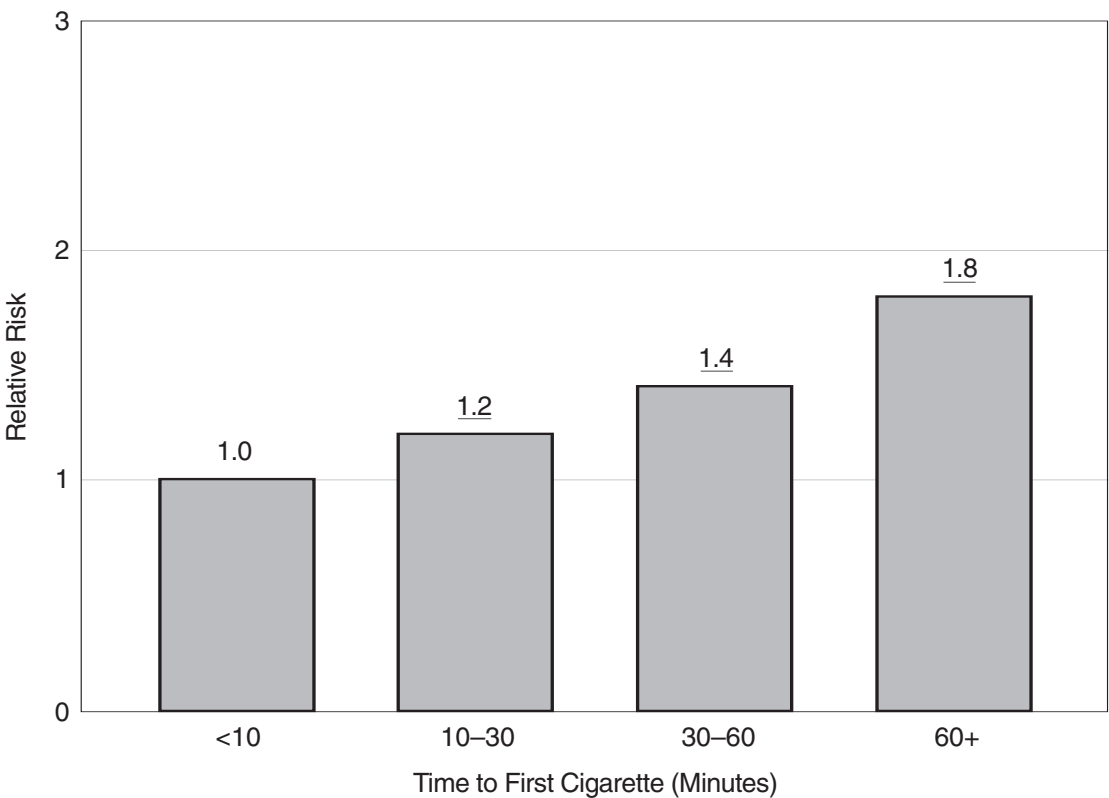


See Chapter 6.

stratified by number of cigarettes smoked per day over the nine-year interval covered by these surveys (Figure 5-1; see Chapter 8). This absence of a change in time to first cigarette occurred even though there was a dramatic decline in the fraction of smokers reporting smoking 15 to 24 and 25-plus CPD over this time period. Massachusetts also reported a similar stability in the fraction of smokers who smoked within 30 minutes of waking (see Chapter 9).

In summary, there is little evidence to suggest that there is an increasing level of addiction of the residual smoking population as measured by changes over time in either number of cigarettes smoked per day or the fraction of smokers who smoke within the first 30 minutes of waking. The validity of self-reported CPD and time to first cigarette as measures of the level of addiction may decline as the social stigma associated with smoking increases. In addition, there is likely a real reduction in the number of

Figure 1-4  
**Time to First Cigarette as a Predictor of Future Cessation, 1988 to 1993\***



\*Data from the COMMIT Endpoint Cohort, *N* = 13,415. Adjusted for the following baseline factors: sex, age, race/ethnicity, income, education, alcohol consumption, age started smoking, amount smoked, use of a noncigarette tobacco product, price category of cigarette smoked, past quit attempts, desire to quit, and number of other smokers in the household. See Chapter 5.

NOTE: Underlined relative risks are statistically significant at the 5% level.



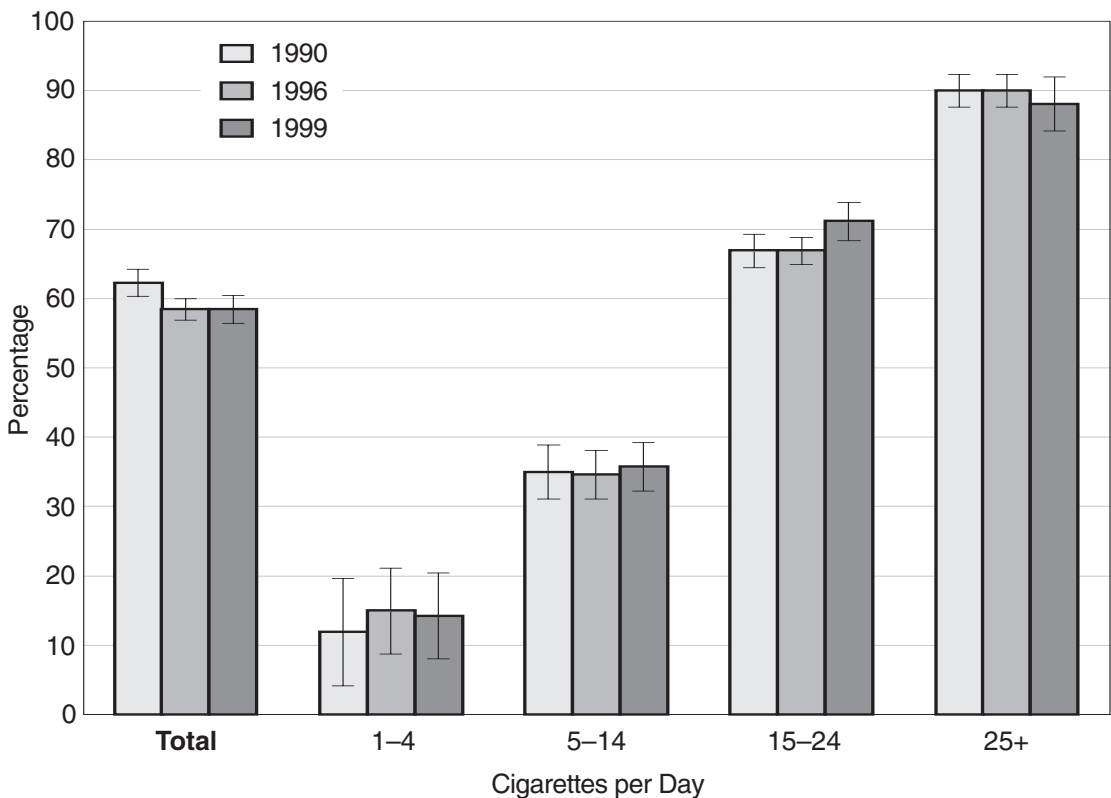
cigarettes smoked per day that has resulted from increasing restrictions on smoking in the workplace and in public places (Brownson et al. 1997, Burns et al. 2000b). However, while CPD and time to first cigarette are not direct measures of the level of addiction in smokers, they are correlated with level of addiction, and the data do not reflect an increase over time in the average levels of these measures among residual smokers.

**DO CURRENT SMOKERS  
HAVE HIGHER  
COMORBIDITY THAN  
SMOKERS DID IN  
PREVIOUS DECADES?**

Smokers with mental illness or codependency on drugs or alcohol have more difficulty in achieving long-term abstinence, and one form of hardening could be an increase in the fraction of residual smokers with these problems. An association of smoking with mental illnesses has been demonstrated in a population with a variety of psychiatric disorders (Black, Zimmerman, and Coryell 1999). An analysis of the National Comorbidity Study found that 22.5% of respondents with no

Figure 1-5

**Percent of Adult Daily Smokers Age 25 and Older Smoking Their First Cigarette Within 30 Minutes of Waking by Number of Cigarettes Smoked per Day, 1990, 1996, and 1999 California Tobacco Surveys**



See Chapter 7.

mental illness smoked, in contrast to 34.8% of those with a history of ever having mental illness and 41% of those who reported having mental illness in the last 30 days (Lasser et al. 2000).

There are limited data on whether the prevalence of mental illness or codependency on drugs and alcohol is changing among smokers over time. Data from Massachusetts (see Chapter 9) suggest that this is not happening, but the time frame for the trend analyses, and the magnitude of the changes in smoking behavior, do not allow the absence of a change in these data to be confidently used as evidence that those changes will not emerge in the future as the prevalence of smoking continues to drop.

In summary, there is evidence that smokers have higher rates of mental illness and codependence on drugs and alcohol than nonsmokers, factors that reduce the likelihood of cessation success (Lasser et al. 2000). However, it is unclear whether this higher prevalence of psychiatric problems is related to higher rates of smoking initiation among individuals with these problems, due to their lack of cessation success resulting in a higher fraction of these individuals among the residual population of smokers, or both.

**ARE RESIDUAL SMOKERS  
CONCENTRATED IN LESS  
ADVANTAGED DEMOGRAPHIC  
GROUPS AND THOSE WITH  
LESS EXPOSURE TO TOBACCO  
CONTROL INTERVENTIONS?**

Over time, the composition of current smokers has shifted toward smoking being a behavior both of lower education and income groups as well as of the racial and ethnic minorities who are disproportionately represented in these lower socioeconomic groups (U.S. DHHS 1998, 2000, 2001). The prevalence of smoking also remains higher among blue-collar workers than among white-collar workers (Bang and Kim 2001). These groups have lower rates of cessation activity and cessation success (Burns et al. 2000a).

While differences in rates of initiation of smoking play a role in smoking prevalence differences among lower socioeconomic and some ethnic groups, lower rates of cessation also make a contribution (U.S. DHHS 1998, 2000). These shifts could be considered hardening of the population of smokers. However, there is considerable evidence that these groups respond to existing tobacco control approaches when they reach the individuals concerned (U.S. DHHS 1998, 2000). This shift in the composition of the population of current smokers may constitute a hardening of the smoking population in the sense that the residual population of smokers is preferentially composed of groups who have historically had low rates of successful cessation. However, it is not clear that these low rates of cessation would persist if these segments of the population had greater access to cessation assistance or more exposure to cessation messages and interventions. This form of hardening may not require a shift in existing tobacco control approaches but, rather, better strategies to reach these populations with tailored, or gender- and culture-appropriate forms of, existing interventions. In addition, the role of price and other barriers to access among lower-income groups should be further explored (Evans and Farrelly 1998).

**DISCUSSION AND SUMMARY**

Logic requires that the current residual population of smokers must have more difficulty, on an individual and abstract basis, in achieving abstinence when compared with those who have already quit. However, trends over time, in measures that should change if the residual smoking population is having more difficulty achieving abstinence, do not seem to be occurring. There is little evidence for a trend over time among continuing smokers toward declining rates of cessation, increasing intensity of smoking, or increasing level of addiction. The absence of a trend is evident when all current smokers are examined, and it is also absent for demographic subgroups that have had the greatest fraction of smokers successfully quit. Successful cessation by those who smoke fewer cigarettes per day and who are less addicted has not hardened the current population of residual smokers, at least as measured by changes over time in number of cigarettes smoked per day, time to first cigarette after waking, or rates of attaining successful abstinence.

The absence of increases in measures of smoking intensity or addiction over time may be partially explained by the influx of new, younger smokers into the smoking population. These smokers are just starting their smoking behavior, and it is highly probable that substantial numbers of them will quit in the future, many with little difficulty. There is little reason to expect that these new smokers are more powerfully addicted than previous cohorts of smokers at the same stage of their smoking history. Indeed, the evidence suggests that there are higher percentages of occasional smokers among these current generations of new smokers (Gilpin et al. 2001; see Chapter 8), a behavior change consistent with less rather than more addiction.

However, the logical paradox that the population of residual smokers should contain more smokers who cannot quit and are more heavily addicted—while trends in these measures over time do not show these shifts—remains to be explained. One potential resolution may be a recognition that abstinence can be influenced by both characteristics of the individual smoker (level of addiction or education, for example) and characteristics of the environment in which that individual smokes (restrictions where smoking is allowed, for example). Environmental influences promoting cessation may be increasing over time, and that increase may help to counterbalance the increased difficulty residual smokers have in achieving cessation.

An increasing effect of environmental influences may occur across all smokers, or environmental influences may interact with individual characteristics of smokers that make it difficult for them to quit. This interaction may occur in at least two important ways. First, the very factors that are likely to make it difficult to quit, such as high levels of smoking and addiction, may also make the same individual more susceptible to changes in the environment. For example, a heavy smoker may be more motivated by an increase in the price of cigarettes than a light smoker for the simple reason that the increase in the dollar price of maintaining his or her smoking behavior is greater than it is for the lighter smoker. Similarly, the difficulty experienced by a highly dependent smoker when a workplace goes smokefree may be more motivating toward cessation than it is for the

less dependent smoker. The repetitive craving for a cigarette when smoking is not allowed may be more frequent and more difficult to tolerate for the heavily addicted smoker. In addition, once the heavily addicted smoker adjusts to the forced abstinence from smoking in the workplace, it may make it easier to achieve complete abstinence in the rest of his or her smoking behavior. The potential that changes in specific environmental tobacco control interventions may differentially affect cessation success in heavily smoking-dependent populations is an area for future investigation.

Some evidence of this differential effect of environmental influences is provided by the 12-year follow-up of the American Cancer Society CPS I (see Chapter 6). For the first five years of the study, there was a clear and large differential in rates of abstinence between smokers of different numbers of cigarettes per day. Heavy smokers were much less likely to be abstinent. However, for the last follow-up, a seven-year period from 1965 to 1972, there were much smaller differences. This time period encompassed an interval (1967 to 1970) when counter-tobacco advertisements were required in broadcast media by the Federal Communication Commission to balance the existing cigarette ads. Per capita consumption fell sharply during this period (Warner 1989) and cessation rates rose (Burns et al. 1997). One possible explanation for the higher rates of cessation and smaller differences in abstinence rates among smokers of different numbers of cigarettes during the last follow-up in CPS I is an effect of the counter-advertising that was larger for heavy smokers than for light smokers.

A second and more complex interaction between environmental influences and intensity of smoking may explain some of the observations in California and in COMMIT. The self-reported number of cigarettes smoked per day has fallen over the last decade in California, and restrictions on where smoking is allowed may have contributed to that decline (Gilpin et al. 2001). However, the fraction of California smokers smoking their first cigarette within 30 minutes of waking did not increase over time for smokers at any level of number of cigarettes smoked per day, as it should have if heavier smokers, with higher frequencies of smoking within 30 minutes of waking, shifted downward without changing their level of addiction. One potential explanation for this observation might be the increase in number of smokers who live in homes where smoking indoors is not allowed (Gilpin et al. 2001). If a smoker cannot smoke indoors, it may be more difficult to smoke within 30 minutes of waking. Similarly, if smokers are required to go for prolonged periods without smoking at work, both the behavioral and pharmacological reinforcement for smoking may be diminished and the level of addiction may decline. It is also possible that smokers are falsely reporting lower rates of smoking within 30 minutes of waking due to social pressure or are actually less likely to smoke within the first 30 minutes without changing their actual level of addiction. The potential for interaction of environmental changes with changes in the intensity of addiction over time for individual smokers remains largely unexplored.

Hardening of the smoking population through an increase in the number of smokers with mental illness or codependency on alcohol or other drugs is a real possibility, but the limited information on trends in prevalence of these problems among smokers makes it difficult to ascertain whether such hardening has occurred.

The residual population of smokers has clearly shifted toward groups with low levels of income and education, groups that historically have also had lower rates of cessation. At least part of that shift is likely due to the reduced rates of cessation present among these groups in the past.

Given the limited evidence that the residual population of smokers is hardening as measured by reduced abstinence or changes in correlates of addiction, and the scant evidence that existing tobacco control approaches no longer work for these residual smokers, it is clearly premature to suggest that existing tobacco control interventions are becoming less effective over time or that environmental and public policy interventions should be abandoned in favor of more individualized and intensive treatment interventions. Evidence from California and Massachusetts (Burns et al. 2000a; Gilpin et al. 2001; Biener, Harris, and Hamilton 2000) suggests just the opposite. Well-funded, comprehensive tobacco control efforts lead to continued reduction in smoking prevalence and enhanced cessation. Substantial reductions in the number of residual smokers could be achieved if these comprehensive tobacco control efforts were replicated in all states (CDC 1999a).

A greater understanding of these trends and the reasons for them is needed, as is a more complete description of the mechanisms by which individual characteristics and environmental factors interact among smokers to promote or inhibit cessation. The hypothesis that the population of current smokers is hardening should continue to be tested as we observe future trends in smoking behavior. However, evidence that hardening is actually occurring should be required before it is used as a justification for changing current tobacco control strategies.

This volume focuses on the evidence for hardening among the residual smokers and the implications for existing programmatic efforts to change smoking behavior. Research efforts focus on what might be achieved in the future. A final and most critical observation is that, while there may be very limited evidence of hardening among current smokers, almost one-half of all living people who have ever smoked are still smoking (CDC 1999b). Our existing tobacco control approaches may not be losing their effectiveness due to hardening of the smoking population, but the majority of people who currently try to quit still fail in the attempt. There remains an urgent need for a broad range of research initiatives to develop newer, different, more effective, and more widely utilized approaches to help smokers quit. Recent insights into the biology of addiction, the pharmacology and chemistry of the brain, genetic and other reasons for variability in response to nicotine, and to cessation interventions all offer exciting possibilities for future interventions to supplement rather than replace current tobacco control strategies.

## REFERENCES

- Bang, K. M., Kim, J. H. Prevalence of cigarette smoking by occupation and industry in the United States. *American Journal of Industrial Medicine* 2001;40:233–39.
- Biener, L., Harris, J. E., Hamilton, W. Impact of the tobacco control programme: Population based trend analysis. *British Medical Journal* 2000;321:351–54.
- Black, D. W., Zimmerman, M., Coryell, W. H. Cigarette smoking and psychiatric disorder in a community sample. *Annals of Clinical Psychiatry* 1999;11(3):129–36.
- Brownson, R. C., Eriksen, M. P., Davis, R. M. et al. Environmental tobacco smoke: Health effects and policies to reduce exposure. *Annual Review of Public Health* 1997;18:163–85.
- Burns, D. M., Anderson, C., Johnson, M. et al. Cessation and cessation measures among adult daily smokers: National and state-specific data. In *Population-Based Cessation: What Works. Smoking and Tobacco Control Monograph No. 12*, edited by D. Burns, D. Shopland, 25–97. NIH Pub. No. 00-4892. Bethesda, MD: U.S. Department of Health and Human Services, National Cancer Institute, 2000a.
- Burns, D. M., Lee, L., Shen, Z. et al. Cigarette smoking behavior in the United States. In *Changes in Cigarette-Related Disease Risks and Their Implication for Prevention and Control. Smoking and Tobacco Control Monograph No. 8*, edited by D. Burns, L. Garfinkel, J. Samet, 13–112. NIH Pub. No. 97-4213. Bethesda, MD: U.S. Department of Health and Human Services, National Cancer Institute, 1997.
- Burns, D. M., Shanks, T., Major, J. et al. Restrictions on smoking in the workplace. In *Population-Based Smoking Cessation: What Works. Smoking and Tobacco Control Monograph No. 12*, edited by D. Burns, D. Shopland, 99–126. NIH Pub. No. 00-4892. Bethesda, MD: U.S. Department of Health and Human Services, National Cancer Institute, 2000b.
- Centers for Disease Control and Prevention. *Best Practices for Comprehensive Tobacco Control Programs*. Atlanta, GA: U.S. Department of Health and Human Services, 1999a.
- Centers for Disease Control and Prevention. Cigarette smoking among adults—United States, 1997. *Morbidity and Mortality Weekly Report* 1999b;48(43):993–96.
- Evans, W. N., Farrelly, M. C. The compensating behavior of smokers: Taxes, tar, and nicotine. *RAND Journal of Economics* 1998;29(3):578–95.
- Fagerström, K. O., Kunze, M., Schoberberger, R. et al. Nicotine dependence versus smoking prevalence: Comparisons among countries and categories of smokers. *Tobacco Control* 1996;5:52–56.
- Fagerström, K. O., Schneider, N. G. Measuring nicotine dependence: A review of the Fagerström Tolerance Questionnaire. *Journal of Behavioral Medicine* 1989;12:159–82.
- Gilpin, E. A., Emery, S. L., Farkas, A. J. et al. *The California Tobacco Control Program: A Decade of Progress, 1989–1999*. La Jolla, CA: University of California at San Diego, 2001.
- Irvin, J. E., Brandon, T. H. The increasing recalcitrance of smokers in clinical trials. *Nicotine and Tobacco Research* 2000;2(1):79–84.
- Johnston, L. D., O'Malley, P. M., Bachman, J. G. *Cigarette Use and Smokeless Tobacco Use Decline Substantially Among Teens*. Ann Arbor, MI: University of Michigan News and Information Services, 2000. Available at ([www.monitoringthefuture.org](http://www.monitoringthefuture.org)) (January 16, 2001).
- Johnston, L. D., O'Malley, P. M., Bachman, J. G. *Monitoring the Future National Survey Results on Drug Use, 1975–2000. Vol. 1, Secondary School Students*. NIH Pub. No. 01-4924. Bethesda, MD: National Institute on Drug Abuse, 2001.
- Kozlowski, L. T., Porter, C. Q., Orleans, C. T. et al. Predicting smoking cessation with self-reported measures of nicotine dependence: FTQ, FTND, and HSI. *Drug and Alcohol Dependence* 1994;34:211–16.
- Lasser, K., Boyd, J. W., Woolhandler, S. et al. Smoking and mental illness: A population-based prevalence study. *Journal of the American Medical Association* 2000;284(20):2606–610.
- National Cancer Institute. *Population-Based Smoking Cessation: What Works. Smoking and Tobacco Control Monograph No. 12*, edited by D. Burns, D. Shopland, 25–97. NIH Pub. No. 00-4892. Bethesda, MD: U.S. Department of Health and Human Services, National Cancer Institute, 2000.
- Townsend, J. L., Roderick, P., Cooper, J. Cigarette smoking by socioeconomic group, sex, and age: Effects of price, income, and health publicity. *British Medical Journal* 1994;309:923–26.
- U.S. Department of Health and Human Services. *The Health Benefits of Smoking Cessation*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1990.



- U.S. Department of Health and Human Services. *Reducing Tobacco Use: A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2000.
- U.S. Department of Health and Human Services. *Tobacco Use Among U.S. Racial/Ethnic Minority Groups; African Americans, American Indians and Alaska Natives, Asian Americans and Pacific Islanders and Hispanics: A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1998.
- U.S. Department of Health and Human Services. *Women and Smoking: A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2001.
- Warner, K. E. Effects of the antismoking campaign: An update. *American Journal of Public Health* 1989;79(2):144–51.
- Warner, K. E., Burns, D. M. Hardening and the hard-core smoker: Concepts, evidence, and implications. *Nicotine and Tobacco Research*, in press 2003.