SMOKING AND TOBACCO CONTROL

MONOGRAPH 15

Those Who Continue To Smoke

Is Achieving Abstinence Harder and Do We Need to Change Our Interventions?

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Smoking and Tobacco Control Monographs Issued to Date

Strategies to Control Tobacco Use in the United States: A Blueprint for Public Health Action in the 1990's. Smoking and Tobacco Control Monograph No. 1. Bethesda, MD: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Cancer Institute, NIH Publication No. 92-3316, December 1991.

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Preface

The End of An Era

Monograph 15, entitled *Those Who Continue to Smoke: Is Achieving Abstinence Harder and Do We Need to Change Our Interventions?*, marks the end of an era. It is the last of the original series of *Smoking and Tobacco Control Monographs* begun in 1991 under the editorial direction of **Donald R. Shopland**, former coordinator for the Smoking and Tobacco Control Program (STCP) at the National Cancer Institute. From the very inception of the monograph series, the National Cancer Institute has been extremely fortunate to have had **David M. Burns,** M.D., professor of family and preventive medicine at the University of California at San Diego, serve as senior scientific editor.

The National Cancer Institute honors the significant contributions of both these men. Mr. Shopland and Dr. Burns have brought keen insight, knowledge, creativity, and boundless energy and dedication to the production of the monographs. Much of the success of this first series of *Smoking and Tobacco Control Monographs* can be attributed to the vision and commitment of these two leaders in the tobacco control community. Their efforts, and those of the hundreds of other contributors to the first 15 volumes, have laid a solid groundwork for future series.

The National Cancer Institute remains strongly committed to producing and disseminating state-of-the-science smoking and tobacco control monographs. The new series will draw from the strengths of the first series and add several new processes and features to improve the breadth, depth, and policy relevance of the evidence reviewed. One major goal will be to provide the most objective and thorough syntheses of research to inform the ongoing efforts of the National Cancer Institute and the extramural research and tobacco control communities.

Stephen E. Marcus, Ph.D.
Series Editor, Smoking and Tobacco Control Monographs
Tobacco Control Research Branch
Behavioral Research Program
Division of Cancer Control and Population Sciences
National Cancer Institute
National Institutes of Health

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The *Introduction* was written by **C. Tracy Orleans**, Ph.D., senior scientist and senior program officer at the Robert Wood Johnson Foundation, based on her comments at a symposium sponsored by the National Cancer Institute at the Society for Research on Nicotine and Tobacco (SRNT) Eighth Annual Meeting held on February 20, 2002, in Savannah, GA. At this symposium, entitled *Hardening the Target: Are Smokers Less Likely to Quit Now Than in the Past?*, authors of several chapters of Monograph 15 participated in a discussion of the scientific evidence, and Dr. Orleans served as the discussant. Chapter 2 is based on data available as of February 2002.

The managing editor of Monograph 15 is **Richard H. Amacher**, project director, KBM Group Inc., Silver Spring, MD. **Stephen E. Marcus**, Ph.D., completed the editorial direction of the monograph after Mr. Shopland retired and served as its managing editor after the KBM contract ended.

The editors gratefully acknowledge the many researchers and authors who made this monograph possible through their numerous hours of writing and review. Contributors to each chapter are as follows:

Introduction		C. Tracy Orleans, Ph.D. Robert Wood Johnson Foundation
Chapter 1	**Smokers Who Have Not Quit: Is Cessation More Difficult and Should We Change Our Strategies?**	David M. Burns, M.D. University of California, San Diego School of Medicine San Diego, CA Kenneth E. Warner, Ph.D. School of Public Health University of Michigan Ann Arbor, MI

Chapter 2	**The Case for Hardening of the Target**	John R. Hughes, M.D. Departments of Psychiatry, Psychology and Family Practice University of Vermont Burlington, VT David M. Burns, M.D. University of California, San Diego School of Medicine San Diego, CA
Chapter 3	**The Case Against Hardening of the Target**	David M. Burns, M.D. University of California, San Diego School of Medicine San Diego, CA
Chapter 4	**Examining a Quarter-Century of Smoking Cessation Trials: Is the Target Becoming Harder to Treat?**	Jennifer E. Irvin University of South Florida and the H. Lee Moffitt Cancer Center and Research Institute Tampa, FL Thomas H. Brandon, Ph.D. University of South Florida and the H. Lee Moffitt Cancer Center and Research Institute Tampa, FL
Chapter 5	**Changes in Measures of Nicotine Dependence Using Cross-Sectional and Longitudinal Data from COMMIT**	Andrew Hyland, Ph.D. Roswell Park Cancer Institute Buffalo, NY K. Michael Cummings, Ph.D., M.P.H. Roswell Park Cancer Institute Buffalo, NY

Chapter 6	**Changes in Smoking Habits in the American Cancer Society CPS I During 12 Years of Follow-Up**	Thomas G. Shanks, M.P.H., M.S. Tobacco Control Policies Project University of California at San Diego San Diego, CA Christy M. Anderson, B.S. Tobacco Control Policies Project University of California at San Diego San Diego, CA
Chapter 7	**Changes in Number of Cigarettes Smoked per Day: Cross-Sectional and Birth Cohort Analyses Using NHIS**	David M. Burns, M.D. University of California, San Diego School of Medicine San Diego, CA Jacqueline M. Major, M.S. Tobacco Control Policies Project University of California at San Diego San Diego, CA Thomas G. Shanks, M.P.H., M.S. Tobacco Control Policies Project University of California at San Diego San Diego, CA
Chapter 8	**Changes in Cross-Sectional Measures of Cessation, Numbers of Cigarettes Smoked per Day, and Time to First Cigarette—California and National Data**	David M. Burns, M.D. University of California, San Diego School of Medicine San Diego, CA

Jacqueline M. Major, M.S.
Tobacco Control Policies Project
University of California at San Diego
San Diego, CA

Christy M. Anderson, B.S.
Tobacco Control Policies Project
University of California at San Diego
San Diego, CA

Jerry W. Vaughn, B.S.
Tobacco Control Policies Project
University of California at San Diego
San Diego, CA

Chapter 9 **Hardening of the Target: Evidence From Massachusetts**

Carolyn C. Celebucki, Ph.D.
Massachusetts Department of Public Health
Tobacco Control Program
Boston, MA
University of Rhode Island, Department of Psychology
Kingston, RI

Phyllis Brawarsky, M.P.H.
Massachusetts Department of Public Health
Bureau of Health Statistics, Research and Evaluation
Boston, MA

Reviewers include:

Erik Augustson, Ph.D.
Cancer Prevention Fellow
Division of Cancer Prevention
National Cancer Institute
Bethesda, MD

Gary Giovino, Ph.D.
Department of Cancer Prevention, Epidemiology and Biostatistics
Roswell Park Cancer Institute
Smoking Control Program
Buffalo, NY

Dorothy K. Hatsukami, Ph.D.
Professor
Department of Psychiatry
University of Minnesota
Minneapolis, MN

Jack Henningfield, Ph.D.
Vice President
Research and Health Policy
Pinney Associates, Inc.
Bethesda, MD

John Hughes, M.D.
University of Vermont
Human Behavioral Pharmacology Laboratory
Burlington, VT

Lynn T. Kozlowski, Ph.D.
Department of Biobehavioral Health
The Pennsylvania State University
University Park, PA

Linda L. Pederson, Ph.D.
Centers for Disease Control and Prevention
Office on Smoking and Health
Atlanta, GA

John Slade
Professor of Medicine
University of Medicine and Dentistry
Program in Addictions
New Brunswick, NJ

Kenneth Warner
School of Public Health
The University of Michigan
Department of Health Management and Policy
Ann Arbor, MI

Contents

Preface iii
Acknowledgements v
Contents xi

Introduction 1
Is the Target Hardening? Are Smokers Less Likely to Quit Now Than in the Past? 2
Are We Seeing a Hardening of the Population? Or a Hardening Of Our Interventions? 4
What Can We Learn From and About Special Populations? How Can Better Surveillance Help Us to Design Better Treatments and Dissemination Efforts? 5
Importance of Widening the Lens—Combining Clinical and Broader Policy-Based and Public Health Approaches and Building Consumer Demand 6
References 9

Chapter 1: Smokers Who Have Not Quit: Is Cessation More Difficult and Should We Change Our Strategies? 11
Introduction 11
Definition of the Question 12
Measures of Hardening 14
Have Cessation and Abstinence Rates Fallen Overall? 16
Have Recent Cessation Rates Fallen Among Populations That Have Achieved Low Smoking Prevalence? 17
Are Residual Smokers Heavier Smokers or More Addicted? 21
Do Current Smokers Have Higher Comorbidity Than Smokers Did in Previous Decades? 25
Are Residual Smokers Concentrated in Less Advantaged Demographic Groups and Those With Less Exposure To Tobacco Control Interventions? 26
Discussion and Summary 27
References 30

Chapter 2: The Case for Hardening of the Target 33
Introduction 33
Why It Is Important to Test the Hardening Hypothesis 35
An Adequate Test of the Hardening Hypothesis Is Needed 36
Dependence May Not Be the Most Relevant Cause of Any Hardening 37
Summary 38
References 38

Chapter 3: The Case Against Hardening of the Target 41
Introduction 41
Effect of Individual Factors on Heavy Smokers 42
Effect of Environmental Factors on Heavy Smokers 46
Summary 47
References 48
Chapter 4: Examining a Quarter-Century of Smoking Cessation Trials: Is the Target Becoming Harder to Treat? 49
Introduction 49
Method 51
Results 54
Discussion 55
References 59

Chapter 5: Changes in Measures of Nicotine Dependence Using Cross-Sectional and Longitudinal Data from COMMIT 61
Introduction 61
Methods 61
Analysis 64
Results 64
Summary 65
References 70

Chapter 6: Changes in Smoking Habits in the American Cancer Society CPS I During 12 Years of Follow-Up 71
Introduction 71
Cancer Prevention Study I 71
Methods of Analysis 72
Results 73
References 81

Chapter 7: Changes in Number of Cigarettes Smoked per Day: Cross-Sectional and Birth Cohort Analyses Using NHIS 83
Introduction 83
Methods 84
Results 86
Discussion 95
References 97

Chapter 8: Changes in Cross-Sectional Measures of Cessation, Numbers of Cigarettes Smoked per Day, and Time to First Cigarette—California and National Data 101
Introduction 101
Changes in National Cessation Rates and Number of Cigarettes Smoked per Day 101
Changes in Cessation Rates, Number of Cigarettes Smoked Per Day, and Time to First Cigarette in California, 1990 to 1999 110
Summary 123
References 125

Chapter 9: Hardening of the Target: Evidence from Massachusetts 127
Background 127
Methods 130
Analysis 132
Results 132
Discussion 141
Limitations 143
References 143

Introduction

C. Tracy Orleans

The decline in U.S. smoking prevalence since the publication of the first Surgeon General's Report in 1964 has been hailed as one of the greatest public health accomplishments of the past century (Warner 2001). Forty-four million Americans—almost half of those who ever smoked—have quit, and lung cancer death rates have decreased greatly as a result. As a nation, we've launched wide-reaching tobacco control programs in worksites, schools, communities, and all 50 states, and we've witnessed enormous shifts in social norms, policies, and public attitudes. Growth in clean indoor-air laws and smoking restrictions have made quit-smoking cues "persistent and inescapable" (Glynn, Boyd, and Gruman 1990), and new data shows that tobacco price increases and mass media cessation campaigns can significantly increase population quit rates (CDC 2001). Over the last three decades, we have developed effective clinical treatments—psychosocial and pharmacological—and seen the publication and update of authoritative practice guidelines recommending evidence-based treatments that, if universally applied, could double our national annual quit rate in a highly cost-effective way (Cromwell et al. 1997; U.S. DHHS 2000). Prospects for preventing and treating tobacco use and addiction have never been better.

Yet the papers in this monograph, *Those Who Continue to Smoke: Is Achieving Abstinence Harder and Do We Need to Change Our Interventions?*, raise important questions about what it will take to build on the successes of the last century and, in particular, on the last few decades of research and practice. While efforts to promote tobacco cessation need to be part of a much broader national tobacco control strategy that emphasizes prevention, it is clear that the greatest gains in reducing tobacco-caused morbidity, mortality, and health care costs in the next 30 to 40 years will come from helping addicted smokers quit (Orleans 1997). Further declines in adult smoking are likely to strengthen prevention efforts as well, since adult smoking is a critical determinant of social norms and a vector for youth initiation.

In this context, the findings presented in this monograph have important implications for the next generation of research and practice to help addicted smokers quit. Specifically, these papers and the findings they present indicate that helping more smokers quit will require: (1) developing more powerful treatments that can break through the 25% to 30% quit-rate ceiling achieved with our best existing treatments; (2) refining, targeting and tailoring treatments for high-risk populations; (3) greatly improving surveillance of quitting patterns and determinants; (4) developing combined

clinical-public health approaches that harness synergies between evidence-based clinical treatments, and macrolevel policy and environmental cessation strategies; and (5) improving the use of and demand for treatments that work.

IS THE TARGET HARDENING? ARE SMOKERS LESS LIKELY TO QUIT NOW THAN IN THE PAST?

This is the central question addressed in different ways by each of the papers in this monograph. Surprisingly, none of the papers presents compelling evidence that this is the case. But each paper offers unique insights into what it will take to raise success rates of individually oriented and population-based approaches.

Burns and Warner (see Chapter 1) approach this question by carefully operationalizing the hardening construct and then testing the hardening hypothesis against available national Current Population Survey (CPS) and National Health Interview Survey (NHIS) data, 1964 to 1999, as well as against data from the California Tobacco Survey (CTS), 1990 to 1999, and the Community Intervention Trial for Smoking Cessation (COMMIT). Their thoughtful paper asks clear questions and gives us mostly clear answers:

- Is there epidemiological evidence that the nation's annual quit rate is falling? No, not at present.
- Is there epidemiological evidence in the United States for decreased cessation rates among groups in which more ever-smokers have quit? No.
- Is there epidemiological evidence that levels of dependence, estimated by cigarettes per day or score on the Fagerström Tolerance Questionnaire (1994), have increased in the United States as prevalence has decreased? No.
- Is there epidemiological evidence among current smokers for increased psychiatric comorbidity among current smokers? The answer here is uncertain, given the lack of systematic surveillance. However, new data from the National Co-morbidity Study (Lasser et al. 2000) shows that patients with diagnosed psychiatric disorders—ranging from anxiety disorders, phobias, and dysthymia to other chemical dependencies to major depressive disorder and schizophrenia—are twice as likely to smoke and currently consume approximately 50% of the cigarettes sold in America. However, Lasser et al. (2000) point out that lifetime quit rates for these smokers are also fairly respectable (ranging from 27% to 34% compared with 43% for smokers with no history of mental illness).

And finally, Burns and Warner highlight the growing concentration of smokers in low socioeconomic status (SES) groups. However, in the absence of evidence that low-SES smokers are any less likely to quit than those in higher income groups when offered proven treatments or exposed to effective cessation policies and environmental influences, it is difficult to conclude support for the hardening hypothesis from these findings.

Hence Burns and Warner conclude that the hardening hypothesis should continue to be tested, and evidence that hardening is actually occurring should be required before it is used as a justification for changing current tobacco control strategies.

Burns' and Warner's paper also raises some important questions about language. They wisely cite John Slade's caution about the use of hardening as a term that could be construed to be demeaning or dismissive of people's quit attempts. Moreover, their findings suggest that a better question for understanding and addressing the challenges of increasing our national quit rate might be "is the target *changing?*" Substituting the word "changing" for "hardening" immediately brings a wider range of solutions into view, pointing not only toward future treatments that might be more intensive but also toward those that might be more effective or better tailored, packaged, promoted, and priced to reach their target populations.

Irvin and Brandon (see Chapter 4) offer another creative and rigorous approach to testing the hardening hypothesis: reviewing published cessation trials conducted in the United States to examine whether success rates have declined. For cognitive-behavioral multicomponent treatments published between 1977 and 1996, they found significant declines in reported end-of-treatment, 3-month, and 6-month (but not 12-month) abstinence rates—with mean 6-month quit rates declining about 10 percentage points, from over 40% to about 30%. Somewhat similar patterns were observed for trials of nicotine gum (1984 to 1996), transdermal nicotine (1990 to 2000), and varied placebo treatment conditions (1983 to 1999).

However, while they carefully examined and attempted to control for a range of potentially confounding and mediating variables (e.g., mean age, years smoked, daily smoking rate, Fagerström Tolerance Questionnaire scores), Irvin et al. point out that they may have missed key mediating variables (especially those related to nonspecific treatment effects) and had limited statistical power to detect mediation effects. In fact, it is quite possible that early adopters of these treatments (both smokers and clinicians) brought higher treatment expectations than later adopters, and that those smokers who were among the first to try each of these treatments had higher treatment-related self-efficacy based on fewer past, unsuccessful quit attempts or treatment experiences. Moreover, while these trials were conducted during periods of significant decline in national adult smoking prevalence, participants represented a very small subset of all U.S. smokers who tried to quit. The 1986 Adult Use of Tobacco Survey (AUTS) found, for instance, that only 30% of smokers tried to quit that year, and that only 10% to 15% of them used any formal treatment (2% to 4% counseling, 3% to 12% nicotine gum) (Fiore et al. 1990). Hence these published treatment studies provide limited insight into national quitting patterns and practices. Irvin and Brandon conclude that they cannot establish that their findings are consistent with the "population target hardening" theory.

ARE WE SEEING A HARDENING OF THE POPULATION? OR A HARDENING OF OUR INTERVENTIONS?

The clear look we get from Irvin and Brandon (see Chapter 4) at the performance of the same basic (essentially unchanged) treatments in published reports dating back 25 years, and over periods of time ranging from 10 to 19 years, begs a more fundamental question: is it our *smokers*, or our *treatments*, that have hardened? As Shiffman pointed out in his landmark 1993 paper (Shiffman 1993), behavioral intervention quit rates plateaued in the 1980s after a period of rapid innovation and improvement in the 1970s. Shiffman concluded in 1993 that behavioral cessation research "was in a rut" and challenged the field to renewed innovation. A few years later, Rimer (1997) pointed out that behavioral medicine research in general was suffering from "a hardening of the theories"—reflecting a growing tendency to abandon both formal theory testing and new theory development. And Piasecki and Baker (2001) recently reached a very similar conclusion, noting that not much had changed since Shiffman's review and concluding that "the rut had deepened."

Each of these reviews makes it clear that we will need to reinvigorate the science base driving treatment research if we are to develop new clinical treatments that can break through current 25% to 30% quit-rate ceilings. This will require new theory and more creative application of existing theory to expand beyond reliance on the handful of cognitive behavioral theories and models on which most recent tobacco dependence treatment research has been based (Orleans 1997). Progress also is likely to come from examining new combinations of pharmacologic and behavioral treatments, developing treatments that are biologically and developmentally tailored as well as environmentally and culturally tailored, and making tobacco dependence treatments more holistic by addressing related lifestyle risks and comorbid conditions. A return to the study of how today's smokers actually quit and how they use existing treatments could furnish important new insights.

Innovative transdisciplinary research efforts, like those supported through the new Tobacco Use Transdisciplinary Research Centers (TUTRCs), cofunded by the National Cancer Institute, the National Institute on Drug Abuse, and the Robert Wood Johnson Foundation, are promising incubators for discovering more powerful approaches to tobacco dependence treatments and public health cessation strategies. Research that bridges the clinical and public health domains, connecting the science of individual behavior change (i.e., individually oriented tobacco dependence treatment) with the science of population-based cessation (i.e., policies and environmental influences that promote cessation in organizations, communities, or larger populations), could be equally transformative—pointing us not only toward more effective treatments and cessation interventions but also toward more effective dissemination strategies to spread their use and application.

WHAT CAN WE LEARN FROM AND ABOUT SPECIAL POPULATIONS? HOW CAN BETTER SURVEILLANCE HELP US TO DESIGN BETTER TREATMENTS AND DISSEMINATION EFFORTS?

At the 2002 Society for Research on Nicotine and Tobacco meeting, Gary Giovino presented a systematic overview of the epidemiology of quitting in America, based on analysis of trends from 1965 to the present in several national data sets (CPS, NHIS, National Household Survey on Drug Abuse, and Monitoring the Future), which confirms a slow but continuing rise in our national annual quit ratio for most adult smoker populations. Trend analyses (national and state) of cigarettes per day and some-day smoking do not indicate hardening. And, despite suggestive evidence for a slight increase in indicators of addiction from 1985 to 1994, trends in measures of dependence do not support the view that U.S. tobacco control efforts have led to proportionately more quitting among less dependent smokers or left behind a population of proportionately more dependent smokers (see also Giovino 1996).

Perhaps most provocative, however, are NHIS data showing much higher quit ratios for some groups than others. Adults aged 18 to 24 and 25 to 44 have the highest rates of current smoking prevalence and lowest quit ratios, while those aged 65 and over and 45 to 64 have the lowest rates of current smoking prevalence and highest quit ratios. Similarly, smoking prevalence is highest and quit ratios are lowest among Americans with fewer than 12 years of education compared with those having a college education or higher. Similar findings have been reported for racial/ethnic minority adult populations (e.g., Boyd et al. 1998; Gilpin et al. 2001). These stark contrasts underscore the need to target and tailor our interventions better to these high-risk groups.

The contrast most germane to the target-hardening hypothesis is that between older adults (65 and over) and young adults (aged 18 to 24):

- Older adults represent a population in which the prevalence of smoking has declined to a very low level (10.6% in 2000) and thus comprises a group in which the most "hardening" should have occurred, a group with the greatest potential recalcitrance to standard treatment approaches. However, with access to in-depth national surveillance data from the 1986 AUTS (Fiore et al. 1990)—which clarified how older adults tried to quit, thought about quitting, what their misconceptions were (e.g., "it's too late to quit"), and identified covariates of successful quitting—we were able to develop population-targeted self-help and primary care treatments designed specifically for them that produced quit rates as high, if not higher, than those seen with the same general approaches in younger populations (e.g., Orleans et al. 1994; Rimer et al. 1994). A strict target-hardening theory would have predicted poorer outcomes.
- In contrast, younger adult smokers, with the highest smoking prevalence (27.9% in 2000), represent the group in which, by definition, the least hardening has occurred. Yet quit rates with standard treatment approaches (counseling, pharmacotherapy)

effective for most adult populations have proven ineffective and unappealing with these younger smokers (Sussman 2002), likely reflecting the different determinants of quitting motivation and success in this population. Unfortunately, given the dearth of national survey data on youth quitting determinants and practices, we are handicapped in developing treatments to better assist them.

The interesting contrast in treatment recalcitrance between these two groups, older and younger smokers, not only challenges the hardening hypothesis but also points strongly to the need for much better surveillance of current quitting motives, barriers, and practices among all smoker populations in the United States. Such survey data could be systematically used to develop more appealing treatments and more effective methods for promoting their use in the targeted populations (Boyd et al. 1998). Without such data, we are working very much in the dark to help more smokers quit.

Systematic longitudinal, nationally representative surveys could help us to engineer more effective treatments and public health cessation strategies and systematically evaluate impacts of varying public policy and environmental interventions. Such surveillance is especially critical now, given the emergence of new so-called reduced-harm tobacco products. Marketed as safe alternatives to quitting, these products may lure many would-be quitters away from serious quit attempts and existing treatments. Monitoring these trends nationally is essential. Improved cessation surveillance should include a special focus on high-risk populations—including youth, racial/ethnic minorities, low-SES groups, as well as smokers with psychiatric comorbidity (Lasser et al. 2000). It is not reasonable to assume that one size fits all when it comes to motivating and assisting smokers to quit, and these populations continue to merit special targeting.

To begin to address neglected surveillance needs, the Robert Wood Johnson Foundation, the Centers for Disease Control and Prevention, and the National Cancer Institute (NCI) are cofunding a youth cessation panel study that will, beginning in 2003, longitudinally follow smokers aged 16 to 20 over two years, and the NCI has identified the need for prospective observational studies of quitting and relapse processes in its 2004 bypass budget. However, more extensive efforts are needed. Comprehensive sustained surveillance would provide the compass we now lack to reach the 2010 quitting goals we have set for the nation (U.S. DHHS *Healthy People 2010*).

IMPORTANCE OF WIDENING THE LENS—COMBINING CLINICAL AND BROADER POLICY-BASED AND PUBLIC HEALTH APPROACHES AND BUILDING CONSUMER DEMAND

Hughes' paper (see Chapter 2) underscores the need for broad-spectrum approaches that combine effective clinical treatments with effective policy and environmental approaches. The past three decades of research have given us vital resources, two sets of evidence-based tobacco intervention guidelines on which we can draw to find new and better ways to help addicted smokers quit: (1) clinical practice guidelines for treating tobacco use and dependence (U.S. DHHS 2000),

and (2) public health guidelines for policy and macrolevel environmental strategies that can help spur quitting by changing the larger social and political contexts in which smokers live and work (e.g., tobacco price increases, smoking bans and restrictions, mass media campaigns, policies that reduce smokers' out-of-pocket treatment costs) (CDC 2001).

Hughes (see Chapter 2) proposes that raising tobacco prices, cessation-oriented media campaigns, and provider advice may have primary impacts on smokers' quitting motivation and attempt rates, while improving treatment efficacy and access may primarily affect quitting success rates among those who make attempts. Unfortunately, without systematic and ongoing cessation surveillance, it is difficult to test these hypotheses, to assess the differential effects of policy and treatment advances on our national quitting profile, or to understand the mechanisms through which these different strategies exert their influence.

As a nation, we have only just begun to understand how to implement these clinical or public health strategies fully or to capitalize on the synergy between them. Lessons learned from states with comprehensive tobacco control policies and programs (e.g., California, Massachusetts, and Oregon) offer vital clues and inspiration. California provides one of the nation's most important laboratories for these kinds of studies (Warner 2000) and serves as a model for the nation.

Elements of California's comprehensive 12-year Tobacco Control Program have included: a statewide smokers' telephone helpline, antitobacco media campaigns (including those designed specifically to motivate quitting and helpline use), local smoking cessation programs, increases in insurance coverage for nicotine pharmacotherapy, clean indoor-air laws, campaigns educating smokers about the dangers of environmental tobacco smoke, tobacco tax increases and enforcement of youth access laws (Fichtenberg and Glantz 2000; Gilpin et al. 2001). These initiatives led to a spontaneous grassroots movement supporting voluntary in-home smoking bans across the state. In fact, 25% of smokers in California now live in smokefree homes, and they report higher quit attempts and quit rates (Gilpin et al. 2001).

While we know little about which of these statewide program elements, alone or in combination, was most responsible for California's rising quit rates, and even less about the mechanisms of change (e.g., exactly how in-home smoking bans are helping more smokers quit), we do have evidence that this comprehensive strategy has worked. From 1989 to 1997, adult smoking prevalence in California dropped 33% compared with 22% in the rest of the country. Rates of lung cancer declined 14% (compared with 4% in the rest of the country), and an estimated 33,000 cardiovascular disease deaths were prevented. Through reduced health care costs, a $3.62 return was estimated for every $1.00 invested (Fichtenberg and Glantz 2000). The NCI monograph *Population-Based Smoking Cessation* (NCI 2000) projected that if comprehensive tobacco control programs like California's were implemented nationally, quit rates would increase by one-third every year, creating 500,000 new ex-smokers annually.

Consistent with the data Burns and Warner (see Chapter 1) present for declining addiction levels among California smokers over the last decade, the most recent state survey data (Gilpin et al. 2001) indicate that California's lower smoking prevalence has been accompanied by a softening rather than hardening of the smoker population. The proportion of light smokers (<15 cigarettes per day) increased from 44% in 1990 to 60% in 1999. Smokers reporting serious past-year quit attempts rose from 49% in 1990 to 62% in 1999. The percentages of attempting quitters who succeeded (24%) and of so-called "hardcore" smokers who reported never expecting to quit (10%) were similar in 1990 and 1999.

Finally, California's results, while very encouraging, also demonstrate the need to dramatically widen the reach, use, and appeal of effective treatment services in order to take full advantage of the softening that has occurred. The proportion of quitters using any formal quitting aids rose only 4 percentage points, from 18% in 1990 to 22% in 1999, and rates of physician advice to quit rose only 8 percentage points, from 38% to 46%, during the same period (Gilpin et al. 2001). These rates may in fact be higher than (unknown) national rates, but they are not high enough, especially in underserved low-income and minority populations (Fiore et al. 1990; Gilpin et al. 2001). At the same time that we are investing in research to discover more powerful clinical treatments and public health cessation strategies, we could realize a more rapid return on investment from parallel efforts to improve the reach and appeal of existing treatments and to boost consumer demand for them (Orleans 2001).

In studies and in situations in which we've succeeded in expanding treatment coverage and reducing smoker out-of-pocket costs, we've found that only a minority of smokers come forward (Curry et al. 1998; Mordavsky et al. 2002)—evidence that more can be done to market our treatments effectively or design (or redesign) them for wider use and appeal. Media campaigns to promote quitting or quitline use, both in general populations and in smoker subgroups (African-American smokers, HMO enrollees, and pregnant smokers), have been very successful in getting smokers to call for help. And those who do call quit at predicted rates (Boyd et al. 1998; CDC 2001). In fact, media cessation campaigns are recommended by the Centers for Disease Control and Prevention (CDC) as an effective cessation strategy (CDC 2001). But, to date, we have invested relatively little energy and dollars in these media strategies or in other forms of creative-treatment marketing or packaging to boost consumer demand. In contrast, our competition, the tobacco industry, invests over $8 billion a year marketing cigarettes and tobacco products (FTC 2001).

Going forward, we need to pursue a two-part strategy—striving both to discover new, more powerful treatments and to get better results from disseminating the proven, science-based interventions we have developed. Just as we need transdisciplinary basic biobehavioral research to discover new quitting approaches, so do we need to bring fresh new perspectives to bear from business, marketing, product design, economics, communications, even new dissemination science to study how quitters actually use our best evidence-based treatments, to reinvent and repackage them for

greater appeal, use, and efficacy. Even small pilot grants to interdisciplinary teams might lead to breakthrough product packaging or delivery improvements that could incorporate what we know to be the most effective treatment elements, comply with U.S. Public Health Service (PHS), CDC, and Food and Drug Administration (FDA) guidelines, and prove to be more widely applicable and cost-effective. These and other dissemination-focused initiatives now being launched or planned by a variety of funders—including the National Partnership to Help Pregnant Smokers Quit (2002) and the *National Blueprint for Disseminating and Implementing Evidence-Based Clinical and Community Strategies to Promote Tobacco Use Cessation* (AHRQ 2002)—could allow us to more fully harvest the fruits of past intervention research and capitalize on the unprecedented potential for social and financial support for smokers' quitting efforts.

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

David M. Burns, Kenneth E. Warner

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.

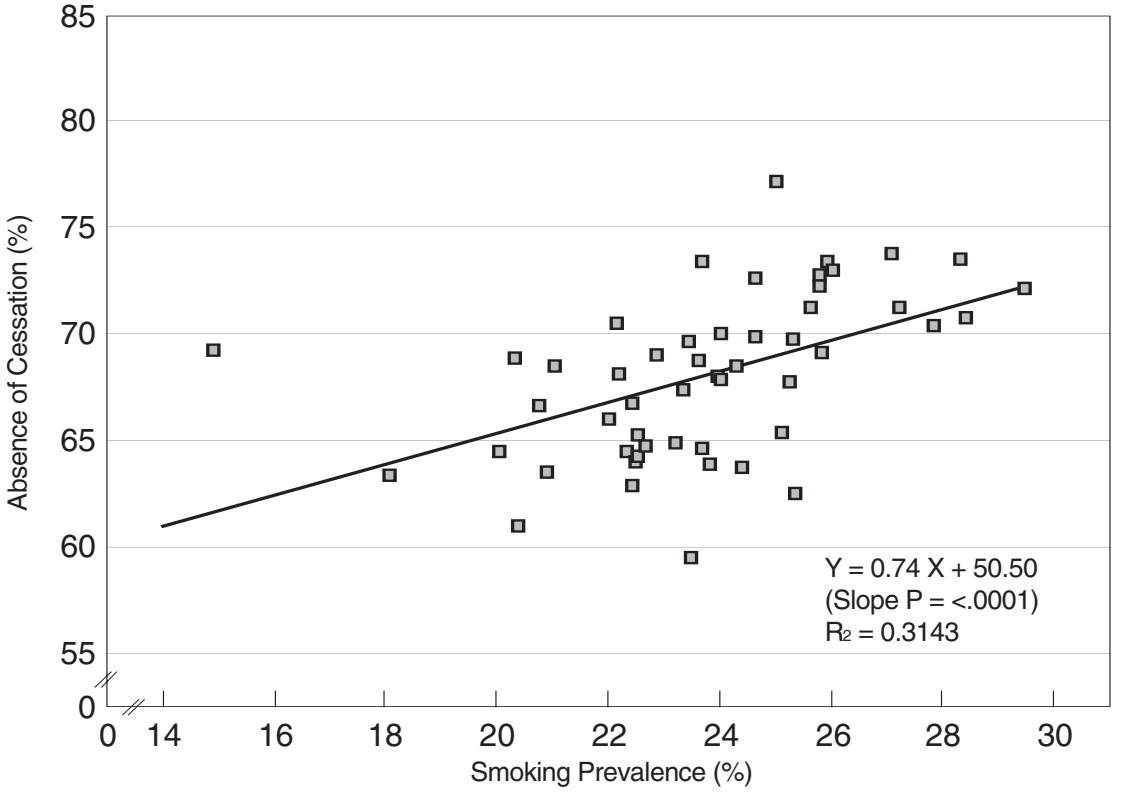
The likelihood that populations with a low prevalence of current smoking or in which a large fraction of ever-smokers have quit contain more smokers who are unwilling or unable to quit makes them fertile ground for examining cessation and abstinence trends for evidence of hardening. If a true hard core 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).

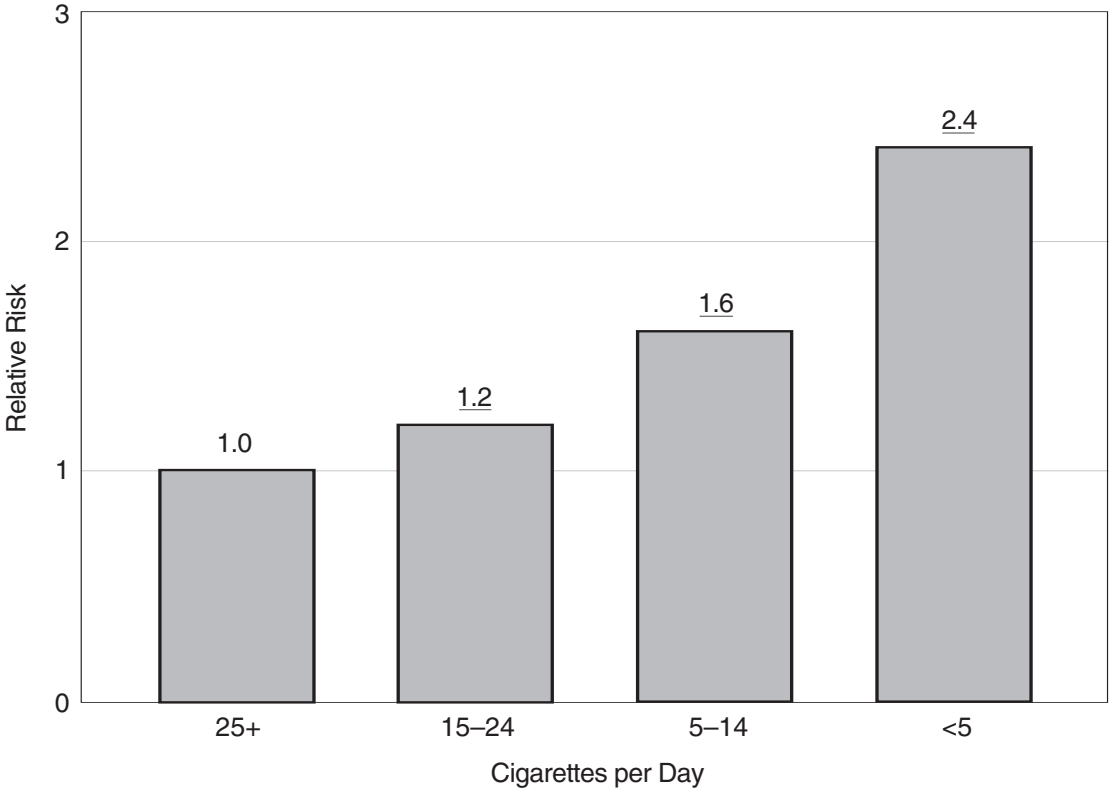
If less-addicted smokers are more likely to quit, remaining smokers should smoke more cigarettes per day and be more likely to have their first cigarette within 30 minutes of waking. If so, trends over time in number of cigarettes smoked per day and time to first cigarette should be good measures of 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.

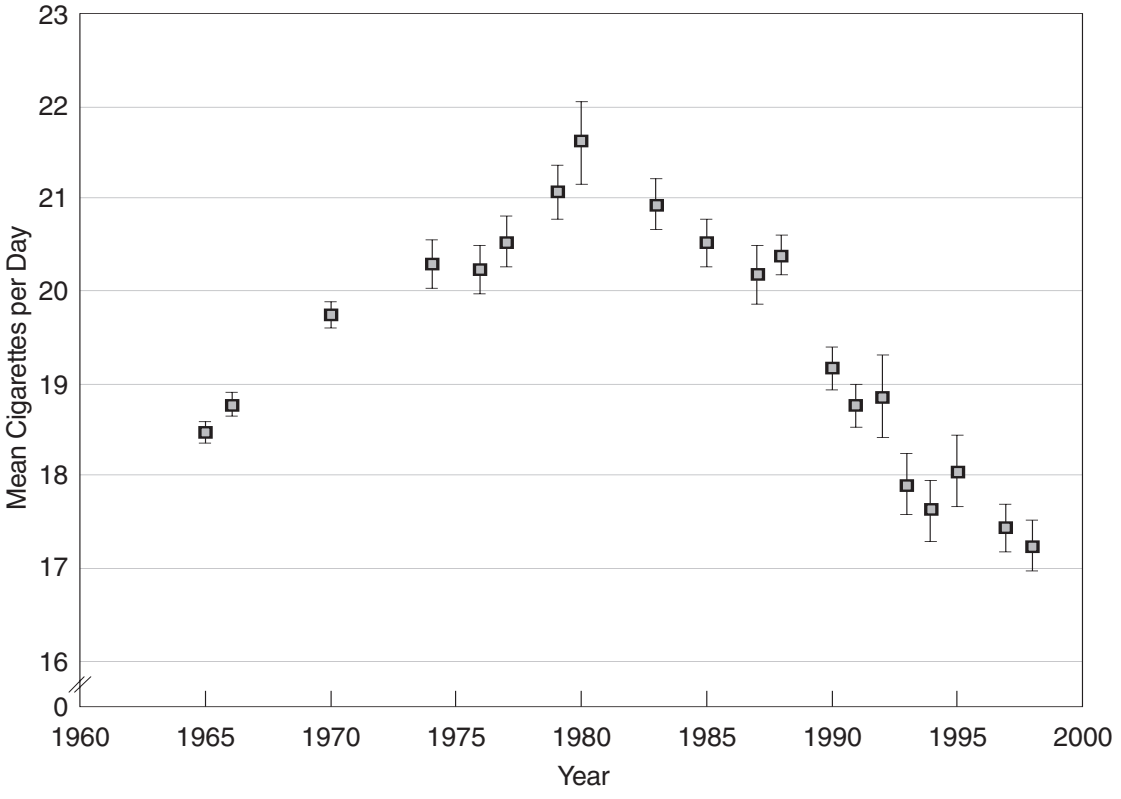
NOTE: Underlined relative risks are statistically significant at the 5% level.

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

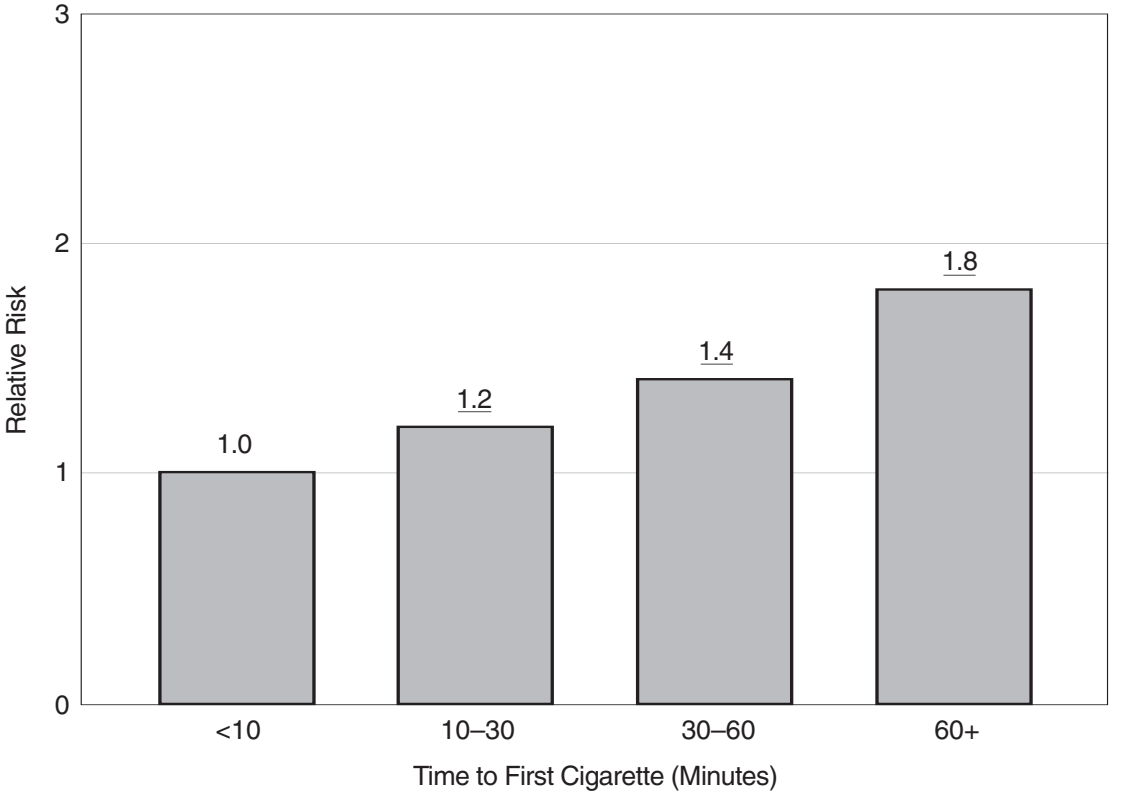


See Chapter 6.

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.

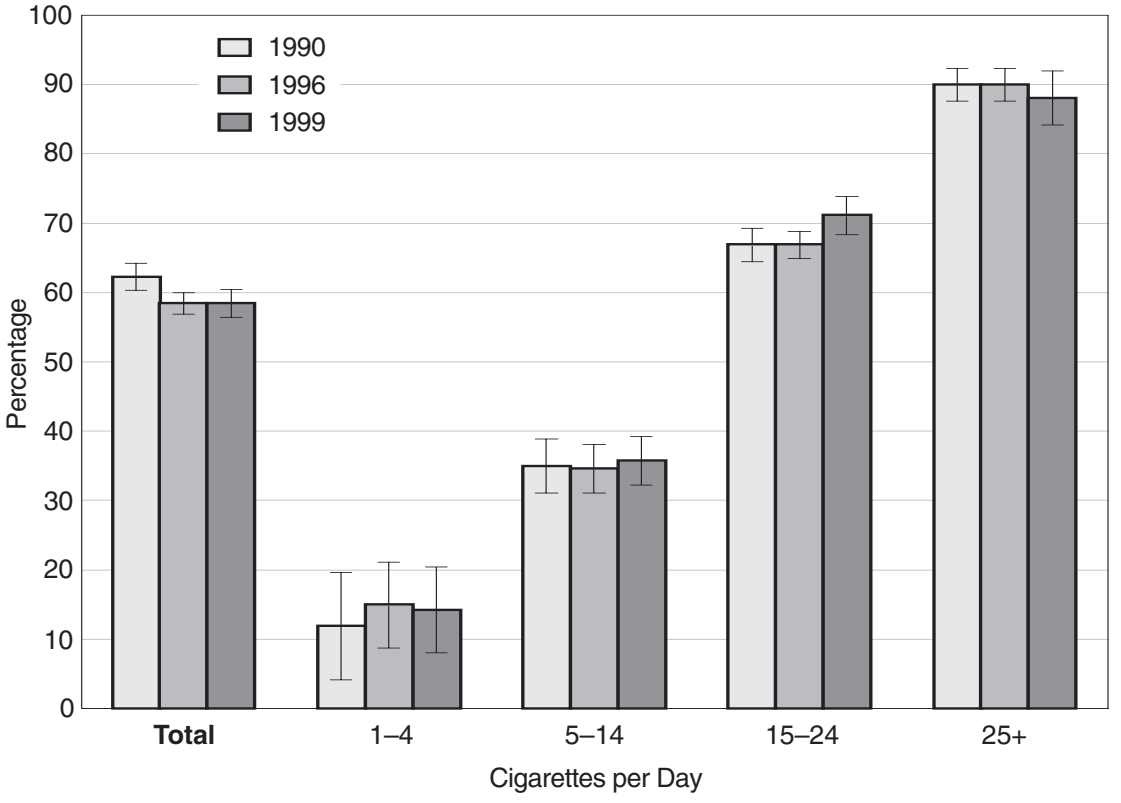
NOTE: Underlined relative risks are statistically significant at the 5% level.

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.

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The Case for Hardening of the Target*

John R. Hughes

INTRODUCTION Tobacco control efforts increased smoking abstinence up until 1990; however, in the mid-1990s, smoking prevalence rates and the U.S. per capita consumption leveled off and remained constant (CDC 1999b; Taylor 2001; see Chapter 8). Per capita consumption again declined in 1999 following the Master Settlement Agreement (MSA) and a subsequent increase in the cost of cigarettes. However, it is unclear whether this decline is a resumption of the previous trends or a one-time drop due to the increase in cost (see Chapter 8). The percent of ever-smokers who have quit (the quit ratio) increased from 1965 to the early 1990s but has changed little since then (Figure 2-1).

One explanation for this plateauing is that a selection bias is operating such that those smokers who found it easy to quit did so, leaving a more hardcore or hardened group of smokers (Hughes 1993) who had more difficulty achieving abstinence. The argument for such a selection bias is that since high dependence predicts low rates of cessation (Fagerström and Schneider 1989), the inevitable consequence is that, over time, remaining smokers will be those who are highly dependent. The only way this would not be true is if those new persons recruited to smoking were the same as those leaving smoking; i.e., if those recruited were destined to become the less dependent smokers. What is noteworthy is that the hardening hypothesis assumes that the level of dependence varies across smokers. Many politicians, public health advocates, and scientists have acted as if all smokers are victims of a ubiquitous addiction that occurs completely and immediately upon smoking initiation. In reality, adult smokers do, in fact, vary from no dependence to heavy levels of dependence (Giovino et al. 1995).

Two tests of the hardening hypothesis support it. One test involved a comparison of smoking prevalence and degree of dependence across European countries (Fagerström et al. 1996). In this study, those countries with a lower prevalence of smoking had higher nicotine dependence scores among remaining smokers than did countries with higher rates of smoking. The other test examined quit rates in published treatment outcome studies and found that quit rates decreased over time (Irvin and Brandon 2000; Irvin, Hendricks, and Brandon 2001) (see Chapter 4).

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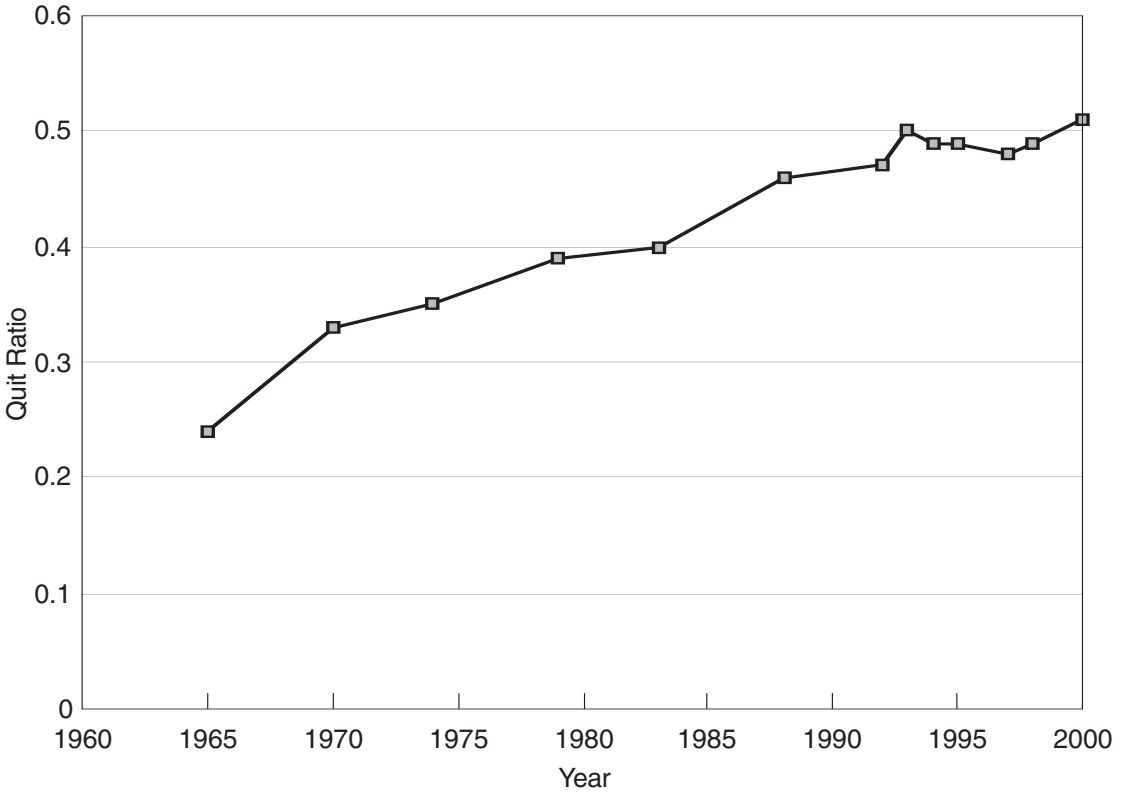
Figure 2-1
Quit Ratio by Calendar Year, 1965–2000



Percent of ever-smokers who had quit by the time of the survey (quit ratio) over time. Data from the National Health Interview Survey @ **www.cdc.gov/tobacco/research_data/adults_prev/tab_3.htm**

Changes in success rates per quit attempt over time have not been published. Data from the U.S. Current Population Survey (CPS) and the California Tobacco Survey (CTS) (Burns et al. 2000) was used to calculate the proportion of quit attempts in the last year that resulted in abstinence of 3-plus months. The success rate per quit attempt is calculated using the percent quit 3-plus months in the numerator and the percent who made a quit attempt in the denominator. This measure does not include either quit <3 months or occasional smokers, but the results are the same when these measures are included. This success rate hovers between 13.6% and 16.3%, with no discernable time trend between 1992 and 1999 for the CPS data.

In the CTS, success rate per quit remained stable from 1990 to 1996 (17% versus 16%). If the number of quit attempts among those who tried to quit has increased over time, this would mask a decline in success rates, but this effect is unlikely to be large enough to mask a meaningful decline. This evidence does not support a decline in the success rate per quit, but limitations on the length of time over which the rates are calculated means that it remains unclear whether success rates per quit attempt have changed over time.

The plateauing of smoking prevalence could possibly be due to a decline in the prevalence of quit attempts. The CPS data reports a decline in the prevalence of quit attempts in the year prior to the survey from 37% in 1992/93 to 32% in 1995/96 (Burns et al. 2000), but they rose again in 1998/99 (see Chapter 8). In California and Massachusetts where tobacco control programs were in effect, quit attempts declined slightly in California (33% in 1990 versus 31% in 1996) and were unchanged in Massachusetts (48% in 1993 and 1997) (Burns et al. 2000). Once again, a clear trend over time is not evident.

In this chapter, there are three points to be discussed: (1) why it is important to continue to test the hardening hypothesis; (2) why one must distinguish between indirect, inadequate tests of the hypothesis and direct, adequate tests of the hypothesis; and (3) why, even though this monograph focuses on dependence, the most important factors in any hardening may be psychosocial factors.

WHY IT IS IMPORTANT TO TEST THE HARDENING HYPOTHESIS

To understand the importance of the hardening hypothesis to tobacco control, it is helpful to first outline the role of cessation in tobacco control. Tobacco control has traditionally focused on prevention; e.g., the U.S. Centers for Disease Control and Prevention (CDC) recommends that only 21% to 33% of tobacco control money be spent on cessation (CDC 1999a). In the past, when tobacco control plans have focused on cessation, they have usually focused on motivating quit attempts and not on providing treatment.

In contrast, plans for the control of alcoholism or illicit drug use make providing for treatment a central component (NIDA 1999). In addition, these plans for controlling alcohol or illicit drug use clearly state that simply increasing motivation is insufficient; rather, drug-dependent individuals need treatment and some will need intensive treatment (NIDA 1999).

One of the reasons that tobacco control has avoided treatment is the myth that treatment is not efficacious and not cost-effective (Hughes 1999b). In terms of efficacy, several meta-analyses have concluded that many treatments for smoking double quit rates (Hughes 1996). Importantly, meta-analyses have found that, unlike alcohol dependence treatment, the efficacy of treatments for smoking cessation is dose-related; i.e., more intensive treatments do, in fact, result in higher quit rates (Fiore et al. 2000).

In terms of cost-effectiveness, therapies such as brief advice (with or without medications), telephone counseling, and over-the-counter (OTC) medications have all been shown to be cost-effective (Cromwell et al. 1997). In fact, provision of smoking cessation has been called the gold standard of cost efficacy as no other treatment in medicine has been able to match it (Eddy 1992).

A corollary myth among many tobacco control advocates is that even though cessation treatment may be cost-effective, prevention is more so. Empirical data to support this belief is lacking. Treatment is likely to be as cost-effective if not more cost-effective than prevention. If one induces a

smoker to stop smoking, the benefit of cessation begins within a year, whereas, if one induces a teenager not to start smoking, the benefit may not occur for 30 or more years. Economists observe that, due to discounting, $100 spent to obtain a given benefit next year is much more cost-effective than $100 spent to obtain the identical benefit 30 years from now (Warner and Luce 1983).

In contrast to tobacco control programmatic efforts, research on smoking behavior has adopted a much broader approach to the problem. Research efforts have examined clinical treatment as well as prevention and public policy interventions, and future directions include examining the interactions of genetic, biologic, psychologic, and sociologic factors in smoking behavior and resultant disease (NCI 1998, 2001).

Given this background on tobacco control and cessation, now let us assume the hardening hypothesis gathers sufficient evidence to become believable. The main implication would be that tobacco control should focus more on cessation; that is, tobacco control would need to reallocate program delivery funds from just motivating smokers to quit to actually providing treatment, including intensive treatment.

AN ADEQUATE TEST OF THE HARDENING HYPOTHESIS IS NEEDED

The major issue in assessing evidence for or against the hardening hypothesis is the validity of the measure of nicotine dependence used. Contrary to what many believe, there are widely accepted criteria of dependence; i.e., those recommended by the American Psychiatric Association's (APA) *Diagnostic and Statistical Manual: Fourth Edition (DSM-IV-R)* (APA 2000), and the almost identical criteria of the World Health Organization's (WHO) *International Classification of Diseases: 10th Edition (ICD–10)* (WHO 1992). These criteria focus on two aspects: physical dependence (i.e., tolerance and withdrawal) and psychological dependence (i.e., impaired control over drug use). Although the DSM/WHO criteria have been widely used in alcohol and illicit drug dependence research and practice, they have been used in only a few studies of nicotine dependence (Giovino et al. 1995). Thus data on their reliability and predictive validity in smokers is limited.

The most widely used measures of nicotine dependence are the Fagerström tests, i.e., the Fagerström Tolerance Questionnaire and the newer Fagerström Test for Nicotine Dependence (Fagerström and Schneider 1989). These measures combine queries about consumption and some indices of psychological dependence, and they predict the success of quit attempts and compensatory smoking (Fagerström and Schneider 1989). The item of the Fagerström scales that carries the most predictive power is time to the first cigarette of the morning, and this single item has been shown to have predictive validity (Kozlowski et al. 1994).

Cigarettes per day (CPD) is often used as a proxy measure for nicotine dependence, as evidenced by many of the chapters in this monograph. Such consumption measures are correlated with the probability of alcohol and other drug dependencies, but this correlation is much smaller than most believe (Mendelson and Mello 1985). In fact, it is noteworthy that the

amount of drug consumption is not part of the DSM/WHO criteria for dependence on any drug.

One major problem with CPD is that it actually is a nonspecific measure of the dose of nicotine (and smoke) received by the smoker (e.g., the correlation between CPD and nicotine levels is usually $r < 0.50$) (Benowitz 1983). This is because the way a smoker smokes a cigarette (number of puffs, puff volume, for example) is as important as CPD in determining nicotine consumption. Another problem with CPD is that currently in the United States many variables other than dependence have large effects on CPD (Evans, Farrelly, and Montgomery 1999). For example, there may be many highly dependent smokers who would like to smoke 40 CPD but can only smoke 15 CPD due to increasing cost and worksite and home restrictions on smoking. There is some evidence that social policy changes, such as tax increases, may be accompanied by compensation in the way individual cigarettes are smoked such that declines in CPD do *not* produce a proportional decrease in nicotine intake (Evans and Farrelly 1998), again suggesting CPD may be an imprecise measure of intake or dependence.

Currently, only Fagerström scores, and perhaps the time to the first cigarette, are adequately validated measures of nicotine dependence. The problem is that the majority of data sets one could use to examine the hardening hypothesis only include CPD. It could be argued that CPD is still an adequate measure to test the hypothesis because, with large data sets, a very accurate measure of dependence is not needed, and a measure somewhat related to dependence would be adequate. However, in reality, CPD is poorly correlated to nonconsumption measures of dependence. For example, the correlation between CPD and Fagerström scores (minus CPD) is only $r = 0.33$, and the correlation of CPD with the number generated by the DSM/WHO criteria is only $r = 0.23$ (Riggs and Hughes 1999). Thus, when tests of the hardening hypothesis use CPD and give negative results, one must entertain the real possibility of false negative results due to measurement error.

DEPENDENCE MAY NOT BE THE MOST RELEVANT CAUSE OF ANY HARDENING

Several variables other than the variable of dependence predict lower rates of cessation: lower income, psychological comorbidity, younger age, lower education, alcohol/drug problems, stress, certain occupations, and other smokers in the household, for instance (U.S. DHHS 1990). Thus it is probable that future smokers are more likely to be the poor or those with minor or major psychological or other problems (Hughes 1999a), and it may be changes in these factors, not dependence, that account for hardening. Thus it is important to include these factors, as well as dependence, when testing the hardening hypothesis. Also, if psychosocial factors are driving the hardening, then instead of providing treatments tailored for heavily dependent smokers, we may need to provide treatments focusing on the special problems of the poor (e.g., improving access to treatment), on problems with other smokers in the household (e.g., how to handle a smoking spouse), or on more effective and tailored prevention.

SUMMARY Tobacco control advocates should be proud that they have dramatically changed society's view of smoking. But every businessman knows that as the society changes, the characteristics and needs of their clients change. It would be quite foolish for tobacco control advocates to assume the same is not true for their clients, i.e., smokers. Thus, in reality, the question is not whether the target is hardening but rather, how the remaining smokers are changing and whether they changed enough to necessitate changes in our tobacco control efforts. We should not rely on imprecise measures of dependence (e.g., studies using CPD as a measure of dependence) to prematurely make what has a good chance of being a false negative or false positive decision. Rather, new studies with good measures of dependence and those other factors that might be changing over time are needed. Marketers do this type of "characterizing the changing market" all the time. Why shouldn't those in tobacco control do the same?

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The Case Against Hardening of the Target

David M. Burns

INTRODUCTION One of the most compelling arguments for the hypothesis that past successful smoking control interventions have left behind a group of smokers who have more difficulty quitting and are therefore a hardened target is that of direct logic. Those who have already successfully quit must, as a group, have less difficulty quitting than those who continue to smoke, a group that includes substantial numbers of smokers who have failed in past cessation attempts.

An extension of this logic provides the following argument against hardening: if smokers who have more difficulty quitting are left behind, then the residual population of smokers should show an increasing prevalence of those smokers' characteristics that predict reduced cessation activity or failure to maintain abstinence. For example, if smokers of greater numbers of cigarettes per day (CPD) have more difficulty quitting, then, over time, as smokers of fewer CPD preferentially quit, the residual population of smokers should show an increase in the mean number of cigarettes smoked per day. Because the mean CPD reported in surveys has fallen rather than risen over the last decade (see Chapter 7), this logic would argue that the target in not hardening.

Evidence presented throughout this monograph suggests that neither of these "logical" arguments is compelling. In each case, the single dimension of change in smoking behavior on which the logic is based does not fully account for the other changes over time in both smoking behavior and in the environment in which smoking occurs. Much of this monograph is devoted to a presentation of evidence on trends over time in various measures of smoking behavior that have been associated with difficulty in achieving long-term abstinence. Changes in these measures over time do not provide a convincing demonstration that cessation of about one-half of ever-smokers has produced a residual population of smokers which is increasingly composed of heavier smokers, more-addicted smokers, or smokers with greater comorbidity. Therefore, even in the presence of the compelling logic that the smoking population must be hardening, there is little objective evidence that it is actually occurring.

The following section addresses the paradox of a logical inevitability that the target must be hardening when there is little evidence that the residual population of smokers has actually hardened. The section explains why leaving behind a population of smokers who have more difficulty achieving abstinence on an individual level may not translate into lower rates of successful cessation on a population level.

EFFECT OF INDIVIDUAL FACTORS ON HEAVY SMOKERS

A comprehensive review of the predictors and determinants of cessation is beyond the scope of this section and has been presented elsewhere (U.S. DHHS 1990, 2000, 2001). However, in general terms, the factors influencing cessation can be divided into those that are characteristics of the individual and those that are characteristics of the environment in which the smokers smoke. Individual factors are those most often considered in discussions of whether the target is hardening, but consideration of changes in both individual and environmental factors over time is important for examining whether achieving successful cessation is becoming less likely over time.

Among the individual factors that might influence cessation are the strength of the addiction to nicotine, the extent of comorbidity with other substance dependence disorders or with psychiatric illness, and the personal resources that the smoker brings to the cessation attempt (Fiore et al. 2000). Studies of cessation interventions have demonstrated an inverse relationship between the number of cigarettes smoked per day and the likelihood of cessation success (U.S. DHHS 1990). However, there has been a decline rather than an increase over the last two decades in the fraction of smokers smoking 25 or more cigarettes per day (U.S. DHHS 2001), and the mean number of cigarettes smoked per day as reported by smokers has declined as well (see Chapter 7).

This paradoxical outcome was confirmed in a five-year follow-up of cigarette smokers conducted as part of the Community Intervention Trial for Smoking Cessation (COMMIT) evaluation (Hymowitz et al. 1997; see Chapter 5). In the longitudinal sample of smokers followed for the entire study, the likelihood of quitting over the five-year interval was much lower among heavy smokers and among those who reported smoking within the first 30 minutes after waking. However, cross-sectional surveys performed over the same five-year interval in the same cities where the longitudinal study was conducted showed a decline in mean number of cigarettes smoked per day and no change in the fraction of smokers who reported smoking within the first 30 minutes of waking. The longitudinal data are consistent with observations that higher levels of addiction predict lower rates of cessation (U.S. DHHS 1990), and they present a convincing case that individual characteristics of smoking behavior, particularly those reflecting the degree of addiction, define how hard it is for an individual to achieve long-term abstinence. However, the cross-sectional COMMIT data point to the paradox of heavy and more-addicted smokers having more difficulty achieving abstinence without the population of residual smokers being composed of higher percentages of heavy smokers or smokers who are more addicted.

Defining a group of individuals at one point in time and following them for short periods of time examines smokers' responses to a fixed set of environmental factors. Over a short period of time, factors that influence cessation, such as cost, restrictions on where smoking is allowed, and social norms about smoking, change only modestly. Therefore, the individual characteristics that define how much difficulty a smoker may have in quitting will be more powerful in predicting cessation success. Short-term

evaluations have difficulty examining the possibility that changes in environmental factors that promote cessation may have a greater effect on heavy smokers than on light smokers. Within a fixed set of environmental factors, more-addicted smokers will have more difficulty quitting than less-addicted smokers; but as environmental factors change, it is possible that the impact of these environmental factors on cessation may be more powerful on heavier smokers than on lighter smokers.

The discordance between the longitudinal data and the cross-sectional data in the COMMIT observations cannot be explained by differences in the duration of observation, since the duration is the same for the longitudinal and cross-sectional measures. One potential explanation is the possibility that some of the environmental changes taking place may shift smokers downward in the amount that they smoke, or in their level of addiction, and this shift might be more pronounced for heavy smokers or more-addicted smokers. For example, increased restriction on where smoking is allowed in California is suggested as one reason for the marked decline in the percentage of California smokers over the last decade who report smoking 15 or more cigarettes per day (Brownson et al. 1997; Burns et al. 2000b; Gilpin et al. 2001).

It is also possible that heavy smokers are currently more likely to shift downward over time than light smokers are to shift upward. If this trend occurs, the mean number of cigarettes smoked per day in a population will shift downward unless current populations of heavy smokers are replaced by future generations of smokers with equally high numbers of heavy smokers. If those smokers who initiated smoking in the recent past are less likely to become heavy smokers than previous generations of smokers because of restrictions on where smoking is allowed or other factors, then the mean number of cigarettes smoked per day among all current smokers in cross-sectional surveys can fall.

Some evidence on the stability of smoking behavior over a one-year interval is available from the 1996 California Tobacco Survey (CTS) (Burns et al. 2000a) and is presented in Table 3-1.

The population examined was restricted to those who were daily smokers one year prior to the survey and were 25 years of age or older. Table 3-1 compares the number of cigarettes respondents reported smoking one year prior to the survey to the smoking status and amount smoked at the time of the survey. Among those who reported smoking 5 to 14 or 15 to 24 cigarettes per day one year prior to the survey, 74% reported still smoking the same number of cigarettes per day at the time of the survey. In contrast, only 69% of those who smoked 25 or more cigarettes one year prior to the survey reported smoking the same number of cigarettes per day at the time of the survey. This difference was statistically significant and suggests that the likelihood of heavy smokers reducing the number of cigarettes that they smoked per day over the one-year interval was greater than the likelihood of lighter smokers changing their smoking behavior in any direction, either increasing or decreasing it. The data in Table 3-1 are subject to biases resulting from self-reporting and recall, but they suggest that heavy smokers

may be less stable in their smoking intensity than are lighter smokers, and this differential instability over time could explain the paradoxical result observed between the longitudinal and cross-sectional observations made over the five-year interval of the COMMIT study.

It is possible that smokers who shift downward in the number of cigarettes they smoke per day remain heavily addicted and retain the same difficulty quitting that they had when they were smoking a greater number of cigarettes per day. However, it is also possible that the reduction in the frequency with which they smoke may modify the strength of their addiction in ways that facilitate their ability to quit. If this happens, the shift downward in number of cigarettes smoked per day would be accompanied by a shift upward in their likelihood of quitting. Changes in environmental factors over time may modify the strength of addiction for individual smokers.

The COMMIT data suggest that reducing the number of cigarettes smoked per day may have some impact on the strength of addiction, at least for smoking within the first 30 minutes of waking as a measure of addiction. Smokers who reported smoking within the first 30 minutes of waking had a lower likelihood of quitting, but, over the five-year interval, the fraction of smokers who reported smoking within the first 30 minutes of waking did not increase. This suggests that, as the continuing heavy smokers reduced the number of cigarettes that they smoked, they may also have reduced their likelihood of smoking within the first 30 minutes of waking and possibly reduced their level of addiction.

The discussion above points out that the validity of individual smoking characteristics for predicting cessation success can coexist with a residual population of smokers that is not hardened by containing a higher percentage of smokers with those same characteristics that predict poor cessation outcomes. The logical imperative that supports an argument that the population of residual smokers is hardening is driven by the impact of individual characteristics of smokers on the likelihood of cessation success. Environmental factors that promote cessation may not affect all smokers equally, and those same individual characteristics that make a smoker less likely to quit may make the same smoker more likely to be influenced by environmental factors. To the extent that environmental factors shift the behavior of heavy smokers to that of lighter smoking, the behavioral shifts may improve the likelihood of that smoker successfully quitting.

It is possible that a differential impact of environmental factors on heavy smokers could counter the effect of heavy smoking on the likelihood of cessation success, with the two forces canceling each other out as environmental influences increase over time. The residual smoking population may be composed of individuals who are having more difficulty achieving abstinence, but the impact of environmental factors is also increasing, creating a circumstance in which the hardened smoker has more motivation and support for cessation and therefore does not have a lower likelihood of successful cessation.

Table 3-1
California Tobacco Survey:
Current Smoking Status Compared to Smoking Status 1 Year Ago for Daily Smokers 1 Year Ago, 25 Years and Older

	Current Smoker: Cigarettes Smoked per Day																					
	25+		15–24		5–14		1–4		Unknown		Occasional Smoker		Former Smoker: Quit Duration									
													<3 Months		3+ Months		Unknown					
Cigarettes Smoked 1 Year Ago	%	± CI	%	± CI	%	± CI	%	± CI	%	± CI	%	± CI	%	± CI	%	± CI	%	± CI	Population Size (N)		Sample Size (n)	
Overall	18.3	1.1	37.6	1.3	26.0	1.5	2.9	0.5	0.3	0.2	4.6	0.7	4.8	0.7	5.0	0.8	0.4	0.2	2,894,421		6,211	
25+	69.5	2.8	13.2	1.8	3.9	1.1	0.6	0.6	0.0	0.1	1.8	0.6	5.2	1.4	5.5	1.1	0.3	0.3	703,264		1,542	
15–24	2.7	0.7	74.4	1.6	10.1	1.4	0.8	0.5	0.0	0.0	3.2	0.9	4.2	0.8	4.2	0.9	0.4	0.3	1,266,356		2,835	
5–14	0.5	0.4	5.6	1.3	74.1	2.8	1.8	0.7	0.1	0.2	7.0	1.6	5.0	1.3	5.6	1.6	0.4	0.3	779,441		1,560	
1–4	0.5	1.1	1.1	1.0	12.6	8.1	50.7	11.0	0.4	0.7	18.3	8.2	8.3	5.9	6.8	3.5	1.3	1.6	106,769		203	
Unknown	9.5	8.9	26.1	12.3	20.3	9.6	2.6	3.5	20.8	9.7	11.3	8.5	2.7	3.0	6.7	8.3	.	.	38,593		71	

NOTE: CI = 95% confidence interval; "." = insufficient data.

Data source: CTS 1996 (Burns et al. 2000a).

EFFECT OF ENVIRONMENTAL FACTORS ON HEAVY SMOKERS

A variety of tobacco control interventions are intended to influence the environment around the smoker in order to promote cessation and abstinence (U.S. DHHS 2000). Increasing the cost of cigarettes, restricting where smoking is allowed, changing social norms about smoking, and encouraging the provision of physician advice to quit are all components of tobacco control programs intended to influence the environment around the smoker in ways that provide motivation to quit and support abstinence.

One potential explanation for the paradox of heavier smokers finding it more difficult to quit without the residual population of smokers containing an increasing fraction of heavy smokers is that there is a differential effect of these environmental interventions on cessation success among heavy smokers. An example is the price increase experienced by a two-pack-per-day smoker when the cost of cigarettes is raised to twice that of a one-pack-per-day smoker. It is not unreasonable to expect that the impact of that price increase on motivation to change smoking behavior might also be greater in the two-pack-per-day smoker. At a constant price, heavier smokers would have more difficulty quitting than light smokers, but when a price increase is implemented, the change in price may have a more powerful effect on heavy smokers than on light smokers. During periods when the cost of cigarettes is changing rapidly, the differences in successful cessation among smokers of different numbers of cigarettes per day might diminish or even invert for a period of time, with heavy smokers being more likely to quit than light smokers.

Over long periods of time, the relationship between intensity of smoking or level of addiction and difficulty quitting may not be constant. Rapid changes in environmental factors might alter the gradient of successful abstinence across number of cigarettes smoked per day, might eliminate the gradient altogether, or might even invert the gradient for short periods of time. If the relationship of number of cigarettes smoked per day with successful abstinence varies substantially over time, this variation might reduce the impact of CPD-related differences in cessation success on the mean number of cigarettes smoked by the residual smokers.

A similar differential effect can be postulated for restrictions on where smokers are allowed to smoke. Bans on smoking in the workplace are likely to inconvenience heavy smokers and disrupt their pattern of smoking more than for lighter smokers. It is unclear whether the effect of a smokefree workplace on smoking cessation is more powerful on heavier smokers than on lighter smokers, but the possibility of a differential effect is not unreasonable.

Another area of differential impact on heavy smokers may be the likelihood of receiving an intervention to promote cessation. Heavy smokers are more likely than lighter smokers to report having received physician advice to stop smoking in the last 12 months (Hollis 2000), and they are more likely to participate in or utilize cessation assistance as well. The differential provision of proven cessation assistance to heavy smokers may

offer a gain in achieving long-term abstinence that partially offsets their increased difficulty in quitting.

It is also possible that, as the fraction of smokers and particularly heavy smokers decline, the negative social pressures on heavy smokers may increase disproportionately compared with those experienced by lighter smokers. Pressure to quit from family and friends, plus the frequency of requests to put out a cigarette or other negative messages from strangers, may be life experiences that are more intense or more frequent for heavy smokers.

Not all changes in the environment influence heavy smokers more than light smokers, as evidenced by the response to the intervention in the COMMIT study. Light and moderate smokers had increased abstinence rates in response to the intervention, but heavy smokers did not (COMMIT 1995a,b).

Consideration of hardening of the target must, therefore, involve an examination of changes in both the population of individuals smoking and the environment within which smokers smoke. Removal of those individual smokers who can easily quit from the smoking population may well leave behind a group of smokers who require more motivation to make a quit attempt, need more assistance for that attempt to be successful, or find achieving cessation a greater challenge. If the meaning of hardening is simply an abstract concept of the difficulty a smoker has in achieving cessation, then little more than a logical imperative is needed to conclude that the current population of smokers is hardening. However, if hardening is intended to mean that the population of smokers is less likely to achieve cessation, or that existing tobacco control strategies are becoming ineffective, then evidence of these effects actually occurring over time is needed before reaching a conclusion that the population of smokers is hardening.

Careful consideration of the changing environment around the smoker and its potential to differentially affect heavier and more-addicted smokers is needed before the conclusion that the population of smokers must be hardening can be converted into a judgment both that the population of smokers has actually hardened and that we need to adjust our tobacco control approaches to recognize that hardening.

SUMMARY Smoking cessation is influenced both by individual characteristics of the smoker and by environmental forces that make smoking more expensive, more difficult, or less rewarding. These external environmental forces may not influence all smokers equally. Heavy smokers and those who are more strongly addicted may be more influenced by these environmental changes than lighter smokers. An increased intensity of environmental motivation to quit may counterbalance a greater personal difficulty in quitting among the residual population of smokers. The probability that it is harder for the residual population of smokers to quit than it was for their former smoking colleagues does not translate into a probability that they are less likely to achieve cessation with existing tobacco control approaches until the level of environmental support for cessation is also considered. If

difficulty in achieving cessation on an individual level results in a reduced likelihood of successful cessation over time, then, over time, we should see an increase in the mean number of cigarettes smoked per day, an increase in measures of addiction (e.g., time to first cigarette), and a fall in rates of successful cessation. The absence of convincing trends in these measures suggests that the population of residual smokers is not "measurably" harder.

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Examining a Quarter-Century of Smoking Cessation Trials: Is the Target Becoming Harder to Treat?*

Jennifer E. Irvin, Thomas H. Brandon

INTRODUCTION Are tobacco smokers becoming harder to treat? Anecdotal reports by smoking-cessation providers would suggest that they are. The notion is that as the prevalence of smoking in the United States has declined, those smokers who have not yet quit represent the "hardcore" recalcitrant subset of the historical smoking population. Between 1974 and 1995, the prevalence of smoking dropped from 43.1% to 27.0% among men and from 32.1% to 22.6% among women (U.S. Bureau of the Census 1998). This decline in smoking prevalence can be attributed to factors such as increased knowledge about the health consequences of smoking, the deleterious effects of secondhand smoke on nonsmokers, antismoking public health campaigns, antismoking legislation (e.g., limitations on smoking in public places), and the availability of relatively effective behavioral and pharmacological smoking cessation interventions. Moreover, the last two decades were characterized by a dramatic decline in the social acceptance of smoking, which has led to increased social pressure to quit smoking. Indeed, approximately half of all ever-smokers have now quit (U.S. DHHS 1989).

Those who believe that smokers are becoming increasingly recalcitrant argue that those individuals who continue to smoke or who initiate smoking, despite the health warnings and the social pressure, are probably different from those who have already quit; that is, because of selective quitting and initiation, the current population of smokers is likely to be comprised of individuals more entrenched in their smoking behavior than would be found in earlier years. Although this is a frequent clinical observation, there has been little direct evidence to support this hypothesis, and the hypothesis is controversial. Based on data that such characteristics are associated with poorer cessation rates and greater initiation rates, Hughes (1996) offered indirect evidence that today's smokers are more likely to be highly nicotine-dependent and to have comorbid psychiatric and substance abuse disorders than in the past. Similarly, Fagerström and colleagues (1996) found that ex-smokers had lower nicotine dependence levels (when they were smokers) than current smokers, and that the typical dependence level of smokers in the United States is higher than that found

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in countries in which smoking is more prevalent. Hughes (1996) also noted that the prevalence of smoking is declining slowest among the poor and less educated. Other evidence suggesting that the population of smokers might be becoming more dependent is that an intensive community-based tobacco control intervention—the Community Intervention Trial for Smoking Cessation (COMMIT)—led to increased cessation among light to moderate smokers but not among heavy smokers (COMMIT 1995). If this result is representative of other tobacco control efforts, the remaining population of smokers should be becoming increasingly nicotine-dependent. In contrast to this perspective, indirect evidence that the population of smokers is *not* changing is provided by epidemiological evidence that indicates that the average smoking rate (cigarettes per day) in the population has not changed in recent years. This evidence is presented in other chapters of this monograph (see Chapters 7 and 8).

If the smoking population has been changing, we would expect that smoking cessation interventions should have become progressively less successful at producing abstinence within it. This would be expected because smokers who are highly nicotine-dependent, of low socioeconomic status, or who suffer from comorbid psychopathology or substance abuse tend to have poorer outcomes from clinical interventions. To the degree that these characteristics have become more common among smokers in recent years, this should be reflected in declining success rates of smoking interventions. However, Shiffman (1993) conducted a historical analysis of outcomes from published smoking cessation interventions and concluded that cessation rates have been stable since the mid-1970s. It is possible, though, that the increasing recalcitrance of smokers during this period was masked by the concurrent development of new and improved smoking cessation aids that were employed in the published trials. Thus it is important that the type of intervention be held relatively constant over a historical analysis for changes in recidivism to be revealed.

For the present analysis, we searched for smoking cessation trials published between 1975 and 1998. In order to maximize the historical range available for comparison, it was necessary to examine a treatment that has remained relatively constant over that time span. Very few treatments were available throughout this entire historical period. For example, pharmacotherapies were not available during the early portion of the period, and aversive therapies (i.e., rapid smoking) had fallen into disuse by the latter portion of the period. A treatment that did remain relatively constant was cognitive-behavioral coping skills training, which is defined below. This treatment was used as the constant treatment, and reported outcome data was examined based on year of the publication of the research report. It was hypothesized that we would find a trend in which end-of-treatment and follow-up abstinence rates have been declining over the years under study. Such a finding would support the notion that smokers presenting for treatment over the past quarter-century have become progressively more difficult to treat, consistent with the hypothesis of a changing population of smokers.

METHOD A search of the smoking cessation treatment literature was conducted to identify all relevant studies. Keyword searches (e.g., smoking cessation, multicomponent smoking treatment) of the computerized databases *Psyc Lit*, *PsycINFO*, and *MedLine*, and manual searches of bibliographies of smoking cessation reviews (e.g., Glasgow and Lichtenstein 1987; Lichtenstein and Glasgow 1992; Shiffman 1993; Fiore et al. 1996; Silagy et al. 1998), were conducted. We searched for studies published between 1975 and 1998 that met the inclusion criteria. To limit the variability of treatments compared over this 24-year period, the inclusion criteria were strictly defined. We limited the analyses to studies that used multicomponent smoking cessation treatments provided in a group format, emphasizing the training of cognitive and behavioral coping skills. Additionally, studies were required to have been conducted in the United States, and articles must have reported point-prevalence abstinence rates for at least one of the following time points: end-of-treatment, 3 months, 6 months, or 1 year post treatment. Treatment approaches that used purely behavioral techniques (e.g., desensitization, cue exposure, rapid smoking) were not included. We also excluded studies in which smoking interventions were provided to special or captive populations, such as worksite- or hospital-based treatments. Nicotine replacement therapies became available and dominant during the period under study, so we included studies both with and without nicotine replacement.

Table 4-1 lists the 23 studies identified by our search of the literature as meeting inclusion criteria and reporting relevant abstinence rates. Publication dates of the selected articles ranged from 1977 to 1996. Several studies compared highly similar interventions, often with the difference between treatments being the intensity of the intervention or whether nicotine replacement therapy was used. Because of this, 15 studies provided more than 1 treatment that met the inclusion criteria. We therefore conducted two separate sets of analyses. An initial set of analyses was conducted using only one treatment from each study (n = 23). When more than one treatment in a study met inclusion criteria, we selected for these analyses the treatment that most closely fit the prototype of coping skills training plus nicotine replacement. For example, we selected treatments that included nicotine replacement over those that did not, yet we were unlikely to select treatments that included additional elements, such as spousal involvement. To increase statistical power and to ensure the inclusion of all appropriate interventions, a second set of analyses was conducted based on all treatments that met the inclusion criteria (n = 44), allowing for multiple treatments from a single study. No study contributed more than four treatments to the analyses.

Table 4-1
Studies Included in the Historical Analyses

Study	Tx. Condition	*n*	NRT	Biochemical Verification	Abstinence Rates (%) End of Tx.	3 Months	6 Months	12 Months
Lando, 1977	Broad Spectrum Behavioral Tx.	17	no	yes	100	—	76	—
Elliott and Denny, 1978	Cognitive-Behavioral Tx. Package	15	yes	no	65	—	45	—
Lando, 1981	Two-Stage, Intensive Contact Behavioral Tx.	21	no	yes	88	63	58	46
	Two-Stage, Minimal Contact Behavioral Tx.	12	no	yes	60	30	30	17
	Three-Stage, Intensive Contact Behavioral Tx.	19	no	yes	83	35	22	19
	Three-Stage, Minimal Contact Behavioral Tx.	22	no	yes	67	52	42	19
Brown et al., 1984	Nicotine Fading + Relapse Prevention	16	no	yes	—	—	25	19
Rabkin et al., 1984	Behavior Modification	34	no	yes	—	—	24	—
Hall et al., 1984	6 s. Aversive Smoking + Skills Training	29	no	yes	90	—	55	52
	30 s. Aversive Smoking + Skills Training	28	no	yes	89	—	50	39
Killen et al., 1984	Skills Training + Nicotine Gum	22	yes	yes	86	—	—	—
	Skills Training Only	20	yes	yes	55	—	—	—
Hall et al., 1985	Intensive Behavioral Tx. + Nicotine Gum	35	yes	yes	—	73	59	44
	Behavioral Tx. Only	36	yes	yes	—	47	31	28
Lando and McGovern, 1985	Nicotine Fading + Maintenance	32	no	yes	62	36	21	19
	Oversmoking + Maintenance	32	no	yes	62	46	42	46
	Nicotine Fading/Smoke-holding + Maintenance	32	no	yes	85	63	51	44
Davis and Glaros, 1986	Basic Tx. + Relapse Prevention	15	no	yes	73	20	7	13
	Discussion of Relapse Situations Control	14	no	yes	21	29	21	21
McIntyre-Kingsolver et al., 1986	Basic Program	32	no	yes	48	36	19	32
	Basic Program + Spousal Support	32	no	yes	73	42	27	36
Molgienecki et al., 1986	Behavior Modification Clinic	89	no	yes	—	—	20	—
	Behavior Modification Clinic + Media Campaign	38	no	yes	—	—	37	—
Hall et al., 1987	Intensive Behavioral Tx. + 2 mg Nicotine Gum	35	yes	yes	—	43	43	34
	Intensive Behavioral Tx. + Placebo Gum	34	yes	yes	—	35	21	21
Curry et al., 1988	Group-Based Relapse Prevention Tx.	~ 24	no	yes	47	28	—	28
Stevens and Hollis, 1989	Relapse Prevention	184	no	yes	—	—	—	48

continued

Table 4-1 (continued)

Study	Tx. Condition	*n*	NRT	Biochemical Verification	Abstinence Rates (%)			
					End of Tx.	3 Months	6 Months	12 Months
Goldstein et al., 1989	Behavioral Tx. + Fixed Nicotine Gum Schedule	25	yes	yes	52	—	32	—
	Behavioral Tx. + Ad lib Nicotine Gum Schedule	24	yes	yes	58	—	42	—
Lando et al., 1990	Freedom From Smoking Clinic	331	no	yes	—	24	24	22
	Fresh Start Clinic	363	no	yes	—	29	27	25
	Laboratory Clinic	347	no	yes	—	37	29	29
McGovern and Lando, 1992	Freedom From Smoking Clinic + Nicotine Gum	146	yes	yes	86	40	—	35
	Freedom From Smoking Clinic Only	127	no	yes	—	40	—	32
Hill et al., 1993	Behavioral Training Only	22	no	yes	46	—	—	—
	Behavioral Training + Nicotine Gum	22	no	yes	46	—	—	—
	Behavioral Training + Exercise	18	no	yes	33	—	—	—
Cincirpini et al., 1994	Cognitive-Behavioral Tx. + Scheduled Smoking	17	no	yes	59	—	53	41
Fiore et al., 1994	High Contact Cognitive-Behavioral Tx. + 22 mg Nicotine Patch	44	yes	yes	59	—	34	—
	High Contact Cognitive-Behavioral Tx. + Placebo Patch	43	no	yes	40	—	21	—
Jorenby et al., 1995	Cognitive-Behavioral Tx. + 22 mg Nicotine Patch	87	yes	yes	59	26	—	—
	Cognitive-Behavioral Tx. + 44 mg Nicotine Patch	80	yes	yes	49	25	—	—
Cincirpini et al., 1996	Behavior Therapy Only	32	no	yes	63	22	22	22
	Behavioral Therapy + Patch	32	yes	yes	79	48	39	38

RESULTS Pearson correlations were calculated between year of publication and abstinence rates for four assessment points ranging from treatment end to 12 months post treatment. Because of differences across studies in the particular assessment points reported, analyses of the four assessment points were based on different subsets of the total sample of studies. One-tailed significance tests were used because the strong a priori directional hypothesis was that negative correlations would be found.

Table 4-2 displays the results from these two sets of analyses. The pattern of negative correlations between publication year and abstinence rates suggests that rates have declined over the 20 years represented by the sampled studies. The greatest effect was found at the first two assessment points (end-of-treatment and 3-month follow-up). By 12 months post treatment, the correlations had disappeared.

We considered several potential moderator variables. First, because biochemical verification (i.e., breath carbon monoxide, thiocyanate, cotinine) may have become more commonly used in later studies, the declining abstinence rates could reflect the use of these more objective measures of smoking status. However, only 1 of the 23 studies did not use biochemical verification, and exclusion of this study did not substantively change the results. Second, nicotine replacement products became available in the 1980s, so they were more likely to be used in the later studies. Of the 44 total treatments used in the analyses, 11 included nicotine replacement. Given that nicotine replacement is intended to enhance treatment outcomes, this possible confound should, if anything, attenuate the effect of declining abstinence rates over time. Indeed, as seen in Table 4-2, controlling for nicotine replacement yielded negative partial correlations of greater magnitude than the corresponding zero-order correlations reported above.

Three additional methodological variables were examined: whether or not an intent-to-treat analysis was used (reported for 20 studies, 41 treatments), time interval used to determine point-prevalence abstinence (13 studies, 29 treatments), and treatment sample size (all 23 studies and 44 treatments). Additionally, we examined four subject variables that were reliably reported: gender proportions, mean age (22 studies, 43 treatments), mean years of smoking (15 studies, 31 treatments), and mean daily smoking rate (20 studies, 41 treatments). Of these seven variables, three were significantly correlated with year of publication: mean daily smoking rate ($r = -0.46$, $p < 0.01$), and the highly redundant ($r = 0.96$) variables of age and years of smoking (both r's = 0.67, $p < 0.001$); that is, over the period of analysis, subjects in the more recent clinical trials tended to be older, have longer smoking histories, and smoke fewer cigarettes per day. Smoking rate was not related to any of the four outcome measures, but both age and years of smoking were negatively correlated with abstinence rates at treatment end ($r = -0.47$, $p < 0.01$, and $r = -0.40$, $p < 0.05$) but not at the later assessment points. Controlling for mean age reduced the association between publication year and abstinence rates at the four assessment points below statistical significance (pr's = –0.21, –0.27, –0.13, 0.12, respectively).

Table 4-2
Correlations Between Year of Publication and Reported Point-Prevalence Abstinence Rates at Treatment End and Follow-Up for Three Analyses: (1) Including Only a Single Treatment per Study, (2) Including All Treatments That Met Inclusion Criteria, and (3) Partial Correlations Including All Treatments, but Controlling for the Use of Nicotine Replacement Therapy (NRT)

	Assessment Point			
	End of Treatment	3 Months	6 Months	12 Months
One treatment per study	–0.48* (n = 16)	–0.55* (n = 11)	–0.31 (n = 17)	–0.03 (n = 14)
Multiple treatments per study	–0.45** (n = 31)	–0.32† (n = 25)	–0.32* (n = 33)	0.09 (n = 28)
Multiple treatments, controlling for NRT	–0.49** (n = 31)	–0.44* (n = 25)	–0.45** (n = 33)	–0.01 (n = 28)

*p <0.05, one-tailed.

**p <0.01.

†p <0.1.

Because of severely restricted statistical power due to the cumulative effects of missing data, similar analyses could not be performed using years of smoking or smoking rate as covariates.

DISCUSSION Findings indicate a robust downward trend in abstinence rates since the mid-1970s among multicomponent cognitive-behavioral smoking cessation interventions, as measured immediately following treatment and at 3- and 6-month follow-up. These results are consistent with the notion that the target has been hardening; that is, as more and more smokers quit, the population of remaining smokers may be changing and becoming progressively more difficult to treat. Because the prevalence of smoking is again increasing among adolescents (CDC 1995), it is possible that this trend will soon reverse.

The declining trend in treatment outcome was not found when one-year post treatment follow-up was used as the outcome index. Smoking relapse is no doubt influenced by multiple factors such as personality, level of nicotine dependence, exposure to cigarettes and other conditioned stimuli, environmental stressors, and so on. With the passage of time since quitting, there is greater opportunity for a variety of factors to influence whether or not an individual relapses. It is therefore not surprising that abstinence rates at later follow-up points will show weaker relationships with any single predictor variable—including year of cessation. In addition to such "noise" affecting the correlations, it is also likely that later assessment points suffer from greater measurement error due to subject attrition, repeated quit attempts, and the like. At the very least, however,

our findings suggest that smokers in clinical trials are relapsing more quickly than they have in the past, even if the eventual, long-term outcomes have not changed much over time.

The observed declining trend in successful outcome was particularly noteworthy given that the average smoking rate (cigarettes per day) among study participants also declined during the period of analysis. Epidemiological studies tend to find that smoking rate is inversely related to the probability of smoking cessation (e.g., Hymowitz et al. 1997); that is, lighter smokers are more likely to quit than heavier smokers. In this study, smoking rate was unrelated to outcome. This leads us to question the validity of smoking rate as an index of nicotine dependence. We believe that smoking rate is an imperfect measure of dependence for two reasons. First, because of variability in smoking topography (e.g., frequency, strength, and duration of inhalations), smoking rate is only modestly associated with actual level of nicotine delivery. Second, factors other than nicotine delivery—such as vulnerability to negative affect, cognitions, and culture—influence nicotine dependence (Shadel et al. 2000).

The present findings may initially appear to contradict the conclusions from Shiffman's (1993) analysis of historical trends (1957 to 1989) in treatment outcomes. Shiffman found that treatment outcomes improved during the early 1970s and remained stagnant thereafter. However, he acknowledged that the apparent lack of improved outcomes since the mid-1970s may have been a product of more heavily addicted smokers being seen in smoking cessation clinics; that is, improvements in cessation technology may have been masked by the counterforce of more difficult clients. The present findings are consistent with this explanation, because treatment outcomes actually *declined* when we held treatment constant in the historical analysis—especially when we controlled for the use of nicotine replacement therapies.

In drawing conclusions based on this historical analysis, certain methodological limitations should be considered. First, our findings are based on only one general type of treatment. It was necessary to select a prototype treatment that has been in use over the entire time period under investigation and for which there were enough published studies to conduct meaningful correlational analyses. Nevertheless, the possibility that the observed declining success rates are somehow limited to this particular treatment approach should be addressed. It may be that over time the better therapists or more motivated clients became attracted to newer treatments, and they became less likely to participate in the fairly standard treatment considered in this analysis. Given that nicotine replacement was the major innovation during the period under study, and that many of the studies included in our analyses used nicotine replacement, this scenario seems unlikely. In fact, it is interesting that nicotine replacement, which is considered an empirically supported treatment (Fiore et al. 1996), was found to be no more effective than placebo in two recent studies (Jorenby et al. 1999; Joseph and Antonnucio 1999). This suggests that other interventions may be experiencing a declining efficacy similar to that found in the

current study. Nevertheless, historical outcome analyses similar to the present one should be conducted for other smoking cessation approaches, and perhaps for the control conditions of clinical trials as well.

An alternative explanation for our findings is that, over time, less dependent smokers have become more likely to elect treatment options that do not require attending a formal cessation clinic. In particular, our findings may have been affected by the recent availability of over-the-counter nicotine replacement. Thus it is possible that our findings reflect a trend in which the subset of smokers seen in research clinics has become more challenging, whereas the general population of smokers has not changed. It may also be that participant recruitment strategies changed over the period under study. For example, in recent years there has been greater emphasis placed on recruiting research samples that are representative of the ethnic, racial, gender, and socioeconomic diversity of the population at large. Thus it may be that more recent studies have included a greater proportion of smokers from subpopulations that have greater difficulty quitting smoking or maintaining abstinence.

Unfortunately, most of these descriptive statistics were not reliably reported, precluding analysis of historical changes in subject characteristics. Of the subject variables examined, only age, years smoking, and smoking rate changed over time, with recent studies including older, more experienced smokers who smoked fewer cigarettes per day. That the remaining pool of smokers willing to participate in clinical trials may be becoming older with a longer history of smoking is consistent with a smoking population who will have more difficulty achieving long-term abstinence. But the dropping rate of number of cigarettes smoked per day appears inconsistent with the notion that remaining smokers should be more nicotine-dependent than in the past. Of course, smoking rate may be influenced by other historical factors such as increasing restrictions on smoking at work, the rising cost of cigarettes, and the growing tendency for smokers to be clustered within lower income groups. Regrettably, other indices of nicotine dependence, such as the Fagerström Tolerance Questionnaire (Fagerström 1978), were reported too infrequently to be analyzed.

Because mean subject age covaried with both publication year and abstinence rates, when we statistically controlled for subject age, the associations between publication year and abstinence rates declined to below statistical significance. There are at least two possible interpretations of this finding. First, the clinical trials included in the analysis may have—for some reason unrelated to the hypothesized changing population of smokers—attracted older, more experienced smokers in the more recent studies. Because older smokers have more difficulty with cessation, subjects' age may be a confound that accounts for the observed association between publication date and outcome. The second interpretation is that subject age, rather than being a confound, is one of the variables that mediates the relationship between year and outcome. That is, over the past 24 years, as fewer adolescents (until recently) began smoking and as the younger, less

experienced smokers may have been the most likely to quit, it is logical that the age of smokers seeking treatment in clinical trials would have increased. The latter interpretation is consistent with the hypothesis that smokers seeking treatment are becoming progressively more recalcitrant, and it is possible that this trend reflects changes in the general population of remaining smokers.

As with any analysis of archived publications, the possibility exists that our findings were influenced by publication bias; that is, studies that did not find significant differences between conditions are less likely to be published; therefore, archived publications may be biased toward studies with significant differences. However, unlike traditional meta-analyses of effect sizes, our analyses were based upon the absolute magnitude of abstinence rates for individual treatment conditions. These statistics should be less susceptible to the problem of publication bias. Moreover, because our analyses focused on changes over time, publication bias could influence the findings only if its effect also changed over time.

A final limitation of the present study is the small sample size necessitated by our desire to hold treatment constant. Even for a fairly common treatment, the number of published studies that met the inclusion criteria (i.e., group treatments that were conducted in the United States and that reported point-prevalence abstinence rates) was small. This may limit the robustness of our findings. In other words, it is possible that our findings are sample-dependent. However, we verified that exclusion of any single data point from the analyses did not appreciably change the results. Moreover, that the negative trend was found for three different assessment points (end-of-treatment, 3 months, and 6 months), based on different subsets of studies, also increases confidence in the robustness of the general trend.

In summary, with the caveat that unknown third variables (e.g., changes in study methodology or subject self-selection) may influence the results of any correlational study, the finding of declining treatment outcomes over the past quarter-century supports the observation that smokers seeking cessation help today are more recalcitrant than in the past. That is, the preliminary answer to the question that began this chapter (are tobacco smokers becoming harder to treat?) appears to be "yes." This may very well reflect the likelihood that today's smokers are more nicotine-dependent, of lower socioeconomic status (SES), and more likely to suffer from comorbid psychopathology and substance abuse, as suggested by Hughes (1996). Or it may simply reflect a change in the subset of smokers who actively seeks behavioral treatments rather than a change in the larger population of smokers. The final answer awaits more direct evidence.

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Changes in Measures of Nicotine Dependence Using Cross-Sectional and Longitudinal Data from COMMIT

Andrew Hyland, K. Michael Cummings

INTRODUCTION This chapter uses cross-sectional and longitudinal survey data from the Community Intervention Trial for Smoking Cessation (COMMIT) to assess changes in measures of nicotine dependence between 1988 and 1993. We examine rates of successful smoking cessation in relation to different smoking behaviors, specifically the number of cigarettes smoked per day and the time to first cigarette in the morning (a measure commonly used to assess addiction).

METHODS

The COMMIT Study The COMMIT study was initiated in 1986 and involved testing a comprehensive community-based smoking control intervention in 11 matched pairs of communities throughout the United States and Canada (COMMIT 1991). Table 5-1 shows the names of the communities that participated in the study along with their demographic characteristics and smoking prevalence rates. For the purposes of the trial, a community was broadly defined to include an individual city, multiple smaller geographically linked cities, and portions of well-defined metropolitan areas. Within each community pair, one community was randomly assigned to comprehensive intervention and the other served as a comparison community. The intervention phase of the trial was completed in December 1992. Details on the COMMIT intervention and findings from the trial are published elsewhere (U.S. DHHS 1995; COMMIT 1995a,b).

COMMIT Surveys

Cross-Sectional Surveys The first cross-sectional survey was conducted during a telephone interview implemented between January and May 1988. Details of the survey are published elsewhere (COMMIT 1991). In addition to the cross-sectional component of the survey, current smokers aged 25 to 64 years were eligible for inclusion in a cohort of smokers to be followed until 1993. A current smoker was defined as someone who reported having smoked at least 100 cigarettes in his or her lifetime and who also reported smoking at the time of interview.

The 1988 survey was administered in two stages. The first stage involved identifying representative samples averaging 5,400 households within each community and gathering information on the age, gender, and smoking behaviors of all adults within selected households. In the second stage, a sample of current smokers aged 25 to 64 years was selected for an extended cross-sectional interview that included questions about current and past smoking behaviors, brand and type of cigarette usually smoked, interest in

Table 5-1
Characteristics of the 22 Communities Participating in COMMIT

Community Pairs (I/C)*	State/ Country	Population (*N*)	High School Graduates (%)	Low Income (%)	White (%)	% Adult Smoking 1988	% Adult Smoking 1993
Yonkers (I)	NY/USA	63,278	67	40	76	25	22
New Rochelle (C)	NY/USA	57,493	68	44	75	25	20
Bellingham (I)	WA/USA	65,632	79	49	95	20	18
Longview/Kelso (C)	WA/USA	60,424	72	41	96	26	24
Vallejo (I)	CA/USA	89,046	73	42	66	26	19
Hayward (C)	CA/USA	121,134	69	37	77	25	19
Santa Fe (I)	NM/USA	57,572	77	47	80	22	19
Las Cruces (C)	NM/USA	53,757	73	55	80	20	17
Paterson (I)	NJ/USA	138,317	42	59	52	27	21
Trenton (C)	NJ/USA	91,726	49	60	47	29	26
Medford/Ashland (I)	OR/USA	58,929	78	51	97	21	20
Albany/Corvallis (C)	OR/USA	73,452	83	50	95	18	16
Raleigh (I)	NC/USA	163,036	77	40	73	23	20
Greensboro (C)	NC/USA	166,824	66	47	64	26	26
Utica (I)	NY/USA	85,490	58	58	93	27	24
Binghamton/Johnson City (C)	NY/USA	76,418	63	57	96	26	23
Cedar Rapids (I)	IA/USA	144,835	78	35	97	22	22
Davenport (C)	IA/USA	136,408	75	35	93	26	24
Fitchburg/Leominster (I)	MA/USA	75,805	61	49	97	26	23
Lowell (C)	MA/USA	92,418	58	52	96	29	26
Brantford (I)	Ont/Canada	86,985	46	34	NA	32	30
Peterborough (C)	Ont/Canada	84,800	54	36	NA	28	25

*I/C: Within each community pair, one community was randomly assigned to comprehensive intervention (I), and the other served as a comparison (C) community.

quitting smoking, alcohol consumption, the presence of other smokers in the household, and sociodemographic characteristics. The mean response rate for the household rostering portion of the survey was 84%. Of the eligible smokers identified from the household rostering, 92% completed the extended interview. There were 34,443 respondents to the 1988 cross-sectional survey with complete smoking status, amount smoked, demographic categories, and other tobacco-related variables indicated.

From August 1993 to January 1994, a similar random-digit–dialed telephone survey was conducted to identify approximately 2,300 households in each COMMIT community. A disproportionate sample of smokers, ex-smokers, and never-smokers aged 25 to 64 years was selected to participate in an extended interview to gather information on current and past smoking status, other tobacco-use patterns, and demographic variables.

The response rate for the survey was 80%. Data used for this analysis are for the sample of 13,146 respondents with complete data on tobacco-related variables.

Longitudinal Survey A sample of approximately 500 light-to-moderate (<25 cigarettes per day) and 500 heavy smokers (>25 cigarettes per day) in each community was taken from the 1988 cross-sectional survey. These individuals comprise the smoker cohort for COMMIT, were followed until 1993, and reinterviewed using an instrument comparable to the baseline survey. In 1988, the cohort consisted of 20,417 smokers (10,328 light-to-moderate and 10,019 heavy smokers). By 1993, 13,415 smokers remained, including 3,214 (24%) former smokers. Persons who were younger, single, and less educated were more likely to be lost to follow-up over the five-year study period.

Measures of Smoking Status A current smoker is defined as someone who reports he or she has smoked 100 cigarettes in his or her lifetime and answers "yes" to the question: "Do you smoke cigarettes now?"

A person is classified as a successful quitter if he or she was previously defined as a current smoker and also reported not smoking any cigarettes in the 6 months prior to the interview.

Measures of Nicotine Dependence Number of cigarettes smoked per day is defined as the weighted average of amount smoked per weekday and weekend. For these analyses, this continuous measure is categorized into the following groups: <5 cigarettes per day, 5 to 14 cigarettes per day, 15 to 24 cigarettes per day, 25-plus cigarettes per day.

The time to the first cigarette in the morning is based on responses to the following question: "How soon after you wake up do you have your first cigarettes?" Response categories were "less than 10 minutes," "from 10 to 30 minutes," "from 31 minutes to 1 hour," "from 61 minutes to 1.5 hours," "from 91 minutes to 3 hours," and "more than 3 hours." The latter three categories were collapsed for these analyses to comprise a category of "more than 60 minutes."

Tar yields of cigarettes were determined by linking self-reported UPC code and brand descriptor information provided in the surveys to the 1993 Federal Trade Commission (FTC) report (FTC 1995) on the tar, nicotine, and carbon monoxide content of varieties of cigarettes for sale in the United States. These tar yields were used to assign subjects to one of three categories: ultra-light (0 to 6 mg tar), light (7 to 15 mg tar), and regular (16-plus mg tar). Self-reported generic brands typically were not able to be matched to the FTC data; therefore, there is a disproportionate percentage of missing data in the 1993 survey (28% missing) compared with the 1988 survey (14% missing) because generic use was much more prevalent in 1993 (Cummings et al. 1997).

Other Predictor Variables: The following predictor variables were used for these analyses:

- Gender (male or female)
- Age (25 to 34 years, 35 to 44 years, 45 to 54 years, 55 to 64 years)
- Race/ethnicity (white non-Hispanic, black non-Hispanic, Hispanic, Asian, American Indian, Canadian, other)
- Gross household income (<$10,000/year, $10,000 to $25,000/year, $25,001 to $40,000/year, >$40,000/year)
- Education (<12 years, 12 years, 13 to 15 years, 16-plus years)
- Alcohol consumption (daily, 3 to 4 times/week, 1 to 2 times/week, 1 to 3 times/month, <1 time/month)
- Age started smoking daily (<16 years, 16 to 19 years, >19 years)
- Use of a noncigarette tobacco product (yes or no)
- Price category of cigarette smoked (generics, discount, premium)
- Desire to quit (none, a little, somewhat, a lot)
- Presence of another smoker in the household (yes or no)

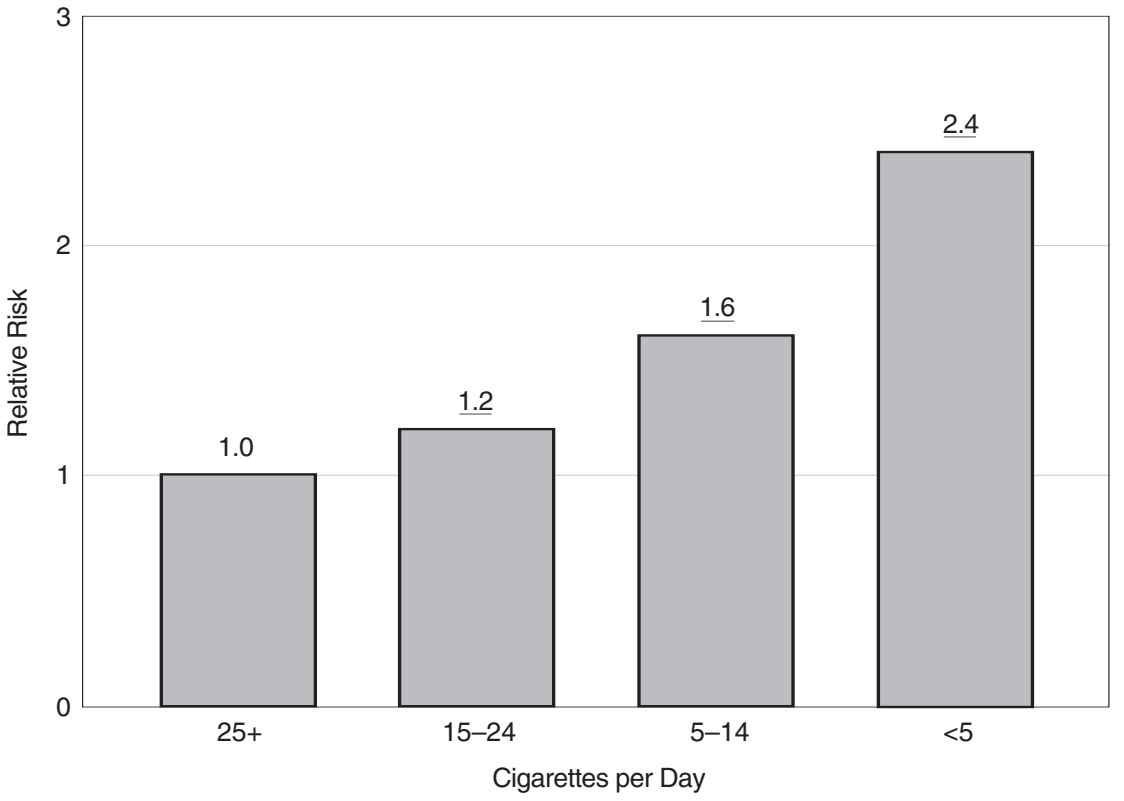
ANALYSIS Analyses focus on the association between quitting, measures of dependence, and other factors. Some of these findings have been previously reported (Hymowitz et al. 1997). Briefly, a logistic regression model was constructed with successful cessation in 1993 as the outcome, and the baseline measures of tobacco dependence and other variables outlined above included as predictors.

Change in the number of cigarettes smoked per day, time to first cigarette in the morning, and tar level of cigarettes smoked between 1988 and 1993 from the cross-sectional surveys are also reported. Independent samples t-tests are used to assess the statistical significance of change in these measures over time.

RESULTS Figures 5-1 and 5-2 show the association between amount smoked or time to first cigarette and future cessation, controlling for a variety of other potential confounding factors. Lower levels of consumption and longer duration before smoking in the morning were both significantly predictive of an increased likelihood of success in stopping smoking.

The percentage of respondents at each level of the measures of dependence from the two cross-sectional surveys is reported in Figures 5-3 to 5-5. The average amount smoked per day decreased from 20.4 cigarettes per day in 1988 to 18.7 cigarettes per day in 1993 (p = <0.01), and fewer smokers fell into the 25-plus cigarettes category (29% in 1988 versus 25% in 1993) (Figure 5-3). Time to first cigarette in the morning remained virtually unchanged between 1988 and 1993 (Figure 5-4). The reported tar level, per the FTC method, decreased from 1988 to 1993; in 1988, 52% of subjects reported smoking a light or ultra-light cigarette, whereas 69% reported the same in 1993 (p = <0.01) (Figure 5-5).

Figure 5-1
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.

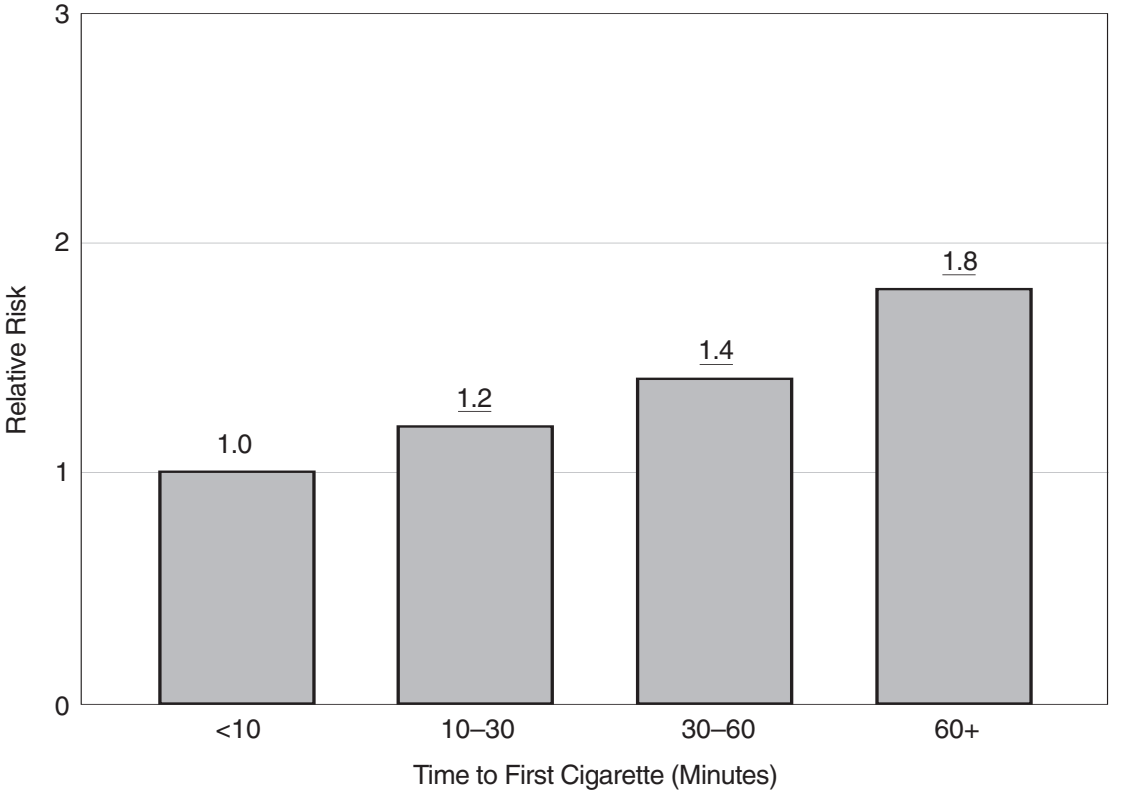
NOTE: Underlined relative risks are statistically significant at the 5% level.

SUMMARY Data collected from COMMIT between 1988 and 1993 indicate the following: (1) smokers who are less dependent (as measured by amount smoked and time to first cigarette) are more likely to stop smoking in the future, and (2) population-based surveys in 22 North American communities indicate that the number of cigarettes smoked per day and the tar level of cigarettes smoked have decreased, and that the time to first cigarette has remained constant over this relatively short interval.

There are many ways to measure tobacco dependence. Three measures are highlighted in this study: (1) cigarettes smoked per day, (2) time to first cigarette in the morning, and (3) tar level of cigarettes smoked.

Although it is recognized that the measures used in this study are crude measures that are only moderately correlated with a more standard measure of dependence (i.e., Fagerström Tolerance Questionnaire) (Riggs and Hughes

Figure 5-2
Time to First Cigarette as a Predictor of Future Cessation, 1988 to 1993*



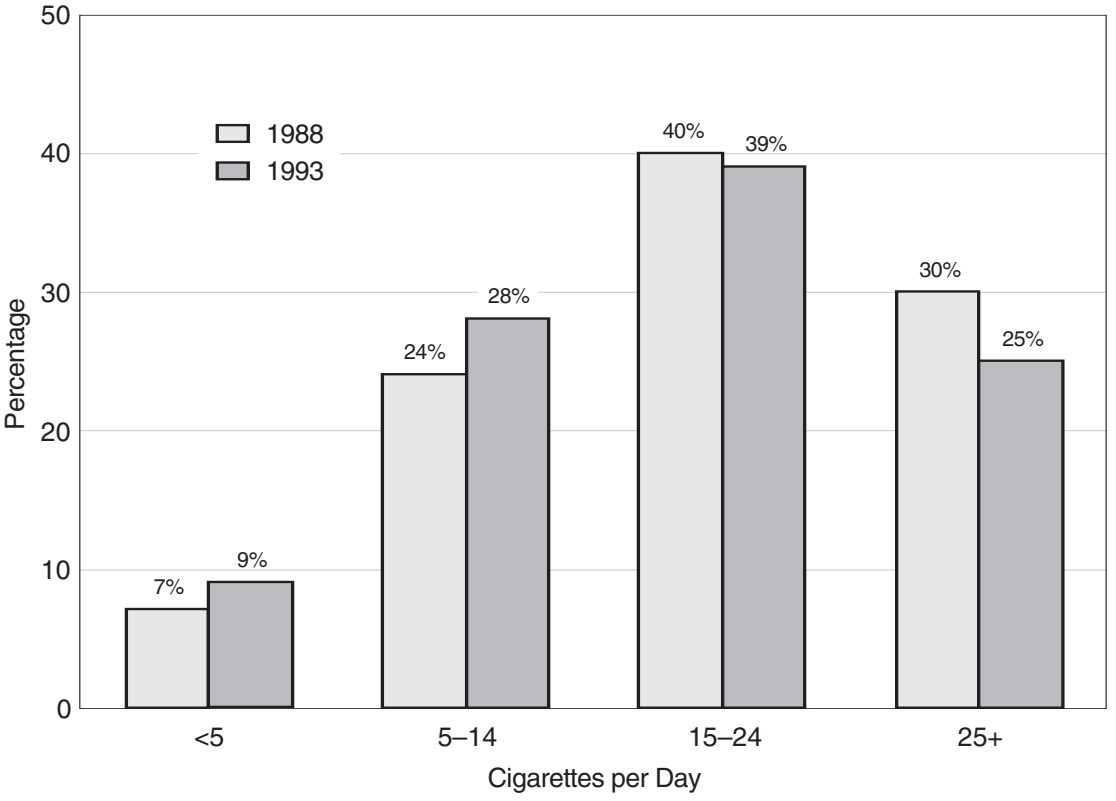
*Data from the COMMIT Endpoint Cohort, *N* = 13,415. Adjusted for the following baseline factors: sex, age, race/ethnicity, income, education, alcohol consumption, age started smoking, amount smoked, use of a noncigarette tobacco product, price category of cigarette smoked, past quit attempts, desire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

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

1998), studies clearly show that some of these measures of dependence are among the strongest predictors of who makes a cessation attempt and who succeeds in quitting (Hymowitz et al. 1997; Farkas et al. 1996).

Time to first cigarette in the morning does have predictive validity for tobacco dependence (Kozlowski, Pillitteri, and Sweeney 1994). The finding that this measure remained virtually unchanged between 1988 and 1993 in this study provides little support for the hardening hypothesis. The average number of cigarettes smoked per day decreased by nearly 10% in this study. This is likely due to increased restrictions about smoking in the workplace and public places during the course of the COMMIT study (Glasgow, Cummings, and Hyland 1997); however, population levels of dependence have probably remained unchanged as smokers tend to compensate for their smoking behavior (Evans and Farrelly 1998; Kozlowski et al. 1989, 1994) and still exhibit behaviors consistent with dependence.

Figure 5-3
Average Daily Amount Smoked From the 1988 and 1993 Cross-Sectional COMMIT Surveys*



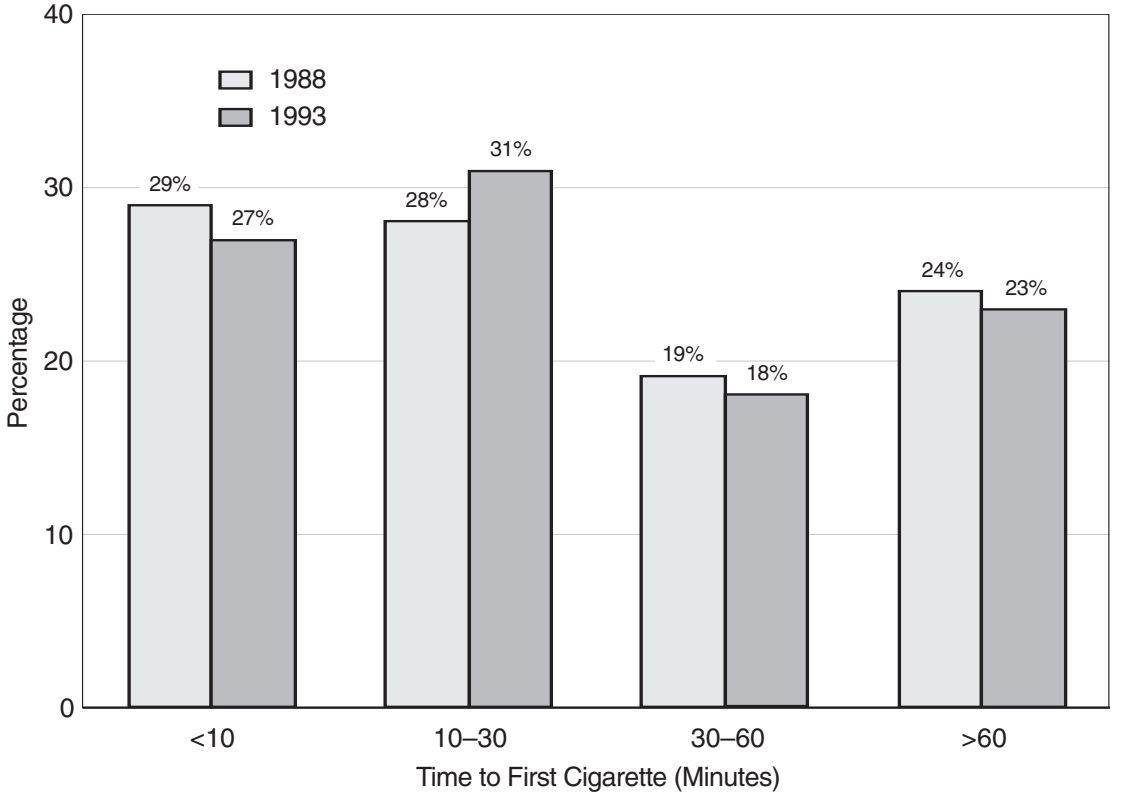
The average daily amount smoked among smokers was 20.4 in 1988 and 18.7 in 1993.

*Among smokers age 25–64. *N* = 34,443 in 1988 and *N* = 13,146 in 1993.

Three possible alternative explanations are offered that reconcile the findings from this study and the hardening hypothesis. They are:

- The population of smokers is dynamic and the characteristics of smokers have changed over time; however, on balance, the dependence level of the population has remained constant. For example, older smokers are more likely to quit than younger smokers, but younger smokers are less dependent than older smokers and smoking initiation rates have been increasing until recently. A dynamic smoking population with a greater percentage of younger smokers who are less likely to quit and are less addicted may explain why population cessation rates have not continued to increase and time to first cigarette has not changed.

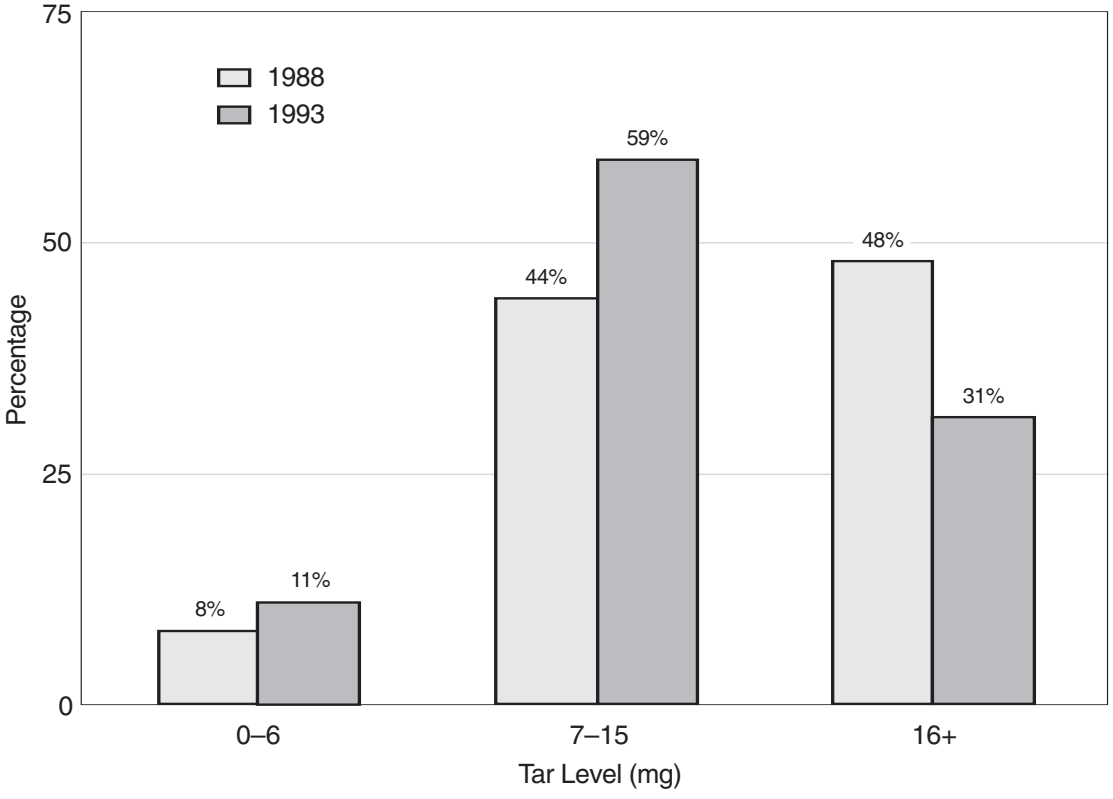
Figure 5-4
Time to First Cigarette in the Morning From the 1988 and 1993 Cross-Sectional COMMIT Surveys*



*Among smokers age 25–64. *N* = 34,443 in 1988 and *N* = 13,146 in 1993.

- The population has changed with respect to other factors that are associated with decreased smoking cessation rates, such as lower incomes, younger age, alcohol consumption, and other factors. Data from the 1988 and 1993 COMMIT cross-sectional surveys indicates that the mean age and the frequency of alcohol consumption remained constant and annual income increased (data not shown), disputing this explanation. However, a more detailed study of changes in population-based predictors of smoking cessation over time is warranted to better address this issue.
- The introduction of readily available treatments for tobacco use, including the sale of nicotine gum and patches over the counter, may have shifted the primary source of treatment for tobacco dependence from the physician to the individual smoker. Persons who enter clinics today for smoking cessation may be more likely to be smokers who tried a variety of unsuccessful measures to quit on their own and are inherently less likely to quit smoking, thus potentially explaining the observation of decreased clinical cessation rates.

Figure 5-5
Average Tar Level of Cigarettes Smoked From the 1988 and 1993 Cross-Sectional COMMIT Surveys*



*Among smokers age 25–64. *N* = 34,443 in 1988 and *N* = 13,146 in 1993.

In summary, data from COMMIT do not indicate that the number of cigarettes smoked per day or time to first cigarette has changed as population-level measures of tobacco dependence between 1988 and 1993. The short time period available to measure changes consistent with hardening may limit the opportunity to observe these changes, and the measures of dependence used have their limitations; however, the data available from the COMMIT study do not demonstrate a clear hardening in the population.

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Changes in Smoking Habits in the American Cancer Society CPS I During 12 Years of Follow-Up

Thomas G. Shanks, Christy M. Anderson

INTRODUCTION The question whether smokers who continue to smoke after large numbers of their smoking peers have quit represent a group who has more difficulty quitting can be examined in studies which provide longitudinal follow-up of groups of smokers (see Chapter 5). The Cancer Prevention Study I (CPS I) of the American Cancer Society (Garfinkel 1985) followed over one million subjects over a 12.75-year period. At baseline and at four follow-up surveys, subjects provided information about current smoking habits. Changes in smoking behaviors over time can be examined for evidence of falling cessation rates among the residual smokers in the population and trends toward the residual population of smokers being disproportionately composed of heavy smokers as lighter smokers quit in larger numbers. The focus of this chapter is on descriptive analyses of the cessation rates and changing smoking behaviors of current smokers in the CPS I.

The data contained in this chapter describe smoking behaviors that are over 30 years old and the use of cigarettes that are quite different in design and smoke yield with machine testing. However, the data offer some insight into the important questions whether the difference in cessation rates by number of cigarettes smoked per day remains constant across time and whether enhanced cessation success by lighter smokers leads to an increase in the fraction of heavier smokers over time.

CANCER PREVENTION STUDY I

Description of CPS I Data The CPS I was a major prospective study carried out by the American Cancer Society (Garfinkel 1985). Over one million individuals were followed for up to 12.75 years from 1959 to 1972. The baseline survey included age at initiation of smoking, present cigarette use or age at cessation, as well as information about health history and other behaviors. The major outcome variable was mortality by specific cause as indicated on the death certificate.

Data on Smoking Status The focus of the present chapter is on white male subjects who were current cigarette smokers on the baseline questionnaire in 1959. Subjects who were former smokers at that time or who used other forms of tobacco along with cigarette smoking were excluded from these analyses. The baseline data with these restrictions included 174,997 white male current cigarette smokers. Follow-ups were conducted in 1961, 1963,

1965, and 1972 and included questions about continuing smoking status, the brand of cigarette smoked, and number of cigarettes smoked each day. In order to consider changes in smoking habits in a healthy population, the analyses presented in this chapter are further subset to include only individuals reporting "good" health at baseline, surviving for the duration of the study, and responding to questions at each follow-up survey with answers to the smoking questions. These restrictions reduce the number of subjects to 50,598 individuals for whom complete data are available, but they also reduce the biases introduced by smokers quitting when they develop disease. If subjects in fair or poor health or individuals who died during the years of follow-up had been included, rates of cessation and level of daily smoking would be more influenced by factors related to changing health status.

Cigarettes per Day Levels At baseline and follow-up surveys, smokers were asked how many cigarettes they smoked each day. Responses were categorized into levels 1 to 9, 10 to 19, 20, 21 to 39, 40, 40-plus for all survey periods except the final follow-up, in which the specific number of cigarettes smoked per day was recorded. For these analyses, levels 40 and 40-plus were combined and the final follow-up was converted to the same categorical levels as the earlier surveys. The data categories in the CPS I study do not distinguish between complete cessation and occasional smoking (not smoking every day). Thus these cessation rates also include smokers who had shifted to occasional smoking status.

METHODS OF ANALYSIS A database of healthy white male subjects smoking cigarettes exclusively at baseline and surviving to the end of the 12-year follow-up period, with smoking questions answered on all follow-up surveys, was assembled. For age standardization of rates, a fictitious population was constructed representing the combined age distribution of subjects across all surveys by five-year age groups. This was accomplished by averaging the age distribution of the subjects at the time of each of the surveys. This age distribution standard is given in Table 6-1, with the age distributions at the beginning of the study (January 1959) and at the last follow-up (September 1972) also given for comparison. Simple nonparametric bootstrapping was undertaken (percentile interval method) with 200 bootstrap resamples, producing the 95% confidence interval estimates shown. Rates of cessation over a period of time are estimated using the model of a continuously compounded function, with a resulting rate of continuous cessation that would produce the cessation totals observed across the interval, as given by Formula 6.1:

$$\text{Rate} = -\ln (1 - d_{\text{Cess}})/d_{\text{Time}}$$

in which Rate is the rate of continuous cessation in percent per year; d_{Cess}, the observed proportion of cessation; d_{Time}, the time interval in years.

Table 6-1
Fictitious Standard Population Used for Age-Standardization (%)

Age	Fictitious Standard Population	1/1959	9/1972
<40	5.0	9.6	0.0
40–44	6.4	9.7	1.1
45–49	16.0	28.7	5.1
50–54	23.9	26.1	7.5
55–59	20.5	14.8	18.5
60–64	14.7	6.9	29.8
65–69	8.1	2.9	20.9
70–74	3.6	0.9	10.4
75–79	1.3	0.2	4.6
>80	0.5	0.0	2.2
Total	100.0	100.0	100.0

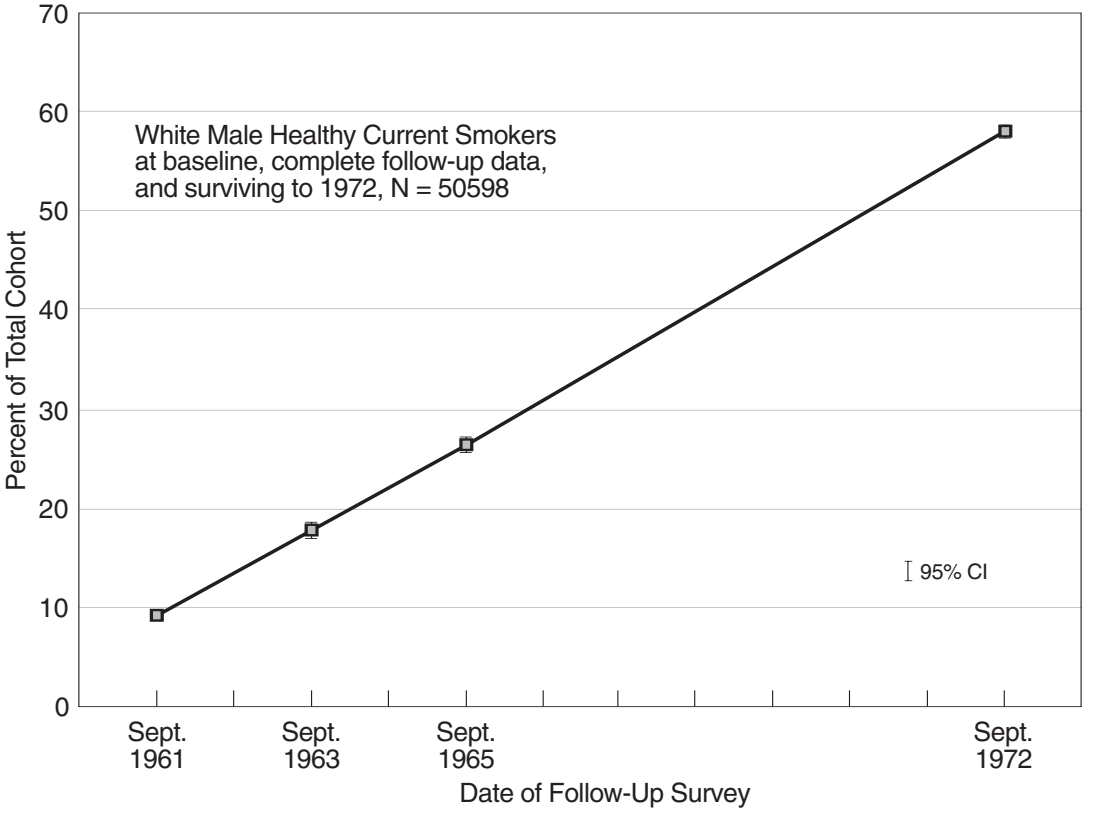
RESULTS

Rates of Cessation During Follow-Up

Figure 6-1 shows the cumulative cessation over the 12.75-year period across the entire group of healthy current cigarette smokers at baseline, N = 50,598. The cumulative cessation shown for each follow-up date is the percent of subjects who reported not smoking at that time; all values are age standardized. Figure 6-1 reveals a steady rate of increasing cumulative cessation during the follow-up period. By the end of the 12.75 years of follow-up, 58.0% (57.3% to 58.6%) (95% confidence intervals) of the group of current smokers at baseline reported not smoking.

Using the number of subjects smoking at the beginning and end of each interval of follow-up and Formula 6.1, we can calculate the annual rate of cessation during each period of follow-up that would underlie the observed cumulative cessation totals, with the result shown in Figure 6-2. At the first follow-up period in September 1961, 9.3% (9.0% to 9.5%) of the original group of smokers reported not smoking, which converts to an average rate of 5.6% (5.4% to 5.8%) annual cessation over the interval of 1.75 years. During the subsequent periods of follow-up, cessation rates of 6.8% (6.6% to 7.0%), 8.6% (8.4% to 8.8%), and 9.6% (9.3% to 9.7%) were estimated from the number quitting over the interval (shown in Table 6-2 under the category "Combined"). Since the pool of current smokers declined during the 12.75-year period as more and more smokers became former smokers, the rate of cessation among the remaining smokers must increase to produce the apparent uniform rate of cumulative cessation seen in Figure 6-1. The bootstrapped confidence intervals shown in Figure 6-2 are nonoverlapping, which confirms the observation of an increasing rate of cessation during the years 1959 to 1972 with significant probability.

Figure 6-1
Cumulative Reported Cessation at Successive Follow-Up Surveys, Among Respondents Who Were Smokers at Start of Survey



Rates of Cessation by Baseline CPD Figure 6-3, a variation of Figure 6-1, shows the cumulative cessation for smokers of different numbers of cigarettes per day as recorded at the beginning of the study. Cumulative cessation is highest for the lower CPD levels, with significantly higher cessation for the 1 to 9 CPD group, followed by the 10 to 19 CPD group. This consistent pattern is sustained by the 20 CPD group, which has slightly higher cumulative cessation than the groups smoking more than 20 CPD. The highest CPD groups of 21 to 39 and 40-plus have the lowest rates of cumulative cessation and are not always distinguishable. Clearly there is a relationship between the baseline CPD and likelihood of cessation, with the lower CPD levels (1 to 9 CPD and 10 to 19 CPD) having higher cumulative levels of cessation. At the final survey, among the 1 to 9 CPD group at baseline, 72.6% (70.2% to 74.4%) reported not smoking. The rates for the other CPD groups are 62.5% (60.9% to 64.3%), 56.5% (55.5% to 57.4%), 53.6% (52.3% to 54.8%), and 54.1% (51.9% to 56.1%) for the initial 10 to 19 CPD, 20 CPD, 21 to 39 CPD, and 40-plus CPD groups, respectively.

Table 6-2
Within-Interval Annual Rate of Reported Cessation in Successive Follow-Up Intervals. CPD Based on Level Reported at Beginning of Each Period of Follow-Up. Rates Age-Standardized

Period	Combined	1–9 CPD	10–19 CPD	20 CPD	21–39 CPD	40+ CPD
1	5.6% (5.4–5.8)	13.3% (12.2–14.1)	6.5% (6.1–6.9)	4.8% (4.5–5.1)	4.1% (3.7–4.4)	4.2% (3.7–5.0)
2	6.8% (6.6–7.0)	12.4% (11.6–13.4)	8.5% (7.9–8.9)	6.4% (6.1–6.7)	5.6% (5.1–6.0)	4.7% (4.3–5.2)
3	8.6% (8.4–8.8)	15.6% (14.5–16.6)	10.9% (10.3–11.6)	8.3% (7.9–8.6)	6.8% (6.4–7.2)	5.8% (5.2–6.3)
4	9.6% (9.3–9.7)	12.2% (11.2–13.1)	11.0% (10.4–11.6)	9.4% (9.0–9.7)	8.9% (8.5–9.3)	8.1% (7.6–8.6)

Figure 6-2
Rate of Reported Cessation at Successive Follow-Up Intervals, Annualized Within Follow-Up Interval

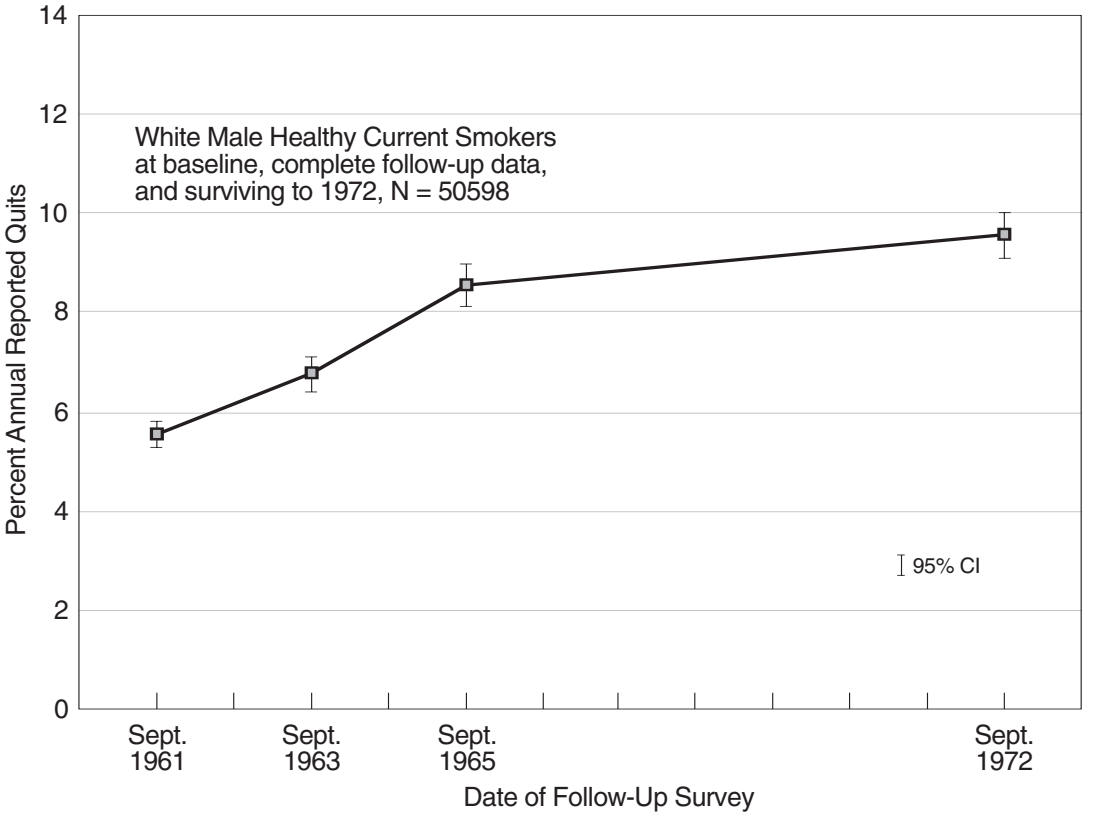


Figure 6-4 presents cessation rates annualized within each follow-up interval and calculated separately for the different CPD levels. The CPD levels from which the rates in Figure 6-4 are calculated are based on the *transient* CPD levels rather than the baseline categories—i.e., with the CPD levels for the most recent survey response used in the analysis. This figure shows that over the 12-year period of the CPS I follow-up, there was a convergence of quit rates among the different CPD levels. Both initially and throughout the period of follow-up, cessation rates for the 1 to 9 CPD group are highest, with rates for the 10 to 19 CPD group also higher than for the 20 cigarette a day and higher smokers but lower than for the 1 to 9 CPD group. This differential is clear during the first five years of the study, with rates generally increasing for all CPD levels. During the last seven years, there is a marked tendency for the quit rates from all groups to converge toward a mean value. Rates for the lower CPD groups flatten, but rates in the higher CPD group show an increase during the last seven years of follow-up.

Figure 6-3
Cumulative Percent of Smokers Reported Quit for Different Baseline CPD, Age-Standardized

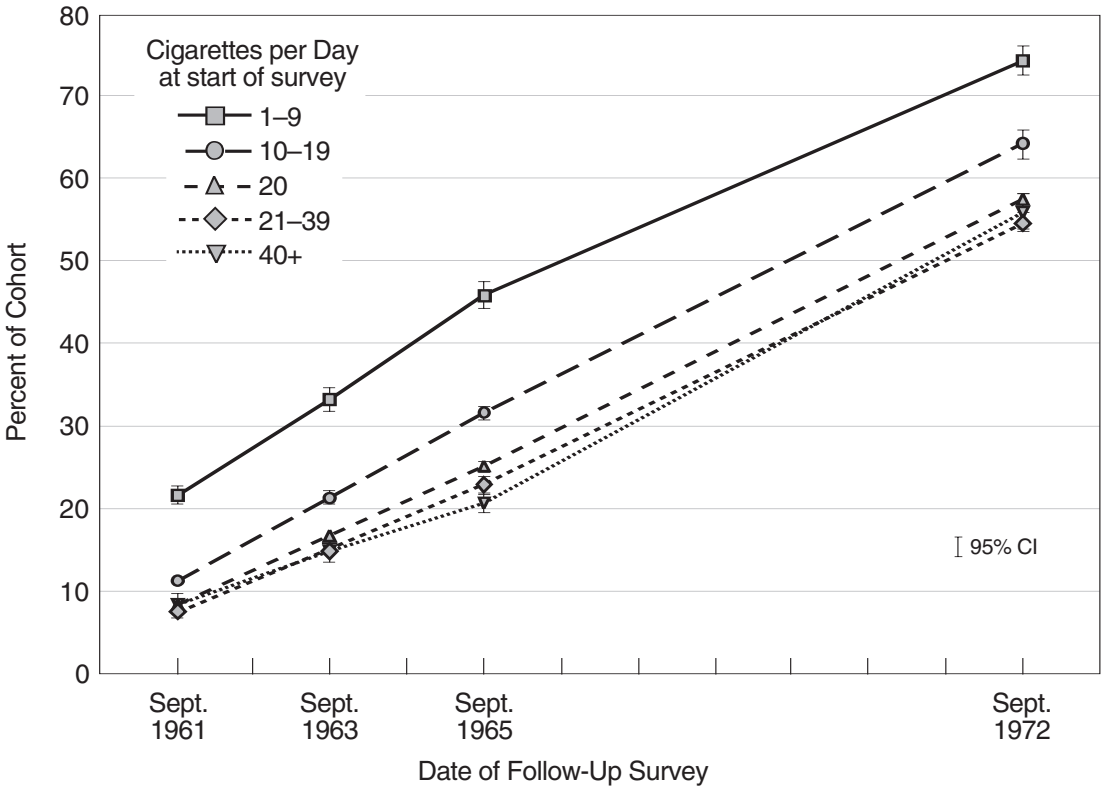
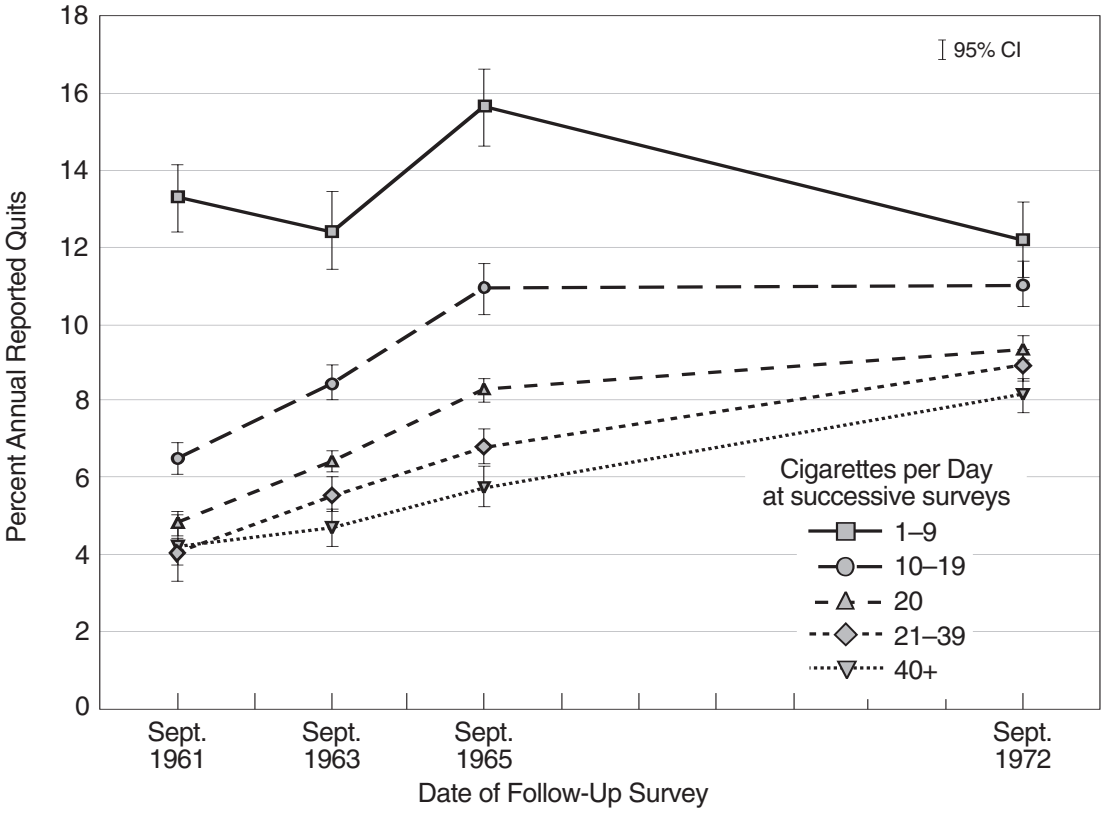


Figure 6-5 presents the same data shown in Figure 6-4, but changes the X axis to the CPD level, connecting the points from each follow-up survey so that we can see the quit-rate profile across the CPD levels as it changes during the successive periods of follow-up. With this presentation, the pattern of generally increasing rates of cessation during the period of the study as the lines from the successive surveys move upward can be seen. Within each follow-up period, the quit rates for the lower CPD levels are higher than for the levels with 20 or more CPD. However, the slope of the lines decreases for the last seven-year period, showing less of a rate difference between the CPD levels in the last follow-up period.

Mean CPD at Successive Surveys Figure 6-6 shows the mean CPD across all currently smoking subjects at each survey using the CPD reported at the time of each follow-up. Since CPD is a categorical variable, mean CPD is calculated using a CPD value for each subject based on the observed means for each category at the time of the final follow-up (1972), when actual numbers of cigarettes smoked each day is recorded. These values are 4.48, 11.97, 20.00, 29.15, and 43.52 for the successive CPD categories. Because CPD data is categorical, the increasing mean CPD seen for successive surveys is

Figure 6-4
Within-Interval Annualized Rate of Reported Quits by CPD Reported at Successive Surveys, Age-Standardized

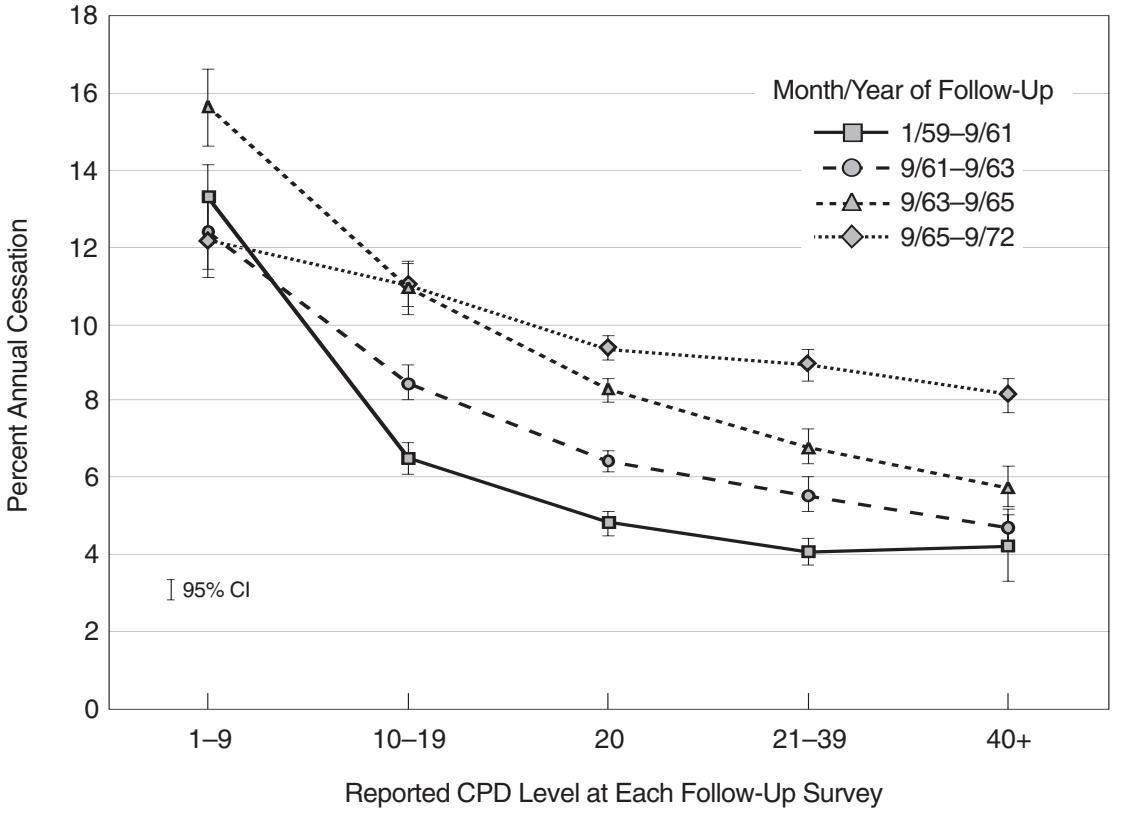


equivalent to a decreasing proportion of subjects at the lower CPD levels compared with the higher CPD levels. This result is consistent with the results seen in Figures 6-4 and 6-5, showing higher rates of cessation among the lower CPD levels. Although there is some migration between CPD levels (results not shown), Figure 6-6 shows that a greater proportion of smokers at the higher levels of CPD continued to smoke at the end of the 12 years of follow-up. The successive mean CPD values for the subjects still smoking are 22.0 (21.9 to 22.1) at baseline, increasing successively to 22.3 (22.2 to 22.4), 22.5 (22.4 to 22.6), 22.7 (22.6 to 22.8), and 23.8 (23.6 to 24.1) by the end of the study.

Discussion of Results

The mean CPD among remaining smokers increased during the 12 years of follow-up from this study (Figure 6-6). This is consistent with the view that it is harder for a heavy smoker to quit smoking, so that, over time, more heavy smokers remain among the current smoking population. This conclusion is supported by a generally higher rate of cessation for the lower CPD levels compared with the higher levels. Both of these trends are consistent with the view that cessation rates are highest for lighter smokers

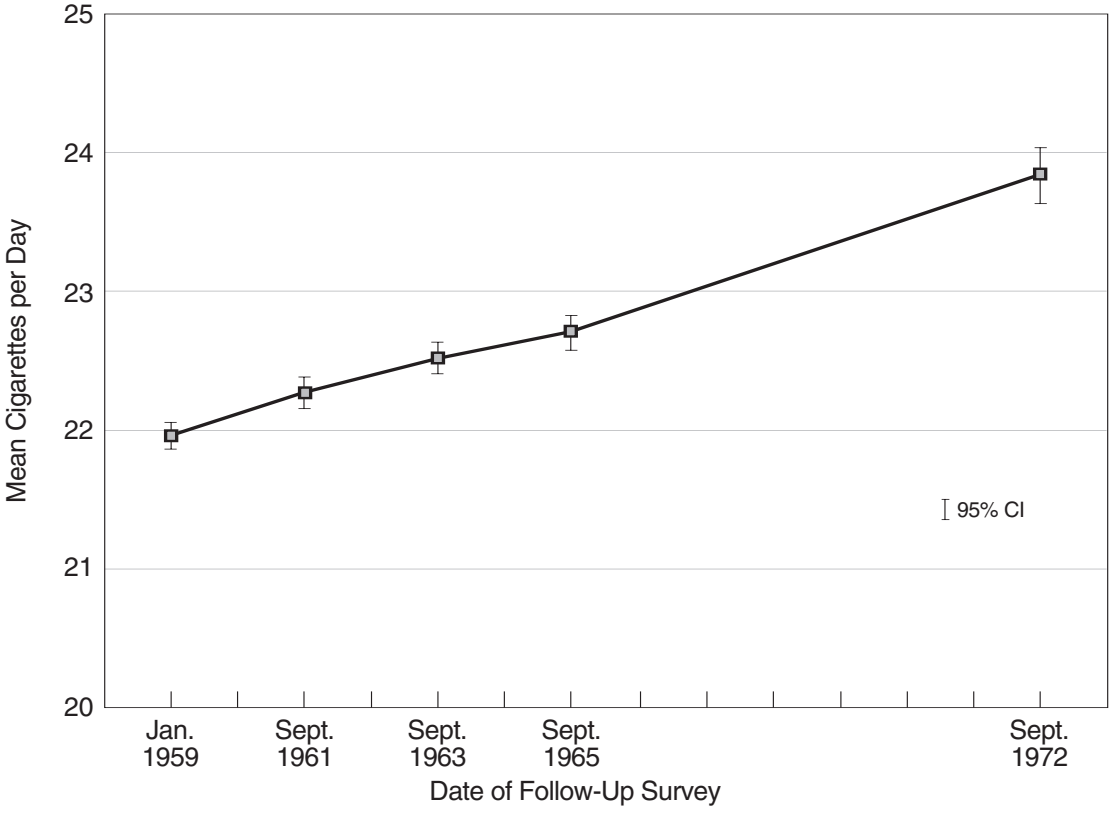
Figure 6-5
Within-Interval Annual Rate of Cessation by Transient CPD as Reported at Successive Surveys, Age-Standardized



and that the remaining population of smokers tends to become increasingly composed of heavier smokers for whom quitting is more difficult or less frequently undertaken.

The increasing mean CPD among the remaining smokers may be confounded by *compensation* in smoking behavior due to the declining machine-measured nicotine yields of cigarettes during the period of this study. During the CPS I study, tar and nicotine were declining rapidly in many brands. Using nicotine estimates for each brand from lab tests from the period (Miller 1959; Federal Trade Commission 1967–1973) and the brand reported by each individual, the average nicotine yield for a single cigarette was 1.83 mg nicotine across these subjects at the beginning of the study in 1959, but that had declined to 1.29 mg of nicotine at the end of the study in 1972 for those subjects still smoking. These values are age-standardized using subjects for whom nicotine values were available. If smokers increase the number of cigarettes smoked in order to compensate for the declining nicotine yields, the mean CPD increase may reflect compensation instead of hardening. The increasing CPD seen in this study

Figure 6-6
Mean Number of Cigarettes Smoked per Day Across Subjects Still Smoking



is consistent with the increasing mean CPD observed in the population-based National Health Interview Survey (NHIS), whose results are reviewed in Chapter 7 of this monograph.

In contrast to this evidence of hardening, there was a generally increasing rate of cessation across the 12 years of the CPS I study. The thesis of hardening would suggest that as the smokers for whom quitting is easier become former smokers, the residual pool of smokers would have decreasing rates of cessation. Instead, we have cessation rates increasing across all subjects, from 5.6% annual cessation during the first period of follow-up to a final rate of 9.6% annual cessation during the final follow-up period. Moreover, the increase in rates of cessation over the final follow-up period is most pronounced among the higher CPD groups (Figure 6-4), which shows a general increase in rates of cessation during the period of the study for the higher CPD group.

These seemingly contradictory trends may have resulted from independent factors in play during this period. Physiological and psychological factors may make cessation rates higher among lighter, less dependent smokers, which would lead to a residual smoking population with higher mean CPD levels and progressively lower rates of cessation. But

across this variation are broad social factors during the period of the CPS I study (from 1959 to 1972), which may have tended to increase rates of cessation across all categories. This period was characterized by changes in the public perception of health risks related to smoking, increased marketing of filtered cigarettes with health-related advertising messages, release of the U.S. Surgeon General's report on smoking and health in 1964 (U.S. DHEW 1964), and the period of counter-advertising on television from 1967 to 1970 (Warner 1977). These social forces served to increase rates of cessation generally in the population, as observed in the data from this study.

We therefore conclude that there is evidence of hardening within the CPS I data in the differential rates of quitting related to CPD and in the increasing mean CPD observed during the study. However, there is also evidence of general trends toward increased rates of cessation across all CPD categories, which may be related to the effect of changing public perceptions in modifying rates of cessation.

These observations were made 30 to 40 years ago, during a period when the cigarette was changing rapidly in design and major tobacco educational campaigns were being initiated by many groups. They offer little insight into whether the current generation of smokers is actually becoming more resistant to cessation, but they do demonstrate that over a 12-year period, the relationships between number of cigarettes smoked per day and smoking abstinence can vary, and that variation raises the possibility that environmental influences may influence heavy smokers more than light smokers.

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Changes in Number of Cigarettes Smoked per Day: Cross-Sectional and Birth Cohort Analyses Using NHIS

David M. Burns, Jacqueline M. Major, Thomas G. Shanks

INTRODUCTION Smoking norms and behaviors have changed slowly and incompletely despite growing scientific evidence of adverse health effects and strong efforts to prevent continuance of tobacco use (U.S. DHHS 2000). Smoking prevalence has remained stable for much of the last decade, declining at the end with the increase in cost resulting from the Master Settlement Agreement (Giovino et al. 1995; Shiffman 1993). Data from the Current Population Survey (CPS) show a nationwide decline in cessation activity from 1992 to 1996 (NCI 2000). The question raised in this monograph is whether those smokers who can easily quit have done so, leaving behind a group of smokers who are more heavily addicted and more difficult to get to quit (Hughes 1993). Since smoking a high number of cigarettes per day is one characteristic of strongly addicted smokers, and since smoking higher numbers of cigarettes per day reduces the likelihood of successful cessation, one hallmark of a hardening population of smokers might be an increase over time in the mean number of cigarettes smoked per day by those smokers who remain current smokers.

Data from the series of National Health Interview Surveys (NHIS) conducted periodically since 1965 are used to examine changes in number of cigarettes smoked per day reported by smokers over the last four decades. These trends are examined in the cross-sectional surveys for individual calendar years. Birth cohort analyses are also constructed using data from all of the surveys combined in order to examine changes in number of cigarettes smoked per day by cohorts of smokers born during specified calendar years as they age. A birth cohort is a group of individuals born during the same calendar years (10 years in these analyses).

In a single cross-sectional survey, age-specific rates of smoking behaviors are often used to examine the changes in smoking behavior with age. However, the rate of ever-smoking is very different for populations of individuals born during different periods in the last century (Burns et al. 1997). As a result, individuals of different ages in cross-sectional surveys will have different rates of ever-smoking. Therefore, comparing the current smoking prevalence in a cross-sectional survey of smokers at age 30 with those at age 60 (individuals who had a much higher prevalence of smoking when they were age 30) will underestimate the impact of age on smoking

cessation. A similar concern exists for describing changes in number of cigarettes smoked per day, since age is also an important correlate of the number of cigarettes smoked per day.

This chapter describes changes in the number of cigarettes smoked per day and examines whether there has been a shift over time in the number of cigarettes smoked per day using both cross-sectional and birth cohort analyses.

METHODS

Data

The National Center for Health Statistics, through the annual National Health Interview Survey, has collected health information since 1964 from a probability sample of the civilian, noninstitutionalized population of the United States. With developmentally consistent methodology from 1965 onward, smoking supplements to the National Health Interview Survey were undertaken during the following 20 calendar years: 1965, 1966, 1970, 1974, 1976, 1977, 1979, 1980, 1983, 1985, 1987, 1988, 1990, 1991, 1992, 1993, 1994, 1995, 1997, and 1998. Sampling methods for these surveys changed over time. Details concerning the survey methodology are reported elsewhere (U.S. DHHS 1985; U.S. DHHS 1989).

The NHIS is a cross-sectional survey of the civilian, noninstitutionalized U.S. population conducted mostly within households. Surveys prior to 1974 included smoking information on all the adult members of a household collected from a single adult from that household. However, from 1974 onward, smoking information was collected from a randomly selected member of the household with the survey undertaken by telephone only when the person was not present during the initial household interview. The mean response rate for the 1965 to 1991 NHIS was approximately 85% (U.S. DHHS 1994). The mean response rates for the 1993 to 1995 surveys were approximately 81% (CDC 1994; CDC 1996; CDC 1997). Survey weights were included with each data set. The weights were constructed to account for the probability that an individual is sampled and to adjust for nonresponse.

Measures

These analyses are confined to adults aged 20 years and older. Respondents aged 19 years and younger were excluded from the analysis so that the age range of the sample would be uniform across all survey years. Two of the surveys, NHIS 1976 and 1977, interviewed only respondents aged 20 years and older. To be considered a current smoker, respondents must have smoked at least 100 cigarettes in their lifetime and smoked at the time of the survey. The sample sizes varied between 769 and 15,067 adult current smokers who reported number of cigarettes smoked per day. Of the 20 surveys used, 10 (1979, 1980, 1983, and 1991 to 1998) made a distinction between daily and occasional smokers when reporting number of cigarettes smoked per day.

Data gathered from the interviews provided information on demographics including age, gender, race/ethnicity, and month/year of birth. The number of cigarettes smoked per day (CPD) was obtained as a continuous measure. For the purpose of cross-sectional prevalence tables,

this continuous measure was categorized into the following six groups: occasional smoker, <1 cigarettes per day, 1 to 4 cigarettes /day, 5 to 14 cigarettes /day, 15 to 24 cigarettes /day, and 25-plus cigarettes per day. Because not all of the surveys asked about occasional smoking, some categories were not available in all surveys. The change in definition of smoking used in the surveys alters the prevalence of smoking reported. In order to prevent this change in definition from confusing the trends over time, the tabular presentations of number of cigarettes smoked per day are shown as a percentage of the entire population as well as a percentage of current smokers.

Statistical Analyses The mean CPD was calculated for each survey year after standardizing each year's population to the age and race distribution of the nation as indicated in the 1965 NHIS. The mean CPD for the total population as well as gender-specific means were calculated. In order to explore the differences in mean reported number of cigarettes per day produced by the use of different questions to record smoking intensity, the gender-specific mean number of cigarettes was calculated both for all smokers (daily and occasional) and for all daily smokers in the surveys in which that information was available. Surveys prior to 1991 define current smokers with the question, "Do you smoke some days, every day, or not at all?" and later surveys ask, "Do you smoke now?" followed by a question asking whether the respondent smokes daily or occasionally.

The cross-sectional change in number of cigarettes smoked per day was examined by calculating the prevalence of current smokers for six categories of CPD for each survey year. Because demographics of the population changed between 1965 and 1998, data from each survey was standardized according to the age and race distribution as indicated by the 1965 NHIS using the direct method for weighted prevalence.

The smoking patterns of heavy smokers are evaluated using 10-year birth cohorts. For the purpose of this chapter, a heavy smoker is defined as an individual who smokes 25 or more cigarettes per day. The birth cohort analyses were restricted to persons born between 1890 and 1969, who were 20 years or older at the time of the survey, and for whom smoking status could be ascertained. Birth year, which was present for every respondent, was used to categorize each respondent into one of eight 10-year birth cohorts (1890 to 1899, 1900 to 1909, 1910 to 1919, 1920 to 1929, 1930 to 1939, 1940 to 1949, 1950 to 1959, and 1960 to 1969). Gender-specific birth cohort analyses were performed. The percentage of smokers reporting 25-plus cigarettes per day per birth cohort was calculated for each of the survey years after adjusting for race. These percentages were plotted by survey year. A smoothing procedure was then applied to the rates to minimize the effect of sampling variability. The "Loess" smoother, available in the statistical software package S-PLUS, is a local regression model that was set to use a quadratic fit over the span of calendar years (Chambers and Hastie 1992). The rates were weighted by the denominator sample size at each specific calendar year. By smoothing, we make the assumption that changes occurring in the population are continuous.

The weights of the responses for the above analyses were scaled so that, after weighting, the number of responses added up to the sample size. The scaled weight was obtained by dividing each individual's original weight by the sum of all the original weights. This quotient was then multiplied by the total sample size.

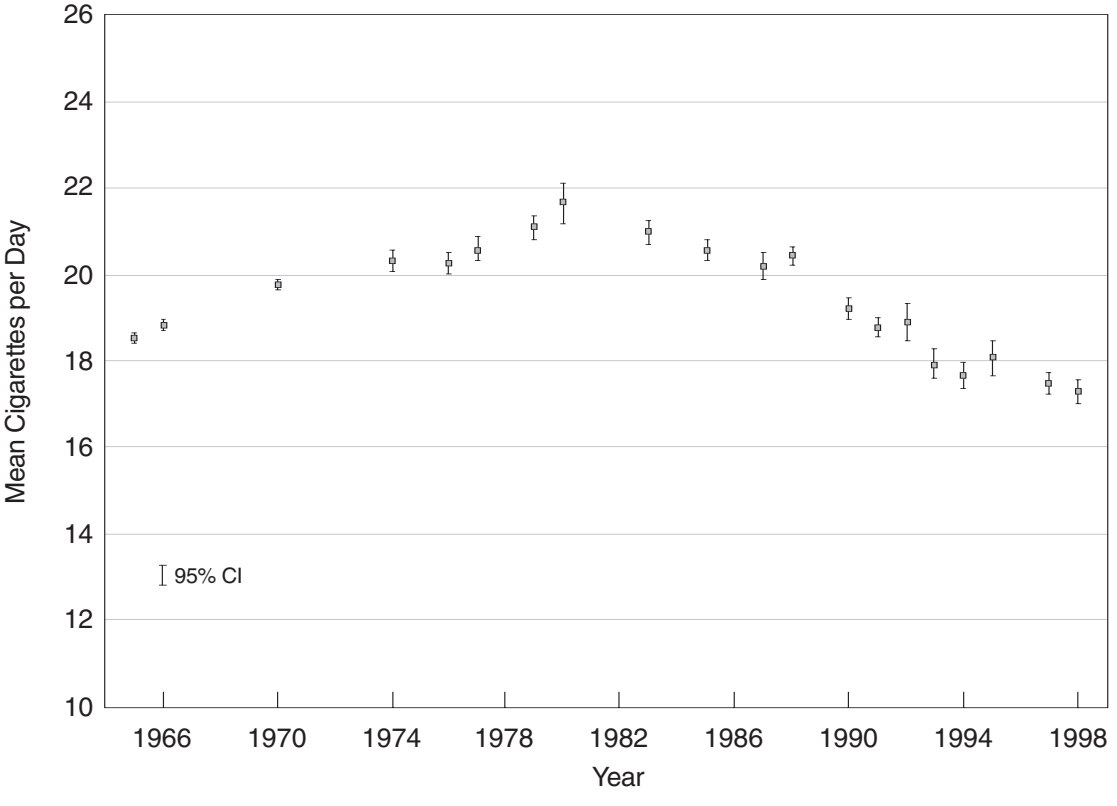
RESULTS

Average Number of Cigarettes Per Day

The mean number of cigarettes smoked per day reported by all current smokers, while controlling for age and race, has changed over time in the NHIS. The mean increased from 1965 to 1980 and then declined significantly through the late 1990s (Figure 7-1). This trend is evident for both males and females (Figure 7-2).

However, much of the decline occurs during the 1990s, and the definition used to identify a current smoker shifted between the 1990 and 1991 surveys. Participants in the 1965 to 1990 surveys were asked if they "smoke cigarettes now." In the 1991 to 1998 surveys, participants were asked whether they "currently smoke every day, some days, or not at all."

Figure 7-1
Mean Number of Cigarettes per Day* for All Current Smokers in Each NHIS Survey Year

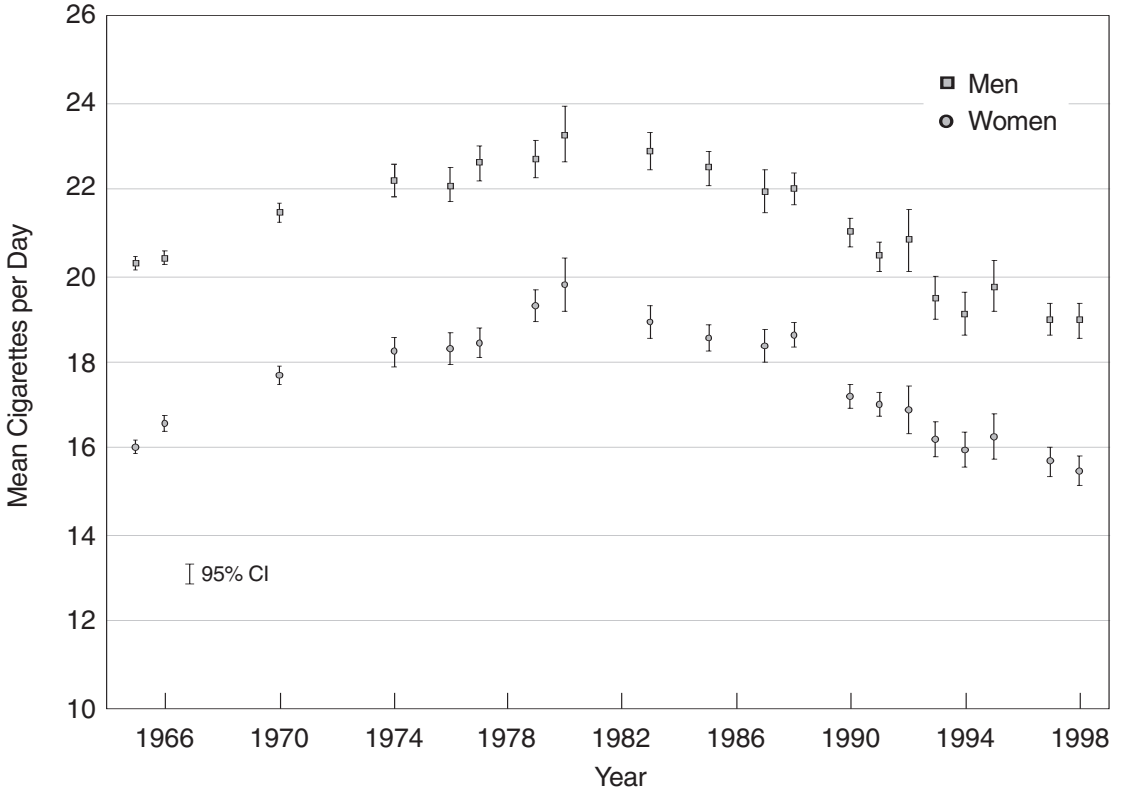


*Average number of cigarettes per day standardized to the age and race distribution of NHIS 1965. Brackets indicate 9% confidence intervals on the estimates.

This change in definition increases the prevalence of current smokers, largely by increasing the number of individuals who report smoking occasionally. This increase in occasional smokers would be expected to have a substantial effect on the mean number of cigarettes smoked since the mean is calculated across all current smokers, including those who report smoking only occasionally.

Tables 7-1 through 7-3 present the percentages of current smokers who smoke different numbers of cigarettes per day. It is clear from the table that a substantial proportion of current smokers using the new definition are classified as occasional smokers, and that fraction has been increasing during the decade of the 1990s. The current percentage of occasional smokers is more than twice the percentage estimated in the 1979 to 1983 surveys, but it is not clear whether this difference is due to the difference in the question used to define current smokers or due to trends over time in the frequency of occasional smoking. However, there appears to be a trend toward an increasing percentage of occasional smoking after 1991, and the

Figure 7-2
Mean Number of Cigarettes per Day* for All Current Smokers in Each NHIS Survey Year



*Average number of cigarettes per day standardized to the age and race distribution of NHIS 1965. Brackets indicate 9% confidence intervals on the estimates.

Table 7-1
Cross-Sectional Number of Cigarettes Smoked per Day for Current Smokers by Year

	Cigarettes per Day													
	Occasional		< 1		1 to 4		5 to 14		15 to 24		25+			
NHIS	(%)	CI	(%)	CI	(%)	CI	(%)	CI	(%)	CI	(%)	CI	Population	Sample
1965	*	*	1.7	0.14	8.4	0.29	24.7	0.46	44.6	0.53	20.6	0.43	47,020,967	34,298
1966	*	*	2.1	0.15	7.8	0.28	23.6	0.45	45.1	0.53	21.5	0.43	48,003,483	34,455
1970	*	*	0.6	0.09	7.0	0.31	22.6	0.51	42.9	0.59	23.7	0.51	44,567,267	25,706
1974	*	*	*	*	7.1	0.56	22.5	0.91	43.2	1.07	26.5	0.94	46,295,102	8,198
1976	*	*	*	*	7.6	0.59	21.5	0.92	43.8	1.10	25.9	0.96	45,456,439	7,678
1977	*	*	0.4	0.14	6.7	0.58	22.0	0.96	43.0	1.13	27.1	1.01	44,616,055	7,272
1979	6.6	0.55	0.3	0.11	5.4	0.50	19.3	0.88	39.6	1.07	27.3	0.96	47,662,861	7,457
1980	6.3	0.81	0.3	0.19	5.4	0.76	18.8	1.32	39.5	1.63	28.4	1.49	48,847,313	3,237
1983	1.6	0.30	0.1	0.08	5.0	0.53	21.3	0.99	44.0	1.18	27.6	1.05	50,319,264	6,652
1985	*	*	1.6	0.25	5.7	0.47	22.1	0.83	41.8	0.97	28.1	0.88	48,370,474	9,725
1987	*	*	1.7	0.32	5.9	0.60	22.7	1.06	41.8	1.23	27.4	1.10	47,724,640	6,134
1988	*	*	1.5	0.22	4.9	0.40	21.9	0.75	43.1	0.88	26.7	0.78	46,944,920	11,936
1990	*	*	1.7	0.25	6.9	0.50	24.1	0.83	42.8	0.96	24.2	0.82	44,202,813	10,243
1991	13.3	0.64	*	*	2.9	0.32	18.7	0.74	41.7	0.92	22.7	0.77	44,155,778	10,800
1992	14.6	1.27	*	*	3.0	0.62	19.5	1.43	39.5	1.72	23.1	1.47	45,969,845	2,994
1993	17.9	1.05	*	*	2.5	0.45	19.5	1.10	39.7	1.34	19.7	1.07	43,083,427	4,920
1994	17.0	1.07	*	*	2.4	0.44	21.1	1.16	40.2	1.37	18.4	1.06	45,441,782	4,766
1995	18.0	1.18	*	*	2.3	0.46	19.9	1.22	38.4	1.47	20.7	1.21	44,468,861	4,064
1997	17.2	0.81	*	*	2.7	0.36	21.4	0.88	39.0	1.02	19.2	0.81	45,541,495	8,538
1998	16.9	0.85	*	*	3.7	0.44	21.4	0.94	38.9	1.10	18.5	0.86	44,527,060	7,420

*Information not available.

NOTE: Percents are standardized to the age and race distribution of the nation as indicated by NHIS 1965.

definition used to classify current smokers was consistent through this series of NHIS.

In order to minimize the effect both of the change in definition of current smoking and of the trend toward a higher prevalence of occasional smoking on the distribution of number of cigarettes smoked per day, we examine the change in mean number of cigarettes smoked per day among only those who report smoking every day for the NHIS years in which that question was asked. Figure 7-3 presents data for male and female smokers. There is no clear decline over time in number of cigarettes smoked per day in this figure. Since it is difficult to characterize as hardened smokers those who do not smoke every day, the group for whom a change over time in number of cigarettes smoked per day is most relevant as a measure of hardening is daily smokers.

Table 7-2
Cross-Sectional Number of Cigarettes Smoked per Day for Male Smokers by Year

	Cigarettes per Day													
	Occasional		< 1		1 to 4		5 to 14		15 to 24		25+			
NHIS	(%)	CI	(%)	CI	(%)	CI	(%)	CI	(%)	CI	(%)	CI	Population	Sample
1965	*	*	1.4	0.16	6.7	0.35	20.2	0.56	46.3	0.70	25.4	0.61	27,001,634	19,518
1966	*	*	1.8	0.18	6.3	0.34	19.5	0.55	46.6	0.70	25.9	0.61	27,538,859	19,661
1970	*	*	0.5	0.11	5.9	0.38	18.7	0.64	43.0	0.81	28.0	0.73	24,318,169	13,912
1974	*	*	*	*	6.0	0.72	17.8	1.17	42.9	1.49	32.7	1.40	24,453,968	4,225
1976	*	*	*	*	6.4	0.76	16.9	1.18	44.0	1.54	31.6	1.43	23,489,129	3,950
1977	*	*	0.2	0.14	5.4	0.74	17.8	1.26	41.7	1.60	33.7	1.52	22,516,926	3,617
1979	6.7	0.77	0.2	0.14	5.3	0.69	16.2	1.15	38.3	1.49	31.9	1.42	25,323,489	3,776
1980	6.8	1.16	0.3	0.26	4.6	0.97	15.2	1.70	38.8	2.26	32.5	2.16	26,077,192	1,650
1983	1.5	0.42	0.2	0.13	4.1	0.71	17.2	1.34	42.7	1.72	34.0	1.62	26,110,678	3,141
1985	*	*	1.3	0.34	5.0	0.65	18.1	1.15	40.7	1.44	34.1	1.37	24,792,850	4,451
1987	*	*	1.6	0.49	5.6	0.86	18.8	1.48	40.4	1.82	33.0	1.72	24,629,866	2,778
1988	*	*	1.4	0.32	4.0	0.53	19.0	1.04	41.8	1.29	31.8	1.20	24,446,987	5,552
1990	*	*	1.6	0.37	6.4	0.71	19.0	1.14	41.9	1.40	30.7	1.29	23,356,894	4,767
1991	12.8	0.94	*	*	3.0	0.48	15.0	1.01	40.3	1.35	28.4	1.22	22,977,773	4,987
1992	14.9	1.90	*	*	2.6	0.87	14.1	1.89	38.3	2.53	29.8	2.33	23,244,280	1,383
1993	18.9	1.58	*	*	2.0	0.60	15.2	1.49	37.8	1.94	25.4	1.70	22,668,556	2,294
1994	17.1	1.60	*	*	2.4	0.63	16.5	1.56	39.9	2.01	23.1	1.70	23,971,556	2,210
1995	17.2	1.70	*	*	2.2	0.66	15.1	1.60	37.6	2.13	27.0	1.92	23,198,580	1,937
1997	16.8	1.15	*	*	2.5	0.49	16.7	1.15	40.1	1.47	23.4	1.24	24,406,479	4,191
1998	17.2	1.24	*	*	3.2	0.59	16.5	1.23	38.2	1.56	24.2	1.35	23,388,276	3,629

*Information not available.

NOTE: Percents are standardized to the age and race distribution of the nation as indicated by NHIS 1965.

Distribution of Number of Cigarettes Smoked per Day in the Population 1965 to 1998

The percentage of current smokers who reported smoking different numbers of cigarettes per day is presented in Tables 7-1 through 7-3 for each of the NHIS where the data were available, and the data are presented in the format in which the data was collected; that is, some of the surveys in which current smoking was defined by the question "Do you smoke now?" also asked a question of those who responded "yes" as to whether they smoke daily or occasionally. The percentage of smokers who reported smoking 25 or more cigarettes per day increased from the first survey in 1965 and peaked in 1980. Between 1980 and 1990, there was a decline in the prevalence of heavy smoking, which accelerated with the change in definition in 1991.

In order to minimize the effects of the change in definition and the trend toward an increased prevalence of occasional smoking, Tables 7-4 through 7-6 present the data as percentages of the entire population rather than as percentages of current smokers. The percentage of the entire

Table 7-3
Cross-Sectional Number of Cigarettes Smoked per Day for Female Smokers by Year

	Cigarettes per Day													
	Occasional		< 1		1 to 4		5 to 14		15 to 24		25+			
NHIS	(%)	CI	(%)	CI	(%)	CI	(%)	CI	(%)	CI	(%)	CI	Population	Sample
1965	*	*	2.1	0.23	10.8	0.50	30.8	0.74	42.2	0.80	14.2	0.56	20,019,333	14,780
1966	*	*	2.5	0.25	9.8	0.48	29.0	0.73	43.1	0.80	15.5	0.58	20,464,624	14,794
1970	*	*	0.8	0.16	8.5	0.50	27.5	0.80	42.5	0.88	18.5	0.69	20,249,098	11,794
1974	*	*	*	*	8.3	0.87	27.7	1.40	43.6	1.53	19.8	1.22	21,841,134	3,973
1976	*	*	*	*	8.7	0.91	26.2	1.41	43.6	1.58	20.0	1.26	21,967,310	3,728
1977	*	*	0.5	0.23	7.9	0.89	26.2	1.44	44.4	1.60	20.3	1.28	22,099,129	3,655
1979	6.7	0.77	0.4	0.18	5.5	0.73	22.9	1.33	41.4	1.53	22.0	1.27	22,339,372	3,681
1980	6.8	1.16	0.3	0.26	6.3	1.20	22.4	2.04	40.3	2.34	23.8	2.00	22,770,121	1,587
1983	1.5	0.42	0.1	0.10	6.0	0.80	25.6	1.45	45.5	1.63	20.8	1.30	24,208,586	3,511
1985	*	*	1.9	0.37	6.4	0.67	26.2	1.20	42.8	1.33	22.0	1.09	23,577,624	5,274
1987	*	*	1.6	0.43	6.1	0.83	26.8	1.51	43.4	1.67	21.4	1.36	23,094,774	3,356
1988	*	*	1.7	0.31	5.8	0.59	25.0	1.07	44.7	1.21	21.2	0.98	22,497,933	6,384
1990	*	*	1.8	0.35	7.4	0.71	29.5	1.21	43.8	1.31	17.3	0.99	20,845,919	5,476
1991	12.8	0.94	*	*	2.8	0.44	22.7	1.08	43.3	1.26	16.8	0.94	21,178,005	5,813
1992	14.9	1.90	*	*	3.5	0.89	25.2	2.11	40.1	2.36	16.6	1.78	22,725,565	1,611
1993	18.9	1.58	*	*	3.3	0.68	24.2	1.61	41.5	1.84	13.6	1.26	20,414,871	2,626
1994	17.1	1.60	*	*	2.4	0.61	26.3	1.70	40.8	1.87	13.2	1.27	21,470,226	2,556
1995	17.2	1.70	*	*	2.4	0.65	25.5	1.83	39.1	2.04	14.2	1.45	21,270,281	2,127
1997	16.8	1.15	*	*	3.0	0.53	26.8	1.32	37.8	1.42	14.5	1.01	21,135,016	4,347
1998	17.2	1.24	*	*	4.1	0.65	26.6	1.41	39.9	1.54	12.6	1.03	21,138,784	3,791

*Information not available.

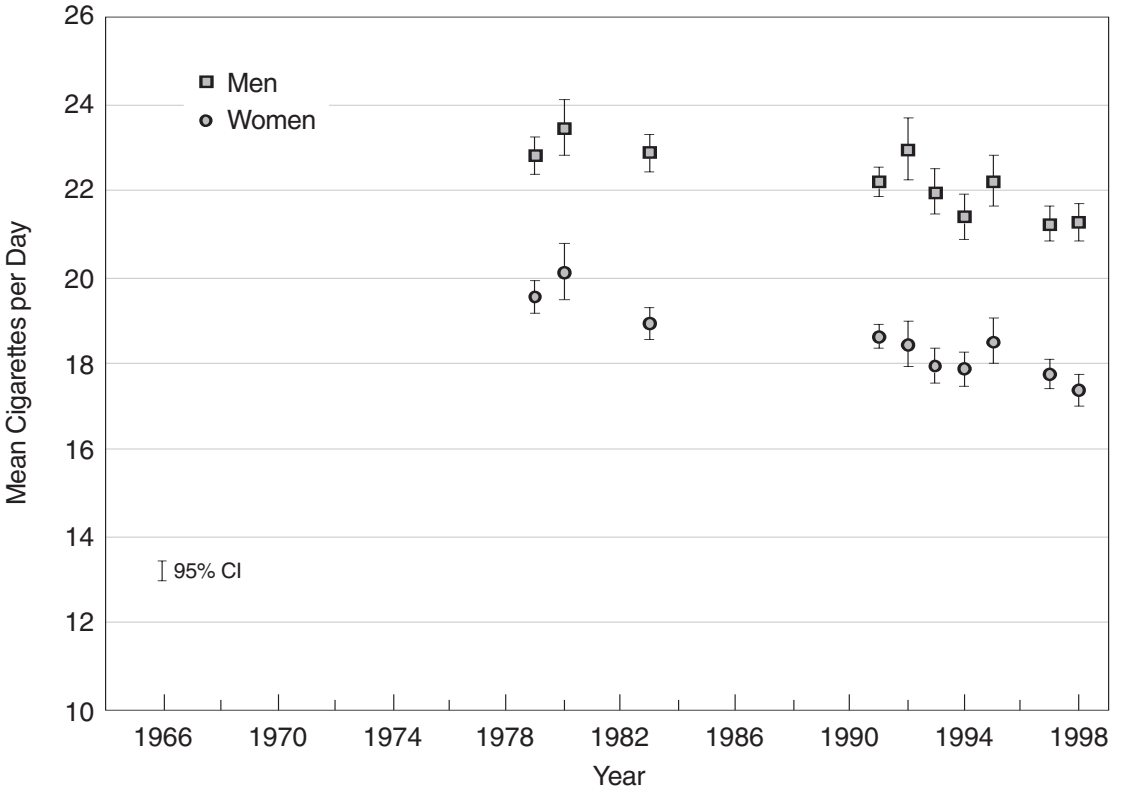
NOTE: Percents are standardized to the age and race distribution of the nation as indicated by NHIS 1965.

population who reported smoking 25 or more cigarettes per day also peaked in 1980 and then declined. There is also a statistically significant decline in the prevalence of heavy smoking from 1991 through 1998, a period during which the new definition of current smoking was consistently used. This trend toward fewer heavy smokers is accompanied by an increase in the prevalence of smoking 5 to 14 cigarettes per day.

There is no dramatic shift in the percentage of the population reporting smoking 25 or more cigarettes per day between the pre-1990 period during which the old definition was in use and the post-1991 period during which the new definition was in use. This suggests that the trends in prevalence of heavy smoking were not influenced by the definition of current smoking used in the individual NHIS.

In summary, the cross-sectional evaluation of the NHIS data suggests that between 1965 and 1980, there was a trend toward an increasing number of cigarettes smoked per day and a higher prevalence of heavy smoking. Since that time, however, the prevalence of heavy smoking has

Figure 7-3
Mean Number of Cigarettes Smoked per Day* Reported by Daily Cigarette Smokers in Each NHIS Survey Year



*Average number of cigarettes per day standardized to the age and race distribution of NHIS 1965.

NOTE: Includes only those surveys that distinguished daily from occasional smokers. Brackets indicate 9% confidence intervals on the estimates.

fallen substantially and has continued to fall through the decade of the 1990s. This fall in heavy smokers is similar in proportion to the fall in prevalence of daily smoking over this same period, but the accompanying trend of an increasing prevalence of smoking 5 to 14 cigarettes per day suggests a general shift toward lighter smoking among daily smokers during the 1990s. These data do not suggest that the remaining current smokers are a heavier-smoking population. There is no suggestion that the residual population of smokers has become hardened over the last 15 years, at least for number of cigarettes smoked per day as a measure of hardening.

Table 7-4
Cross-Sectional Number of Cigarettes Smoked per Day for the Total U.S. Population by Year

	Cigarettes per Day													
	Occasional		< 1		1 to 4		5 to 14		15 to 24		25+			
NHIS	(%)	CI	(%)	CI	(%)	CI	(%)	CI	(%)	CI	(%)	CI	Population	Sample
1965	*	*	0.7	0.06	3.6	0.13	10.4	0.21	18.8	0.27	8.7	0.19	111,604,002	81,436
1966	*	*	0.9	0.06	3.3	0.12	10.1	0.21	19.3	0.27	9.2	0.20	112,594,597	81,081
1970	*	*	0.2	0.04	2.7	0.12	8.6	0.21	16.2	0.27	9.0	0.21	121,729,938	70,136
1974	*	*	*	*	2.7	0.21	8.5	0.37	16.1	0.48	9.9	0.39	125,080,937	22,280
1976	*	*	*	*	2.8	0.22	7.9	0.37	16.1	0.49	9.5	0.39	126,397,470	21,250
1977	*	*	0.1	0.05	2.4	0.21	8.0	0.38	15.5	0.50	9.8	0.40	124,968,643	20,440
1979	2.4	0.20	0.1	0.04	1.9	0.18	6.9	0.33	14.1	0.45	9.7	0.38	144,538,295	22,750
1980	2.3	0.29	0.1	0.07	1.9	0.27	6.7	0.50	14.0	0.68	10.1	0.58	147,895,036	9,912
1983	0.5	0.10	0.0	0.03	1.7	0.17	7.0	0.35	14.2	0.47	8.9	0.37	158,654,252	21,420
1985	*	*	0.5	0.08	1.8	0.15	6.8	0.28	12.7	0.36	8.5	0.30	160,299,371	31,858
1987	*	*	0.5	0.10	1.7	0.18	6.7	0.35	12.4	0.45	8.1	0.36	163,376,109	20,778
1988	*	*	0.4	0.06	1.4	0.12	6.3	0.23	12.2	0.31	7.6	0.25	168,456,196	42,439
1990	*	*	0.4	0.07	1.8	0.13	6.2	0.24	11.1	0.31	6.3	0.23	172,274,935	39,464
1991	3.4	0.18	*	*	0.8	0.08	4.8	0.21	10.8	0.29	5.9	0.22	173,611,554	41,961
1992	3.8	0.36	*	*	0.8	0.17	5.3	0.41	10.6	0.55	6.2	0.43	176,871,804	11,564
1993	4.5	0.29	*	*	0.6	0.11	4.9	0.30	10.1	0.41	5.0	0.29	179,189,372	20,274
1994	4.4	0.30	*	*	0.6	0.11	5.5	0.33	10.5	0.43	4.7	0.29	180,952,643	19,057
1995	4.4	0.32	*	*	0.6	0.12	5.0	0.33	9.7	0.44	5.3	0.33	182,986,412	16,736
1997	4.3	0.22	*	*	0.7	0.09	5.4	0.24	9.9	0.31	4.8	0.22	186,456,771	34,889
1998	4.2	0.22	*	*	0.9	0.11	5.3	0.25	9.6	0.32	4.6	0.22	187,965,272	31,360

*Information not available.

NOTE: Percents are standardized to the age and race distribution of the nation as indicated by NHIS 1965.

Birth Cohort Analyses of the Prevalence of Smoking 25 Or More Cigarettes Per Day

Since the NHIS records date of birth in all survey years, it is possible to assemble the smoking prevalence data by the year in which individuals were born as opposed to their age at the time of survey. It is then possible to examine the changes in smoking behavior for repetitive cross-sectional samples of 10-year birth cohorts of individuals as they advance in age through the sequential series of the NHIS from 1965 to 1998. Since ever-smoking prevalence has varied from 70% to 80% among men born between the years 1910 and 1929 to 45% or less among those born after 1960 (Burns et al. 1997), examining changes in smoking behavior by birth cohort gives a more valid description of the changes in smoking prevalence occurring with age, and over time, than does cross-sectional data presented as age-specific analyses.

Table 7-5
Cross-Sectional Number of Cigarettes Smoked per Day for Male Population by Year

	Cigarettes per Day													
	Occasional		< 1		1 to 4		5 to 14		15 to 24		25+			
NHIS	(%)	CI	(%)	CI	(%)	CI	(%)	CI	(%)	CI	(%)	CI	Population	Sample
1965	*	*	0.7	0.08	3.5	0.18	10.4	0.31	23.9	0.43	13.1	0.34	52,341,553	37,819
1966	*	*	0.9	0.10	3.3	0.18	10.2	0.31	24.5	0.43	13.6	0.35	52,524,255	37,560
1970	*	*	0.2	0.05	2.6	0.17	8.3	0.30	19.2	0.43	12.5	0.36	56,742,829	32,440
1974	*	*	*	*	2.6	0.32	7.8	0.54	18.6	0.77	14.2	0.68	56,695,042	9,828
1976	*	*	*	*	2.7	0.33	7.1	0.52	18.5	0.78	13.2	0.67	56,683,201	9,499
1977	*	*	0.1	0.06	2.2	0.31	7.3	0.54	17.1	0.78	13.8	0.70	55,695,105	9,017
1979	2.7	0.31	0.1	0.05	2.1	0.28	6.5	0.49	15.3	0.70	12.9	0.64	67,932,678	10,214
1980	2.7	0.48	0.1	0.11	1.9	0.40	6.1	0.72	15.6	1.07	13.3	0.98	69,634,859	4,455
1983	0.5	0.15	0.1	0.05	1.5	0.25	6.1	0.51	15.1	0.74	12.1	0.66	74,458,847	9,127
1985	*	*	0.4	0.11	1.6	0.22	6.0	0.41	13.4	0.58	11.2	0.53	75,399,614	13,373
1987	*	*	0.5	0.16	1.8	0.28	6.1	0.52	13.0	0.71	10.7	0.64	77,044,177	8,580
1988	*	*	0.4	0.10	1.2	0.17	5.9	0.36	12.9	0.50	9.9	0.43	79,676,062	17,751
1990	*	*	0.5	0.11	1.8	0.21	5.4	0.36	12.0	0.50	8.8	0.42	81,544,750	16,373
1991	3.6	0.28	*	*	0.8	0.14	4.2	0.31	11.3	0.47	8.0	0.39	82,230,069	17,510
1992	4.1	0.58	*	*	0.7	0.25	4.0	0.57	10.9	0.87	8.3	0.75	83,848,847	4,914
1993	5.3	0.48	*	*	0.6	0.17	4.2	0.44	10.4	0.65	7.0	0.53	85,254,203	8,514
1994	4.9	0.49	*	*	0.7	0.18	4.7	0.47	11.3	0.69	6.5	0.53	86,223,037	7,992
1995	4.6	0.50	*	*	0.6	0.18	4.1	0.47	10.2	0.70	7.3	0.59	87,274,556	7,214
1997	4.7	0.35	*	*	0.7	0.14	4.8	0.35	11.2	0.50	6.4	0.38	89,074,914	14,936
1998	4.6	0.36	*	*	0.9	0.16	4.5	0.35	10.2	0.50	6.4	0.40	89,850,921	13,682

*Information not available.

NOTE: Percents are standardized to the age and race distribution of the nation as indicated by NHIS 1965.

Figure 7-4 demonstrates the relationship between number of cigarettes smoked per day and age. This 10-year birth cohort (born between 1930 and 1939) has been adjusted for race and shows that the number of cigarettes smoked per day increases with age to midlife and then declines with advancing age. This pattern is consistent across multiple cohorts and is therefore not simply a function of calendar-year effects influencing the 1930 to 1939 cohort.

The percentage of current smokers in the birth cohort smoking 25-plus cigarettes per day is presented by survey year for males and females in Figures 7-5/7-6 and 7-6/7-7, respectively. The oldest male cohorts (Figure 7-5) show a steady decline in percentage of heavy smokers, as expected given their advanced age at the time of the first survey. The more recent cohorts show a percentage of heavy smoking that increases at younger ages and then either declines or levels off at a constant percentage. None of the cohorts shows an increase in the fraction of current male smokers who smoked 25-plus CPD during the 1990s.

Table 7-6
Cross-Sectional Number of Cigarettes Smoked per Day for Female Population by Year

	Cigarettes per Day													
	Occasional		< 1		1 to 4		5 to 14		15 to 24		25+			
NHIS	(%)	CI	(%)	CI	(%)	CI	(%)	CI	(%)	CI	(%)	CI	Population	Sample
1965	*	*	0.7	0.08	3.6	0.18	10.4	0.29	14.3	0.33	4.8	0.20	59,262,449	43,617
1966	*	*	0.9	0.09	3.4	0.17	9.9	0.28	14.7	0.33	5.3	0.21	60,070,342	43,521
1970	*	*	0.3	0.05	2.7	0.17	8.9	0.29	13.6	0.35	5.9	0.24	64,987,109	37,696
1974	*	*	*	*	2.7	0.29	9.2	0.51	14.1	0.61	6.3	0.42	68,385,895	12,452
1976	*	*	*	*	2.9	0.30	8.6	0.51	14.1	0.62	6.4	0.44	69,714,270	11,751
1977	*	*	0.2	0.07	2.6	0.29	8.6	0.52	14.3	0.64	6.5	0.44	69,273,538	11,423
1979	2.1	0.25	0.1	0.06	1.8	0.23	7.3	0.46	13.0	0.58	6.9	0.43	76,605,617	12,536
1980	1.8	0.35	0.1	0.08	2.0	0.38	7.2	0.69	12.5	0.87	7.2	0.67	78,260,177	5,457
1983	0.5	0.13	0.0	0.03	1.8	0.24	7.8	0.48	13.5	0.60	6.0	0.41	84,195,405	12,293
1985	*	*	0.5	0.11	1.9	0.20	7.5	0.38	12.2	0.47	6.1	0.34	84,899,757	18,485
1987	*	*	0.5	0.12	1.7	0.23	7.4	0.47	11.9	0.57	5.9	0.41	86,331,932	12,198
1988	*	*	0.4	0.08	1.5	0.16	6.6	0.31	11.7	0.39	5.5	0.28	88,780,134	24,688
1990	*	*	0.4	0.08	1.8	0.17	6.9	0.33	10.4	0.39	4.1	0.25	90,730,185	23,091
1991	3.2	0.22	*	*	0.7	0.11	5.4	0.29	10.4	0.38	4.1	0.24	91,381,485	24,451
1992	3.6	0.45	*	*	0.9	0.23	6.4	0.59	10.4	0.71	4.3	0.47	93,022,957	6,650
1993	3.8	0.35	*	*	0.7	0.16	5.6	0.41	9.8	0.53	3.2	0.31	93,935,169	11,760
1994	4.0	0.37	*	*	0.6	0.15	6.3	0.45	9.8	0.54	3.1	0.32	94,729,606	11,065
1995	4.3	0.41	*	*	0.6	0.15	5.8	0.47	9.2	0.57	3.4	0.35	95,711,856	9,522
1997	4.0	0.27	*	*	0.7	0.12	6.11	0.33	8.6	0.38	3.2	0.24	97,381,857	19,953
1998	3.7	0.28	*	*	0.9	0.14	6.04	0.35	9.0	0.41	2.9	0.24	98,114,351	17,678

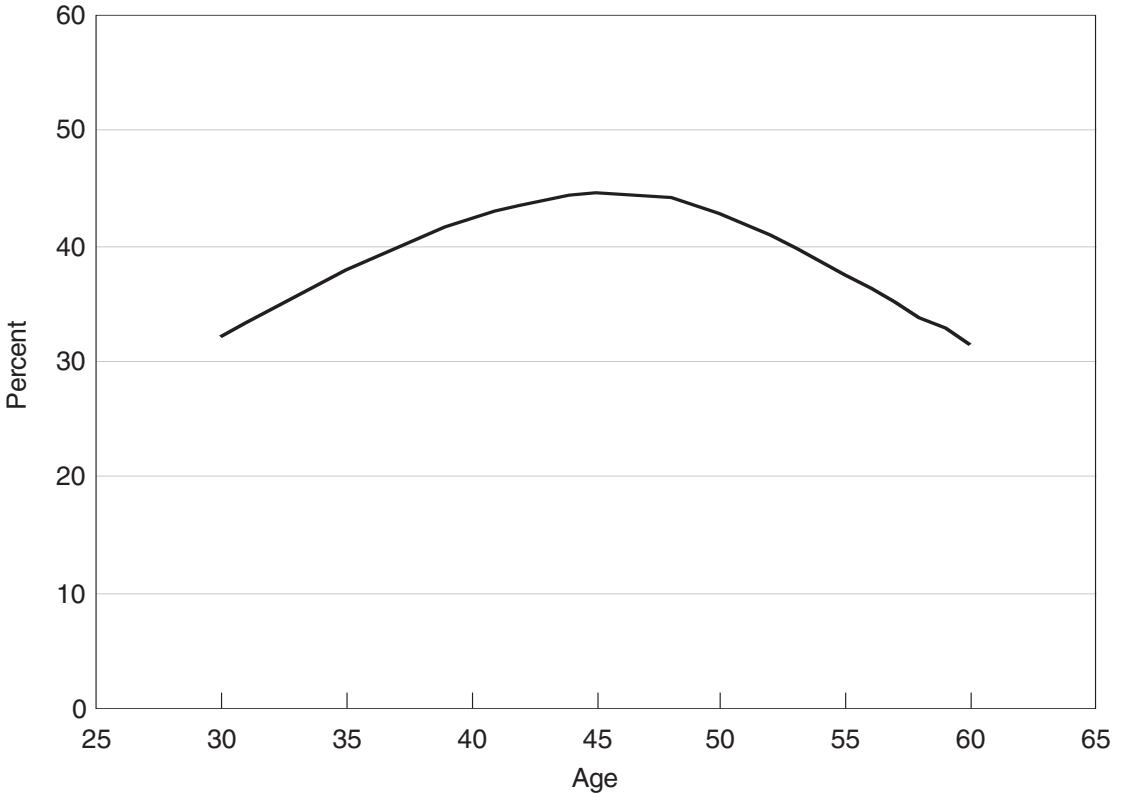
*Information not available.

NOTE: Percents are standardized to the age and race distribution of the nation as indicated by NHIS 1965.

Data for females (Figures 7-7/7-8) show lower percentages of female smokers reporting smoking 25-plus cigarettes per day, particularly for the older cohorts. In more recent cohorts, the percentages are similar to those for males. There is no suggestion of an increase in the fraction of females smoking 25-plus CPD during the 1990s.

Birth cohort analyses of those smoking 25-plus cigarettes per day as a percentage of the entire population, as distinct from the analyses as a percentage of all current smokers, were also conducted. These results are not shown, as they depict progressive declines in the prevalence of heavy smoking with advancing survey years. These declines sum up the effects of smoking cessation, excess mortality, and shifts to lower intensity of smoking with advancing age, and they offer little insight into whether the residual population of smokers is hardening.

Figure 7-4
Effect of Age on Number of Cigarettes Smoked per Day*

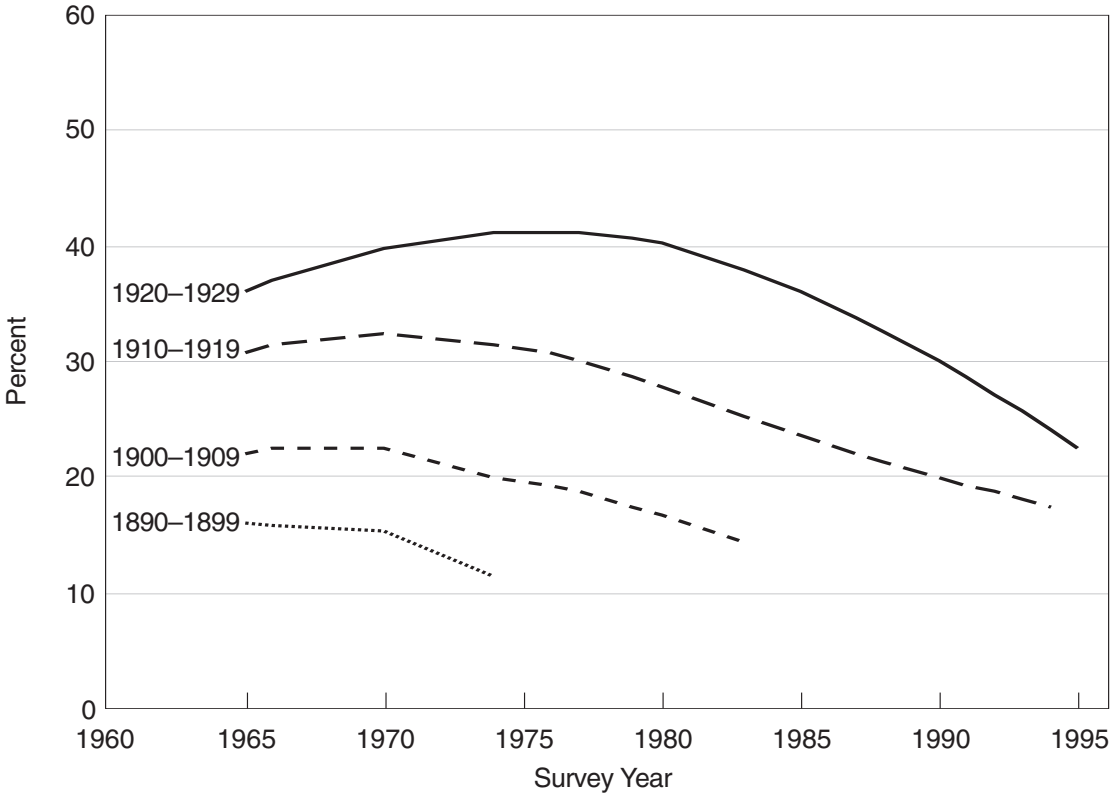


*NHIS percentage of male smokers reporting 25+ cigarettes per day (cohort born 1930–39).

DISCUSSION This chapter provides analyses of changes in number of cigarettes smoked per day from the NHIS conducted between 1965 and 1998. There has been a substantial fall in smoking prevalence over the last 25 years, but there is no evidence for a rise in the number of cigarettes smoked per day over the last 15 years in either cross-sectional analyses or in birth cohort analyses. The mean number of cigarettes smoked per day and the fraction of smokers who reported smoking 25-plus cigarettes per day appear to have declined over the last decade, although at least part of this decline is due to the increasing percentage of occasional smokers recorded in the surveys conducted since 1991, when the definition of current smoker was changed to ask specifically about occasional smoking.

These data are based on the reported number of cigarettes smoked per day in surveys, and it is possible that changes in the social acceptability of smoking over the last several decades have led to an increased underreporting of the number of cigarettes smoked over the last decade

Figure 7-5
Birth Cohort-Specific Percentage* of Male Smokers Reporting Smoking 25+ Cigarettes per Day 1965–1995

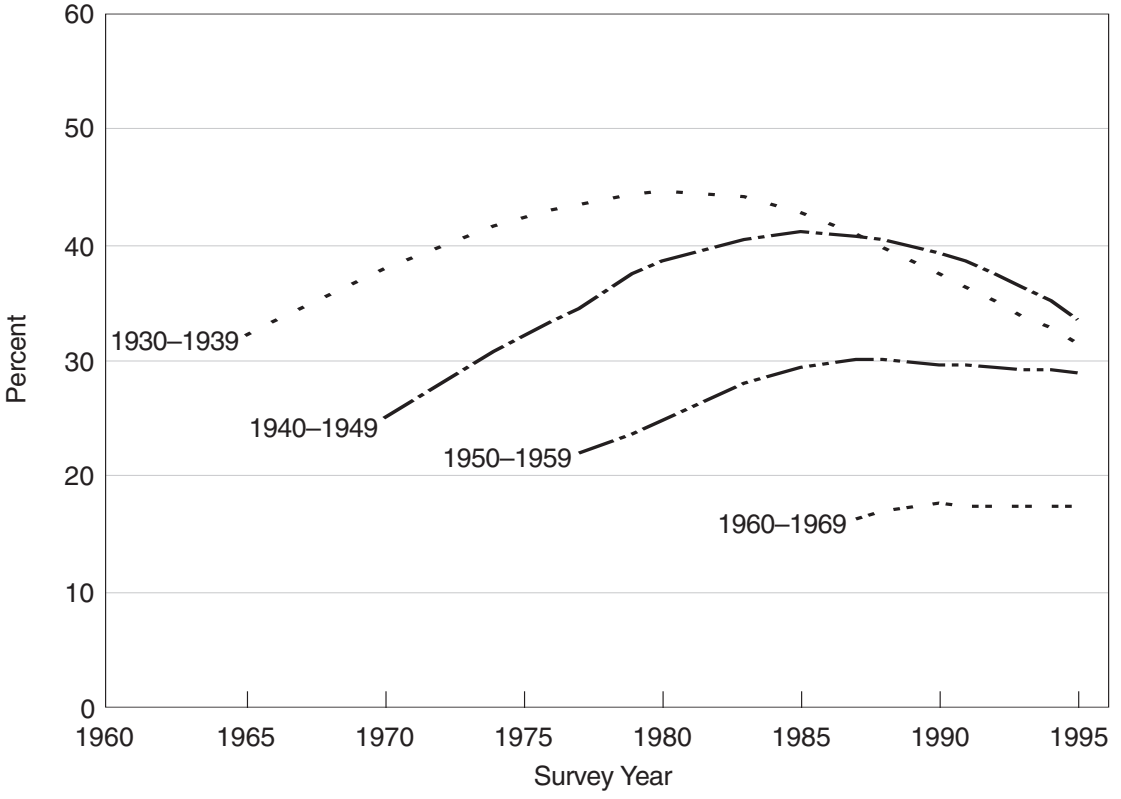


*Adjusted by race

(Warner 1978). If this underreporting is becoming more extensive, then the results of the NHIS would underestimate the actual trends in heavy smoking in the population. These underestimations could artifactually produce the declines in heavy smoking observed in the NHIS and could even mask an increase in the prevalence of heavy smoking if they are severe enough. However, concordance of the trends in per capita consumption with the trends observed in the NHIS, the increased prevalence of occasional smoking, and the decline in per capita consumption in California that is well in excess of the decline in smoking prevalence all suggest that the observations described in this chapter reflect real changes in smoking behavior of the U.S. population.

In summary, analyses of the National Heath Interview Surveys neither demonstrate a rise in the fraction of the population who are heavy smokers (i.e., smoking 25-plus CPD) nor suggest that cessation among those who smoke has increased the mean of number of cigarettes smoked per day in the national adult smoker population.

Figure 7-6
Birth Cohort-Specific Percentage* of Male Smokers Reporting Smoking 25+ Cigarettes per Day 1965–1995



*Adjusted by race

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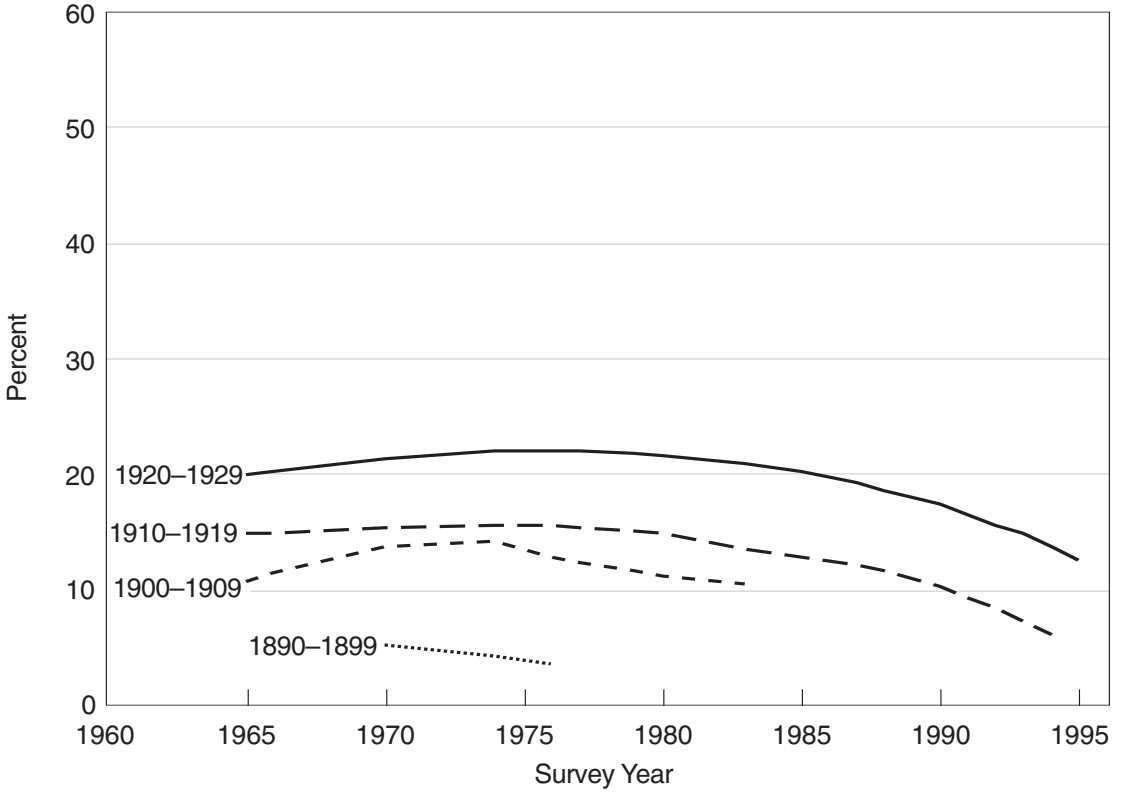
Figure 7-7

Birth Cohort-Specific Percentage* of Female Smokers Reporting Smoking 25+ Cigarettes per Day 1965–1995



*Adjusted by race

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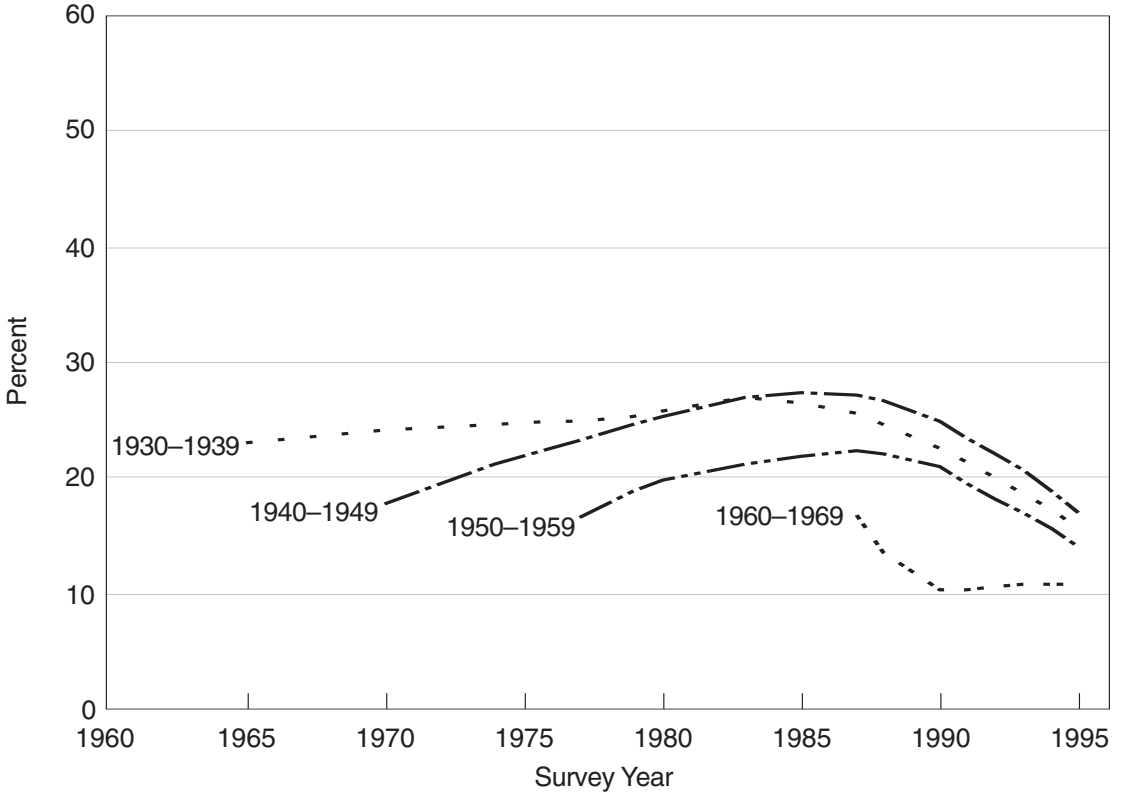
Figure 7-8
Birth Cohort-Specific Percentage* of Female Smokers Reporting Smoking 25+ Cigarettes per Day 1965–1995



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Changes in Cross-Sectional Measures of Cessation, Numbers of Cigarettes Smoked per Day, and Time to First Cigarette—California and National Data

David M. Burns, Jacqueline M. Major, Christy M. Anderson, Jerry W. Vaughn

INTRODUCTION Per capita consumption of cigarettes and smoking prevalence have been declining since the 1960s (U.S. DHHS 2000), but trends in these measures ceased to decline and became flat during the mid-1990s. These observations suggest that smoking cessation rates may also have fallen because those who could easily quit may have done so and left behind a more-addicted and hardened target population of smokers.

This chapter presents the decline in national cessation rates observed between the 1992/93 and 1995/96 Current Population Surveys (CPS) and explores whether these declines in cessation are accompanied by changes in smoking behavior or in the pattern of cessation activity consistent with hardening of the residual smoking population. Data from the 1990, 1996, and 1999 California Tobacco Surveys (CTS) are also examined. California has experienced a decline in both per capita consumption and prevalence over the last decade well in excess of that seen nationally (Gilpin et al. 2001). If a hardened population of residual smokers is developing because those who could be induced to quit using current tobacco control strategies have already quit, then it might be most evident in California where the largest gains in reducing smoking with current tobacco control approaches have occurred. Changes in cessation, number of cigarettes smoked per day, and time to first cigarette (a measure of addiction) occurring between 1990 and 1999 in California are explored for evidence of hardening.

CHANGES IN NATIONAL CESSATION RATES AND NUMBER OF CIGARETTES SMOKED PER DAY One of the clearest measures of change in smoking behavior is the per capita consumption of cigarettes. Figure 8-1 presents the U.S. per capita consumption from 1950 to 2000. It shows a progressive decline from 1974 through the early 1990s. However, between 1993 and 1996, there was very little change in per capita consumption, and the total consumption of cigarettes was also essentially unchanged. This flattening in the per capita consumption trend is one of the lines of evidence raising concerns that smokers are becoming unresponsive to existing tobacco

control approaches. However, following the Master Settlement Agreement (MSA) of the state attorneys general's litigation against the tobacco companies in 1998, and the subsequent substantial increase in the cost of cigarettes, per capita consumption declined steeply. This suggests that, at least as far as cost as a tobacco control intervention is concerned, the population of smokers in 1997 remained responsive to environmental measures previously shown to alter smoking behavior.

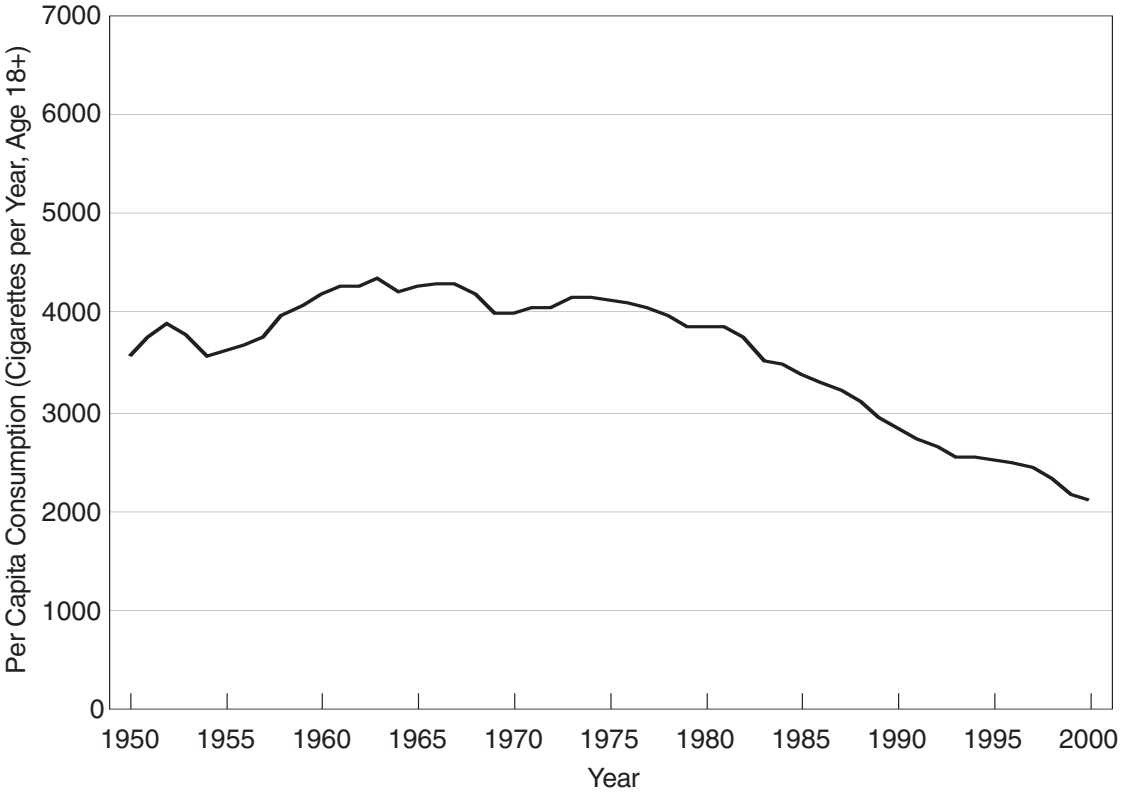
CPS data for the years 1992/93, 1995/96, and 1998/99 are used to examine changes in cessation and number of cigarettes smoked per day in order to determine whether the per capita consumption changes are consistent with a hardening of the residual smoking population as cessation activity fell between the 1992/93 and 1995/96 surveys. The measures of cessation used for the CPS are based on the changes in smoking behavior reported during the 12 months prior to the survey, and they allow changes in the level of cessation activity in the year prior to each survey to be compared.

The cessation measures are calculated using the current smoking status reported by those who were daily smokers one year prior to the survey and who were age 25 or older at the time of the survey. Those smokers could be current daily smokers who had not made a quit attempt, current daily smokers who had made a quit attempt and failed, current occasional smokers, or former smokers. Former smokers were divided into those who had quit for less than 3 months and those who had quit for 3 or more months at the time of the survey. In addition, current daily smokers who had made a quit attempt and occasional smokers were combined into a single measure of those who had made a change in their smoking behavior short of cessation in the prior year. A more detailed description of this measure is presented elsewhere (Burns et al. 2000).

There was a small but statistically significant decline in the prevalence of smoking among self-respondents who were age 25 or older between the 1992/93 and 1995/96 CPS. The percentage declined from 20.06 ± 0.28% daily and 4.26 ± 0.11% occasional smokers in 1992/93 to 19.23 ± 0.23% daily and 3.99 ± 0.11% occasional smokers in 1995/96. However, the percentage of the population reporting that they were former smokers did not increase and actually declined slightly between the two surveys, from 25.99 ± 0.23% to 24.95 ± 0.23%. This suggests that the fall in prevalence between the two surveys may not be the result of increased cessation.

The measures of cessation for the surveys are presented in Table 8-1. The percentage of those who were daily smokers one year prior to the survey who had not made a quit attempt during that year rose between the 1992/93 CPS and the 1995/96 CPS. The percentage who had quit at the time of the survey or who had quit for 3 or more months at the time of the survey fell. Each of these changes was statistically significant, and a multiple logistic regression analysis demonstrated that the differences across surveys persisted when gender, age, education, income, and number of cigarettes smoked per day were entered into the regression (Burns et al. 2000).

Figure 8-1
Per Capita Consumption of Cigarettes in the U.S.A., 1950–2000



These data from the CPS are consistent with changes in per capita consumption over the same period. They suggest that cessation activity and success fell during the mid-1990s and contributed to the absence of a decline in consumption during those years.

Cessation rates vary over time (Burns et al. 1997), both increasing and decreasing, and it is possible that the decline observed in the 1995/95 CPS was one of these variations. Data from the 1998/99 CPS show that the fraction of daily smokers one year prior to the survey who had not made any change in their cessation behavior fell to 63.17%, a level similar to that reported in the 1992/93 survey. In addition, the fraction of smokers who were successfully abstinent at the time of the survey or who had been abstinent for 3 or more months increased significantly between the 1995/96 and 1998/99 surveys. A rapid increase in cigarette cost occurred due to the Master Settlement Agreement in November of 1998, and this increase almost certainly contributed to the increase in cessation activity recorded in the 1998/99 CPS. However, the 1998/99 data were collected in September 1998, January 1999, and May 1999; and the September 1998 survey was conducted prior to the settlement and subsequent price increase. Therefore, cessation behavior reported in the September 1998 survey would represent

Table 8-1
Current Smoking Status Among Those Who Were Daily Smokers 1 Year Prior to the Survey and Who Were Age 25 or Older; Self-Respondents Only

	Daily Smokers						Former Smokers					
	No Quit Attempts		Quit Attempts		Occasional		Quit <3 Months		Quit 3+ Months		Sample
Survey Years	%	±95% CI	%	±95% CI	%	±95% CI	%	±95% CI	%	±95% CI	Size
1992/93											
Total	63.59	(0.60)	25.90	(0.63)	3.05	(0,.22)	2.41	(0.19)	5.06	(0.28)	38,283
Male	64.54	(0.84)	25.25	(0.82)	2.67	(0.30)	2.56	(0.30)	4.98	(0.44)	18,247
Female	62.51	(0.73)	26.63	(0.77)	3.48	(0.30)	2.23	(0.22)	5.14	(0.33)	20,036
1995/96											
Total	67.89	(0.63)	23.51	(0.62)	2.93	(0.19)	1.97	(0.18)	3.69	(0.25)	30,606
Male	68.37	(0.86)	23.02	(0.83)	2.72	(0.25)	2.11	(0.25)	3.79	(0.33)	14,322
Female	67.36	(0.74)	24.05	(0.74)	3.18	(0.29)	1.83	(0.24)	3.58	(0.30)	16,284
1998/99											
Total	63.20	(0.60)	25.60	(0.60)	3.40	(0.20)	2.80	(0.20)	5.00	(0.30)	26,989
Male	63.40	(0.90)	25.40	(0.80)	3.30	(0.30)	2.90	(0.30)	5.00	(0.40)	12,890
Female	62.90	(1.00)	25.80	(0.90)	3.60	(0.40)	2.70	(0.30)	4.90	(0.40)	14,099
Total											
September 1998	63.70	(1.10)	26.70	(1.00)	2.90	(0.40)	1.80	(0.30)	4.90	(0.50)	9,614
January 1999	62.80	(1.10)	24.10	(1.00)	4.20	(0.40)	4.40	(0.50)	4.50	(0.50)	8,984
May 1999	63.20	(1.10)	26.00	(1.00)	3.20	(0.40)	2.10	(0.30)	5.50	(0.50)	8,391

Source: CPS 1992/93, 1995/96, 1998/99.

behavior not influenced by the cost increase, and the cessation measures for the September 1998 survey show an increase in cessation compared with the 1995/96 CPS. This suggests that the increased cessation activity observed between the 1995/96 and 1998/99 CPS occurred prior to, and was the result of factors other than, the increase in cost following the MSA.

It is possible that the increase in cessation observed by the 1998/99 CPS was transient and that cessation rates will fall again in the future. However, per capita consumption fell substantially during the two years following the MSA, suggesting that the effects on smoking behavior continued and that, at least in regard to cost as an intervention, the residual population of smokers did respond to the temporal changes.

In order to examine whether the decline in cessation rates observed between the 1992/93 and 1995/96 CPS is consistent with hardening, Table 8-2 presents the shift between the two surveys in self-reported number of cigarettes smoked per day. In contrast to what might have been expected if the decline in cessation was the result of hardening of the residual population of smokers, the fraction of smokers who smoked 25 or more cigarettes per day did not increase. It declined nonsignificantly from 20.80% to 20.25%. The percentage of smokers smoking 15 to 24 cigarettes per day also remained constant.

Multiple logistic regression analyses were performed independently for each of the measures of cessation described above in the 1992/93 and 1995/96 CPS with gender, age, race/ethnicity, education, income, and cigarettes smoked per day (CPD) included in the regression (Tables 8-1 and 8-2) (Burns et al. 2000). The odds ratios for making a cessation attempt declined with increasing amount smoked in both surveys. The odds ratio for having successfully quit at the time of the survey also was lower for those who had smoked 5-plus CPD compared with those who had smoked 1 to 4 CPD, but there was no clear decline in cessation success with increasing number of cigarettes smoked per day for amounts above 5 CPD. However, the likelihood of making a cessation attempt and the difficulty in achieving cessation did not change between the two surveys for those smokers who smoked 25-plus CPD, at least as measured by the magnitude of the odds ratios. There was no significant difference between the two surveys in the odds ratio for making a cessation attempt or for achieving successful cessation of any duration among those who smoked 25-plus CPD compared with those who smoked 1 to 4 CPD, suggesting that the decrease in quitting seen between the 1992/93 and 1995/96 CPS was not greater for heavy smokers. Thus the proportion of heavy smokers in the population did not increase as cessation fell, and those smokers who were left behind as heavy smokers when their peers quit did not appear to have a greater fall between the two surveys in cessation activity or success than lighter smokers.

An alternate mode of hardening over this period is also examined in the same multiple logistic regressions (Tables 8-1 and 8-2). If those who successfully quit leave behind a more resistant population of smokers, then the fall in cessation rates should be greatest among those demographic groups in which the most cessation has occurred. In multivariate logistic

Table 8-2
Number of Cigarettes Smoked per Day Among Current Smokers 25 Years and Older; Self-Respondents Only, National Data

Survey Years	Occasional Smokers		Cigarettes per Day: 1–4		5–14		15–24		25+		Sample Size
	%	±95% CI	%	±95% CI	%	±95% CI	%	±95% CI	%	±95% CI	
1992/93											
Total	17.65	(0.45)	2.39	(0.17)	19.19	(0.46)	39.96	(0.58)	20.80	(0.38)	48,915
Male	17.41	(0.65)	2.25	(0.27)	15.41	(0.55)	39.06	(0.77)	25.87	(0.58)	22,914
Female	17.92	(0.52)	2.55	(0.23)	23.34	(0.64)	40.95	(0.76)	15.24	(0.41)	26,001
1995/96											
Total	17.31	(0.42)	2.59	(0.17)	19.77	(0.53)	40.08	(0.64)	20.25	(0.50)	38,817
Male	17.30	(0.62)	2.36	(0.24)	15.47	(0.67)	39.89	(0.93)	24.98	(0.74)	17,943
Female	17.33	(0.55)	2.85	(0.25)	24.50	(0.71)	40.28	(0.71)	15.04	(0.51)	20,874

Source: CPS 1992/93 and 1995/96.

regression analyses controlled for age, gender, race/ethnicity, education, income, and number of cigarettes smoked per day, the magnitude of odds ratios for cessation activity and for abstinence or abstinence for 3-plus months at the time of the survey were unchanged between the two survey periods for those with 16-plus years of education compared with those with less than 12 years of education. The magnitude of the odds ratio is a measure of the relative difference in cessation activity or success across the different educational groups. If successful cessation among higher educational groups left behind a group of smokers who were more resistant to cessation, the odds ratios for the highest educational level compared with the lowest should decline between the two surveys, and it does not.

In contrast, there was a substantial decline between the two surveys in the odds ratio for the highest income group compared with the lowest for the measure of cessation activity. There was a substantial, but not statistically significant, decline in the odds ratio for abstinence of 3 or more months. These analyses suggest that a disproportionate fall between the two surveys in cessation activity and successful abstinence did not occur among the most highly educated smokers, but may have occurred among smokers in the highest income group.

The relationship between smoking prevalence and cessation activity was also examined across the 50 states. State-specific data from the 1995/96 CPS on the percentage of those who were daily smokers one year prior to the survey who had not had any cessation activity (no cessation attempt and not becoming an occasional smoker) or who had successfully quit for 3 or more months at the time of the survey were examined in relation to the state-specific prevalence of smoking (age 18-plus and age 25-plus). These cessation measures were also examined in relation to the quit ratio (fraction of ever-smokers age 18-plus in the state who had quit at the time of the survey). If the population of residual smokers is hardening, one might expect to see less cessation activity (higher percentages not making a cessation attempt) and fewer smokers with 3-plus month successful abstinence in those states where smoking prevalence is lower or where the quit ratio is higher. Presumably, the smoking population in these states might be the most hardened.

When plotted against either the prevalence of smoking or the quit ratio, trends across states in the absence of cessation activity and 3-plus month successful abstinence show linear slopes in the opposite direction from that expected if the population were hardening. Absence of cessation activity in the past year decreases (i.e., cessation activity increases) on a state-specific basis when plotted against decreasing state-specific prevalence of smoking (age 25-plus, $p = <.0001$) and increasing quit ratio ($p = 0.000024$). The percentage of those who were daily smokers one year prior to the survey who had quit for 3 or more months increases nonsignificantly as smoking prevalence declines ($p = 0.17$) and increases significantly as the quit ratio increases ($p = 0.011$).

Since the cost of cigarettes may influence both prevalence and cessation, Figure 8-2 presents data for the 1995/96 CPS for all of the states in the form

of a weighted regression that includes both state-specific prevalence (age 25-plus) and total cost of cigarettes (Tobacco Institute 1998) as terms in the regression. The state-specific prevalence was weighted by size of the sample for the state. The dependent variable in the analysis is the percentage of those smokers age 25 and older who were daily smokers one year prior to the survey and who did not attempt to quit or become an occasional smoker in the year prior to the survey; that is, smokers who made no attempt to change their smoking behavior in the year prior to the survey. This variable is adjusted in the figure for the effect of the state-specific price of cigarettes. Cessation activity is higher rather than lower in those states where smoking prevalence rates are the lowest. Similar results are seen for both the 1992/93 and 1995/96 surveys.

Table 8-3 presents the various measures of cessation calculated for the 10 states with the highest smoking prevalence compared with the 10 states with the lowest smoking prevalence. In this analysis as well, cessation activity and success are lower in states with higher smoking prevalence compared with states with lower smoking prevalence.

Figure 8-2
State-Specific Percentage of Daily Smokers One Year Prior to the Survey Who Had No Cessation Activity in the Last Year Compared to State-Specific Smoking Prevalence, Controlling for Price of Cigarettes—1995/96 CPS (Age 25 and Older)

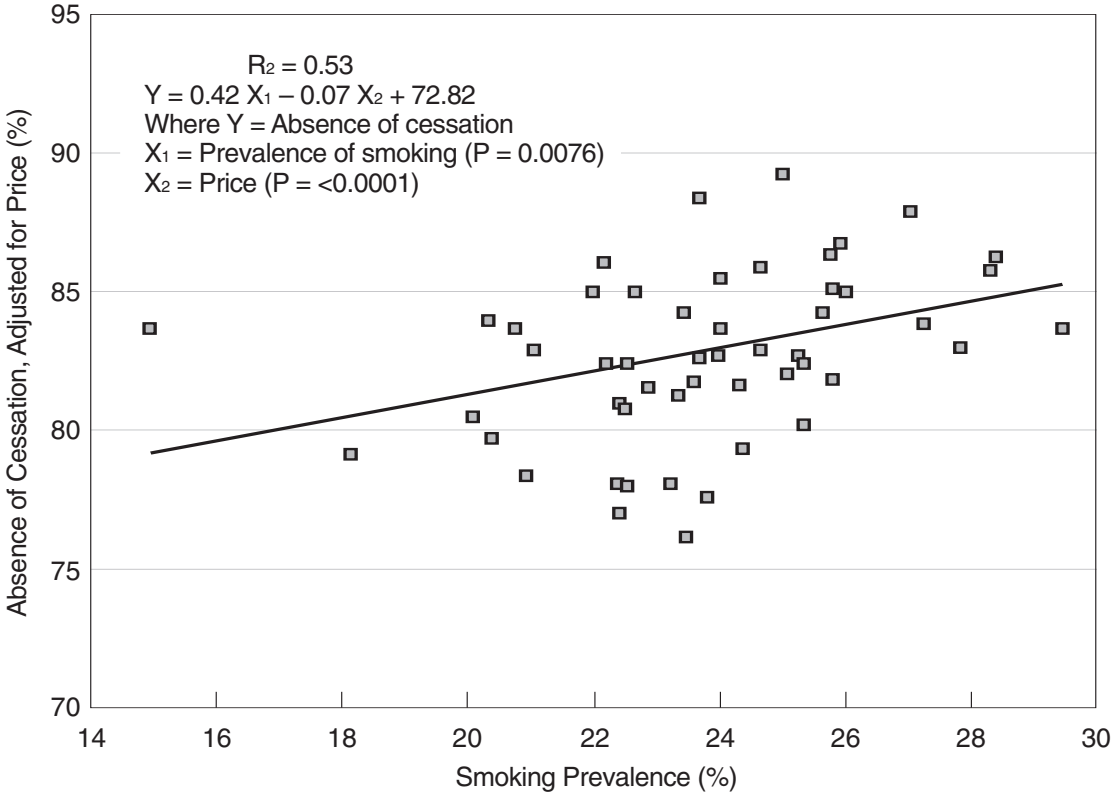


Table 8-3

Current Smoking Status Among Smokers Who Were Daily Smokers 1 Year Prior to the Survey (Age 25+) for States With Lowest and Highest Smoking Prevalence; Self-Respondents Only

	Daily Smokers						Former Smokers					
	No Quit Attempts		Quit Attempts		Occasional		Quit <3 Months		Quit 3+ Months		Sample
Survey Years	%	±95% CI	%	±95% CI	%	±95% CI	%	±95% CI	%	±95% CI	Size
1992/93											
10 states with the lowest smoking prevalence	61.22	(1.03)	26.92	(1.12)	3.45	(0.42)	2.59	(0.35)	5.81	(0.55)	9,110
Other states	63.66	(0.79)	25.87	(0.88)	3.15	(0.27)	2.37	(0.24)	4.95	(0.39)	22,025
10 states with the highest smoking prevalence	66.76	(1.42)	24.53	(1.10)	2.10	(0.38)	2.28	(0.44)	4.34	(0.46)	7,148
1995/96											
10 states with the lowest smoking prevalence	65.25	(1.21)	24.61	(1.18)	3.52	(0.46)	2.26	(0.44)	4.36	(0.48)	6,575
Other states	67.71	(0.89)	23.95	(0.81)	2.85	(0.28)	1.99	(0.23)	3.50	(0.33)	18,562
10 states with the highest smoking prevalence	71.99	(1.49)	20.70	(1.53)	2.39	(0.50)	1.54	(0.32)	3.37	(0.57)	5,469

Source: CPS 1992/93.

These analyses suggest that cessation behavior, as distinct from personal difficulty in achieving cessation, may be enhanced as smoking prevalence falls or in environments where there are fewer smokers. This interpretation provides some support for the hypothesis that the effect of environmental forces is magnified as the fraction of smokers in the population falls, counterbalancing the increased personal difficulty in quitting experienced by the residual smokers.

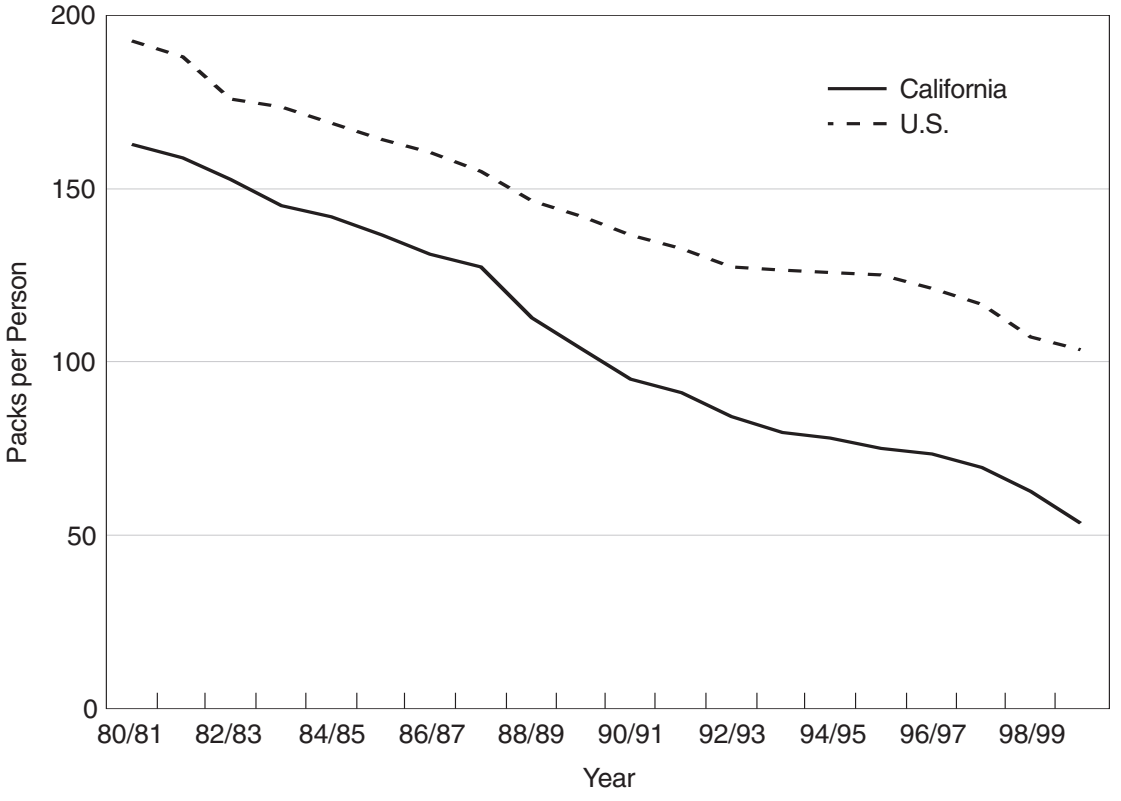
In summary, data from the national CPS demonstrate a fall in cessation activity and success between the 1992/93 and 1995/96 surveys, but cessation activity increased again in the 1998/99 survey concurrent with an increase in the cost of cigarettes. There has been little or no shift in the distribution of number of cigarettes smoked in the population of smokers between the 1992/93 and 1995/96 surveys, and what shift there has been may be a trend toward fewer heavy smokers. Neither heavy smokers nor highly educated smokers show increased difficulty in quitting between the two surveys, but upper income smokers have less cessation activity and may have less abstinence in the 1995/96 survey compared with the 1992/93 survey. Comparisons across states show that cessation activity and success are higher rather than lower in states with lower smoking prevalences, states that might be expected to have the most-hardened smoking populations.

In considering all of this information, it is difficult to see any clear demonstration that the national population has hardened between 1992/93 and 1995/96 as an explanation for the fall in rates of cessation over that interval. However, the time period examined in these national studies is short, and this brief interval may limit the power of these analyses to identify trends consistent with hardening in the population. Alternatively, hardening may have occurred prior to the 1992/93 CPS and would have been missed in the 1992/93 versus 1995/96 comparison. However, the decline in cessation activity and successful abstinence observed between these two surveys are not accompanied by any clear shift in the characteristics of the residual smoking population that would suggest hardening. In order to examine trends over a slightly longer interval during which a larger change in smoking behavior had occurred, data from California are examined.

CHANGES IN CESSATION RATES, NUMBER OF CIGARETTES SMOKED PER DAY, AND TIME TO FIRST CIGARETTE IN CALIFORNIA, 1990 TO 1999

In 1988, California passed an increase in the tax on cigarettes and devoted a portion of that tax to funding a comprehensive tobacco control campaign. That campaign has been successful in reducing per capita consumption of cigarettes and smoking prevalence more rapidly in California than in the rest of the nation (Gilpin et al. 2001). Per capita consumption fell by more than 50% (Figure 8-3) in California, and the prevalence of smoking fell from 22.8% in 1988 to 17.1% in 2000 (California Tobacco Control Section Evaluation Web site 2001).

Figure 8-3
Adult Per Capita Cigarette Consumption in California and U.S., Packs per Fiscal Year, 1980/1981–1999/2000



Data from the CTS are available for the years 1990 through 1999, and they are presented to examine the question whether the substantial decline in smoking behavior observed over this interval resulted in a hardening of the population of residual smokers in California. The CTS uses a modified Waksberg random-digit–dialed telephone methodology to obtain random samples of the California population. Each cross-sectional survey began with a brief screener interview from which an adult provided smoking status and demographic information for each member of the household. Based on the information obtained from the screener interview, adults were randomly selected to answer an extended interview. The data gathered from the extended interviews provide information on smoking prevalence, cessation activity, and number of cigarettes smoked per day for adults (≥25 years of age) in the calendar years 1990, 1996, and 1999. Base weights for those interviewed were computed to take into account the design effect on the probability of selection. Poststratified weights were then used to adjust the samples to the California population provided by the Census in the years 1990, 1994, and 1999, respectively.

Table 8-4 presents the cigarette smoking status of those self-respondents aged 25 and older for the 1990, 1996, and 1999 surveys. The definition of current smoker changed between the 1990 and 1996 surveys. Ever-smokers are defined as those who had smoked 100 or more cigarettes in their lifetime for both surveys. The 1990 survey defined current smokers by asking whether ever-smokers smoked now, and the 1996 and 1999 surveys asked whether they currently smoke every day, some days, or not at all. In these analyses, only the ever-smokers' responses to the current smoking question were tabulated. The difference in definition of current smoker produces a slight increase in the prevalence of current smoking, particularly for occasional smokers (Gilpin et al. 2001). However, over the interval from 1990 through 1999, the prevalence of daily smoking among Californians aged 25 and older fell from 17.8% to 13.0%. This decline is large enough to be beyond that which could be attributed to a change in the definition, and it is also large enough to expect that some evidence of hardening might be evident if it was occurring. It should be noted that the decline in prevalence was accompanied by a rise in never-smoking prevalence and a fall in the prevalence of former smokers between the 1990 and 1996 surveys. It is not clear whether these differences are due to the change in definition, other changes in the survey, or shifts in the population.

Table 8-5 presents the current cessation status for those who were daily smokers one year prior to the survey. In contrast to the fall in cessation attempts and activity seen for the nation, cessation attempts and success held constant between 1990 and 1996 in California. Between 1996 and 1999, cessation attempts and the fraction who had quit for 3 or more months increased. These cessation measures are presented by demographic characteristics in Tables 8-3 to 8-5. The surveys for the 1999 CTS were conducted between August and December of 1999. In November of 1998, there was a price increase following the Master Settlement Agreement, and

Table 8-4
California Cigarette Smoking Prevalence, Ages 25 and Older—1990, 1996, 1999

	Current Smoker				Former Smoker		Never Smoker		Population Size	Sample Size
	Daily		Occasional							
Year	%	CI	%	CI	%	CI	%	CI	(N)	(n)
1990										
Total	17.8	0.57	3.3	0.34	30.1	0.96	48.7	1.08	18,248,686	20,718
Male	19.9	1.05	4.0	0.53	35.8	1.49	40.3	1.62	8,887,409	9,680
Female	15.8	0.67	2.7	0.25	24.6	1.21	56.8	1.32	9,361,269	11,038
1996										
Total	14.2	0.27	4.1	0.29	27.4	0.62	54.2	0.61	19,829,250	16,117
Male	16.1	0.41	5.0	0.51	32.8	1.00	46.1	1.00	9,633,769	7,769
Female	12.5	0.35	3.3	0.32	22.3	0.73	61.9	0.71	10,195,419	8,348
1999										
Total	13.0	0.28	4.7	0.39	27.7	0.56	54.6	0.58	20,538,778	12,518
Male	14.9	0.52	5.9	0.59	32.5	0.85	46.7	1.04	9,926,575	6,104
Female	11.2	0.50	3.7	0.45	23.2	0.69	62.0	0.83	10,612,211	6,414

Table 8-5

Current Smoking Status of Californians Age 25 and Older Who Were Daily Smokers 12 Months Prior to the Survey, 1990, 1996, and 1999 CTS

	Daily Smoker				Occasional Smoker				Former Smoker				Unknown			
	Quit Attempts		Without Quit Attempts		Quit Attempts		Without Quit Attempts		Former <3 mos		Former >=3 mos		Attempts or Duration		Population Size	Sample Size
Year	%	CI	%	CI	%	CI	%	CI	%	CI	%	CI	%	CI	(N)	(n)
1990	32.7	1.72	53.2	1.72	2.6	0.51	0.8	0.32	4.2	0.68	5.6	0.73	0.9	0.50	3,419,535	7,260
1996	31.4	1.28	53.6	1.40	3.3	0.53	1.3	0.45	4.8	0.66	5.0	0.79	0.6	0.22	2,894,421	6,211
1999	35.8	2.09	46.9	2.09	4.5	0.92	1.3	0.67	4.2	0.82	7.1	1.06	0.2	0.15	2,790,004	3,798

Table 8-6
1990 California Tobacco Survey: Multiple Logistic Regression Model of Cessation Measures

	Cessation Activity[1]		Cessation Attempt*[2]		Occasional[3]		Former (Any Length)		Former (3–12 Months)	
Variable	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Gender										
Male	1.00									
Female	1.00	(0.90, 1.11)	1.00	(0.90, 1.11)	0.86	(0.64, 1.15)	1.23	(1.04, 1.45)	1.41	(1.13, 1.76)
Age (Years)										
25–44	1.00									
45–64	0.75	(0.67, 0.85)	0.75	(0.67, 0.84)	0.95	(0.69, 1.31)	1.21	(1.01, 1.45)	1.47	(1.16, 1.86)
65+	0.74	(0.62, 0.90)	0.74	(0.62, 0.89)	0.73	(0.40, 1.31)	1.40	(1.04, 1.88)	1.70	(1.18, 2.45)
Race/Ethnicity										
Non-Hispanic White	1.00									
Hispanic	1.60	(1.35, 1.90)	1.49	(1.25, 1.76)	2.02	(1.35, 3.01)	1.69	(1.31, 2.20)	1.54	(1.09, 2.17)
African-American	2.05	(1.66, 2.54)	2.02	(1.64, 2.50)	2.99	(2.00, 4.46)	1.19	(0.86, 1.65)	1.33	(0.89, 2.00)
Other	1.07	(0.87, 1.32)	1.09	(0.88, 1.34)	0.78	(0.40, 1.55)	0.72	(0.49, 1.07)	0.77	(0.47, 1.29)
Education (Years)										
<12	1.00									
12	1.10	(0.95, 1.27)	1.09	(0.94, 1.26)	1.08	(0.72, 1.63)	1.28	(0.99, 1.66)	1.44	(1.03, 2.01)
13–15	1.34	(1.14, 1.57)	1.31	(1.11, 1.53)	1.50	(0.97, 2.34)	1.64	(1.24, 2.15)	1.68	(1.17, 2.40)
16+	1.26	(1.04, 1.51)	1.25	(1.03, 1.50)	1.06	(0.61, 1.85)	1.91	(1.41, 2.59)	1.66	(1.11, 2.49)
Household Income										
<=$10,000	1.00									
$10,001–20,000	1.32	(1.09, 1.60)	1.24	(1.02, 1.50)	1.20	(0.74, 1.96)	1.48	(1.03, 2.13)	1.03	(0.67, 1.59)
$20,001–30,000	1.22	(1.01, 1.48)	1.20	(0.99, 1.45)	0.75	(0.44, 1.27)	1.69	(1.19, 2.42)	1.27	(0.83, 1.92)
$30,001–50,000	1.30	(1.08, 1.57)	1.28	(1.07, 1.55)	1.08	(0.67, 1.76)	1.76	(1.24, 2.48)	1.11	(0.74, 1.68)
$50,001–75,000	1.38	(1.12, 1.70)	1.36	(1.10, 1.67)	1.02	(0.57, 1.80)	2.12	(1.46, 3.06)	1.29	(0.83, 2.02)
$75,001+	1.16	(0.92, 1.46)	1.13	(0.89, 1.42)	1.44	(0.78, 2.66)	2.35	(1.58, 3.49)	1.85	(1.16, 2.95)

continued

Table 8-6 (continued)

Variable	Cessation Activity[1] OR	Cessation Activity[1] 95% CI	Cessation Attempt*[2] OR	Cessation Attempt*[2] 95% CI	Occasional[3] OR	Occasional[3] 95% CI	Former (Any Length) OR	Former (Any Length) 95% CI	Former (3–12 Months) OR	Former (3–12 Months) 95% CI
Cigarettes per Day										
1 to 4	1.00									
5 to 14	0.75	(0.55, 1.02)	0.73	(0.54, 0.99)	0.63	(0.39, 1.01)	0.52	(0.36, 0.75)	0.49	(0.31, 0.77)
15 to 24	0.41	(0.30, 0.55)	0.43	(0.32, 0.57)	0.22	(0.13, 0.37)	0.38	(0.26, 0.55)	0.34	(0.22, 0.54)
25+	0.39	(0.28, 0.53)	0.40	(0.29, 0.54)	0.13	(0.07, 0.25)	0.46	(0.31, 0.67)	0.52	(0.32, 0.83)

*Cessation Attempts include attempts made by occasional smokers.

NOTE: Model adjusted for gender, age, race/ethnicity, education, household income, and number of cigarettes smoked per day. Population includes respondents who reported smoking daily 12 months ago, ages 25 and older.

[1]Cessation Activity: Includes those who have made a quit attempt, have become occasional smokers, or have become former smokers.

[2]Cessation Attempt: Includes those who have made a quit attempt or have become former smokers.

[3]Occasional: Includes those who reduced from smoking every day to smoking some days.

in January of 1999, the tax on cigarettes increased in California by $0.50. Both of these price increases occurred during the one-year period prior to the survey and may have contributed to the increase in cessation attempts and 3-plus month cessation success in 1999 compared with prior surveys. However, it is clear that the measures of cessation increased in California as the prevalence fell, suggesting that the residual population was not hardening, at least not to cost as a tobacco control intervention.

Multiple logistic regression analyses were performed for each survey with age, race/ethnicity, education, income, and number of cigarettes smoked per day entered into the analyses. The odds ratios from these analyses are presented in Tables 8-6 through 8-8. As was true for the analyses of the CPS data, there is no clear trend toward lower cessation activity or successful abstinence by level of education across the three California surveys as measured by the odds ratio for the highest education group compared with the lowest. This suggests that the increased cessation activity and abstinence experienced by those with higher levels of education are not diminishing compared with those with less education. This effect is present even though the higher educational groups have lower smoking prevalence and higher cumulative cessation, factors that might be expected to make them the most-hardened population of smokers.

In contrast, the effect of income on cessation success has diminished over time, and the absence of an effect of income on cessation was also observed in the national CPS analyses. Income is no longer a statistically significant predictor of being a former smoker or having successfully quit for 3 or more months in the 1999 California Tobacco Survey. This trend may have been influenced by the increase in the cost of cigarettes in the year prior to the 1999 survey, but it appears that the trend may have been present in the 1996 survey as well, although the differences between 1990 and 1996 were not statistically significant.

Table 8-9 examines the prevalence of smoking different numbers of cigarettes for the three California tobacco surveys. The data are presented as percentages of the population rather than as percentages of smokers in order to avoid the effect of the change in definition of smoking on overall smoking prevalence. The change in definition would not be expected to have a substantive impact on the fraction of the population reporting that they smoked 25 or more cigarettes, but it does have an effect on the fraction reporting occasional smoking and hence on the total smoking prevalence. The percentage of the population who smokes 25 or more cigarettes per day in California fell by more than 50% between 1990 and 1999, a much greater proportional reduction than had occurred with either total smoking prevalence or prevalence of daily smoking. This decline in prevalence of heavy smoking in California was confirmed using the California-specific data from the CPS between 1992/93 and 1995/96, during which period there was no change in the definition used to define current smokers (data not shown). Clearly, the fall in smoking prevalence in California was not accompanied by a higher fraction of smokers who were in the heavy-smoking categories.

Whether the heavy smokers who remain in the California population have more difficulty quitting than the larger group of heavy smokers in the prior surveys can be examined using the odds ratios for cessation activity and abstinence by number of cigarettes smoked per day in the multiple logistic regression analyses presented in Tables 8-6 through 8-8. There is an effect of number of cigarettes smoked per day on the likelihood of making a cessation attempt and on the likelihood of having quit at the time of the survey. In the 1990 and 1996 surveys, heavy smokers were less likely to make a cessation attempt than were lighter smokers. In all three surveys, lower odds ratios with increasing amount smoked were evident for any smoking success and for 3-plus months of abstinence, but only for the comparison with those who smoked 1 to 4 CPD one year prior to the survey. There was no gradient of reduced success with increasing amount smoked above 5 CPD.

If the population of heavy smokers has become hardened, the likelihood of making a cessation attempt or of having successfully quit among those who smoke 25-plus CPD should fall. This would be manifest as a lower odds ratio for the 25-plus CPD smokers as the prevalence of heavy smoking falls in sequential surveys. When the odds ratios for heavy smokers in the three surveys are compared (Table 8-10), the impact of smoking 25-plus CPD on the likelihood of cessation attempts has not changed over the nine-year interval. There are also no changes in the odds ratios for cessation success or for 3-plus–month abstinence between the 1990 and 1999 surveys. The odds ratios for the 1996 survey were higher and, statistically, were not significantly different from the comparison group (1 to 4 CPD). These data suggest that, even in the face of a more than 50% decline in the fraction of the population that report smoking 25-plus CPD, those who remain heavy smokers are not less likely to make a cessation attempt or less likely to be successful in that attempt. Even in this population of heavy smokers, who persist in being heavy smokers in spite of the powerful trends toward lower number of cigarettes smoked per day in California, there is no evidence that they have fewer quit attempts or less cessation success.

Smoking the first cigarette of the day within 30 minutes of waking is a measure commonly used in scales of addiction (Fagerström and Schneider 1989), and it is one of the most powerful individual measures used to predict addiction in these scales (Kozlowski et al. 1994). If addicted smokers are less likely to try to quit or to remain abstinent, then the fraction of addicted smokers in the population should increase over time. Among Californians who were daily cigarette smokers at the time of the survey, the proportion reporting that they smoked their first cigarette within 30 minutes of waking decreased from 62.5 ± 1.6% in 1990 to 58.6 ± 2.0% in 1999. In order to control for the shift toward reporting fewer cigarettes smoked per day over this interval, the percentages of smokers reporting smoking a cigarette within 30 minutes of waking are presented by number of cigarettes smoked per day for each of the three surveys in Figure 8-4. Over the nine years covered by the California surveys, and after a 27% fall in the prevalence of daily smoking and a more than 50% fall in the prevalence of heavy smoking, there is no change in the percentage of

Table 8-7
1996 California Tobacco Survey: Multiple Logistic Regression Model of Cessation Measures

	Cessation Activity[1]		Cessation Attempt*[2]		Occasional[3]		Former (Any Length)		Former (3–12 Months)	
Variable	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Gender										
Male	1.00									
Female	0.96	(0.86, 1.07)	0.93	(0.83, 1.04)	1.26	(0.97, 1.65)	1.23	(1.03, 1.48)	1.17	(0.91, 1.49)
Age (Years)										
25–44	1.00									
45–64	0.65	(0.58, 0.73)	0.67	(0.59, 0.76)	0.83	(0.61, 1.11)	0.78	(0.64, 0.95)	0.97	(0.75, 1.27)
65+	0.63	(0.51, 0.77)	0.64	(0.52, 0.79)	0.88	(0.52, 1.51)	1.25	(0.92, 1.70)	1.43	(0.96, 2.15)
Race/Ethnicity										
Non-Hispanic White	1.00									
Hispanic	1.22	(1.04, 1.46)	1.21	(1.02, 1.44)	1.68	(1.16, 2.43)	1.12	(0.86, 1.48)	1.15	(0.79, 1.66)
African-American	1.29	(1.04, 1.60)	1.20	(0.97, 1.49)	1.54	(1.00, 2.35)	0.47	(0.30, 0.75)	0.66	(0.38, 1.15)
Other	0.93	(0.77, 1.12)	0.94	(0.78, 1.13)	0.69	(0.41, 1.17)	0.72	(0.52, 1.00)	0.73	(0.47, 1.15)
Education (Years)										
<12	1.00									
12	0.73	(0.62, 0.85)	0.73	(0.63, 0.86)	1.08	(0.71, 1.65)	0.76	(0.58, 1.00)	0.80	(0.55, 1.15)
13–15	0.95	(0.80, 1.11)	0.92	(0.78, 1.08)	1.96	(1.31, 2.95)	1.04	(0.79, 1.36)	1.04	(0.72, 1.50)
16+	1.16	(0.95, 1.40)	1.17	(0.97, 1.42)	1.65	(1.02, 2.67)	1.40	(1.03, 1.88)	1.39	(0.93, 2.08)
Household Income										
<=$10,000	1.00									
$10,001–20,000	1.18	(0.96, 1.44)	1.25	(1.02, 1.53)	0.87	(0.54, 1.39)	1.23	(0.86, 1.77)	0.98	(0.60, 1.61)
$20,001–30,000	0.96	(0.79, 1.17)	1.04	(0.85, 1.27)	0.67	(0.41, 1.09)	1.22	(0.85, 1.74)	1.21	(0.76, 1.93)
$30,001–50,000	1.05	(0.87, 1.27)	1.09	(0.90, 1.32)	0.89	(0.57, 1.38)	1.44	(1.03, 2.01)	1.24	(0.79, 1.93)
$50,001–75,000	1.10	(0.89, 1.35)	1.12	(0.91, 1.38)	0.94	(0.59, 1.51)	1.26	(0.87, 1.82)	1.45	(0.90, 2.32)
$75,001+	1.08	(0.86, 1.35)	1.13	(0.91, 1.42)	0.72	(0.41, 1.26)	1.87	(1.29, 2.71)	1.60	(0.98, 2.62)

continued

Table 8-7 (continued)

Variable	Cessation Activity[1] OR	Cessation Activity[1] 95% CI	Cessation Attempt*[2] OR	Cessation Attempt*[2] 95% CI	Occasional[3] OR	Occasional[3] 95% CI	Former (Any Length) OR	Former (Any Length) 95% CI	Former (3–12 Months) OR	Former (3–12 Months) 95% CI
Cigarettes per Day										
1 to 4	1.00									
5 to 14	0.77	(0.56, 1.06)	1.05	(0.77, 1.42)	0.34	(0.22, 0.51)	0.64	(0.42, 0.98)	0.88	(0.49, 1.60)
15 to 24	0.48	(0.35, 0.66)	0.68	(0.51, 0.92)	0.17	(0.11, 0.26)	0.50	(0.33, 0.77)	0.62	(0.34, 1.13)
25+	0.40	(0.29, 0.55)	0.57	(0.41, 0.78)	0.11	(0.06, 0.20)	0.67	(0.43, 1.04)	0.83	(0.45, 1.54)

*Cessation Attempts include attempts made by occasional smokers.

NOTE: Model adjusted for gender, age, race/ethnicity, education, household income, and number of cigarettes smoked per day. Population includes respondents who reported smoking daily 12 months ago, ages 25 and older.

[1]Cessation Activity: Includes those who have made a quit attempt, have become occasional smokers, or have become former smokers.

[2]Cessation Attempt: Includes those who have made a quit attempt or have become former smokers.

[3]Occasional: Includes those who reduced from smoking every day to smoking some days.

Table 8-8
1999 California Tobacco Survey: Multiple Logistic Regression Model of Cessation Measures

	Cessation Activity[1]		Cessation Attempt[2]		Occasional[3]		Former (Any Length)		Former (3–12 Months)	
Variable	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Gender										
Male	1.00									
Female	0.86	(0.74, 0.99)	0.87	(0.75, 1.00)	1.09	(0.79, 1.49)	0.86	(0.69, 1.08)	0.75	(0.57, 1.00)
Age (Years)										
25–44										
45–64	0.63	(0.54, 0.73)	0.62	(0.53, 0.72)	1.10	(0.79, 1.54)	0.81	(0.64, 1.03)	1.04	(0.78, 1.39)
65+	0.63	(0.49, 0.80)	0.60	(0.47, 0.77)	0.95	(0.40, 1.31)	1.27	(0.87, 1.84)	1.47	(0.94, 2.30)
Race/Ethnicity										
Non-Hispanic White										
Hispanic	1.11	(0.90, 1.37)	1.08	(0.87, 1.33)	1.15	(0.74, 1.80)	1.41	(1.03, 1.93)	1.25	(0.85, 1.85)
African-American	1.68	(1.25, 2.26)	1.68	(1.26, 2.25)	1.49	(0.89, 2.49)	1.29	(0.85, 1.96)	0.86	(0.48, 1.54)
Other	0.97	(0.77, 1.23)	1.01	(0.80, 1.28)	1.01	(0.61, 1.68)	0.89	(0.61, 1.31)	0.89	(0.56, 1.41)
Education (Years)										
<12										
12	1.31	(1.07, 1.61)	1.27	(1.04, 1.56)	1.09	(0.69, 1.72)	1.35	(0.96, 1.91)	1.30	(0.86, 1.98)
13–15	1.18	(0.95, 1.46)	1.17	(0.95, 1.45)	1.27	(0.78, 2.05)	1.37	(0.96, 1.97)	1.38	(0.89, 2.15)
16+	1.45	(1.13, 1.87)	1.46	(1.13, 1.88)	1.25	(0.71, 2.20)	2.00	(1.35, 2.97)	1.74	(1.07, 2.82)
Household Income										
<=$10,000										
$10,001–20,000	1.24	(0.95, 1.62)	1.19	(0.91, 1.55)	0.73	(0.42, 1.26)	0.90	(0.57, 1.42)	0.80	(0.47, 1.38)
$20,001–30,000	1.19	(0.91, 1.56)	1.20	(0.92, 1.56)	0.92	(0.54, 1.56)	1.09	(0.70, 1.69)	1.07	(0.64, 1.79)
$30,001–50,000	1.03	(0.80, 1.33)	1.03	(0.80, 1.32)	0.61	(0.35, 1.06)	1.10	(0.72, 1.67)	0.79	(0.47, 1.32)
$50,001–75,000	1.12	(0.86, 1.47)	1.15	(0.88, 1.50)	0.49	(0.27, 0.91)	1.22	(0.79, 1.88)	0.94	(0.56, 1.59)
$75,001+	1.14	(0.86, 1.50)	1.16	(0.87, 1.53)	0.54	(0.29, 1.00)	1.42	(0.91, 2.22)	1.22	(0.72, 2.06)

continued

Table 8-8 continued

Variable	Cessation Activity[1] OR	Cessation Activity[1] 95% CI	Cessation Attempt[2] OR	Cessation Attempt[2] 95% CI	Occasional[3] OR	Occasional[3] 95% CI	Former (Any Length) OR	Former (Any Length) 95% CI	Former (3–12 Months) OR	Former (3–12 Months) 95% CI
Cigarettes per Day										
1 to 4										
5 to 14	0.54	(0.35, 0.82)	0.76	(0.51, 1.12)	0.40	(0.24, 0.66)	0.53	(0.33, 0.84)	0.46	(0.27, 0.80)
15 to 24	0.38	(0.25, 0.58)	0.55	(0.37, 0.81)	0.15	(0.09, 0.26)	0.40	(0.25, 0.64)	0.38	(0.22, 0.66)
25+	0.35	(0.23, 0.54)	0.51	(0.34, 0.76)	0.11	(0.06, 0.22)	0.58	(0.36, 0.95)	0.51	(0.29, 0.90)

*Cessation Attempts include attempts made by occasional smokers.

NOTE: Model adjusted for gender, age, race/ethnicity, education, household income and number of cigarettes smoked per day. Population includes respondents who reported smoking daily 12 months ago, ages 25 and older.

[1]Cessation Activity: Includes those who have made a quit attempt, have become occasional smokers, or have become former smokers.

[2]Cessation Attempt: Includes those who have made a quit attempt or have become former smokers.

[3]Occasional: Includes those who reduced from smoking everyday, to smoking some days.

Table 8-9
Percentage of the California Population Age 25 and Older Who Smoke Different Numbers of Cigarettes per Day

	Occasional*		1–4		5–14		15–24		25+		Daily, Unknown Amount	
Year	%	CI	%	CI	%	CI	%	CI	%	CI	%	CI
1990	3.3	0.34	0.6	0.14	4.7	0.29	7.9	0.33	4.4	0.33	0.2	0.07
1996	4.1	0.29	0.7	0.09	4.7	0.26	6.0	0.22	2.8	0.19	0.1	0.04
1999	4.7	0.39	0.7	0.14	4.5	0.29	5.6	0.34	2.1	0.16	0.1	0.03

*Change in definition of current smoker 1990–96.

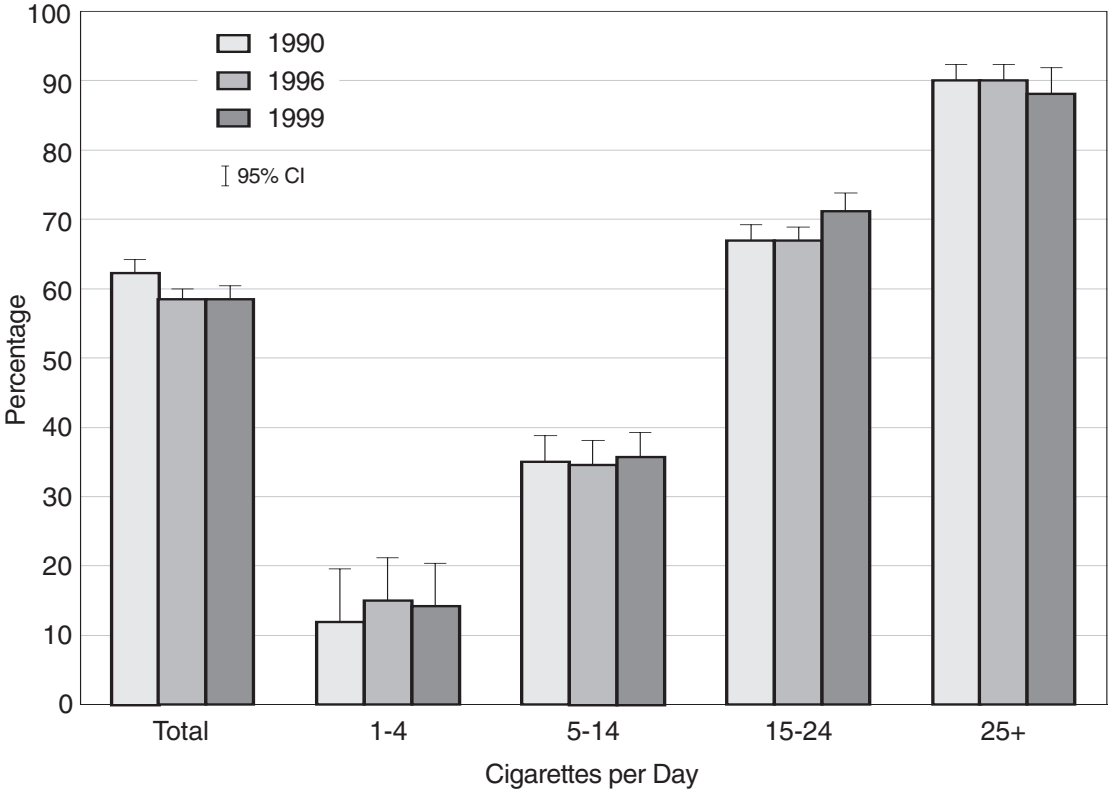
Table 8-10
Multivariate Logistic Regression Models of Cessation Activity and Current Cessation Status for Adult Smokers Who Were Current Daily Smokers One Year Prior to the Survey and Who Were Age 25 or Older at the Time of the Survey, 1990,1996, and 1999 California Tobacco Surveys

	Cessation Activity[1]*		Former*		Former 3+*	
Cigarettes/Day	OR	95% CI	OR	95% CI	OR	95% CI
1990						
1–4	1.00					
5–14	0.75	(0.55, 1.02)	0.52	(0.36, 0.75)	0.49	(0.31, 0.77)
15–24	0.41	(0.30, 0.55)	0.38	(0.26, 0.55)	0.34	(0.22, 0.54)
25+	0.39	(0.28, 0.53)	0.46	(0.31, 0.67)	0.52	(0.32, 0.83)
1996						
1–4	1.00					
5–14	0.77	(0.56, 1.06)	0.64	(0.42, 0.98)	0.88	(0.49, 1.60)
15–24	0.48	(0.35, 0.66)	0.50	(0.33, 0.77)	0.62	(0.34, 1.13)
25+	0.40	(0.29, 0.55)	0.67	(0.43, 1.04)	0.83	(0.45, 1.54)
1999						
1–4	1.00					
5–14	0.54	(0.35-0.82)	0.53	(0.33-0.84)	0.46	(0.27-0.80)
15–24	0.38	(0.25-0.58)	0.40	(0.25-0.64)	0.38	(0.22-0.66)
25+	0.35	(0.23-0.54)	0.58	(0.36-0.95)	0.51	(0.29-0.90)

[1]Cessation activity: Includes those who have made a quit attempt, have become occasional smokers, or have become former smokers.

*Also adjusted for gender, age, race/ethnicity, education, and household income.

Figure 8-4
Percentage 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



smokers, stratified by amount smoked, who reports smoking the first cigarette within 30 minutes of waking.

SUMMARY Data from the national CPS conducted in 1992/93, 1995/96, and 1998/99, and from three California surveys conducted in 1990, 1996, and 1999, are examined for evidence that the residual population of smokers represents a hardened group, more addicted and less likely to be successful in cessation. National rates of cessation attempts declined between 1992/93 and 1995/96, but appear to have increased again in 1998/99. The fall in rates between 1992/93 and 1995/96 was not accompanied by an increased fraction of the population reporting that they smoked more than 25 cigarettes per day, and there was no decline in the odds ratios for cessation attempts and success among those with higher educational attainment between the two surveys. There was a decline in the odds ratios for those with higher income levels.

In California, where cessation rates did not decline between 1990 and 1996 and where there has been a large fall in the prevalence of smoking, particularly heavy smoking, there has been no increase in the fraction of smokers who report smoking more than 25 cigarettes per day or in the percentage of smokers who smoke the first cigarette within 30 minutes of waking. The odds ratios for cessation activity and success for higher levels of education have not declined between 1990 and 1999, which suggests that the group with the highest level of cessation success is continuing to enjoy undiminished higher levels of cessation success. This effect was not seen for those with higher levels of income.

These data do not provide compelling evidence that the residual population of smokers either nationally or in California is becoming hardened or is less likely to successfully quit smoking. It is possible to argue that the absence of evidence for hardening is due to the lack of a measure that adequately quantifies the difficulty an individual smoker has in achieving cessation. However, the measures used do gauge self-reported cessation behavior and success, and an increasing difficulty in quitting on a personal level may be less important for purposes of tobacco control if it is not accompanied by a diminished likelihood of cessation activity or cessation success.

The evidence presented also suggests that the residual population of smokers in California is not composed of a larger fraction of heavily addicted smokers, at least for number of cigarettes smoked per day and time to first cigarette as measures of addiction. One reasonable interpretation of these observations is that comprehensive tobacco control campaigns, such as that conducted in California, produce environmental changes that affect heavy smokers and addicted smokers more powerfully than less dependent smokers. This differential impact may counterbalance the greater personal difficulty in achieving cessation experienced by those who have thus far been unable to quit. It is also possible that those environmental changes that lead to reductions in number of cigarettes smoked per day may also reduce the strength of the addiction among those smokers who manage to reduce the number of cigarettes that they smoke. In this way, the changing environment could make it personally easier for the smoker to quit instead of the residual population of smokers having more difficulty quitting.

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Hardening of the Target: Evidence From Massachusetts

Carolyn C. Celebucki

BACKGROUND For the greater part of the past two decades, adult cigarette smoking prevalence (defined as having smoked at least 100 cigarettes and smoked in the past month) has been steadily declining in the Commonwealth of Massachusetts and in the rest of the nation (Biener, Harris, and Hamilton 2000; CDC 1996; CDC 1999b). Since the beginning of the Massachusetts Tobacco Control Program (MTCP) in 1993/94, the smoking prevalence decline in Massachusetts is close to 2.5 times the national rate (minus California, which initiated a large tobacco control program in 1989) (Biener, Harris, and Hamilton 2000; Hamilton and Norton 2000; Hamilton, Norton, and Weintraub, 2001). Furthermore, when controlling for race/ethnicity, gender, and education level, Massachusetts has experienced significant declines since 1990 in smoking prevalence, while the rest of the nation, minus California, has not (Weintraub and Hamilton 2001).

Massachusetts' per capita consumption of cigarettes by adults (18-plus) is also declining. Since the start of the MTCP, it is declining at greater than 3.5 times the rate of decline of the rest of the nation, minus California (Biener, Harris, and Hamilton 2000). There is evidence that much of the early decline in adult smoking occurred among the more educated, more affluent population (U.S. DHHS 2000; Emery et al. 2000). This chapter examines changes in the characteristics of current smokers in Massachusetts from 1986 to 1999 and, where possible, compares their trends over time to those of current nonsmokers.

A commonly voiced opinion is that smokers are harder to treat or harder to reach now than a few years ago. With an estimated 340,000 fewer smokers in Massachusetts since 1986, logic posits that the "easy quits" would have occurred early in the process, leaving the target population of remaining smokers more hardened—i.e., less able physically or psychologically and/or less motivated to successfully quit as measured by number of quit attempts and intent to quit. These smokers might then be more nicotine-dependent as measured by time to first cigarette, number of cigarettes smoked per day, and use of a pack a day or greater. If they have tried to quit and failed, they may be more discouraged in their ability to quit successfully, less likely to continue to make quit attempts, and more adamant about remaining smokers. If earlier trends continued, they may also be less educated, less affluent, and perhaps less likely to have access to services.

Support for the premise of a hardening of the target is provided by an analysis of published studies of clinical treatment outcomes that controlled for type of services offered and revealed a significant linear trend toward less positive short-term cessation success since the 1980s (see Chapter 4). The author acknowledges that long-term quit success did not decline and posits environmental factors as a probable explanation. Over time, the participants in the studies that were part of the meta-analysis were also significantly more likely to be older, and when age was controlled in the analysis, the significant decrease in quit success was no longer evident.

In Massachusetts, anecdotal information from cessation providers and quantitative data from the Smoker's Quitline (Prout, Martinez, and Ballas 2001) provide limited support for this premise in that smokers in treatment services are smoking their first cigarette sooner upon awakening in 1999 than in 1994. There is evidence from demographic data collected through the Management Information Systems (MIS) that smokers using the Quitline counseling services, although not those using local cessation counseling, are also significantly older now than in 1994, with a mean age of 34.7 in 1993 and 39.2 in 2001. Abt Associates Inc. and Emery and colleagues (Abt Associates 2000, 2001; Emery et al. 2000) found age to be predictive of hardening in smokers. However, smokers in treatment are not smoking more cigarettes per day now than in 1994 (Prout, Martinez, and Ballas 2001; Hamilton and Norton 2000).

Data from national sources (see Chapters 7 and 8) do not support the thesis of a hardened target in the general population of current smokers in that smokers in states with lower rates of prevalence are not reporting higher numbers of cigarettes smoked (one proxy for dependence) over time. It is possible that current smokers in Massachusetts are not becoming more hardened and that the comprehensive public health model of changing social norms, while reducing access and providing treatment services, is still adequate to the task of reducing the morbidity and mortality associated with tobacco use.

An alternative hypothesis posits that the kinds of initiatives undertaken in Massachusetts (Hamilton and Norton 2000; Biener, Harris, and Hamilton 2000; CDC 1999a; Connolly and Robbins 1999; DiFranza, Celebucki, and Mowery 2001; Kozlowski et al. 2000; Bartosch and Pope 1999) and California (Gilpin et al. 2001; Pierce et al. 1998b) differentially affect the hardened core. From a health perspective, a tax increase differentially benefits those with higher marginal costs (relatively less disposable income, higher costs, or higher consumption) (CDC 1996; Chaloupka and Pacula 1999; Harris and Chan 1999; Wakefield and Chaloupka 2000). The increased social cost of smoking, like increased financial cost, may also differentially affect those with higher marginal costs—i.e., those who consume the most relative to their restricted opportunity or increased costs of smoking (Siegal, Biener, and Rigotti 1999; Wakefield et al. 2000). For example, a pack-per-day or greater smoker whose workplace becomes smokefree may have to quit smoking totally, or drastically reduce the number of cigarettes smoked, while one who smokes a few cigarettes may be able to accommodate

changing environmental constraints without altering consumption. Health-related symptoms that drive the smoker to quit or seek medical support may also be more likely to occur in this group, and physicians are known to intervene more often with smokers who are older, smoke more cigarettes, and have poorer health (Gilpin et al. 1993). Unfortunately, attrition (earlier death or disability) should also differentially affect this group as more-addicted smokers with longer smoking histories, presumably higher exposure to tobacco toxicity, and perhaps adjuvant unhealthy conditions (problem drinking, poor mental health, increased limitations) die sooner. This could leave the general population of remaining smokers less hardened in the long term.

If smokers who are less likely to be impacted by the increased "costs" of smoking, less likely to be exposed to interventions, less able to access services, or less successful with services offered increase over time as a proportion of the general population, then a hardening of the target could occur in the short term. For example, current smokers could become less affected by some policy initiatives over time; i.e., they could be less exposed or less responsive to the MTCP motivational/educational media campaign, not be working in employment covered by a smoking restriction, not have seen a physician, or not be covered by health insurance. Emery et al. (2000) describe the hardcore smoker in California (5.6% of current smokers in 1996) as more likely to be white, male, older, living without children in the home, feeling no family pressure to quit, educated at no higher level than high school, and earning $30,000 or less. Additionally, current smokers could be more likely to have other problems that make it more difficult to quit or easier to relapse, such as poor mental health (Lasser, Boyd, and Woolhandler 2000), physical disabilities (Brawarsky et al. 2002), limitations from these illnesses, or alcohol or drug problems. Furthermore, these conditions may also make it less likely that they would be affected by some of the MTCP's policy initiatives—e.g., work in a smokefree workplace.

The MTCP has always funded program components that address cessation as well as prevention of tobacco use, and the reduction of environmental tobacco smoke (ETS) exposure (Begay and Glantz 1997; Hamilton and Norton 2001). Access to free, on-demand telephone counseling services and free or sliding-scale community-based cessation groups has been a component of the program since its inception, as has outreach to harder-to-reach populations. A more complete discussion of MTCP tobacco treatment services can be found elsewhere (Hamilton and Norton 2000). Even as total funding decreased, tobacco treatment services were maintained at a fairly consistent percentage of overall funding (Hamilton and Norton 2001). It is also probable that the increased use of nicotine replacement products due to over-the-counter availability has benefited the more-addicted smoker (Biener, personal communication).

METHODS

Hypothesis

The change in smoking variables in the general population in Massachusetts would not provide evidence of a hardened target; that is, over time, current smokers would not be smoking more, smoking sooner upon awakening, attempting less quitting, or less inclined to quit. Similarly, it was expected that trends over time for smokers would not be toward becoming less educated, earning less money, less likely to be working for wages, less likely to have health insurance, less likely to have checkups, or more likely to have poor physical or emotional health, limited activities, or alcohol problems, or that the trends for these measures would not be worse for smokers than for nonsmokers. While differences between smokers and nonsmokers in these variables were anticipated, we did not expect the trends for these two groups to diverge over time. We hypothesized that the general population of current smokers would actually be less nicotine-dependent, more motivated to quit, and more likely to have had a medical checkup in the past year due in part to the MTCP.

Instruments

The data used for this chapter were collected through the Massachusetts Behavioral Risk Factor Surveillance System (BRFSS) from 1986 to 1999. The BRFSS is an annual, state-based, random-digit–dialed household telephone survey of health-related behaviors and conditions among adults 18 years of age and older that is conducted by all states in cooperation with the Centers for Disease Control and Prevention (CDC). Tobacco-use questions were first asked in 1986. The MTCP has augmented the BRFSS since 1994 with additional tobacco-related items and increased sample sizes. Topics and questions can vary from year to year.

During this reporting period, the Massachusetts BRFSS used a list-assisted methodology to sample households, and interviews were conducted with one randomly selected adult from each contacted household. The annual interview completion rate among contacted households ranged from 54% to 83%; the annual number of completed interviews ranged from 1,105 to 5,024. Completion rates were lower and the number of completed interviews higher in the later years. Characteristics of the BRFSS are described in detail elsewhere (CDC 1996).

Measures

Tobacco Use and Cessation Variables

"Current" smoking status is defined by two questions. In all years, all respondents were asked whether they smoked 100 cigarettes in their lifetime. From 1986 to 1995, those who responded "yes" were asked whether they now smoke cigarettes. In the 1996 to 1999 surveys, those who responded "yes" were asked whether they now smoke cigarettes every day, some days, or not at all. "Current smokers" are those adults who smoked 100 cigarettes in their lifetime and now smoke (1986 to 1995) or now smoke every day or some days (1996 to 1999). "Nonsmokers" are either those who did not smoke 100 cigarettes in their lifetime or those who smoked 100 cigarettes in their lifetime but do not now smoke. In 1994 and 1995, all smokers were asked, "On how many of the past 30 days did you smoke cigarettes?" "Daily smokers" are those who reported that they smoked 30 of the past 30 days in 1994 and 1995 and those who reported smoking every day for the 1996 to 1999 surveys.

From 1986 to 1999, all current smokers were asked about the number of cigarettes they smoked per day. From 1991 to 1993, all current smokers were asked if they quit smoking for one day or longer in the past year, and, between 1994 and 1999, daily smokers were asked the same question. In 1995 and from 1997 to 1999, nondaily smokers were asked whether or not they intentionally quit smoking for one day or longer in the past year. "Quit attempt" for daily and nondaily smokers combined, is reported for 1991 to 1993, 1995, and 1997 to 1999. From 1994 to 1999, all current smokers were asked whether or not they intended to quit in the next 30 days, whether or not they were thinking about quitting in the next 6 months, and how long after waking they smoked their first cigarette. "No intent to quit" is defined as no intent to quit in the next 30 days and not thinking about quitting in the next 6 months.

Demographic Variables During the years 1986 to 1999, respondents provided information on age, educational attainment, employment status, and income. "Less than high school" was defined as never attending school or completing a grade no higher than grade 11. "College graduate" was defined as completing 4 years or more of college. "Unable to work" was added as a separate response category to the employment status question in 1993. Therefore, "out of work/unable to work" is reported only for 1993 to 1999, while "employed for wages" is recorded since 1986 as one of the categorical responses, with "self-employed," "retired," and "out of work" as the other possible choices.

Health Status From 1992 to 1999, adults were asked about their health status. They were asked whether, in general, their health was excellent, very good, good, fair, or poor. In addition, during 1993 to 1999, adults were asked about their physical and mental health and whether they were limited in usual activities due to poor mental or physical health in the past month. "Poor mental health" was defined as having 14 or more days in the past month during which mental health was not good. "Activity limitation" was defined as having 14 or more days in the past month during which poor physical or mental health kept respondents from doing their usual activities.

Health Care Respondents were also asked about health care access. From 1991 to 1999, they were asked whether they had "any kind of health care coverage including health insurance, prepaid plans such as HMOs, or government plans such as Medicare." From 1987 to 1999, adults were asked how long it had been since they visited a doctor for a routine checkup. "No checkup in last year" was defined as those who did not answer "within the past year"; that is, they answered "within past 2 years," " 5 years," "more than 5 years," or "never."

Alcohol Use Questions about alcohol use were asked in 1986 to 1993 and in 1995, 1997, and 1999. "Problem drinking" was defined as consuming 5 or more drinks on any one occasion in the past month or consuming 60 or more drinks in the past month.

ANALYSIS Because BRFSS data are weighted to account for differential probability of selection and to partially adjust for nonresponse, SUDAAN was used to calculate *p* values that took into account the survey sampling scheme and weighting of the data (Shah, Barnwell, and Bieler 1996). Similarly, logistic regression was employed rather than chi-square for the trend test as the latter is not available in SUDAAN. Data for current rather than daily smokers were selected for analyses, because seven additional years could then be included. "Employed for wages" rather than "out of work/unable to work" is the preferred variable for the same reason.

Logistic regression models assessed trends over time in demographic, health status, health care access, and alcohol use characteristics for both current smokers and nonsmokers, and compared the trends of the two groups. We modeled the log odds of various characteristics (i.e., college graduate, fair/poor health, etc.). The independent variables were current smoking status, year, and an interaction term of current smoking status and year. The "year" term was used to test for trends for current smokers and nonsmokers in the following manner: In testing the trend for smokers, smokers were coded as 1 and nonsmokers as 0; coding was reversed when testing trends for nonsmokers, with nonsmokers coded as 1 and smokers as 0. The significance of the interaction term was used to test the difference in trends between smokers and nonsmokers. Similarly, linear regression was used with the same independent variables to assess trends over time in the continuous variable mean age.

Logistic regression models were also used to test trends over time in smoking characteristics among smokers. We modeled the log odds of smoking characteristics (i.e., quit attempt, less than 30 minutes to first cigarette after waking, greater than a pack a day). The independent variable was year. In addition, a linear regression model was used to test the trend in the mean number of cigarettes smoked per day.

RESULTS A total of 1,105 interviews were completed in 1986; 1,422 in 1987; 1,425 in 1988; 1,221 in 1989; 1,296 in 1990; 1,424 in 1991; 1,825 in 1992; 1,857 in 1993; 3,288 in 1994; 3,311 in 1995; 3,041 in 1996; 3,725 in 1997; 4,944 in 1998; and 5,024 in 1999. Table 9-1 depicts current smoking prevalence and smoking behaviors by year and by gender. Also displayed by year and by gender are the distributions of current smokers (Table 9-1) and current nonsmokers (Table 9-2) by education group, income level, employed for wages, out of work/unable to work, no health insurance, no checkup in past year, and the percentages of each with alcohol problems, poor mental health, fair/poor health, or those whose activities are limited by poor mental or physical health. Mean age is also recorded.

Table 9-1

Prevalence of Current Smoking by Year and Gender and the Distribution of Current Smokers by Year and Gender Across Demographic, Health-Related, and Tobacco-Dependence Characteristics,1986–1999

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Prevalence of Current Smoking														
Current Smoker	27.9	27.6	27	23.7	24.1	22.9	23.5	21.1	22.3	22.7	22.7	20.5	21.1	19.3
Men	28.6	27.3	27.1	22	26.7	22.7	25.9	20.7	23.9	24.1	23.3	21	21.2	19.5
Women	27.2	27.9	26.8	25.1	21.8	23.1	21.2	21.4	20.7	21.5	22.2	20.2	21	19.1
Distribution of Current Smokers by Year and Gender Across Demographic Characteristics														
Current Smokers														
Education: All														
<HS	20.9	17.1	21.1	18.2	18.3	16.4	14.6	15.1	14.9	13.6	17.3	12.5	13.4	13.8
HS grad	37.6	39.1	39.3	38.9	41.8	43.9	42.6	41.3	39.6	37.7	38.4	38.5	40.9	37.8
Some college	21.9	23.7	24	24.1	22.6	23.6	22	23.6	26.8	31.1	27.6	29	29.7	26.9
College grad	19.5	20.1	15.6	18.7	18.3	16.1	20.8	20	18.7	17.6	16.7	20	15.9	21.6
Education: Men														
<HS	26.5	19.9	22.9	16.3	19.9	19.5	17.2	18.1	13.4	15.1	22.2	11.6	14	15
HS grad	34.8	34.5	41.8	40.9	37.7	43	41	41	40	31.7	36.1	41.9	43.1	37
Some college	16.8	21.7	19.2	20.3	22.1	16.6	22.1	19.4	25	33.1	23.3	27.4	26.5	27.1
College grad	21.9	23.9	16.1	22.5	20.3	20.8	19.7	21.5	21.7	20.1	18.4	19	16.4	20.9
Education: Women														
<HS	15.8	14.7	19.6	19.6	16.7	13.8	11.8	12.4	16.5	12.1	12.7	13.4	12.9	12.7
HS grad	40.2	43.2	37.1	37.5	44.1	44.6	44.3	41.5	39.2	43.7	40.6	35.2	38.9	38.5
Some college	26.7	25.4	28.3	27.1	23.1	29.6	21.8	27.3	28.6	29.1	31.6	30.5	32.7	26.7
College grad	17.3	16.7	15.1	15.8	16.1	12	22.1	18.8	15.7	15	15.1	20.9	15.5	22.1
Income: All														
<$25,000	50.7	45.1	41	41.3	43.5	49.3	49	39.1	38.5	36.4	32.8	30.6	32.9	31.2
$25,000–34,999	16	15.3	20	16.2	15.3	17.5	13.7	18	24.9	15.2	22.4	16.2	18.3	16.1
$35,000–49,999	16.7	16.9	13	17	18.2	15.9	19.4	17.5	16.5	18.7	20.7	21.5	23.4	19.9
$50,000+	16.5	22.7	25	25.6	22.9	17.3	17.8	25.3	20.1	29.7	24.1	31.7	25.3	32.8
Income: Men														
<$25,000	49.5	46.5	37.7	37.7	35.3	38.2	42.2	39.4	33.1	27.9	26.7	32.6	29.2	30.7
$25,000–34,999	15.7	16.4	18.1	17.5	19.2	19.7	16	17.8	26.7	14.9	23.2	12.6	16.7	15.4
$35,000–49,999	21.1	14.7	13.3	20.1	23.5	23	23.3	18.2	19.2	21.4	22.4	23.6	23.1	17.4
$50,000+	13.7	22.4	30.8	24.7	22	19.1	18.5	24.6	21.1	35.9	27.6	31.2	31	36.3

continued

Table 9-1 (continued)

Distribution of Current Smokers by Year and Gender Across Demographic Characteristics (continued)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Income: Women														
<$25,000	51.7	44.7	43.6	44	52.9	58.9	56.9	38.9	44.5	44.5	38.5	28.6	36.5	31.6
$25–34,999	16.6	12.9	21.5	15.2	10.9	15.8	11.1	18.1	22.9	15.5	21.6	19.5	19.9	16.9
$35–49,999	12.8	19.3	14.7	14.6	12	9.7	15	17	13.5	16.2	19.1	19.6	23.7	22.2
$50,000+	18.9	23.1	20.1	26.3	24.2	15.6	17	26	19	23.9	20.8	32.2	19.9	29.3

Percentage of Current Smokers with Various Health-Related and Tobacco-Dependence Characteristics by Year and Gender

Current Smokers														
Empl. for Wages														
All	67.1	67.3	60.5	61	54.3	62.9	63.1	60.4	61	57	59.1	62.2	70	61.6
Men	68.9	72.4	63	66.5	60.6	68.2	59.7	61.5	64	61.5	61.2	66.3	71.7	62.1
Women	65.4	62.9	58.2	56.8	47.7	57.9	67	59.5	58	52.4	57.1	58.4	68.4	61.1
Out of Work/Unable to Work (18–64)														
All								15.5	11.1	13.7	14.4	15.1	9.7	11.9
Men								13.8	10.4	12	13.5	14.2	10.3	12.5
Women								17	11.7	15.5	15.3	16	9.1	11.4
No Health Insurance (18–64)														
All						18.1	19.4	21.7	18.6	18.7	20.9	16.6	18.2	13.3
Men						25.6	21.6	26.1	20.1	18.7	24.6	19.7	21.2	17.1
Women						10.9	16.9	17.6	17	18.8	17.1	13.7	11.4	9.8
No Checkup in Last Year														
All		32.5	36.4	37.4	38.2	37.3	28	37.9	37.1	38.9	34.1	33.9	31.1	26.7
Men		37.7	44.7	41.8	43.1	47.1	34.3	44.5	44.2	50.1	40.5	42.9	44.2	35.7
Women		28.1	29	34.1	32.9	29	23.2	32	31	27.7	28.1	25.7	19.1	18.4
Fair/Poor Health														
All							10.3	13.4	13.7	13.8	13.6	13	12.2	17.6
Men							11.8	14.4	9.4	15.1	12.8	14	13.1	17
Women							8.7	12.5	18.2	12.4	14.3	12.1	11.4	18.2
Poor Mental Health: 14+ Days in Last Month														
All	16.9	17.5	16.8	16.8	15.8	13	13.1							
Men	16.5	12.4	14.5	12.7	16.8	11.3	10.4							
Women	17.3	22.7	18.9	20.8	14.9	14.6	15.5							
Activities Limited by Poor Physical or Mental Health: 14+ Days in Last Month														
All								7	8.3	7.4	8.1	8.2	5.9	11
Men								7.3	8.6	7.9	7.1	8.9	6.8	8.4
Women								6.7	7.9	6.8	9.1	7.5	5.2	11.6

continued

Table 9-1 (continued)

Percentage of Current Smokers with Various Health-Related and Tobacco-Dependence Characteristics by Year and Gender (continued)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Alcohol Problem (Binge or Chronic Drinker)														
All	37.9	32.9	32.2	28.2	30.1	32.4	31.1	29.4		27.6		35.9		34.3
Men	55.1	48.8	42.9	46	37	45.4	43	39.6		35.6		49.7		43.2
Women	22.1	19.3	22.8	14.4	22.8	21.2	17.7	20.7		19.7		23.2		26
Quit Attempt														
All						55.1	53.8	60.5		59.7		58.9	57.3	63.5
Men						53	49.1	66.8		63.8		59.7	55.7	64.2
Women						56.7	59.3	54.9		55.5		58.2	58.7	62.9
Plan to Quit in Next 30 Days														
All									30.1	29.5	30.1	38.8	41.9	37.9
Men									29.9	33.5	30.8	38.2	44.5	40.8
Women									30.2	25.5	29.4	37.6	39.5	38.7
Time to First Cigarette <= 30 Minutes														
All									49.7	49.9	53.4	51	55.5	53.5
Men									51.3	54.2	57.5	51.5	62.4	53.1
Women									48	45.5	49.4	50.5	49.1	53.9
Mean Number Cigarettes Smoked per Day*														
All	20.3	18.7	19.4	20.1	19.3	19.2	18.7	16.7	15.9	17.4	16.6	15.6	16.2	15.4
Men	22.6	20.1	21.9	23	20.7	21.3	20.3	17.5	16.9	19.2	18.5	16.2	18.7	17.3
Women	18.4	17.6	17.2	17.9	17.8	17.4	17	15.9	14.8	15.6	14.7	14.9	13.9	13.6
Smoke More Than 1 Pack per Day*														
All	26.7	22.9	24.2	26.3	24.5	23.1	23.3	16.8	16.2	17.5	17.2	17.2	18.8	15.7
Men	32.3	25.3	30.7	37.6	30.5	31.7	26.3	19.7	19.5	20.8	22.2	17	24	21
Women	21.7	20.9	18.5	17.7	18	15.7	19.9	14.2	12.7	14.2	12.5	17.4	14	11
No Intent to Quit Smoking														
All									28	26.8	28	26.1	24.6	27.2
Men									31.6	24.4	28.2	26.8	24.6	25.9
Women									24.1	29.1	27.8	25.5	24.7	28.3
Age (Mean Age)														
All	39.9	40.5	39.8	40.9	40.4	39.8	39.3	39.5	40.9	40.6	42.1	39.7	38.8	41.6
Men	39.2	40.2	39.7	39.1	40.4	38.5	38.7	38.4	41.9	39	40.8	38.8	38.5	41.5
Women	40.6	40.6	40.1	42.2	40.4	41	39.9	40.4	39.8	42.1	43.4	40.6	39.1	41.7

* Includes some day and every day smokers. There was a change in questions and response categories in 1994. From 1986–1993, “On the average, about how many cigarettes a day do you now smoke?” was asked of daily and nondaily smokers. “Don’t smoke regularly” was a response category. Therefore, the number of cigarettes smoked per day for “don’t smoke regularly” is not included above for 1986–1993. Starting in 1994, daily smokers were asked the same question and nondaily smokers were asked, “On the average, when you smoked during the past 30 days, about how many cigarettes did you smoke a day?” There was no response category “don’t smoke regularly.” Also, there was a change in coding in 1994. Up to 1993, the maximum number of cigarettes smoked per day was 87. In 1994, that number changed to 76. Therefore, for 1986–1993, if number of cigarettes >76, number of cigarettes was set to 76.

Table 9-2
Distribution of Nonsmokers by Year and Gender for Demographic and Health-Related Characteristics, 1986–1999

	Distribution of Nonsmokers Across Demographic Characteristics													
Year	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Not Current Smokers														
Education: All														
<HS	12.5	14.9	10.2	13.8	11.7	13.1	9.8	10.3	10.1	9.6	11.1	7.6	6.5	7.4
HS grad	29.4	27.2	29	25.5	30	27.8	28.4	25.3	27.2	25.7	24.6	27	28.3	28
Some college	25.4	25	25.8	25.8	23.8	24.8	22.4	25.7	25	23.7	25.1	26.4	25.5	24.5
College grad	32.7	32.9	35.1	34.9	34.5	34.3	39.4	38.6	37.7	41	39.1	39	39.6	40.1
Education: Men														
<HS	12.6	13.9	8	13.3	10.8	15.3	9.4	9.3	8.7	9.3	10.7	7.3	6.8	7
HS grad	24.6	24.6	26.3	22.9	29.4	22.1	27.3	24.8	26.2	23.7	23.3	25.7	26.7	27.3
Some college	23.5	22.2	28.6	23	23.6	24.9	20.1	23.7	24.4	20.6	22.1	25.5	23.7	22.6
College grad	39.3	39.3	37.1	40.8	36.2	37.7	43.1	42.2	40.7	46.5	44	41.5	42.9	43.1
Education: Women														
<HS	12.5	15.8	12	14.3	12.4	11.2	10.1	11.3	11.3	10	11.5	7.9	6.3	7.7
HS grad	33.5	29.5	31.4	27.9	30.5	32.8	29.3	25.8	28	27.5	25.8	28.1	29.8	28.7
Some college	27	27.5	23.3	28.3	24	24.8	24.3	27.6	25.5	26.4	27.8	27.2	27.2	26.1
College grad	27.1	27.3	33.3	29.6	33.1	31.3	36.3	25.3	35.1	36.2	34.9	36.8	36.7	37.4
Income: All														
<$25,000	41.9	39.3	34.3	36	30.3	34.9	31.4	32.2	31.8	26.2	25.3	24.1	22.9	19.3
$25,000–34,999	20.7	15.8	19.9	15.9	16.4	14.3	15.5	13.6	14.4	15	15.2	15.5	12.9	12.5
$35,000–49,999	15.7	19	18.2	17.2	21	18.9	19	17.7	19.5	18.2	17.5	20.6	19.7	17.2
$50,000+	21.6	25.8	27.6	30.9	32.3	31.9	34.1	36.5	34.3	40.5	42	39.9	44.4	51.1
Income: Men														
<$25,000	35.2	32.5	28.1	31.3	25	31.1	25.2	28.6	26.3	22.7	21.4	20.9	17.6	15.6
$25,000–34,999	22.3	19.2	23.9	14.7	18.9	14.2	18	13.4	15.5	16.4	15	13	14.1	12.9
$35,000–49,999	17.4	22.7	18.1	17.6	21.5	21.1	19.8	20.5	21.3	17.5	17.3	20.4	19.9	16.7
$50,000+	25.1	25.5	29.9	36.4	34.6	33.6	37	37.5	36.9	43.4	46.3	45.7	48.4	54.8
Income: Women														
<$25,000	47.7	45.5	40	40.4	34.7	38.3	36.6	35.5	36.7	29.5	28.9	27.2	28.2	22.9
$25,000–34,999	19.5	12.7	16.1	17	14.3	14.4	13.4	13.8	13.4	13.8	15.3	17.8	11.8	12
$35,000–49,999	14.3	15.7	18.4	16.8	20.6	16.8	18.3	15.2	17.9	18.9	17.8	20.8	19.5	17.7
$50,000+	18.5	26.1	25.5	25.8	30.3	30.5	31.7	35.5	32	37.9	38.1	34.2	40.4	47.4

continued

Table 9-2 (continued)

Percentage of Nonsmokers With Various Health-Related Characteristics														
Year	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Not Current Smokers														
Empl. for Wages														
All	55.2	59.4	56.3	51.4	56.6	52.9	54	56.9	58.5	57	58.9	58.4	59.2	57.3
Men	65.6	69.5	61.5	55.8	65.7	55.3	62.1	64	65.3	62.3	65.5	64.7	65.7	61.7
Women	46.2	50.6	51.7	47.6	49.3	50.7	47.1	50.4	52.8	52.5	53.1	52.9	53.3	53.3
Out of Work/Unable to Work (18–64)														
All								7.5	6.5	6.2	6.3	6	5.8	6.5
Men								6.7	6.4	5.7	6.5	6.3	4.5	6.5
Women								8.3	6.5	6.5	6.1	5.8	7.5	6.6
No Health Insurance (18–64)														
All						8.6	8.3	6.9	10	10	10.8	8.7	7.8	7
Men						8.2	10	7.8	11.5	10.7	12.1	10.4	8.5	8
Women						9	6.8	6	8.6	9.4	9.6	7.1	7.2	6
No Checkup in Last Year														
All		36.3	30.3	31	30	27.9	25.2	24.2	26.9	27.1	27.3	20.9	20.2	20.3
Men		47.7	39.1	41.6	40.7	33.3	29.2	30.8	33.8	36.1	36.8	28.5	26.9	26.9
Women		26.3	22.8	21.5	21.4	23.1	21.9	18.3	21.1	19.3	18.9	14.2	14.3	14.4
Fair/Poor Health														
All							8.3	9.3	10.6	11.7	12.2	11.5	9.7	10.1
Men							6.9	9.1	9.7	11.4	11.4	11.2	8.7	10.5
Women							9.4	9.4	11.3	12	12.9	11.8	10.5	9.8
Poor Mental Health: 14+ Days in Last Month														
All	7.6	9.2	8.1	8.1	7.5	7	6.5							
Men	5.2	8.2	6.5	6	6.7	5.2	6.4							
Women	9.8	10.1	9.6	9.9	8.2	8.6	6.6							
Activities Limited by Poor Physical or Mental Health: 14+ days in last month														
All								4.3	4.8	4.7	3.9	4.9	4.5	4.9
Men								4.2	5.7	3.6	3.7	5.1	3.8	5.5
Women								4.4	4	5.7	4.1	4.7	5.1	4.3
Alcohol Problem (Binge or Chronic Drinker)														
All	21.3	18.2	15.2	19.4	16	17	17.4	17.7		15.6		14.9		14.6
Men	29.9	30.7	24.3	31.7	28.5	26.5	25.7	28.3		26.5		23.1		22.7
Women	13.9	7.2	7.2	8.2	5.9	8.8	10.4	8.1		6.3		7.6		7.4
Age (Mean Age)														
All	45.4	45	44.5	44.7	45.7	45.9	45	44.9	44.8	45.7	45.2	46	46.1	46.5
Men	43.6	42.8	42.6	43.2	44.1	44.4	43.5	43.1	42.8	44.5	44	44.5	44.6	45
Women	46.9	46.9	46.1	46.1	47	47.1	46.3	46.5	46.5	46.8	46.3	47.4	47.6	47.9

Table 9-3
Results of Regression Analyses for Trends Over Time and Differences in Trends in Various Characteristics of Smokers and Nonsmokers

Logistic Regression		Smokers		Nonsmokers		Comparison of Smokers to Nonsmokers	Difference in Trend
Variable	Years	Trend	*p* value (Trend)	Trend	*p* value (Trend)	*p* value (Difference in Trend)	
Less Than High School	1986–99						
All		Decrease	0.0001	Decrease	<.0001	0.0808	
Men		Decrease	0.0020	Decrease	<.0001	0.6103	
Women		Decrease	0.0200	Decrease	<.0001	0.0410	Nonsmokers, > dec
College Graduate	1986–99						
All		Increase	0.7988	Increase	<.0001	0.0314	Nonsmokers, > inc
Men		Decrease	0.3036	Increase	0.0082	0.0368	
Women		Increase	0.1336	Increase	<.0001	0.3978	
Out of Work (age 18–64)	1993–99						
All		Increase	0.0026	Increase	0.0042	0.6533	
Men		Increase	0.0800	Increase	0.0200	0.8976	
Women		Increase	0.0089	Increase	0.0617	0.4316	
Employed for Wages	1986–99						
All		Increase	0.6066	Increase	0.0065	0.3691	
Men		Decrease	0.7856	Increase	0.6352	0.6353	
Women		Increase	0.3197	Increase	0.0009	0.4474	
High Income	1986–99						
All		Increase	<.0001	Increase	<.0001	0.0001	Nonsmokers, > inc
Men		Increase	<.0001	Increase	<.0001	0.0684	Nonsmokers, > inc
Women		Increase	0.0431	Increase	0.0020	0.0003	Nonsmokers, > inc
Low Income	1986–99						
All		Decrease	<.0001	Decrease	<.0001	0.0959	
Men		Decrease	<.0001	Decrease	<.0001	0.2769	
Women		Decrease	<.0001	Decrease	<.0001	0.2259	

continued

Table 9-3 (continued)

Variable	Years	Smokers: Trend	Smokers: *p* value (Trend)	Nonsmokers: Trend	Nonsmokers: *p* value (Trend)	Comparison of Smokers to Nonsmokers: *p* value (Difference in Trend)	Difference in Trend
Logistic Regression							
No Health Insurance (age 18–64)	1991–99						
All		Decrease	0.0056	Decrease	0.0633	0.2706	
Men		Decrease	0.1418	Decrease	0.2689	0.2193	
Women		Decrease	0.0109	Decrease	0.1074	0.0466	Smokers, > dec
Fair/Poor Health	1992–99						
All		Increase	0.0557	Increase	0.5885	0.1603	
Men		Increase	0.1298	Increase	0.3365	0.4114	
Women		Decrease	0.2419	Decrease	0.8557	0.2648	
No Checkup in Past Year	1987–99						
All		Decrease	0.0025	Decrease	<.0001	0.0006	Nonsmokers, > dec
Men		Decrease	0.7203	Decrease	<.0001	0.0001	Nonsmokers, > dec
Women		Decrease	<.0001	Decrease	<.0001	0.3804	
Poor Mental Health	1993–99						
All		Decrease	0.0082	Decrease	0.0044	0.6496	
Men		Decrease	0.1645	Decrease	0.4323	0.5080	
Women		Decrease	0.0175	Decrease	0.0009	0.8389	
Activities Limited	1993–99						
All		Increase	0.5250	Increase	0.6869	0.7590	
Men		Decrease	0.8841	Increase	0.6873	0.7212	
Women		Increase	0.2813	Increase	0.8856	0.3904	
Alcohol Problem							
All		Increase	0.6384	Decrease	0.0001	0.0089	
Men		Decrease	0.3087	Decrease	0.0003	0.2668	
Women		Increase	0.0636	Decrease	0.0596	0.0085	
Linear Regression							
Age							
All		Increase	0.0012	Increase	0.0230	0.1765	
Men		Increase	0.0072	Increase	0.0605	0.2676	
Women		Increase	0.0420	Increase	0.1528	0.3925	

Table 9-4
Results of Linear and Logistic Regressions for Trends Over Time in Various Behaviors of Smokers

		Linear Regression		Logistic Regression	
Variable	**Years**	**Change**	***p* value**	**Change**	***p* value**
Current Smoker	1986–99				
All				Decrease	<.0001
Men				Decrease	<.0001
Women				Decrease	<.0001
Quit Attempt	1991–93, 1995, 1997–99				
All				Increase	0.035
Men				Increase	0.1511
Women				Increase	0.1193
Plan to Quit	1994–99				
All				Increase	<.0001
Men				Increase	0.0003
Women				Increase	<.0001
No Intent to Quit	1994–99				
All				Decrease	0.5017
Men				Decrease	0.3002
Women				Increase	0.8712
<=30 Minutes to First Cigarette	1994–99				
All				Increase	0.1407
Men				Increase	0.464
Women				Increase	0.1369
Number of Cigarettes/Day					
All		Decrease	<.0001		
Men		Decrease	<.0001		
Women		Decrease	<.0001		
>1 Pack/Day					
All				Decrease	<.0001
Men				Decrease	0.0003
Women				Decrease	0.0008

Changes in trends over time were tested for the prevalence of a variety of demographic, health status, and health care characteristics, for current smokers as compared with the rest of the population (not current smokers), overall, and by gender. For smokers, change over time in tobacco use and cessation variables was also tested; i.e., mean number of cigarettes smoked per day, smoking over one pack per day, smoking within 30 minutes of waking, past-year quit attempts, intention to quit in next 30 days, and not thinking about quitting within the next 6 months. Table 9-3 depicts the *p* values associated with the trends over time for smokers and nonsmokers and the difference in trends. Table 9-4 depicts the *p* values associated with the trends in tobacco use and cessation variables.

Change in Tobacco-Use and Cessation Variables

Results indicate no support for a hardening of the target among current smokers, and on several measures there is evidence of less tobacco dependence now than in 1986. As noted in Table 9-4, the percentage of current smokers reporting a past-year quit attempt and intention to quit smoking within the next 30 days has significantly increased over time. Similarly, the reported number of cigarettes smoked per day has decreased as have those reporting smoking greater than a pack (20 cigarettes) per day. Patterns for women and men are similar.

There was no significant change in the percentage reporting that they smoke within the first 30 minutes after awakening. But contrary to prediction, there was a suggestion among women of an increase in this variable ($p = 0.14$). There was virtually no change in those who report no intent to quit within the next 6 months.

In summary, changes for current smokers are either in the hypothesized direction of less hardening or are unchanged. No evidence supports a hardening. Smokers do not appear to be less motivated to quit in terms of past quitting history, less likely to quit in next 30 days, or less likely to be thinking about quitting in the next 6 months.

Change in Demographic and Health-Related Variables

Table 9-3 displays the results of logistic and linear regressions for changes over time in various demographic and health-related characteristics for smokers and nonsmokers, and it presents the *p* value of tests for differences in the trends between smokers and nonsmokers. The proportion of those with less than a high school education has significantly decreased over time for both smokers and nonsmokers. The decrease was significantly greater for nonsmoking women than smoking women. There was an increase in college graduates over time among nonsmokers, but not among smokers, and the significant difference between smokers and nonsmokers was largely attributable to changes among men. The population is aging in Massachusetts and trends were significant for smokers and nonsmokers, but there were no significant differences between smokers and nonsmokers.

Significant decreases were evident over time in the lowest income group, with comparable increases in the highest income group. Compared with smokers, the increase in the percent reporting high income was significantly greater for nonsmokers overall and for nonsmoking women, and was suggestive for nonsmoking men. There were increases in the percentage of smokers and nonsmokers who were out of work/unable to work, but no significant differences between them.

The percentage reporting no health insurance declined among smokers (aged 18 to 64), attributable primarily to declines among women, and this decline was greater for women who smoke as compared with those who do not. Declines in the percentage of nonsmokers who reported no health insurance were also suggestive ($p = 0.063$). The percentage of smokers reporting no checkup in the past year declined, a decrease again driven primarily by women, but nonsmokers compared with smokers had a significantly greater decline overall and for men.

There is a suggestion ($p = 0.06$) that an increased proportion of smokers reported being in fair or poor health, while there was no discernable trend among nonsmokers. The difference between smokers and nonsmokers did not reach significance. Among both smokers and nonsmokers, there were reported declines in poor mental health and these were significant for women. However, there was no difference between smokers and nonsmokers in the trend in this measure. There were no significant trends in the percent reporting limited activities over time.

Nonsmokers reported fewer alcohol problems, while smokers did not, and the difference between the trends for smokers and nonsmokers was significant. Self-reported alcohol problems decreased significantly among nonsmoking men, but not among smoking men. The marginal decreases in self-reported problems with alcohol among nonsmoking women ($p = 0.06$) and the marginal increases among smoking women ($p = 0.06$) resulted in a significant difference in trends among women.

DISCUSSION There is scant evidence that smokers in Massachusetts have become more hardened. The results generally show that the residual population of smokers is declining in tobacco dependence and increasing in access to economic and health resources even with the successful implementation of the MTCP. Decreases in tobacco dependence are substantiated by declines in the mean number of cigarettes smoked per day and the percentage of smokers smoking more than one pack per day. In addition, the percentage of smokers reporting a quit attempt in the past year or who plan to quit in the next 30 days increased. The percentage of smokers reporting that they smoke within the first 30 minutes of waking did not change over time, and there was no significant change in the percentage reporting no intent to quit in the next 6 months. Increases in access to resources are documented by the significant decreases in the percentage of smokers with low education, low income, no health insurance, no past-year checkup, and significant increases in those with high income. Smoking women were less likely over time to have no health insurance, no past-year checkups, and poor mental health, but were marginally more likely to report alcohol problems.

While smokers have made significant gains in education and income over the 13 years covered in this study, they have not done so to the same extent as nonsmokers. This divergence is due in part to significantly steeper trends that favored nonsmokers compared with smokers with respect to increases in the percentage with college degrees, decreases among women with less than a high school education, and increases overall and among both women and men in the percentage reporting high income. Additionally, directional differences in trends over time among men with college degrees (nonsignificant decreases among smokers and significant increases among nonsmokers) resulted in significantly greater increases for nonsmokers.

While the increase over time among smokers who reported being out of work or unable to work is consistent with a harder-to-reach, less advantaged or more-hardened smoking population, a comparable increase was evident

among nonsmokers. And since the difference in trends between the two groups was not significant, it is unlikely that this increase is related solely to smoking. The percentage of women without health insurance decreased significantly for smokers but not for nonsmokers, and the difference was significant. The percentage of the population who did not receive a health care checkup in the last year declined over time for female smokers, female nonsmokers, and male nonsmokers, but did not decrease for male smokers. The difference between smokers and nonsmokers was significant overall and for men, favoring nonsmokers.

Finally, with respect to health-related variables that could influence smoking, there were no significant differences over time between smokers and nonsmokers in the percentage reporting poor mental health or limited activity. However, smokers were marginally more likely to increase reporting fair/poor health ($p = 0.06$) over time. It is likely that age differentially affects the health status of smokers compared with nonsmokers, and this effect could account for the marginal increases in reports of fair and poor health among smokers. There was no significant change in smokers' reports of alcohol problems, but alcohol problems among nonsmokers have significantly declined over time, and the difference between smokers and nonsmokers over time is significant. This is especially true for women.

In summary, these trends do not suggest that the population of smokers who remains is more addicted, more resistant to cessation messages, less likely to attempt cessation, or increasingly composed of those with limited activities or poor mental health. However, there is concern that, if program resources are reduced or an economic slowdown diminishes the economic or educational opportunities presently available, smokers may benefit less from the tobacco control initiatives because they are not as economically advantaged as nonsmokers. Should this occur, the target may harden.

LIMITATIONS These findings should be interpreted in light of some important limitations. First, households without telephones have no opportunity to participate in the survey. Second, BRFSS data are based on self-report and subject to resultant biases. Respondents may overreport socially acceptable behaviors and underreport behaviors deemed unacceptable. The response rate to the BRFSS during the years 1986 to 1999 ranged from 54% to 83%. If smoking status was different for people who did not respond to the survey, there could be a bias in the analysis. In addition, many of these observations were made over a relatively short interval of time when there was a relatively small change in smoking prevalence. This may limit the ability to detect trends in mental health and substance abuse behaviors that result from the difficulty in achieving long-term abstinence by smokers with these problems.

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