

CHAPTER 1
INTRODUCTION, OVERVIEW, AND
CONCLUSIONS

CONTENTS

Introduction	5
Major Conclusions	8
Development of the Report	8
Chapter Conclusions	9
Chapter 2: Assessing Smoking Cessation and Its Health Consequences	9
Chapter 3: Smoking Cessation and Overall Mortality and Morbidity	9
Chapter 4: Smoking Cessation and Respiratory Cancers	10
Chapter 5: Smoking Cessation and Nonrespiratory Cancers	10
Chapter 6: Smoking Cessation and Cardiovascular Disease	10
Chapter 7: Smoking Cessation and Nonmalignant Respiratory Diseases	11
Chapter 8: Smoking Cessation and Reproduction	11
Chapter 9: Smoking, Smoking Cessation, and Other Nonmalignant Diseases ..	12
Chapter 10: Smoking Cessation and Body Weight Change	12
Chapter 11: Psychological and Behavioral Consequences and Correlates of Smoking Cessation	13
Volume Appendix: National Trends in Smoking Cessation	13
References	15

INTRODUCTION

The 1964 Report of the Surgeon General's Advisory Committee on Smoking and Health (US PHS 1964) concluded that cigarette smoking is a cause of lung cancer and laryngeal cancer in men, a probable cause of lung cancer in women, and the most important cause of chronic bronchitis. Other diseases, including emphysema and cardiovascular disease, also were found to be associated with cigarette smoking, although the evidence available at that time was not viewed as sufficient to establish the associations as causal. Even in 1964, however, the evidence for adverse health consequences of cigarette smoking was sufficient for the Committee to conclude that "cigarette smoking is a health hazard of sufficient importance in the United States to warrant appropriate remedial action" (US PHS 1964, p. 33).

Subsequent reports of the Surgeon General on smoking and health expanded and strengthened the conclusions of the 1964 Report on active smoking and documented the benefits of smoking cessation. (See US DHHS 1989 for review.) For some diseases, such as cardiovascular disease, newer evidence warranted a determination that associations with cigarette smoking were causal. Further associations of cigarette smoking with disease were identified, and involuntary (passive) smoking was found to be a cause of disease in nonsmokers (US DHHS 1986). Although cigarette smoking has been investigated intensively since the 1950s, new associations of smoking with adverse effects continue to be identified. For example, in a recent study smoking was associated with cataracts (West et al. 1989).

Evidence substantiates cigarette smoking as a cause of disease in smokers and, through involuntary smoking, in never smokers as well. This evidence has motivated the implementation of diverse and far-reaching programs for smoking prevention and cessation. The proportion of U.S. adults who smoke decreased substantially since the 1964 Report. In 1965, 29.6 percent of persons who had ever smoked had quit; by 1987, this percentage had increased to 44.8, representing more than 38 million adults. As the numbers of formerly smoking adults increased in the United States and other countries (US DHHS 1989), epidemiologic and clinical studies provided increasingly extensive information on the health benefits of smoking cessation. Thus, the 1964 Report noted that former smokers had lower overall mortality rates and lower lung cancer risk than current smokers, but the cited evidence was limited. Scientific data are now available on the consequences of cessation for most smoking-related diseases. Major benefits have been shown for overall mortality and for many specific diseases. Although past reports have considered much of the evidence, these data have not received a comprehensive and unified review. This Report systematically reviews the findings on the health benefits and consequences of cessation.

This Report includes a Foreword by the Assistant Secretary for Health and the Director of the Centers for Disease Control, a Preface by the Surgeon General of the U.S. Public Health Service, and the following chapters:

Chapter 1. Introduction, Overview, and Conclusions

Chapter 2. Assessing Smoking Cessation and Its Health Consequences

- Chapter 3. Smoking Cessation and Overall Mortality and Morbidity
- Chapter 4. Smoking Cessation and Respiratory Cancers
- Chapter 5. Smoking Cessation and Nonrespiratory Cancers
- Chapter 6. Smoking Cessation and Cardiovascular Disease
- Chapter 7. Smoking Cessation and Nonmalignant Respiratory Diseases
- Chapter 8. Smoking Cessation and Reproduction
- Chapter 9. Smoking, Smoking Cessation, and Other Nonmalignant Diseases
- Chapter 10. Smoking Cessation and Body Weight Change
- Chapter 11. Psychological and Behavioral Consequences and Correlates of Smoking Cessation
- Volume Appendix. National Trends in Smoking Cessation

A key to acronyms and terms used throughout the Report is found at the end of the volume.

Other publications of the Public Health Service have reviewed determinants of smoking cessation and abstinence (US DHEW 1979; US DHHS 1980, 1988) and methods of smoking cessation and relapse prevention (Schwartz 1987; US DHHS 1988); hence, these topics are not covered in this Report.

Beginning with the 1964 Report, the evidence on active smoking and disease has been reviewed for causality to evaluate the associations of smoking with disease. The explicit criteria used in this evaluation include the consistency, strength, specificity, temporal relationship, and coherence of the association (US PHS 1964; US DHHS 1989). These criteria have provided a consistent and effective framework for examining the epidemiologic, clinical, and experimental data on active smoking. Although the criteria cannot be applied in the same fashion to associations of smoking cessation with changes in disease occurrence, the criteria of consistency, an appropriate temporal relationship, and coherence must be maintained with evidence on smoking cessation and health.

Thus, this Report examines data for consistency among investigations of the associations of cessation with disease occurrence and other outcomes, and considers the biologic plausibility of the known or presumed associations in the context of the mechanisms by which cigarette smoking is known or thought to cause disease. The appropriate time sequence of cessation with its effect is evident; cessation must always precede its presumed effect. In an observational study, this sequence may be reversed by the tendency of persons with initial symptoms of a cigarette-related disease or with frank disease to reduce cigarette consumption or to stop smoking (Chapter 2). The findings of longitudinal studies among former smokers document high mortality rates among short-term former smokers, which is consistent with reversal of the causal

sequence of cessation followed by reduced disease occurrence; that is, disease has caused a change in exposure (Rogot and Murray 1980).

Cigarette smoke in its gaseous and particulate phases contains thousands of agents, many of which can damage tissues and cause disease (US DHEW 1979; US DHHS 1986, 1989). The pathogenetic mechanisms by which cigarette smoking causes disease are diverse, ranging from longer term processes, such as carcinogenesis, to shorter term processes, such as interference with tissue oxygenation by carbon monoxide. Thus, the biologic context in which the evidence on cessation is considered must be disease-specific; a unified biologic framework for evaluating the evidence on cessation cannot be offered.

For example, cigarette smoking causes emphysema, an irreversible destruction of the gas-exchanging structure of the lung, and permanent or only partially reversible damage to the airways of the lung. Little improvement of lung function after cessation would be anticipated for a long-term smoker with disabling chronic obstructive pulmonary disease (COPD) and extensive irreversible damage to the lung. However, cessation would benefit a smoker who has less extensive damage by slowing the rate of lung function decline and thereby reducing the likelihood of clinically significant impairment. By contrast with COPD, smoking cessation following myocardial infarction has both relatively immediate and longer term benefits. The immediately decreased risk of death in those who stop smoking in comparison with those who continue to smoke may reflect a decrease of blood coagulability, improved tissue oxygenation, and less predisposition to cardiac arrhythmias after cessation.

The findings of studies on the health consequences of smoking cessation also provide evidence relevant to determining the causality of associations of active smoking with disease. A decline in disease incidence after cessation needs to be considered as a positive indication of such a causal association. However, the pattern of changing risk after cessation must be interpreted in the context of the mechanism of disease causation by active smoking.

In interpreting individual studies on the consequences of smoking cessation, difficult methodologic and conceptual issues must be considered. Chapter 2 addresses these issues in depth. Because smoking cessation is a dynamic process, often involving multiple relapses to active smoking, accurate characterization of the former smoker is difficult and best accomplished by longitudinal observation. Misclassification of cigarette smoking status may lead to biased estimates of the consequences of smoking cessation. In observational studies and trials some subjects may report that they are former smokers, even though they continue to smoke; the resulting misclassification tends to result in underestimation of the benefits of cessation. Unraveling the consequences of smoking cessation from the effects of other factors determining the occurrence of disease poses a substantial analytical challenge. In reviewing individual reports on the consequences of smoking cessation, the approaches to these potential methodologic issues were assessed (Chapter 2).

MAJOR CONCLUSIONS

More than 38 million Americans have quit smoking, and almost half of all living adults in the United States who ever smoked have quit (Volume Appendix). Nevertheless, more than 50 million Americans continue to smoke. This Report reviews in detail the health consequences of smoking cessation for those who have quit and for those who will quit in the future. The following major volume conclusions summarize the health consequences of smoking cessation for those who quit smoking in comparison with those who continue to smoke:

- 1. Smoking cessation has major and immediate health benefits for men and women of all ages. Benefits apply to persons with and without smoking-related disease.**
- 2. Former smokers live longer than continuing smokers. For example, persons who quit smoking before age 50 have one-half the risk of dying in the next 15 years compared with continuing smokers.**
- 3. Smoking cessation decreases the risk of lung cancer, other cancers, heart attack, stroke, and chronic lung disease.**
- 4. Women who stop smoking before pregnancy or during the first 3 to 4 months of pregnancy reduce their risk of having a low birthweight baby to that of women who never smoked.**
- 5. The health benefits of smoking cessation far exceed any risks from the average 5-pound (2.3-kg) weight gain or any adverse psychological effects that may follow quitting.**

DEVELOPMENT OF THE REPORT

This Report was developed by the Office on Smoking and Health (OSH), Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control, Public Health Service of the U.S. Department of Health and Human Services, as part of the Department's responsibility under Public Law 91-222 to report new and current information on smoking and health to the U.S. Congress.

The scientific content of this Report was produced through the efforts of more than 120 scientists in the fields of medicine, psychology, the biologic and social sciences, and public health. Manuscripts for the Report, constituting drafts of chapters or sections of chapters, were prepared by 26 scientists selected for their expertise in specific content areas. An editorial team, including the Director of OSH, a medical psychologist with the Uniformed Services University of the Health Sciences, and four non-Federal experts, edited and consolidated the individual manuscripts into chapters. These draft chapters were subjected to an intensive outside peer review, with each chapter reviewed by an average of five individuals knowledgeable about the chapter's subject matter. Incorporating the reviewers' comments, the editors revised the chapters and assembled a draft of the complete Report. The draft Report was then submitted to 25 distinguished

scientists for their review and comment on the entirety of its contents. Simultaneously, the draft Report was submitted to 10 institutes and agencies within the U.S. Public Health Service for review. Comments from the senior scientific reviewers and the agencies were then used to prepare the final draft of the Report, which was then reviewed by the Office of the Assistant Secretary for Health and the Secretary, Department of Health and Human Services.

CHAPTER CONCLUSIONS

Chapter 2: Assessing Smoking Cessation and Its Health Consequences

1. Most former smokers have cycled several times through the process of smoking cessation and relapse before attaining long-term abstinence. Any static measure of smoking status is thus a simplification of a dynamic process.
2. In studies of the health effects of smoking cessation, persons classified as former smokers may include some current smokers. Consequently, the health benefits of smoking cessation are likely to be underestimated.
3. In contexts other than intervention trials, self-reported smoking status at the time of measurement and concurrent biochemical assessment are highly concordant. This high concordance supports self-report as a valid measure of smoking status in observational studies of the health effects of smoking cessation.

Chapter 3: Smoking Cessation and Overall Mortality and Morbidity

1. Former smokers live longer than continuing smokers, and the benefits of quitting extend to those who quit at older ages. For example, persons who quit smoking before age 50 have one-half the risk of dying in the next 15 years compared with continuing smokers.
2. Smoking cessation at all ages reduces the risk of premature death.
3. Among former smokers, the decline in risk of death compared with continuing smokers begins shortly after quitting and continues for at least 10 to 15 years. After 10 to 15 years of abstinence, risk of all-cause mortality returns nearly to that of persons who never smoked.
4. Former smokers have better health status than current smokers as measured in a variety of ways, including days of illness, number of health complaints, and self-reported health status.

Chapter 4: Smoking Cessation and Respiratory Cancers

1. Smoking cessation reduces the risk of lung cancer compared with continued smoking. For example, after 10 years of abstinence, the risk of lung cancer is about 30 to 50 percent of the risk in continuing smokers; with further abstinence, the risk continues to decline.
2. The reduced risk of lung cancer among former smokers is observed in males and females, in smokers of filter and nonfilter cigarettes, and for all histologic types of lung cancer.
3. Smoking cessation lowers the risk of laryngeal cancer compared with continued smoking.
4. Smoking cessation reduces the severity and extent of premalignant histologic changes in the epithelium of the larynx and lung.

Chapter 5: Smoking Cessation and Nonrespiratory Cancers

1. Smoking cessation halves the risks for cancers of the oral cavity and esophagus, compared with continued smoking, as soon as 5 years after cessation, with further reduction over a longer period of abstinence.
2. Smoking cessation reduces the risk of pancreatic cancer, compared with continued smoking, although this reduction in risk may only be measurable after 10 years of abstinence.
3. Smoking is a cause of bladder cancer; cessation reduces risk by about 50 percent after only a few years, in comparison with continued smoking.
4. The risk of cervical cancer is substantially lower among former smokers in comparison with continuing smokers, even in the first few years after cessation. This finding supports the hypothesis that cigarette smoking is a contributing cause of cervical cancer.
5. Neither smoking nor smoking cessation are associated with the risk of cancer of the breast.

Chapter 6: Smoking Cessation and Cardiovascular Disease

1. Compared with continued smoking, smoking cessation substantially reduces risk of coronary heart disease (CHD) among men and women of all ages.

2. The excess risk of CHD caused by smoking is reduced by about half after 1 year of smoking abstinence and then declines gradually. After 15 years of abstinence, the risk of CHD is similar to that of persons who have never smoked.
3. Among persons with diagnosed CHD, smoking cessation markedly reduces the risk of recurrent infarction and cardiovascular death. In many studies, this reduction in risk of recurrence or premature death has been 50 percent or more.
4. Smoking cessation substantially reduces the risk of peripheral artery occlusive disease compared with continued smoking.
5. Among patients with peripheral artery disease, smoking cessation improves exercise tolerance, reduces the risk of amputation after peripheral artery surgery, and increases overall survival.
6. Smoking cessation reduces the risk of both ischemic stroke and subarachnoid hemorrhage compared with continued smoking. After smoking cessation, the risk of stroke returns to the level of never smokers; in some studies this has occurred within 5 years, but in others as long as 15 years of abstinence were required.

Chapter 7: Smoking Cessation and Nonmalignant Respiratory Diseases

1. Smoking cessation reduces rates of respiratory symptoms such as cough, sputum production, and wheezing, and respiratory infections such as bronchitis and pneumonia, compared with continued smoking.
2. For persons without overt chronic obstructive pulmonary disease (COPD), smoking cessation improves pulmonary function about 5 percent within a few months after cessation.
3. Cigarette smoking accelerates the age-related decline in lung function that occurs among never smokers. With sustained abstinence from smoking, the rate of decline in pulmonary function among former smokers returns to that of never smokers.
4. With sustained abstinence, the COPD mortality rates among former smokers decline in comparison with continuing smokers.

Chapter 8: Smoking Cessation and Reproduction

1. Women who stop smoking before becoming pregnant have infants of the same birthweight as those born to never smokers.
2. Pregnant smokers who stop smoking at any time up to the 30th week of gestation have infants with higher birthweight than do women who smoke throughout pregnancy. Quitting in the first 3 to 4 months of pregnancy and abstaining

throughout the remainder of pregnancy protect the fetus from the adverse effects of smoking on birthweight.

3. Evidence from two intervention trials suggests that reducing daily cigarette consumption without quitting has little or no benefit for birthweight.
4. Recent estimates of the prevalence of smoking during pregnancy, combined with an estimate of the relative risk of low birthweight outcome in smokers, suggest that 17 to 26 percent of low birthweight births could be prevented by eliminating smoking during pregnancy; in groups with a high prevalence of smoking (e.g., women with less than a high school education), 29 to 42 percent of low birthweight births might be prevented by elimination of cigarette smoking during pregnancy.
5. Approximately 30 percent of women who are cigarette smokers quit after recognition of pregnancy, with greater proportions quitting among married women and especially among women with higher levels of educational attainment.
6. Smoking causes women to have natural menopause 1 to 2 years early. Former smokers have an age at natural menopause similar to that of never smokers.

Chapter 9: Smoking, Smoking Cessation, and Other Nonmalignant Diseases

1. Smokers have an increased risk of development of both duodenal and gastric ulcer, and this increased risk is reduced by smoking cessation.
2. Ulcer disease is more severe among smokers than among nonsmokers. Smokers are less likely to experience healing of duodenal ulcers and are more likely to have recurrences of both duodenal and gastric ulcers within specified timeframes. Most ulcer medications fail to alter these tendencies.
3. Smokers with gastric or duodenal ulcers who stop smoking improve their clinical course relative to smokers who continue to smoke.
4. The evidence that smoking increases the risk of osteoporotic fractures or decreases bone mass is inconclusive, with many conflicting findings. Data on smoking cessation are extremely limited at present.
5. There is evidence that smoking is associated with prominent facial skin wrinkling in whites, particularly in the periorbital ("crow's foot") and perioral areas of the face. The effect of cessation on skin wrinkling is unstudied.

Chapter 10: Smoking Cessation and Body Weight Change

1. Average weight gain after smoking cessation is only about 5 pounds (2.3 kg). This weight gain poses a minimal health risk.

2. Approximately 80 percent of smokers who quit gain weight after cessation, but only about 3.5 percent of those who quit smoking gain more than 20 pounds.
3. Increases in food intake and decreases in resting energy expenditure are largely responsible for postcessation weight gain.

Chapter 11: Psychological and Behavioral Consequences and Correlates of Smoking Cessation

1. Short-term consequences of smoking cessation include anxiety, irritability, frustration, anger, difficulty concentrating, increased appetite, and urges to smoke. With the possible exception of urges to smoke and increased appetite, these effects soon disappear.
2. Smokers who abstain from smoking show short-term impairment of performance on a variety of simple attention tasks, which improves with nicotine administration. Memory, learning, and the performance of more complex tasks have not been clearly shown to be impaired. Whether the self-reported improvement in attention tasks upon nicotine administration is due entirely to relief of withdrawal effects or is also due in part to enhancement of performance above the norm is unclear.
3. In comparison with current smokers, former smokers have a greater perceived ability to achieve and maintain smoking abstinence (self-efficacy) and a greater perceived control over personal circumstances (locus of control).
4. Former smokers, compared with current smokers, practice more health promoting and disease-preventing behaviors.

Volume Appendix: National Trends in Smoking Cessation

1. By 1987, more than 38 million Americans had quit smoking cigarettes, nearly half of all living adults who ever smoked.
2. The percentage of ever cigarette smokers who are former cigarette smokers (quit ratio) has increased from 29.6 percent in 1965 to 44.8 percent in 1987 at an average rate of 0.68 percentage points per year. The quit ratio has increased among men and women, among blacks and whites, and among all age and education subgroups. Between 1966 and 1987, the rate of increase in the quit ratio among college graduates was twice the rate among high school dropouts.
3. About one-third of all former cigarette smokers who have maintained abstinence for at least 1 year may eventually relapse. As the duration of abstinence increases, relapse becomes less likely.

4. Quitting activity, as measured by the proportion of people smoking at 12 months before a survey who quit for at least 1 day during those 12 months, has increased slightly over time. Between 1978 and 1987, this proportion increased from 27.8 to 31.6 percent.
5. Female smokers were more likely than male smokers to have quit smoking cigarettes for at least 1 day during the previous year; however, there were no gender differences in the proportion abstinent for 1 to 4 years. Men were more likely than women to have been abstinent for 5 years or more. These findings do not take into account the use of tobacco products other than cigarettes.
6. Black smokers were more likely than white smokers to have quit for at least 1 day during the previous year. Blacks, however, were less likely than whites to have been abstinent for 1 year or more.
7. Younger smokers (aged 20 to 44) were more likely than older smokers to have quit for at least 1 day during the previous year.
8. Smokers with less education tend to be less likely to have quit for at least 1 day during the previous year compared with those having more education. In addition, those with lower levels of education are less likely to have been abstinent for 1 year or more.
9. In 1964, about three-fourths of all current smokers predicted that they would “definitely” or “probably” be smoking in 5 years. In 1986, fewer than half of all current smokers felt the same way. Moreover, while more than 20 percent of current smokers in 1964 predicted that they would “definitely” be smoking in 5 years, only about 7 percent of current smokers in 1986 so predicted.
10. Current smokers in 1987 were more than three times as likely as current smokers in 1964 to report having received advice from a doctor to stop smoking.

References

- ROGOT, E., MURRAY, J.L. Smoking and causes of death among U.S. veterans: 16 years of observation. *Public Health Reports* 95(3):213–222, May–June 1980.
- SCHWARTZ, J.L. *Review and Evaluation of Smoking Cessation Methods: United States and Canada, 1978–1985*. U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, NIH Publication No. 87-2940, April 1987.
- U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES. *The Health Consequences of Smoking for Women. A Report of the Surgeon General*. U.S. Department of Health and Human Services, Public Health Service, Office of the Assistant Secretary for Health, Office on Smoking and Health, 1980.
- U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES. *The Health Consequences of Involuntary Smoking. A Report of the Surgeon General*. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control. DHHS Publication No. (CDC) 87-8398, 1986.
- U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES. *The Health Consequences of Smoking: Nicotine Addiction. A Report of the Surgeon General, 1988*. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, Center for Health Promotion and Education, Office on Smoking and Health. DHHS Publication No. (CDC) 88-8406, 1988.
- U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES. *Reducing the Health Consequences of Smoking: 25 Years of Progress. A Report of the Surgeon General*. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. DHHS Publication No. (CDC) 89-8411, 1989.
- U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE. *Smoking and Health. A Report of the Surgeon General*. U.S. Department of Health, Education, and Welfare, Public Health Service, Office of the Assistant Secretary for Health, Office on Smoking and Health. DHEW Publication No. (PHS) 79-50066, 1979.
- U.S. PUBLIC HEALTH SERVICE. *Smoking and Health. Report of the Advisory Committee to the Surgeon General of the Public Health Service*. U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control. PHS Publication No. 1103, 1964.
- WEST, S., MUÑOZ, B., EMMETT, E.A., TAYLOR, H.R. Cigarette smoking and risk of nuclear cataracts. *Archives of Ophthalmology* 107(8):1166–1169, August 1989.

CHAPTER 2
ASSESSING SMOKING CESSATION AND ITS
HEALTH CONSEQUENCES

CONTENTS

Introduction	21
Part I. Assessing the Dynamic Process of Smoking Cessation	22
The Process of Smoking Behavior Change	22
Behavioral Measures	25
Self-Report: Questionnaires and Interviews	25
Temporal and Frequency Issues	27
Improving Self-Report Measures	28
Alternative Behavioral Measures	29
Surrogate Assessments	30
Nonbehavioral Measures	31
Physiologic Measures	32
Biochemical Markers	33
Terminology	33
Carbon Monoxide	34
Thiocyanate	35
Cotinine	36
Bogus Pipeline	37
Contextual Issues Affecting Biochemical Assessment	37
Part II. Assessing the Consequences of Smoking Cessation	46
Study Designs Used To Assess the Consequences of Cessation	46
Overview of Study Design	46
Ecologic Studies	47
Cross-Sectional Studies	47
Cohort Studies	48
Case-Control Studies	49
Intervention Trials	50
Methodologic Issues	51
Introduction	51
Statistical Considerations	52
Bias	52
Analytic Issues in Observation Studies	55
Summary	57
Conclusions	58
References	59

INTRODUCTION

Smoking cessation is a dynamic process that begins with a decision to stop smoking and ends with abstinence from cigarettes maintained over a long period of time. Typically, initiation of regular cigarette smoking occurs at a young age, usually during the teenage years (US DHHS 1989); cessation may be contemplated and initiated at any age. The spectrum of factors motivating cessation is diverse: some smokers quit before being adversely affected by cigarette smoking whereas others quit as a result of developing smoking-related disease. Most attempts to quit are temporarily successful, and most smokers attempting to quit return several times to regular smoking before achieving long-term abstinence.

For the purpose of health research, smoking status (i.e., never, former, or current smoker) can be evaluated by using an interview or questionnaire to query subjects about their smoking behavior. However, self-reports may not fully characterize the process of cessation in individual smokers, particularly if information is collected retrospectively or cross-sectionally. Moreover, persons who are smoking may falsely report themselves as former or never smokers. Biochemical markers, such as cotinine and thiocyanate (SCN^-) levels in body fluids, provide complementary measures of tobacco product use.

However, reliance solely on biochemical markers of smoking also may lead to some misclassification. For example, intake of some foods can result in high SCN^- levels unrelated to smoking behavior. Individuals who accurately report being quitters may fail to participate in the validation process and therefore may be misclassified as continuing smokers if nonparticipants in biochemical testing are assumed to be smoking. Because proper classification of smoking behavior is critical for conducting research on the health consequences of smoking cessation and for evaluating the results of such research, it is important to consider how smoking status is assessed.

The health consequences of smoking cessation have been studied using conventional approaches of epidemiologic and clinical research: ecologic study, cross-sectional study or survey, case-control study, cohort study, and intervention trial. Each design has well-described advantages for studying causes of disease and preventive factors among human populations (Kleinbaum, Kupper, Morgenstern 1982). In addition, each design type is subject to the three types of bias potentially affecting any epidemiologic study: selection bias, information bias, and confounding bias (Rothman 1986) (Chapter 2, Part II). Misclassification resulting from information bias is of particular concern in studies of smoking cessation; misclassification is addressed in detail in this Chapter.

These conventional research designs have been used successfully to characterize the adverse effects of active cigarette smoking and to amass the scientific information on smoking cessation reviewed in this Report. For example, the evidence on smoking cessation and mortality derives from cohort studies (Chapter 3); evidence on cancer comes largely from case-control and cohort studies (Chapters 4 and 5); and information on respiratory morbidity and mortality is based primarily on cross-sectional and cohort studies (Chapter 7).

This Chapter establishes a methodologic framework for interpreting the evidence on smoking cessation obtained from observation studies and intervention trials. Part I

describes the process of smoking cessation and the methods used to assess smoking behavior. Part II reviews research methods used to study smoking cessation as well as the potential limitations of data obtained from observational studies and intervention trials including biases that may affect the results.

PART I. ASSESSING THE DYNAMIC PROCESS OF SMOKING CESSATION

This Section describes the dynamic nature of smoking behavior, the various measures of smoking status applied in observational and intervention studies, and the effect of these measures on classification of smoking status.

The Process of Smoking Behavior Change

Smoking behavior in U.S. populations has been changing, and three-fourths of all smokers have attempted to quit (Volume Appendix). The proportion of adult former smokers in the population is now about the same as the proportion of current smokers. These population changes have provided opportunity to describe the consequences and, thereby, the benefits of cessation.

Progressing from smoking to former smoking is a complex, dynamic process and not a one-time event. Retrospective, cross-sectional, and longitudinal studies of how people quit smoking on their own have demonstrated that smokers move through a series of stages in their cessation efforts (DiClemente and Prochaska 1982; Lichtenstein and Brown 1980; Prochaska and DiClemente 1983; Prochaska et al. 1985; Rosen and Shipley 1983). These stages have been labeled motivation and commitment, initial change, and maintenance by Brownell and coworkers (1986); contemplating change, deciding change, short-term change, and long-term change by Horn (1976); motivation and commitment, cessation and possible relapse, and maintenance by Marlatt and Gordon (1985); precontemplation, contemplation, action, and maintenance and/or relapse by Prochaska and DiClemente (1983); and initial decision, initial control, and maintenance by Rosen and Shipley (1983).

The stage model of Prochaska and DiClemente (1983; Prochaska et al., in press) has generated the most research and is described in more detail below (Figure 1). Precontemplation is a period in which smokers are not thinking about quitting smoking, or at least not about quitting within the next 6 months. The basis for the 6-month timeframe is the assumption that 6 months into the future is as far as most people plan a specific behavior change. Contemplation is the period in which smokers seriously consider quitting smoking within the next 6 months. Action is the period that begins when actual cessation occurs and continues for 6 months after stopping smoking. Maintenance is defined as the period beginning 6 months after cessation occurrence. In all of the proposed stage models, differentiation is made between short-term (generally up to 6 months) and long-term (generally 6 months and longer) change or between initial cessation and maintenance of cessation. Maintenance continues until relapse to regular smoking, or until a return to regular smoking is of minimal or no concern and "termination" of the behavior occurs for the confirmed ex-smoker.

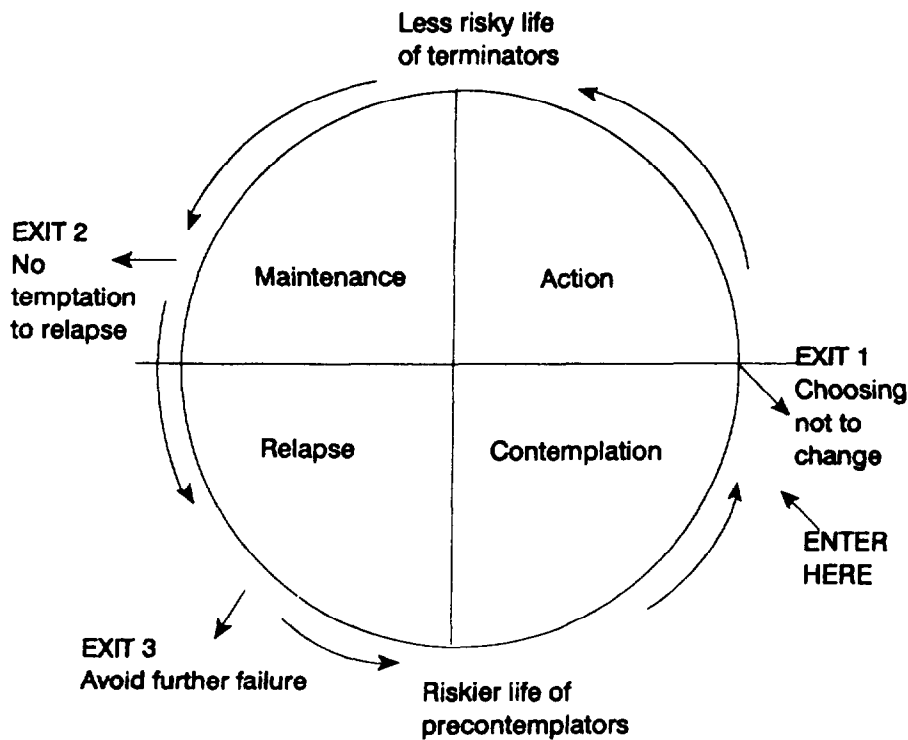


FIGURE 1.—Cyclical model of the stages of change

SOURCE: Prochaska et al. (in press).

On any single cessation attempt (action stage), the majority of smokers relapse and return to regular smoking. A National Heart, Lung, and Blood Institute consensus conference defined relapse as at least one puff per day for 7 days and recommended that this definition be applied uniformly (Shumaker and Grunberg 1986); however, this definition is not used in all studies. Any return to smoking that is less than the criterion for relapse is considered a “lapse” or a “slip,” which may or may not cause a return to regular smoking (Brownell et al. 1986; Marlatt, Curry, Gordon, 1988).

Although 75 to 80 percent of relapse occurs at 6 months and before (Hunt, Barnett, Branch 1971; Hunt and Bepalec 1973; Hughes et al. 1981; Garvey, Heinold, Rosner 1989), individuals who maintain abstinence for 6 months continue to relapse by 12 months and beyond. For example, in a review of 10 studies in which minimal or no intervention occurred (i.e., self-change studies), relapse rates at 12 months for smokers who had previously maintained abstinence for at least 6 months ranged from 7 to 35 percent (Cohen et al. 1989). Data from the National Health and Nutrition Examination

Survey I (NHANES-I) Epidemiologic Followup Study demonstrate that even after 1 year of prolonged abstinence, relapse continues to occur in about one-third of former smokers. Relapse continues to occur at a much lower rate after 2 years (Volume Appendix). In the Multiple Risk Factor Intervention Trial (MRFIT), a multifactor intensive intervention study, Ockene and colleagues (1982) found that among smokers who had stopped with the aid of intensive intervention, relapse continued to occur throughout the 6 years of followup. However, relapse was at a much higher rate in the first year than in years two through six. Kirscht and colleagues (1987) reported that 9.5 percent of adults who had been abstinent for 24 to 119 months reported smoking again in a followup survey. Even after 120 months, 2.3 percent of former smokers reported smoking again.

Research would be simplified if the probability of remaining a former smoker were 100 percent after a prolonged period of abstinence. If this were the case, then there would be no concern about future misclassification of these confirmed former smokers. However, the continuous nature of the relapse process and the curves that represent this process indicate that the probability of maintained cessation will never be 100 percent. The available data (Garvey, Heinold, Rosner 1989; Ockene et al. 1982; Cohen et al. 1989; Volume Appendix) suggest that for most research purposes, 24 months of continuous abstinence can be used as a practical criterion for categorizing individuals as confirmed former smokers. However, use of this timeframe is often not feasible or applicable in many research studies, and as a general guideline for interpreting outcomes—the longer the duration of continuous abstinence, the greater the probability that individuals will remain former smokers.

Cessation is a cyclical, not linear, process; smokers can enter or leave the process at any point (Prochaska and DiClemente 1983; Prochaska et al., in press) (Figure 1). Research on self-change approaches to smoking cessation suggests that the average smoker cycles three to four times through the stages before attaining long-term continuous abstinence and becoming a confirmed former smoker (Prochaska and DiClemente 1984, 1986; Marlatt, Curry, Gordon 1988; Schachter 1982). In a review of self-change studies, Cohen and colleagues (1989) found that only 4.3 percent of the participants in the reviewed studies shifted immediately from current smokers to former smokers without experiencing any lapses or relapses. Most smokers who relapse return to a point where they think about stopping again, that is, the contemplation stage. A smaller proportion lose their motivation to change and regress back to the pre-contemplation stage (Prochaska and DiClemente 1984).

In summary, because of the dynamic nature of change in smoking behavior, any categorization of smoking status at a single point in time becomes a simplification. A group of former smokers will include individuals who have stopped recently or who have been abstinent for varying lengths of time; some will maintain abstinence, and some will relapse. Knowledge of the dynamics of smoking cessation and its usual time course can help investigators minimize misclassification by choosing the most appropriate methods for assessing smoking behavior and the appropriate sampling procedures (e.g., number of measurements made and time between repeated measures of smoking status).

Behavioral Measures

Self-Report: Questionnaires and Interviews

For health research purposes, smoking status is usually assessed by using self-administered questionnaires or interviews. However, other behavioral methods, surrogate assessments, and nonbehavioral methods such as biochemical assessments are also used as sources of smoking data. These other sources will be reviewed in subsequent sections. (See also reviews by Pechacek, Fox et al. 1984 and Marsh et al. 1988.)

Questionnaires and interviews may include information concerning smoking at the time of the assessment or concerning a complete or partial retrospective lifetime history. Assessment can be made once or serially over time, thus providing more valid data regarding cessation and possible relapse. Information gathered from an interview or questionnaire about smoking categorizes respondents as never, current, or former smokers. Two standard items used in the National Health Interview Survey (Volume Appendix) to classify smoking status are "Have you smoked at least 100 cigarettes in your entire life?" and "Do you smoke cigarettes now?" Someone responding "yes" to the first question and "no" to the second would be classified as a former smoker. Such a broad definition for former smokers combines persons who experimented with smoking enough to have smoked 100 cigarettes with individuals who may have smoked during their entire adult life and quit in the week prior to being interviewed.

The commonly used item, "Have you smoked at least 100 cigarettes in your entire life?" has an advantage of counting as never smokers those individuals who experimented with 1, 2, or quite a few cigarettes. Only those who have smoked at least 5 packs of cigarettes in their lifetime are counted as ever smokers. The arbitrariness of this definition reflects the lack of accepted and standardized definitions for ever smokers and never smokers. A definition of never smokers that requires only minimal or no use of tobacco may result in many individuals with extremely low exposure to cigarettes being classified as former smokers, which in general would not be biologically appropriate.

Another commonly used type of item, as in the Medical Research Council (MRC) National Survey of Health and Development (Britten 1988), for defining ever smokers is "Have you ever smoked as much as 1 cigarette a day for as long as 1 year?" This item is used by the American Thoracic Society, Division of Lung Disease in its Adult Respiratory questionnaire; however, two other choices are added— "or 20 packs of cigarettes" or "12 ounces of tobacco" (Ferris 1978). A comparable question is "Have you ever smoked at least 5 cigarettes per week, almost every week for at least 1 year?" (Petitti, Friedman, Kahn 1981). These items that are used to classify ever smokers are based on a combination of the amount of cigarettes smoked (e.g., 365) and the duration of smoking (e.g., at least 6 or 12 months).

The particular question used to differentiate between ever smokers and never smokers can directly affect categorization of individuals. For example, Petitti, Friedman, and Kahn (1981) found that with a more specifically defined question such as "Have you ever smoked at least 5 cigarettes per week almost every week for at least 1 year?" which