

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

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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 The CPS I was a major prospective study carried out by the American Cancer Society (Garfinkel 1985). Over one million individuals were

Description of CPS I Data 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

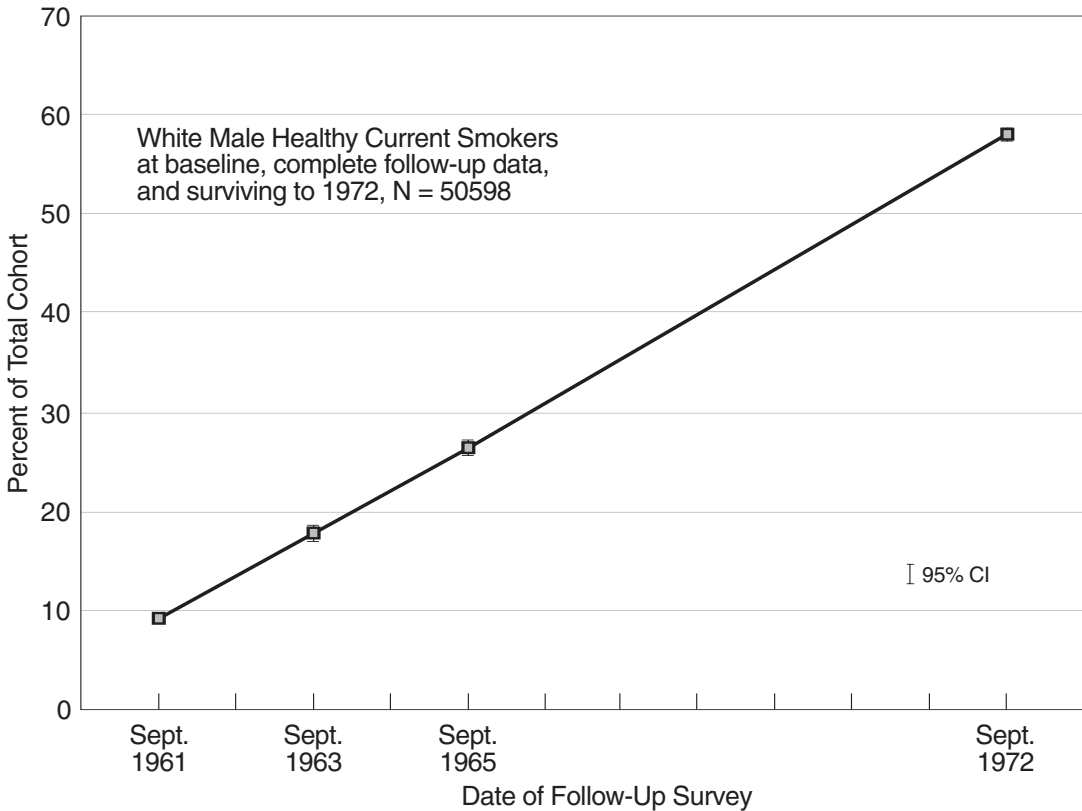
RESULTS

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

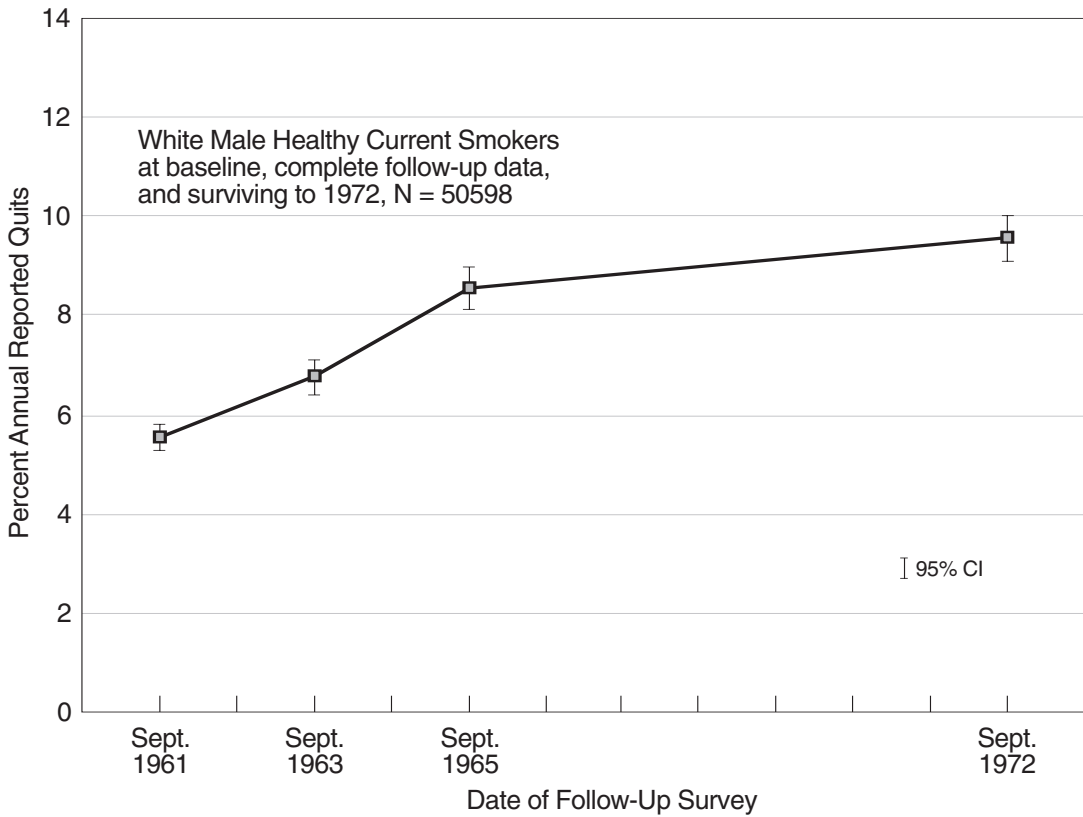


Figure 6-4 presents cessation rates annualized within each follow-up interval and calculated separately for the different CPD levels. The CPD levels from which the rates in Figure 6-4 are calculated are based on the *transient* CPD levels rather than the baseline categories—i.e., with the CPD levels 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**

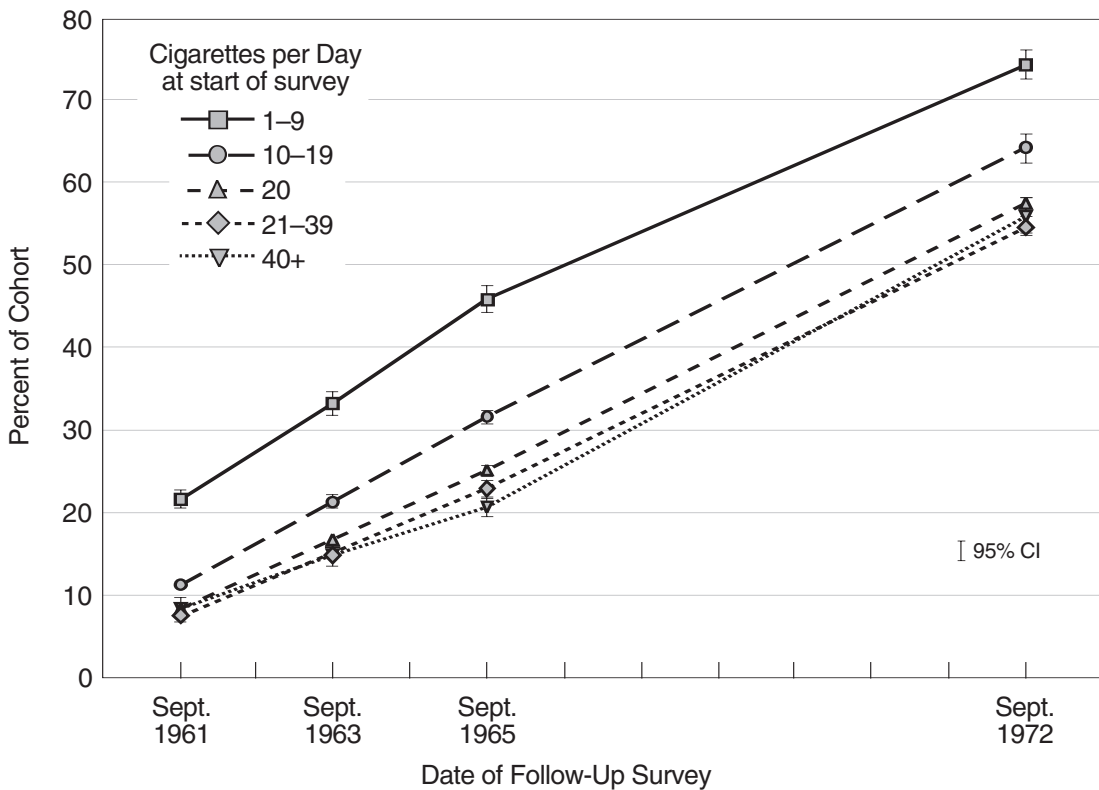
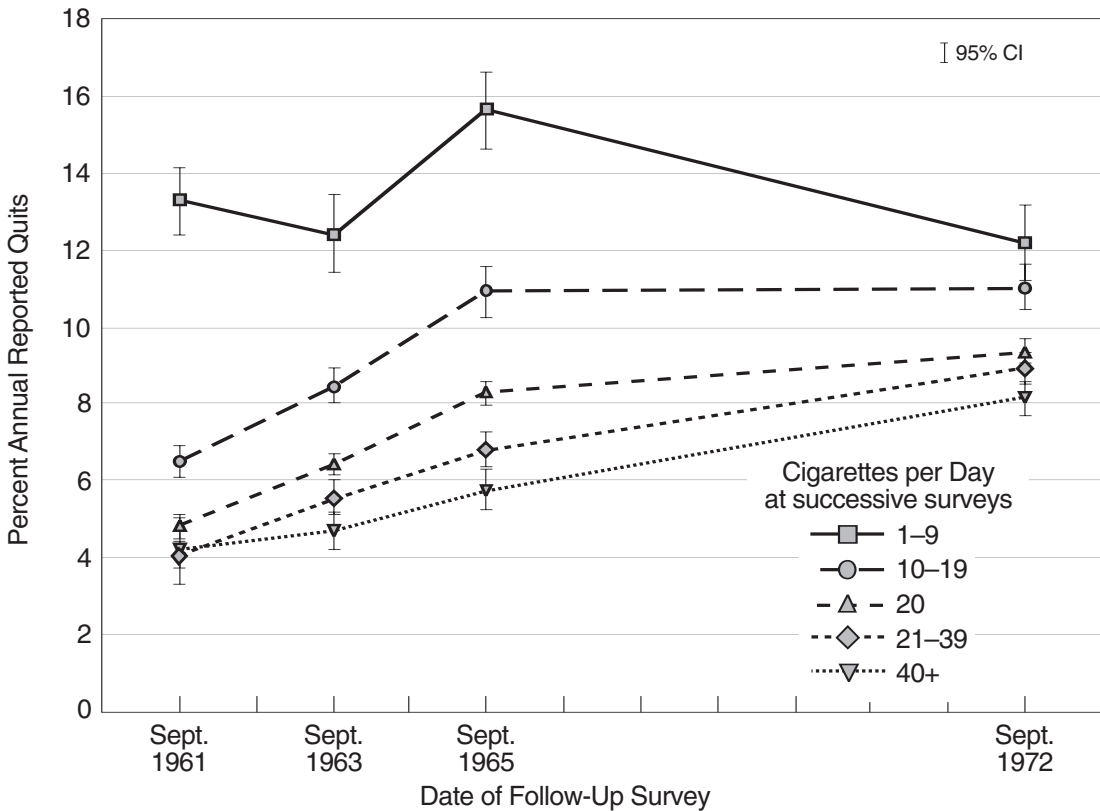


Figure 6-5 presents the same data shown in Figure 6-4, but changes the X axis to the CPD level, connecting the points from each follow-up survey so that we can see the quit-rate profile across the CPD levels as it changes during the successive periods of follow-up. With this presentation, the pattern 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

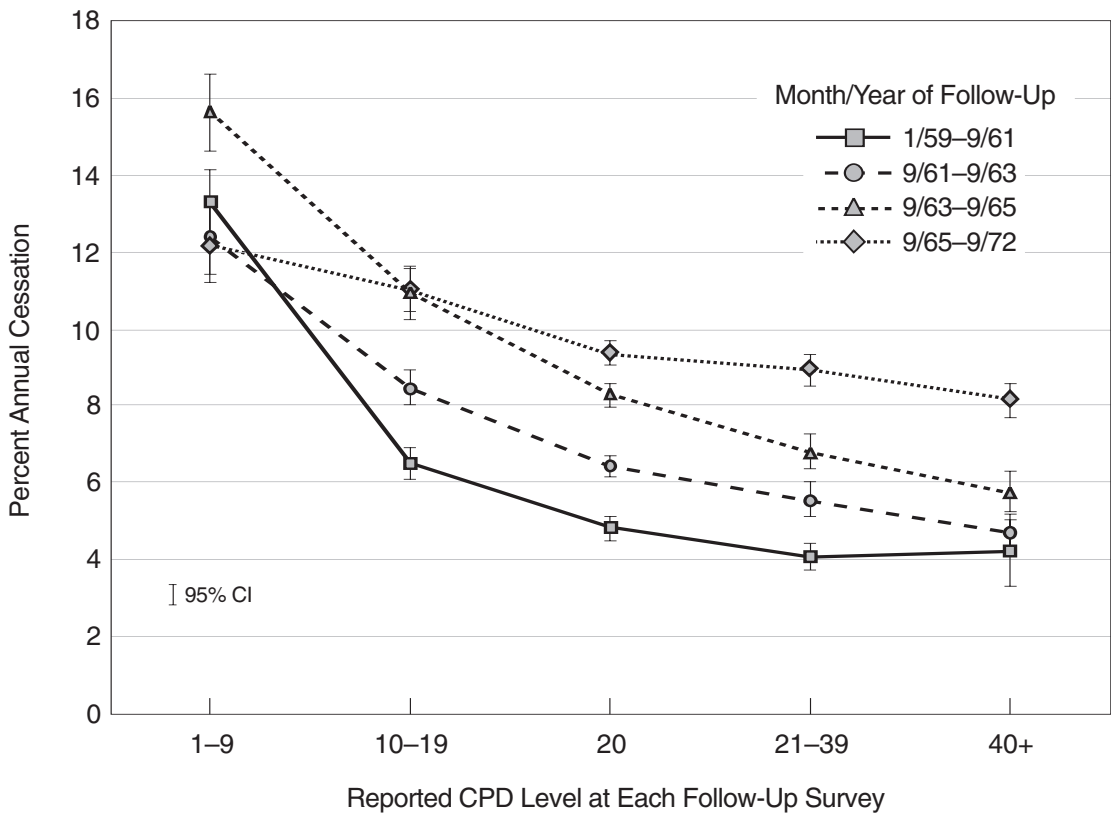


equivalent to a decreasing proportion of subjects at the lower CPD levels compared with the higher CPD levels. This result is consistent with the results seen in Figures 6-4 and 6-5, showing higher rates of cessation among the lower CPD levels. Although there is some migration between CPD levels (results 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

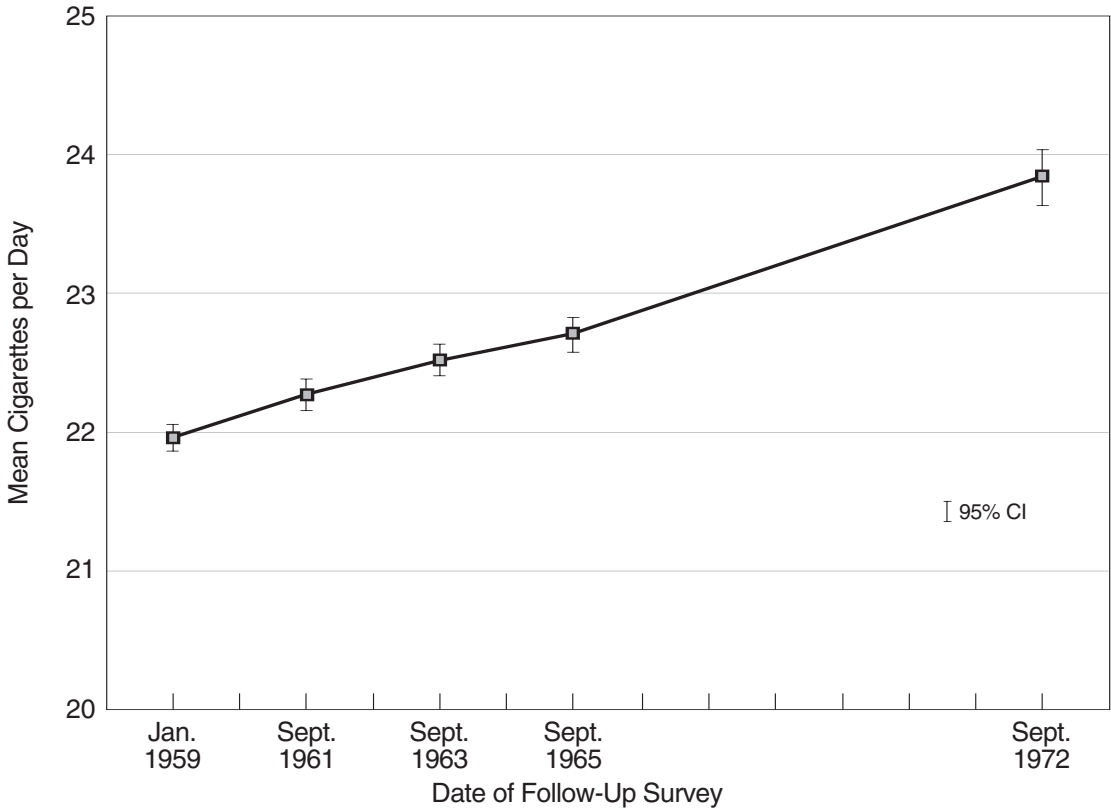
Within-Interval Annual Rate of Cessation by Transient CPD as Reported at Successive Surveys, Age-Standardized



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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