Cigarette Smoking Among Successive Birth Cohorts of Men and Women in the United States During 1900–80[1,2]

Jeffrey E. Harris[3,4,5,6]

ABSTRACT—Trends in cigarette smoking among successive cohorts of men and women were reconstructed from smoking histories of respondents to the 1978–80 Health Interview Surveys. Estimated smoking rates among the older cohorts were then adjusted for the differential mortality of cigarette smokers and nonsmokers. By 1920, over half of the young male population smoked cigarettes. Not until 1950 did more than a third of the young female population smoke cigarettes. The proportion of men who ever smoked cigarettes progressively declined with each successive cohort born after 1920. By contrast, the proportion of women who ever smoked declined only among cohorts born after 1940. Cessation of cigarette smoking from age 30 years onward was observed for all cohorts of men. Cessation rates accelerated for men who reached age 30 after 1960. By contrast, smoking cessation from age 30 was observed only for women who reached age 30 after 1950. Cessation rates accelerated only for women who reached age 30 after 1970. For each cohort, recent smoking cessation rates for men have exceeded those for women. Maximum exposure to cigarette smoking probably occurred among men who are now in their seventh and eighth decades. By contrast, peak exposure to smoking probably occurred among women who are now only in their fifth and sixth decades.—JNCI 1983; 71:473–479.

This paper documents the rise and fall of cigarette smoking among successive generations of Americans in the 20th century.

In a report of the Surgeon General (*1*), I presented preliminary estimates of the prevalence of cigarette smoking among successive birth cohorts of men and women. In the present paper, I describe in detail the methods used to estimate the cohort cigarette smoking rates, and I present more refined estimates that are based on a larger survey sample. The reliability of the results is then critically examined. Finally, I briefly consider the value of the cohort estimates for future research on the health consequences and prevention of cigarette use.

MATERIALS AND METHODS

Histories of cigarette smoking from the HIS.—During July 1978 through December 1979 and July through December 1980, the U.S. National Center for Health Statistics appended a cigarette smoking supplement to its continuing Health Interview Survey (HIS). The estimates in my previous report (*1*) were based only on the 1978 responses to the supplement. The estimates in the present paper are based on the responses for all 3 years (1978–80). The details of the HIS, a stratified, household-based, face-to-face interview sample that is representative of the U. S. noninstitutionalized civilian population, are reported elsewhere (*2, 3*).

During 1978–80, HIS attempted to contact 48,306 persons born during or before 1960 concerning their cigarette smoking practices (22,485 males and 25,821 females). Proxy interviews were not permitted. Each person interviewed was asked whether he or she ever smoked cigarettes regularly and, if so, at what age regular cigarette use began. Among respondents who ever smoked cigarettes regularly, those not currently smoking regularly were asked when they stopped entirely. Those currently smoking regularly were asked whether they had ever made a serious attempt to quit smoking and, if so, the time of onset and the duration of their most recent attempt.

Six percent of potential respondents could not be contacted and were thus excluded from the analysis (9.1% males, 3.4% females). An additional 2% reported incomplete histories of current or past cigarette use (2.5% males, 1.5% females). Because such respondents were known to be cigarette smokers, they were included under assumptions to be detailed below. Table 1 shows the number of respondents and of nonrespondents according to sex and birth date.

On the basis of each respondent's sex and calculated calendar year of birth, he or she was classified into a particular sex–birth cohort. The cohorts comprised those individuals born during 1881–90, 1891–1900, 1901–10, 1911–20, 1921–30, 1931–40, 1941–50, and 1951–60. A respondent, so classified, was then included in the cohort population base for each year from his or her calendar year of birth up to and including the year of survey.

For each year from date of birth to date of survey, a respondent was further classified as either smoking cigarettes or nonsmoking. Those who never smoked cigarettes regularly were classified as nonsmoking for the entire interval. Former cigarette smokers were classified as smoking from their year of initiation of smoking up

ABBREVIATION USED: HIS=Health Interview Survey.

[1] Received November 29, 1982; accepted April 7, 1983.

[2] Supported by Public Health Service grant DA-02620 from the National Institute on Drug Abuse.

[3] Department of Economics, Massachusetts Institute of Technology, Cambridge, Mass. 02139; and Medical Services, Massachusetts General Hospital, Boston, Mass. 02114.

[4] *Address reprint requests* to Dr. Harris at Department of Economics, Massachusetts Institute of Technology, Cambridge, Mass. 02139.

[5] Recipient of Public Health Service Research Career Development Award DA-00072 from the National Institute on Drug Abuse.

[6] I thank Mr. Eugene Rogot, National Heart, Lung, and Blood Institute, National Institutes of Health, for providing unpublished data from the U.S. Veterans Study, and Dr. Ronald Wilson, National Center for Health Statistics, for providing unpublished data from the U.S. Health Interview Survey.

TABLE 1.—*Numbers of respondents and nonrespondents according to sex and birth cohort: HIS, 1978–80*

Birth cohort decade	No. of males		No. of females	
	Respondents	Nonrespondents	Respondents	Nonrespondents
1881–90	61	6	129	5
1891–00	466	14	808	26
1901–10	1,530	64	2,057	48
1911–20	2,575	200	3,305	90
1921–30	3,238	334	3,805	127
1931–40	3,093	353	3,773	137
1941–50	4,222	484	4,907	148
1951–60	5,255	590	6,171	285
Total	20,440	2,045	24,955	866

to and including their year of cessation. Current cigarette smokers who had never made a serious attempt to quit were classified as smoking from their year of initiation up to and including the survey year. Current cigarette smokers who reported their most recent quit attempt were classified as smoking from their year of initiation up to and including the calculated year of quitting and from their calculated year of resumption up to and including the survey year. (No such corrections could be made for earlier unsuccessful quit attempts, for which data were unavailable.) Among current and former cigarette smokers, all remaining years from date of birth to date of survey were classified as nonsmoking years.

Those known cigarette smokers, past or current, with partially missing data were classified according to the following assumptions: 1) When a current or former smoker's age of initiation of cigarette smoking was unknown, he or she was assumed to have the mean age of initiation for his or her cohort. (Beginning with the oldest cohort, the mean ages of initiation were, respectively, 21, 19, 18, 18, 18, 17, 17, and 16 years for males, and 31, 32, 28, 23, 21, 20, 18, and 17 years for females. Note that these are the mean initiation ages for currently living respondents only.) 2) When the onset or duration of a known current cigarette smoker's most recent quit attempt was unknown, he or she was assumed to have smoked continuously from age of initiation to year of survey. 3) When a known former cigarette smoker's date of cessation was unknown, he or she was also assumed to have smoked continuously from age of initiation to year of survey. Respondents with unknown current cigarette smoking status who provided an age of initiation of smoking were similarly treated as current smokers.

For each birth cohort in a particular calendar year, the estimated prevalence of cigarette smoking was the ratio of total respondents classified as having smoked cigarettes in that year to the cohort population base in that year.

Correction for differential mortality of cigarette smokers and nonsmokers.—The HIS estimates were based on the cigarette smoking histories only of currently living persons. Because cigarette smokers have higher mortality rates than nonsmokers (*4, 5*), such estimates may understate the actual past prevalences. However, a correction for this possible source of bias is available.

Let p_{tu} denote the prevalence of cigarette smoking at age t among respondents alive at age u, where u is greater than or equal to t. Let S_{tu} denote the proportion of individuals regularly smoking cigarettes at age t who survive to age u, and let N_{tu} denote the corresponding survival probability among those not smoking at age t. Then p_{tt}, the contemporary prevalence of cigarette smoking at age t, can be derived from the following equation:

$$p_{tt} = \frac{p_{tu}/S_{tu}}{p_{tu}/S_{tu} + (1-p_{tu})/N_{tu}}. \qquad [1]$$

Estimates of p_{tu} were obtained from the HIS results under the simplifying assumptions that the birth date of each cohort occurred at the midpoint of the cohort's birth decade and that all interviews occurred in 1980. Thus the cohort born during 1901–10 was assigned age 35 in 1940 and age 75 in 1980. The prevalence of cigarette smoking among this cohort in 1940, as calculated from the HIS smoking histories, corresponded to $p_{35,75}$.

Estimates of S_{tu} and N_{tu} were derived by standard life-table methods from the death rates of cigarette smokers and nonsmokers reported in prospective epidemiologic studies of mortality in relation to cigarette use. For males, the death rates were taken from the 16-year follow-up of the 1954 cohort of the U. S. Veterans Study [(*5*); also, Rogot E: Unpublished data)]. For females, I used the results of the 4-year follow-up of the 1959–60 cohort of the American Cancer Society Study [appendix tables 1 and 3b in (*4*)]. In both cases, death rates of current nonsmokers represented the combined mortality experience of former cigarette smokers and those who never smoked. Stable mortality data in the two studies were available only for ages 35 through 84 years. For ages 85 through 94 (relevant only to the cohorts born during 1881–90), I assumed that the ratio of smokers' to nonsmokers' annual death rates was 1.2±0.1 for males and 1.05±0.1 for females. Otherwise, no smoothing or adjustment of death rates was performed.

For calculation of confidence limits of p_{tt}, equation 1 can be rewritten as follows:

$$\log\left(\frac{p_{tt}}{1-p_{tt}}\right) = \log\left(\frac{p_{tu}}{1-p_{tu}}\right) + \log\left(\frac{N_{tu}}{S_{tu}}\right). \qquad [2]$$

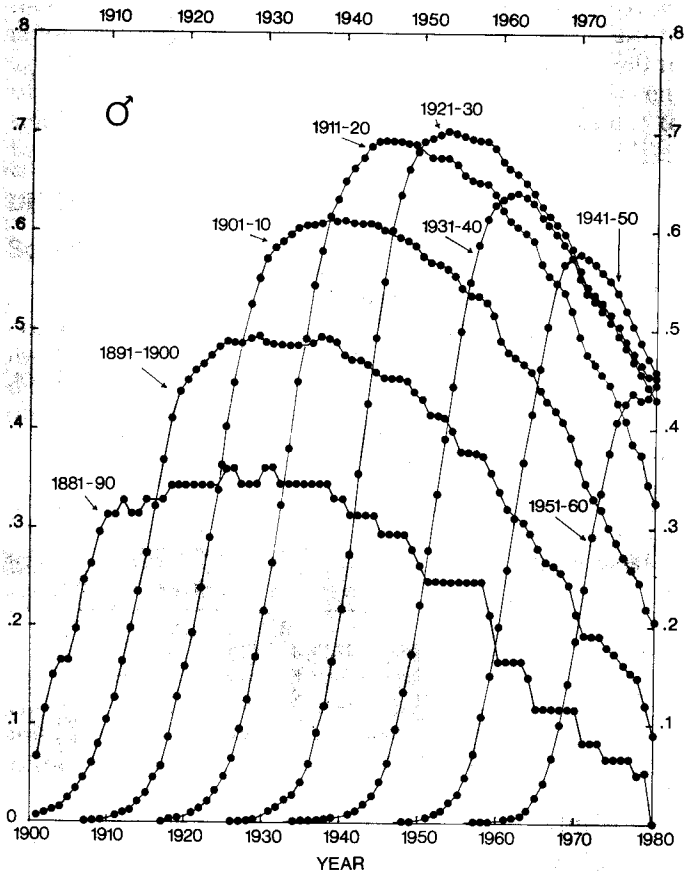
From the HIS data and the epidemiologic data, respectively, I calculated the means and approximate variances of the estimates of log $[p_{tu}/(1-p_{tu})]$ and log (N_{tu}/S_{tu}). I then assumed that the two estimates were independent and asymptotically normally distributed, so that the estimate of log $[p_{tt}/(1-p_{tt})]$ would similarly be asymptotically normal, with estimated variance equal to the sum of the two variances.

RESULTS

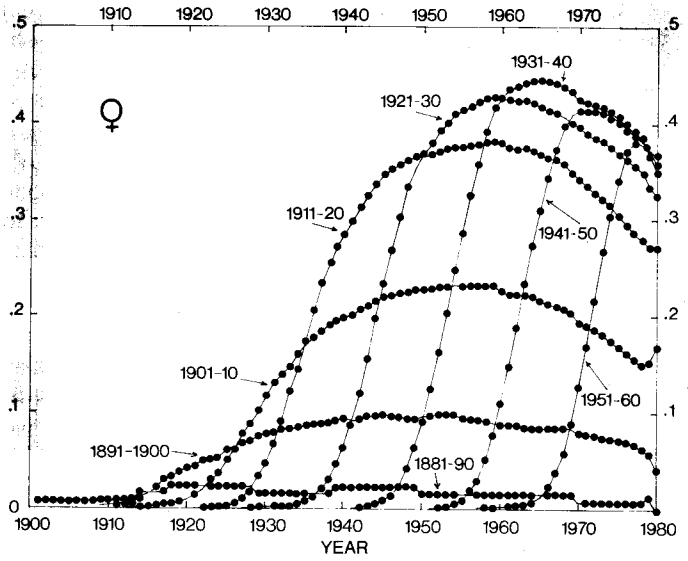
Prevalence Estimates

For men and women, respectively, text-figures 1 and 2 depict the estimates of the prevalence of cigarette smoking from 1900–80, as derived from the smoking histories in the HIS. Each continuously graphed time series corresponds to a particular birth cohort; e.g., among women born during 1931–40 (text-fig. 2) who reached 40–49 years of age in 1980, the prevalence of cigarette smoking rose rapidly during the post-World War II period and reached a peak of about 45% by 1965. Thereafter, their overall prevalence of cigarette smoking declined to about 35% in 1980. (The data points for 1979 and especially for 1980 were necessarily based on reduced sample sizes. Therefore, very recent changes during 1978–80 are less reliably estimated.)

For men and women, respectively, text-figures 3 and 4 depict the estimates of cigarette smoking prevalence after correction for the differential mortality of cigarette smokers and nonsmokers. The estimates are shown at 5-year intervals from the calendar year in which a given cohort reached age 35 up to 1975. For the cohorts born during 1931–40, the corrected estimates were nearly identical to those based solely on the HIS cigarette smoking histories, as given in text-figures 1 and 2, and, therefore, are not shown. Because death rates for cigarette smokers and nonsmokers before age 35 were unavailable, corrected estimates for cohorts born after 1940 were not obtained.



TEXT-FIGURE 1.—Prevalence of cigarette smoking among successive birth cohorts of men, 1900–80, derived from smoking histories in the HIS.



TEXT-FIGURE 2.—Prevalence of cigarette smoking among successive birth cohorts of women, 1900–80, derived from smoking histories in the HIS.

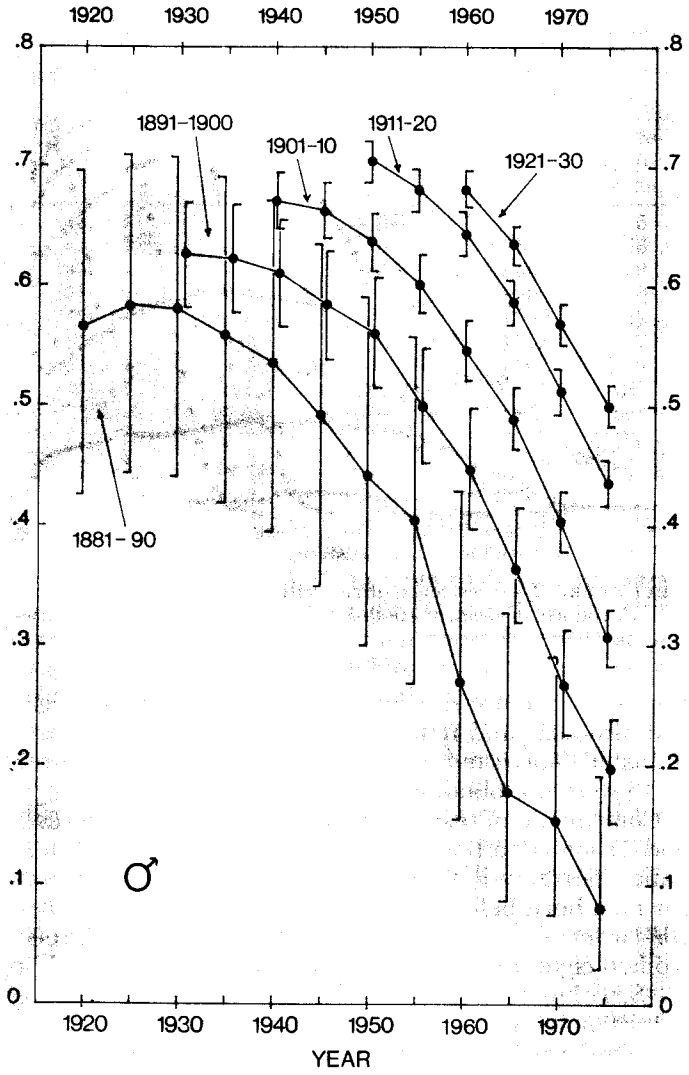
Comparison of text-figures 3 and 4 with text-figures 1 and 2 shows that the main effect of correction for differential mortality is to increase the prevalence estimates for men born before 1910. The corrections are smaller for women because mortality differences between women cigarette smokers and nonsmokers in the oldest U. S. cohorts were much less pronounced, a finding consistent with other epidemiologic studies (*6*). Both sampling variability in the HIS data and uncertainty about death rates at advanced ages markedly reduce the overall precisions of the estimated prevalences in the oldest cohorts. In general, HIS sampling error contributed over 70% of the total variance in the log-odds of the estimated prevalence (*see* equation 2).

As a check on the validity of the HIS estimates, I repeated the analysis under alternate assumptions about the cigarette smoking practices of the 2% of respondents with incomplete histories. The results were trivially different from those in text-figures 1 and 2. As a check on the validity of the corrected estimates, I repeated the correction procedure on the male HIS histories using the death rates for men from the American Cancer Society Study [appendix tables 1, 3a, and 7 in (*4*)]. The results were within one percentage point of those in text-figure 3, but the confidence intervals for the older cohorts were slightly wider.

Selected estimates of cigarette smoking prevalence, based on text-figures 1–4, are given in table 2.

Trends in Cigarette Smoking

Among men born during 1881–1920, as shown in text-figures 1 and 3, the peak prevalence of cigarette



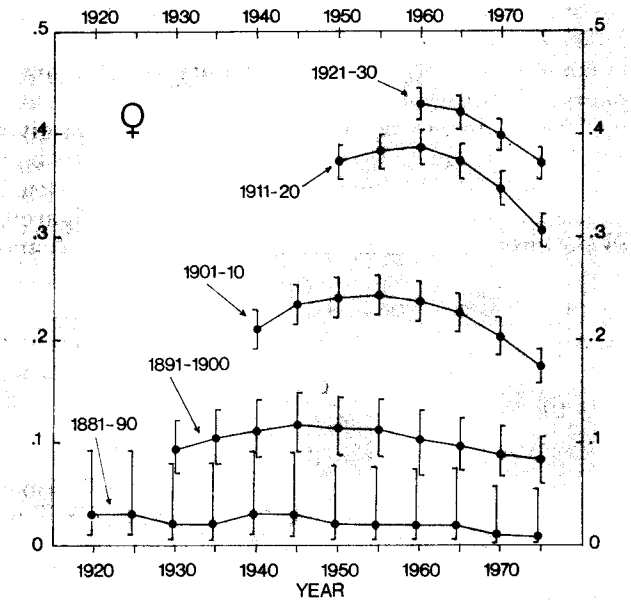
TEXT-FIGURE 3.—Prevalence of cigarette smoking among selected birth cohorts of men, corrected for the differential mortality of smokers and nonsmokers. *Vertical bars* represent 95% confidence intervals.

smoking increased with each successive birth cohort. Among men born during 1921–60, the peak prevalence of smoking declined with each successive cohort. When the prevalences that are based solely on cigarette smoking histories of currently living men are corrected for the differential mortality of smokers and nonsmokers, the growth of cigarette smoking among the early cohorts is still apparent though less marked.

Moreover, with each successive cohort, cigarette smoking rates began to decline at progressively earlier ages. Thus, among men born during 1891–1900, smoking rates began to decline in 1930, when this cohort was aged 30–39 years. For men born during 1921–30, cigarette smoking rates began to decline at ages 25–34, and for men born during 1951–60, the prevalence of smoking appears to have peaked at ages 20–29.

Whereas the peak prevalences approximate the percentages of males who ever smoked, the declining portions of each cohort curve represent smoking cessation. From text-figure 3, cigarette smoking prevalence among men born during the years 1891–1900 declined from 63% in 1930 (ages 30–39) to 61% in 1940 (ages 40–49). For men born during 1901–10, prevalence declined from 67% at ages 30–39 to 64% at ages 40–49, a relative decline of 5%. The corresponding relative declines during the decade from ages 30–39 to ages 40–49 were, respectively, 9% for men born during 1911–20, 17% for men born during 1921–30, and 19% for men born during 1931–40. Thus smoking cessation rates in midlife increased with successively younger cohorts of men, especially for those who reached their thirties after 1960.

Moreover, as shown in text-figure 1, the prevalences among surviving males born during 1941–50 declined from 57% in 1968 to 49% in 1978, a 10-year relative



TEXT-FIGURE 4.—Prevalence of cigarette smoking among selected birth cohorts of women, corrected for the differential mortality of smokers and nonsmokers. *Vertical bars* represent 95% confidence intervals.

TABLE 2.—*Estimated prevalences of cigarette smoking for the years 1955, 1965, and 1975*

Age group, yr	Sex	Percent of cigarette smokers[a] for the years:		
		1955	1965	1975
25–34	♂	70	62	54
	♀	41	45	40
35–44	♂	68	63	50
	♀	38	42	41
45–54	♂	60	59	50
	♀	24	37	37
55–64	♂	50	49	44
	♀	11	23	31
65–74	♂	41	37	31
	♀	2	10	17
75–84	♂	—	18	20
	♀	—	2	8

[a]Percentages are based on data presented in text-figs. 1–4.

decline of 14%. The corresponding 10-year relative declines among surviving males during 1968–78 were 21% for the 1931–40 cohort, 24% for the 1921–30 cohort, 31% for the 1911–20 cohort, 40% for the 1901–10 cohort, 42% for the 1891–1900 cohort, and 57% for the oldest cohort. Thus recent 10-year quit rates among surviving males increase in relation to age.

The data for women during this century are quite different. As text-figures 2 and 4 show, female cigarette smoking rates continued to rise with each successive birth cohort from those born during 1881–90 up to those born during 1931–40. Among women born after 1940, peak cigarette smoking rates declined with successive cohorts. These conclusions remained unchanged when corrections were made for the differential mortality of cigarette smokers and nonsmokers. Whereas nearly all men started smoking before age 25, a great many women in the earlier cohorts began smoking after age 30. Hence the ages of peak smoking prevalence were delayed in women. For female cohorts born during 1891–1920, the prevalence of cigarette use actually increased during the midlife decade from ages 30–39 to ages 40–49. For subsequent cohorts, the relative declines during this midlife decade were 7% among women born during 1921–30 and 18% for women born during 1931–40. Thus only women who reached their thirties after 1970 achieved midlife cessation rates comparable to those of men. Finally, I gauged the current 10-year quit rates among surviving females to be increasing in relation to age: from 11% among those 30–39 years old in 1980 to 48% among those 80–89 years old in 1980. Recent smoking cessation rates among women thus appear to fall below those of men for each cohort.

DISCUSSION

Sources of Uncertainty

Two percent of HIS respondents were known to be current or former cigarette smokers but gave incomplete histories of cigarette use. Although the treatment of such missing data introduces uncertainty in the estimates, the magnitude of the uncertainty is small.

Six percent of the HIS sample could not be contacted for interview. Among these nonrespondents, males, and especially younger males, were disproportionately represented (table 1). If nonrespondents were more likely to smoke cigarettes, the downward trend in the estimated smoking rates of the younger cohorts of men could be exaggerated.

Among the 92% who responded completely to HIS, intentional or unintentional errors in recall of current cigarette smoking status and, where applicable, ages of initiation, termination, and resumption of regular cigarette smoking represent a critical source of uncertainty. It is difficult to assess the possible magnitude of such errors. Warner (7) found a trend of increased underreporting in contemporary interview surveys conducted during 1964–75. Since cigarette smoking became an increasingly disapproved behavior during that period, Warner reasoned, survey respondents had increasing incentives to misreport cigarette smoking status or to understate the number of cigarettes consumed. In the current analysis, however, reports of past smoking habits, including ages of initiation and termination of smoking, may not be subject to the same motivational biases. Preliminary studies of other surveys suggest that the accuracy of recall of past ages of initiation and cessation of smoking diminishes in relation to the respondent's current age (Harris JE: Unpublished data).

The corrections for differential mortality, particularly among males born up to the year 1910, represent a critical source of uncertainty. In particular, it was necessary to use the estimates N_{tu}/S_{tu} from a single population (U. S. veterans) to calculate the correction factors for each cohort. I also needed to extrapolate the death rates for cigarette smokers and nonsmokers to ages 85–94 years. Such uncertainty is only partly reduced by the finding that the corrected estimates for males based on the American Cancer Society Study data were quite close to those based on the Veterans Study data. Finally, it was not possible to apply the correction for differential mortality to cohort ages less than 35 years. In projecting cigarette smoking prevalences back to early adulthood, one would need to consider mortality in relation to age of initiation of cigarette smoking, since initiation dates reported in current interviews are those of survivors only.

Comparisons With Earlier Surveys

The Fortune Magazine survey of 1935 (8) provided some information on cigarette smoking by age. Among adults under 40 years old at the time (who were born about 1896–1915), the prevalences of cigarette use were 66% for males and 26% for females. Extrapolating from figures 3 and 4, I estimated the prevalences of cigarette smoking in 1935 among the cohort born during 1901–10 to be 67% for males and 22% for females.

Table 3 shows the results of contemporary national surveys of cigarette use during 1955, 1965, and 1974–76. In general, the results in table 3 are quite close to the estimates in table 2, and the trends over time are consistent. Discrepancies among the older male cohorts could be due in part to inaccurate correction for the differential mortality of smokers and nonsmokers. Discrepancies among the younger cohorts tend to confirm the possibility that prevalence estimates based on past cigarette smoking histories are less subject to underreporting than contemporaneous survey estimates.

Dosage of Cigarette Smoking

On the basis of the prevalence estimates only, the peak exposure to cigarette smoking in the United States occurred among men who are now in their sixth and seventh decades. By contrast, the peak exposure to smoking occurred among women who are still in their fifth and sixth decades.

An accurate measure of cigarette smoke exposure, however, would reflect not only smoking prevalence but

TABLE 3.—*Prevalence of cigarette smoking derived from three national surveys in 1955, 1965, and 1974–76*

Age group, yr	Sex	Percent of cigarette smokers in: CPS, 1955[a,b]	HIS, 1965[c,d]	HIS, 1974–76[b,c]
25–34	♂	65–69	61	50
	♀	36–42	44	38
35–44	♂	64–67	58	49
	♀	34–38	44	39
45–54	♂	59–63	56	45
	♀	23–27	37	37
55–64	♂	45–49	47	38
	♀	11–15	25	31
65–74	♂	23–27[e]	33	28
	♀	4–5[e]	12	16
75–84	♂	—	21	16
	♀	—	5	7

[a]CPS = current population survey. Estimates were computed from appendix III, table 12, in (*9*). The lower number in each range is the prevalence of regular cigarette smokers; the higher number includes occasional cigarette smokers.
[b]Percentages are for self-respondents only.
[c]Percentages are based on unpublished data from the HIS.
[d]Percentages are for both self and proxy respondents.
[e]Individuals aged ≥65 yr.

also the number of cigarettes smoked, the type of cigarette, and the style of cigarette smoking (*6, 10*). Each of these dosage parameters appears to have changed over time within a given cohort. Thus earlier cohorts of men and women smoked fewer cigarettes per day than later cohorts (*1*). The mixing of cigarette smoking with other forms of tobacco use was considerably more common in the older male cohorts. The relatively high prevalence of cigarette smoking even among men born during 1881–90 (text-figs. 1, 3) reflects a large number of such mixed tobacco smokers. Moreover, current cigarette smokers appear to have increased their daily consumption in recent years (*1, 10*). Changes in the composition of cigarettes in the United States, at least since 1950, are also well documented (*1, 10*).

Accurate modification of the above prevalence estimates to include the other dimensions of cigarette exposure appears difficult. Surveys since 1955 provide some data on the number of cigarettes consumed according to age and sex, but reconstruction of lifetime cigarette dosages by cohort would appear to require accurate recall data on lifetime patterns of daily cigarette use. Horn (*11*) gave preliminary estimates of cumulative cigarettes smoked per capita for birth cohorts of men. His methods and their possible limitations. however, were not reported.

Changes in Cigarette Smoking and Trends in Cancer Incidence

Numerous investigators have studied the relationships between the cigarette smoking rates for successive generations and trends in the incidences of various cancers (*12–17*). The estimates in this paper might prove valuable for further qualitative comparison of smoking rates and cancer trends. However, caution is required in the quantitative determination of cancer incidence attributable to cigarette smoking from these data alone.

In particular, the data on cigarette smoke exposures for the earliest cohorts, for whom there are the most extensive lifetime mortality figures, are likely to be critical components of any analysis of cancer trends. Yet the prevalence estimates of the earliest cohorts were subject to the largest uncertainty. The cigarette smoke exposure of males born before 1880, who were likely to have lower smoking rates, was not even measurable in the present study. Finally, cigarette smoke exposure in early adulthood may be most crucial to subsequent cancer incidence (*14*). However, insufficient data prevented precise estimation of the prevalence of cigarette use in early adulthood among the oldest cohorts.

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