The positive features of this study include its prospective design, the unusually large population enrolled, which included all major segments of society, the frequency of the follow-up periods, the variety of the data collected, the thoroughness of follow-up with loss of but few enrollees, and the relatively long period of observation.

The U.S. Veterans Study

The U.S. Veterans Study (4,5) was initiated by Dorn in 1954 and continued by Kahn and later by Rogot. This study describes the overall mortality experience of about 250,000 U.S. veterans who held Government Life Insurance policies in December of 1953. Beginning in January 1954, questionnaires on smoking habits were mailed to these policy holders and nearly 175,000 (68 percent) responded. These individuals comprise what in this report is called the "1954 cohort." In January 1957, a second questionnaire was mailed to those not responding in 1954, and an additional 50,000 replies were obtained, raising the response rate to 85 percent. These are referred to as the "1957 cohort." The annual probability of dying for the 1957 cohort was somewhat greater than that of the 1954 cohort. Because of this, the mortality experience of these two cohorts was examined separately. Only the data from the 1954 cohort will be considered here, as a separate analysis of both cohorts is beyond the scope of this paper. The study population was quite select; almost all policy holders were white males. Most were white-collar, skilled workers who were veterans of World War I. This group was questioned as to smoking habits, etc., and followed for 16 years. Since significant changes have occurred in the smoking practices of white males in the United States over the past 20 years, it is likely that similar changes also occurred in the smoking habits of the subjects of this particular study in the study period. It is unfortunate, therefore, that the recent mortality experience of this population has to be correlated with smoking practices of many years ago.

The strengths of this study include its large population, its prospective design, and its long period of follow-up. Its weaknesses include its narrow population, which limits the applicability of the results to the general population, and the lack of information about more recent changes in smoking habits among members of the study population which would affect the mortality experience of the group.

The British Doctors Study

In 1951, a total of 34,440 male British doctors responded to a questionnaire distributed by the British Medical Association relative to smoking habits (1). Nearly all of those enrolled were followed

for a period of 20 years. Updated information concerning smoking practices was obtained in 1957, 1966, and 1972. More than 10,000 deaths occurred in this population in the period of observation. Information was obtained on the type of tobacco used, inhalation practice, the use of filter cigarettes, and the number of cigarettes smoked per day. The usual demographic data concerning the background of the individual were also obtained.

The strengths of this study include its large size, prospective design, the usually long period of follow-up, the frequent determination of smoking habits of the subjects enrolled in the study, and the thoroughness of follow-up. Perhaps the only significant drawback is that the study population was so narrow.

The most recent analysis has been limited to overall mortality, since death certificates were not obtained for those who died in the last half of the study period. Smoking classifications used in the latest paper are somewhat different from those used in previous reports. The occasional smoker was grouped with the nonsmoker, since their mortality experience was essentially similar. As a result, occasional smokers who had quit smoking were grouped with those who had never smoked, and regular smokers who became occasional smokers were grouped with ex-smokers.

OVERALL MORTALITY AND CIGARETTE SMOKING

Cigarette smoking as related to overall mortality was examined in these three studies using several different measures of dosage.

Number of Cigarettes Smoked

In the study of U.S. veterans, mortality increased with the number of cigarettes smoked per day. The mortality ratio was 1.25 for smokers of less than 10 cigarettes per day and increased to 1.89 for men smoking two packs (40 cigarettes) or more per day (Table 1). In the study of British doctors, the mortality ratio was 1.41 for smokers of 1-14 cigarettes per day and increased to 2.16 for smokers of 25 or more cigarettes per day. The mortality ratio for all

TABLE 1. Age-adjusted mortality ratios for male cigarette smokers, by amount smoked, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Number of Cigarettes Smoked Per Day	Mortality Ratio
< 10	1.25
10-20	1.51
21-39	1.69
> 40	1.89
Nonsmokers	1.00
Total	1.55

cigarette smokers compared to nonsmokers was 1.63 (Table 2). The mortality experience of U.S. veterans by age and the number of cigarettes smoked per day are presented in Table 3. Cigarette smoking appears to have a stronger effect on the mortality of younger smokers than on older smokers. The death rate for smokers increases with age, but since the risk of dying in general increases more rapidly with advancing age than the risk associated with smoking, the relative contribution of cigarette smoking to overall mortality decreases with time. This relationship is imperfectly demonstrated when mortality ratios are used.

TABLE 2. Mortality ratios for cigarette smokers, by number of cigarettes smoked per day, British Doctors Study

Number of Cigarettes Smoked Per Day	Mortality Ratio
Mixed (Cigarette / other)	1.21
1-14	1.41
15-24	1.57
>25	2.16
Nonsmokers	1.00
Total	1.63

TABLE 3. Mortality ratios for male cigarette smokers, by age and number of cigarettes smoked per day, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Number of Cigarettes Smoked Per Day	Age				
	30-34	35-44	45-54	55-64	65-74
None	1.00	1.00	1.00	1.00	1.00
< 10	1.94*	1.44	1.44	1.20	1.15
10-20	1.27	1.79	1.64	1.49	1.30
21-39	1.76	2.23	2.10	1.67	1.42
> 40	2.33**	2.72	2.13	1.86	1.65
Total	1.52	1.95	1.83	1.53	1.32

*This figure is calculated on the basis of 140 individuals and nine deaths, which is why it may appear to be somewhat unstable.

**This figure is calculated from 68 individuals and five deaths.

Age Began Smoking

The earlier one begins smoking, the more exposure that individual will have had to cigarette smoke at any subsequent age. In the U.S. Veterans Study, the overall mortality ratio for those men who began smoking before the age of 15 was 1.86. This decreased to 1.32 for those who did not start smoking until after the age of 25 (Table 4). Table 5 presents the mortality ratios for males by number of cigarettes smoked per day and age began smoking. The lowest mortality ratio (1.36) was experienced by those men who smoked fewer

than 21 cigarettes per day and who were more than 20 years old when they began smoking. The highest mortality ratio (1.82) occurred among those who smoked more than 21 cigarettes per day and began smoking before the age of 20.

TABLE 4. Age adjusted mortality ratios for male cigarette smokers, by age began smoking, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Age Began Smoking (Years)	Mortality Ratio
< 15	1.86
15-19	1.64
20-24	1.51
> 25	1.32
Nonsmokers	1.00
Total	1.55

TABLE 5. Age-adjusted mortality ratios for male cigarette smokers, by number of cigarettes smoked per day and age began smoking, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Number of Cigarettes Smoked Per Day	Age Began Smoking (Years)	Mortality Ratio
< 21	> 20	1.36
< 21	< 20	1.56
> 21	> 20	1.59
> 21	< 20	1.82
Nonsmokers	–	1.00

Inhalation Practice

Death rates by inhalation practice were examined in the study of British doctors (Table 6). The mortality ratio for those who did not inhale was 1.28. This increased to 1.43 for those who did inhale.

TABLE 6. Mortality ratios for cigarette smokers, by inhalation practice, British Doctors Study

Inhalation Practice	Mortality Ratio
Smokers Who Inhaled	1.43
Smokers Who Did Not Inhale	1.28
Nonsmokers	1.00

"Tar" and Nicotine

The "tar" and nicotine content of cigarette smoke in relation to overall mortality was examined by Hammond, et al. (3) using the ACS data. Several important issues relative to the concept of less hazardous smoking were settled in this study. It has been generally accepted that the harmful effects of cigarette smoking

are proportional to the "tar" and nicotine levels delivered by the cigarette. For several years, the "tar" and nicotine levels of all the popular brands of cigarettes have been checked periodically by the Federal Trade Commission. This information has been made available to the public through various public and private agencies and is included in cigarette advertisements. Those who have decided not to quit or who have not been able to quit have been encouraged to switch to brands of cigarettes which deliver less "tar" and nicotine. This pattern of smoking is thought to be one way of partially reducing the risks associated with smoking. Some persons in the scientific community have questioned whether or not there would be any substantial reduction in risk of mortality associated with such a switch. Smokers might increase the number of cigarettes smoked per day, thus keeping their intake of "tar" and nicotine relatively constant. Smokers switching to low "tar" and nicotine cigarettes may inhale the smoke more deeply into the lungs, thus tending to maintain a similar exposure to the toxic elements in the smoke.

In the study by Hammond, et al. (3), "tar" and nicotine (T/N) levels were defined as follows: High T/N: 25.8-35.7 milligrams (mg.) "tar" and 2.0-2.7 mg. nicotine; Medium T/N: 17.6-25.7 mg. "tar" and 1.2-1.9 mg. nicotine; Low T/N: less than 17.6 mg. "tar"

TABLE 7. Mortality ratios for all cigarette smokers in two time periods, by sex and "tar" and nicotine (T/N) content of cigarettes smoked*

		Mortality Ratio		
Sex	Period	High T/N	Medium T/N	Low T/N
Male	1	1.00	0.90	0.88
Male	2	1.00	0.98	0.81
Female	1	1.00	0.89	0.84
Female	2	1.00	0.87	0.82
Total		1.00	0.91	0.84

SOURCE: Hammond E.C., et al. (3).

*A matched-group analysis adjusted for several factors. See text.

and less than 1.2 mg. nicotine. A matched group analysis was utilized. Subjects within each group were matched for: (1) age, (2) race, (3) number of cigarettes smoked per day, (4) age began smoking, (5) place of residence (urban or rural), (6) history of hazardous occupational exposure, (7) education, (8) history of lung cancer, and (9) history of heart disease. Matching was done separately for men and women in both time periods of the study. Within each matched group, the subjects were divided into three subgroups according to "tar" and nicotine (high, medium, or low). The entire group was discarded if it did not contain at least one subject in each "tar" and nicotine category. The adjusted number of subjects in Period 1

was 14,688 men and 30,176 women. In Period 2, there were 6,475 men and 15,342 women. The mean age of subjects in Period 1 was 53.6 years for men and 51.6 years for women; in Period 2, the mean age was 58.4 years for men and 56.7 years for women.

Table 7 shows mortality ratios by sex and "tar" and nicotine content of the cigarettes smoked. In this instance, the mortality ratio for the high T/N smokers is represented as 1.00. There is a small but significant ($p < 0.0005$) reduction in the risk of dying with the use of lower T/N cigarettes. The mortality ratio was reduced to 0.91 for the medium T/N smokers and was further reduced to 0.84 for the low T/N smokers. A comparison was also made between the mortality experience of low T/N smokers and nonsmokers. Subjects were matched according to the same factors as the previous analysis with the exception of the number of cigarettes smoked per day. The adjusted number of subjects for Period 1 was 15,346 men and 32,702 women. For Period 2, adjusted numbers were 6,822 and 16,803 for men and women, respectively. The mean age of subjects in Period 1 was 53.8 years for men and 52.3 years for women. In Period 2, the mean ages for men and women were 58.7 and 57.3 years, respectively. The mortality ratios for these matched groups are presented in Table 8. The death ratio for the low T/N group is 1.00, and that for nonsmokers is 0.66. The mortality ratio for the low T/N group is, therefore, approximately 50 percent higher than that for the nonsmokers.

TABLE 8. Mortality ratios for smokers of low "tar" and nicotine (T/N) cigarettes and nonsmokers in two time periods, by sex

Sex	Period	Mortality Ratio	
		Low T/N	Nonsmokers
Male	1	1.00	0.57
Male	2	1.00	0.64
Female	1	1.00	0.76
Female	2	1.00	0.71
Total		1.00	0.66

SOURCE: Hammond E.C., et al. (3).

*A matched-group analysis adjusted for several factors. See text.

Assuming that the composition of the two low T/N groups was quite similar in these separate analyses, whese two sets of data can be combined to compare mortality rates of smokers of various levels of "tar" and nicotine with those of nonsmokers (Table 9). These results are approximate, however, and are subject to some error.

Another matched group analysis was done comparing mortality ratios of smokers of relatively few (1-19) high T/N cigar-

TABLE 9. Mortality ratios for all cigarette smokers and nonsmokers in two time periods, by sex and "tar" and nicotine (T/N) content of cigarettes smoked

Sex	Period	Nonsmokers	Mortality Ratio		
			Low T/N	Medium T/N	High T/N
Male	1	1.00	1.75	1.80	2.00
Male	2	1.00	1.56	1.89	1.92
Female	1	1.00	1.32	1.40	1.57
Female	2	1.00	1.41	1.49	1.73
Total		1.00	1.52	1.64	1.80

SOURCE: Hammond E.C., et al. (3).

ettes with those smokers of relatively large numbers (20-39) of low T/N cigarettes. The mortality ratios of these two groups were very similar, and the difference between them was not statistically significant.

EX-SMOKERS

The mortality experience of ex-smokers is a subject in which there has been increasing interest in the past several years. When the harmful effects of smoking were initially suspected and examined, the question at first was one of the magnitude of the problem. More recently, there has been a nationwide recognition of the adverse morbidity and mortality which results from smoking. As a result, more than 30 million Americans have quit smoking, and millions more anticipate quitting within the next several years. One of the questions of greatest concern to the smoker at this time is not, "How bad is my smoking for my health?" but rather, "After all these years of smoking will it make any difference if I quit?" The benefits of stopping smoking are more clearly understood as a result of the studies reviewed here.

The relationship between cessation of smoking and overall mortality was examined in considerable detail in the study of U.S. veterans. A differentiation was made between ex-smokers who stopped smoking on the recommendation of a doctor and those who quit for other reasons (Tables 10, 11, 12). In each cohort, about 10 percent of the ex-smokers had stopped on doctor's orders, and this group had much higher mortality levels than those who stopped for other reasons. There was a direct relationship between mortality levels and the maximum amount previously smoked, an inverse relationship between mortality and years since stopping smoking, and an inverse relationship between mortality and age when smoking began.

The combined effects of these three factors on mortality are presented in Table 13. The lowest mortality ratio (1.03) was experienced by ex-smokers who began smoking after the age of 20,

smoked fewer than 21 cigarettes per day, and had stopped smoking for more than 10 years at the time of enrollment in the study. Conversely, the highest mortality ratio (1.45) was experienced by ex-smokers who began smoking before the age of 20, smoked more than 21 cigarettes per day, and had stopped smoking for less than 10 years at the time of enrollment in the study.

TABLE 10. Mortality ratios for ex-smokers who quit smoking on doctor's orders and for other reasons, by years since stopping, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Years Since Stopping	Mortality Ratio	
	Quit on Doctor's Orders	Quit for Other Reasons
< 5	1.55	1.23
5-9	1.43	1.23
10-14	1.77	1.14
15-19	1.35	1.04
>20	1.16	1.06
Total	1.52	1.18

TABLE 11. Mortality ratios for ex-smokers who quit smoking on doctor's orders and for other reasons, by number of cigarettes smoked per day, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Number of Cigarettes Smoked Per Day	Mortality Ratio	
	Quit on Doctor's Orders	Quit for Other Reasons
< 10	1.42	1.00
10-20	1.48	1.17
21-29	1.53	1.30
> 40	1.60	1.32
Total	1.52	1.18

TABLE 12. Mortality ratios for ex-smokers who quit smoking on doctor's orders and for other reasons, by age began smoking, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Age Began Smoking (Years)	Mortality Ratio	
	Quit on Doctor's Orders	Quit for Other Reasons
< 15	1.59	1.36
15-19	1.55	1.20
20-24	1.49	1.12
>25	1.34	1.15
Total	1.52	1.18

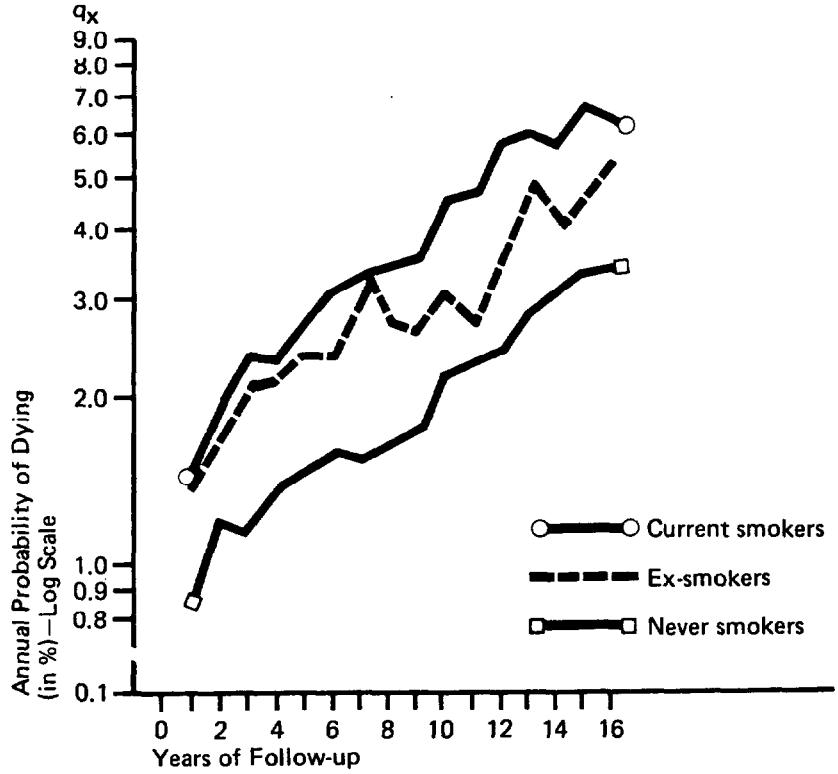
A detailed study of the mortality experience of ex-smokers who stopped smoking for various reasons other than a doctor's order

TABLE 13. Mortality ratios for ex-smokers of cigarettes only, by years since Stopping, number of cigarettes smoked per day, and age began smoking, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Years Since Stopping	Number of Cigarettes Smoked Per Day	Age Began Smoking (Years)	Mortality Ratio
< 10	> 21	< 20	1.45
< 10	> 21	> 20	1.27
< 10	< 21	< 20	1.21
< 10	< 21	> 20	1.12
> 10	> 21	< 20	1.19
> 10	> 21	> 20	1.07
> 10	< 21	< 20	1.08
> 10	< 21	> 20	1.03
Nonsmokers			1.00
Total			1.18

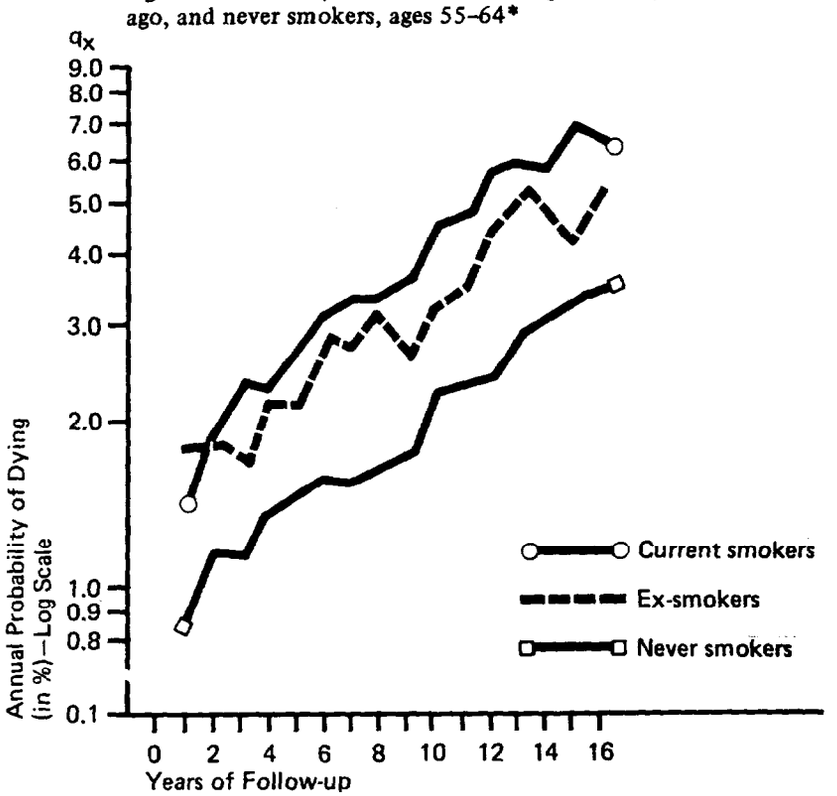
is given in Figures 1-4. This information is derived from the U.S. Veterans Study for men aged 55-64 who used to smoke from

FIGURE 1.—Annual probability of dying for current cigarette smokers, ex-smokers who quit less than 5 years ago, and never smokers, ages 55–64*



*U.S. Veterans Study, 1954 cohort, 16-year follow-up.

FIGURE 2.—Annual probability of dying for current cigarette smokers, ex-smokers who quit 5–9 years ago, and never smokers, ages 55–64*



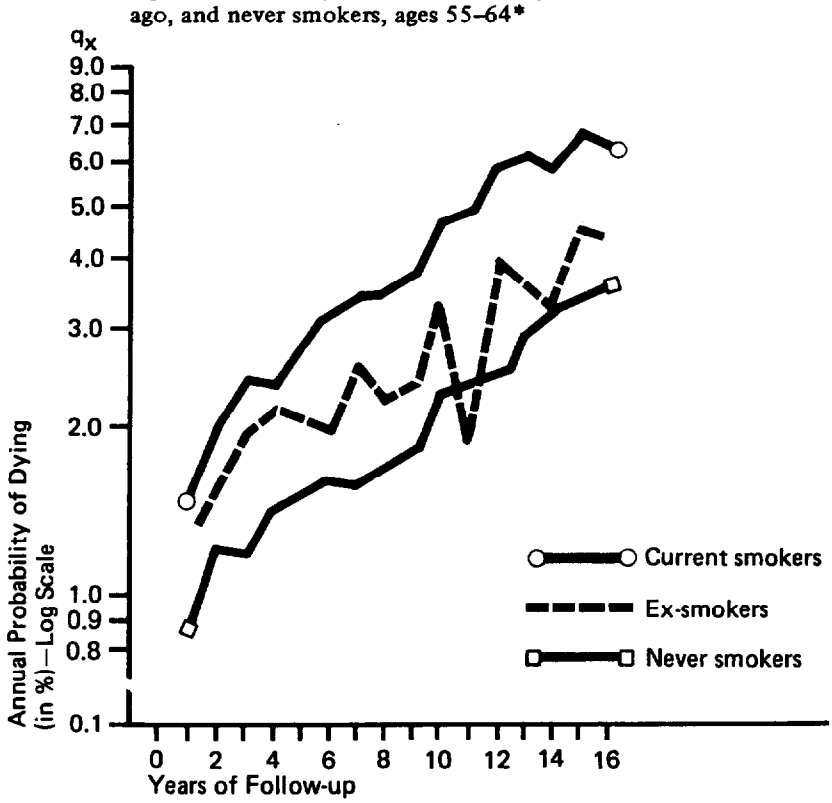
*U.S. Veterans Study, 1954 cohort, 16-year follow-up.

21-39 cigarettes per day. The years since stopping smoking is considered as a variable, and the mortality rates are compared with those of current cigarette smokers and nonsmokers. Annual probabilities of dying are plotted on a logarithmic scale. This results in a fairly smooth, linear pattern for both smokers and nonsmokers. The positive slope indicates increasing mortality with the passing of time of both smokers and nonsmokers. These lines also appear to run parallel or perhaps diverge slightly. This indicates an approximately constant or slightly increasing excess probability of dying between cigarette smokers and nonsmokers over the 16-year period. For ex-smokers who quit less than 5 years prior to the beginning of the study, the probability of dying is at first nearly identical to that of smokers (Figure 1). Over the years, the probability gradually falls to a position approximately halfway between that of smokers and nonsmokers. Figures 2 and 3 show that with longer

periods of cessation the probability of dying more nearly approaches that of nonsmokers. The probability of dying for ex-smokers who had stopped smoking for 15 or more years is virtually the same as that for nonsmokers for the entire 16-year period (Figure 4).

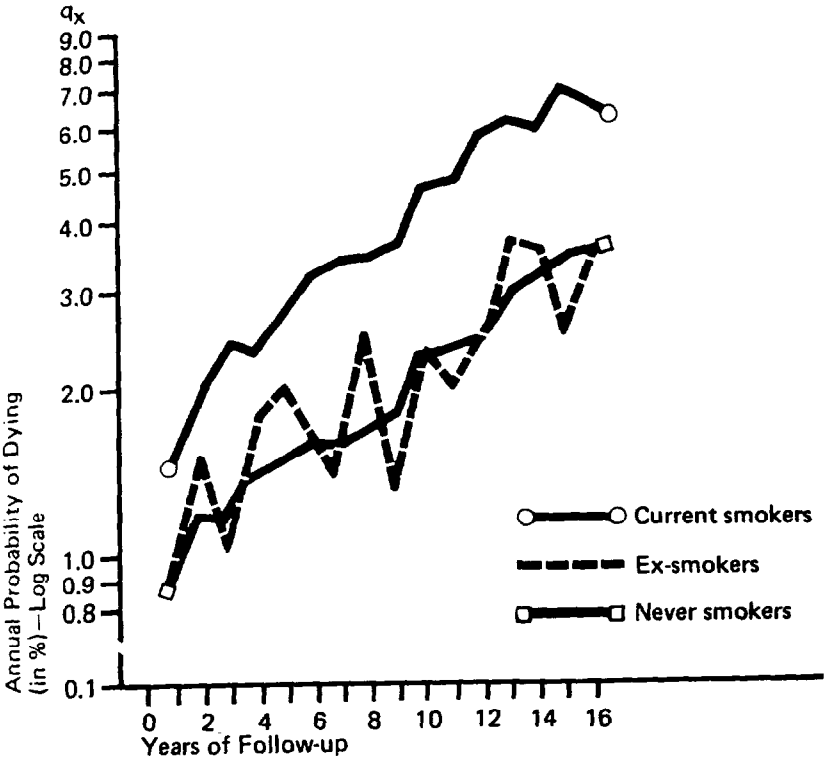
The mortality experience of British doctors who quit smoking indicates that there are benefits to quitting no matter how long one has smoked (Table 14). After 10-15 years of not smoking, the risk of dying for ex-smokers is similar to that of those who have never smoked (1.1 compared to 1.0). It should be remembered that overall mortality examines the probability of dying from all causes. This masks the relative benefits of quitting for specific diseases. It is known that the risk of dying from ischemic heart disease is reduced almost immediately after cessation of smoking,

FIGURE 3.—Annual probability of dying for current cigarette smokers, ex-smokers who quit 10–14 years ago, and never smokers, ages 55–64*



*U.S. Veterans Study, 1954 cohort, 16-year follow-up.

FIGURE 4.—Annual probability of dying for current cigarette smokers, ex-smokers who quit more than 15 years ago, and never smokers, ages 55–64*



*U.S. Veterans Study, 1954 cohort, 16-year follow-up.

while the risk of dying from lung cancer decreases more slowly. Only the net or total effect is demonstrated in overall mortality figures.

TABLE 14. Mortality ratios for ex-smokers compared to nonsmokers, by number of years since stopping and age, British Doctors Study

Years Since Stopping	Mortality Ratio		
	Age 30–64	Age >65	All Ages
0*	2.0	1.6	1.8
1–4	1.7	1.4	1.5
5–9	1.6	1.4	1.5
10–14	1.4	1.2	1.3
> 15	1.1	1.1	1.1
Nonsmokers	1.0	1.0	1.0

*Current Smokers

PIPE AND CIGAR SMOKING

Pipe and cigar smoking as related to overall and specific causes of mortality was last reviewed in the 1973 report of *The Health Consequences of Smoking* (8). The combustion products of pipe and cigar smoke contain many of the same chemical compounds found in cigarette smoke condensate. Since pipe and cigar smokers are less likely to inhale than cigarette smokers, they experience much lower mortality from certain diseases strongly associated with cigarette smoking. These include lung cancer, ischemic heart disease, and chronic obstructive lung disease. They do have death rates that are virtually similar to those for cigarette smokers, however, for cancers of the oral cavity, pharynx, larynx, and esophagus.

It should not be inferred from the above that switching to a pipe or cigar will necessarily reduce the mortality risks experienced by a current cigarette smoker, particularly one who inhales. The reason for this is that a cigarette smoker who inhales would probably continue to inhale after switching (8). Lower risks for pipe and cigar smokers may be associated with the lower prevalence of inhalation among these smokers and not with less hazardous tobacco products.

TABLE 15. Age-adjusted mortality ratios for pipe-only, cigar-only, and cigarette–only smokers, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Type of Tobacco	Mortality Ratio
Pipe Only	1.07
Cigar Only	1.16
Cigarettes Only	1.55
Nonsmokers	1.00

The U.S. Veterans Study contains the most detailed information concerning the mortality experience of pipe and cigar smokers. The mortality ratios for both pipe and cigar smokers are predictably greater than those for nonsmokers, and they are less than the mortality ratios of cigarette smokers (Table 15). Significant dose-response relationships were demonstrated for both pipe and cigar smokers by amount smoked and age began smoking.

The mortality ratio for cigar smokers increased from 1.11 for those smoking 1-2 cigars per day to 1.39 for those smoking nine or more cigars per day (Table 16). The mortality ratio was 1.13 for

TABLE 16. Age-adjusted mortality ratios for current cigar smokers, by number of cigars smoked per day, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Number of Cigars Smoked Per Day	Mortality Ratio
1-2	1.11
3-4	1.13
5-8	1.22
>9	1.39
Nonsmokers	1.00
Total	1.16

those who began smoking after the age of 25 and 1.22 for those who began smoking before the age of 15 (Table 17). Table 18 combines these variables and shows that the lowest mortality ratio for cigar-only smokers is 1.07 for those who smoked less than five cigars per day and began smoking after the age of 25. The highest mortality ratio of 1.28 was experienced by those who smoked more than five cigars per day and began smoking before the age of 25.

Somewhat similar dose-response relationships were demonstrated for pipe-only smokers; however, the risk associated with pipe smoking is slightly less than that with cigar smoking (Tables 19, 20, and 21).

TABLE 17. Age adjusted mortality ratios for current cigar smokers, by age began smoking, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Age Began Smoking (Years)	Mortality Ratio
< 15	1.22
15-19	1.23
20-24	1.16
> 25	1.13
Nonsmokers	1.00
Total	1.16

TABLE 18. Age-adjusted mortality ratios for current cigar smokers, by number of cigars smoked per day and age began smoking, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Number of Cigars Smoked Per Day	Age Began Smoking (Years)	Mortality Ratio
< 5	>25	1.07
< 5	< 25	1.16
> 5	>25	1.28
> 5	< 25	1.23
Nonsmokers		1.00
Total		1.16

TABLE 19. Age-adjusted mortality ratios for current pipe smokers, by number of pipefuls smoked per day, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Number of Pipefuls Smoked Per Day	Mortality Ratio
< 5	0.93
5–9	1.12
10–19	1.08
>20	1.21
Nonsmokers	1.00
Total	1.07

TABLE 20. Age-adjusted mortality ratios for current pipe smokers, by age began smoking, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Age Began Smoking (Years)	Mortality Ratio
< 15	1.04
15–19	1.12
20–24	1.06
>25	1.06
Nonsmokers	1.00
Total	1.07

TABLE 21. Age-adjusted mortality ratios for current pipe smokers, by number of pipefuls smoked per day and age began smoking, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Number of Pipefuls Smoked Per Day	Age Began Smoking (Years)	Mortality Ratio
< 10	> 25	1.03
< 10	< 25	1.05
≥10	> 25	1.12
> 10	>25	1.12
Total		1.07

The above discussion relates to those who have limited their lifetime smoking to cigars only or pipes only. Frequently, however, a smoker will have used tobacco in several different forms. For instance, a cigar smoker may be a former cigarette smoker and may occasionally smoke pipes. The U.S. Veterans Study contains data on the mortality ratios of individuals who use tobacco in various forms. These data have been arranged so that the various patterns of smoking are arranged by increasing risk of mortality. Table 22 shows the age-adjusted mortality ratios of current cigar smokers who have or are using pipes and/or cigarettes. Smoking cigarettes and cigars is more risky, and smoking pipes and cigars is less risky than smoking cigars alone.

TABLE 22. Age-adjusted mortality ratios for current cigar smokers, by use of other types of tobacco, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Type of Tobacco Used		
Cigarettes	Pipes	Mortality Ratio
Never	Never	1.16
Never	Current	1.10
Never	Former	1.10
Former	Former	1.10
Former	Current	1.13
Former	Never	1.23
Current	Current	1.21
Current	Never	1.30
Current	Former	1.33

TABLE 23. Age-adjusted mortality ratios for current pipe smokers, by use of other types of tobacco, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Type of Tobacco Used		
Cigarettes	Cigars	Mortality Ratio
Never	Never	1.07
Never	Current	1.10
Never	Former	1.11
Former	Former	1.14
Former	Current	1.14
Former	Never	1.10
Current	Current	1.21
Current	Never	1.28
Current	Former	1.36

The mortality experience of pipe smokers is shown in Table 23. Pipe smoking alone is the least hazardous form of smoking. The combination of pipes and cigars is a less risky combination than the combination of pipes and cigarettes. It is interesting to note that when the pipe smoker divides his smoking three ways and uses both cigarettes and cigars in addition to pipe smoking, the mortality ratio is less than if the time devoted to smoking is split two ways between pipes and cigarettes. Evidently to the extent that cigarettes are replaced there is a reduction in risk. The mortality ratios of current cigarette smokers who have or are using pipes or cigars is shown in Table 24.

TABLE 24. Age-adjusted mortality ratios for current cigarette smokers, by use of other types of tobacco, U.S. Veterans Study, 1954 cohort, 16-year follow-up

Type of Tobacco Used		
Cigarettes	Cigars	Mortality Ratio
Never	Never	1.55
Never	Current	1.28
Never	Former	1.47
Former	Former	1.48
Former	Current	1.36
Former	Never	1.53
Current	Current	1.21
Current	Never	1.30
Current	Former	1.33

In the study of British doctors, Doll and Peto (1) reported that those who smoked only pipes or cigars experienced mortality rates which were similar to, or only slightly above, those of men who did not smoke at all. Pipe and cigar smokers who also used cigarettes had mortality ratios which were intermediate between those who only smoked pipes and cigars and those who smoked cigarettes. These figures are presented in Table 25.

TABLE 25. Age-adjusted mortality ratios for all smokers, by type of tobacco used, British Doctors Study

Type of Tobacco Used	Mortality Ratio
Pipe or Cigar Never Cigarettes	1.09
Pipe or Cigar and Cigarettes	1.31
Cigarettes Only	1.73
Nonsmokers	1.00

SUMMARY OF SMOKING AND OVERALL MORTALITY

1. Overall mortality rates for cigarette smokers are about 70 percent higher than those for nonsmokers.

2. Overall mortality risk increases with the amount smoked. For the two-pack-a-day cigarette smoker, the risk of premature death is approximately twice that of the nonsmoker.

3. Overall mortality ratios of smokers compared to nonsmokers are highest at earlier ages and decline with increasing age. For cigarette smokers, the risk of premature death is twice that of nonsmokers at age 40.

4. Overall mortality ratios are higher for those who begin smoking at a young age compared to those who begin later. For those who begin smoking before the age of 15, the risk of premature death is about 86 percent higher than that for nonsmokers.

5. Overall mortality ratios are higher for those smokers who inhale than for those who do not.

6. There is about a 15 percent reduction in overall mortality risk for smokers of low "tar" and nicotine cigarettes (less than 17.6 mg. "tar" and less than 1.2 mg. nicotine) compared to those who smoke high "tar" and nicotine cigarettes (25.8-35.7 mg. "tar" and 2.0-2.7 mg. nicotine).

7. Overall mortality rates of low "tar" and nicotine cigarette smokers are about 50 percent higher than for nonsmokers.

8. Overall mortality rates of former smokers decline as the number of years of cessation increase. After 15 years off cigarettes, death rates for former smokers are nearly identical to those of nonsmokers.

9. Overall mortality rates of former smokers are directly proportional to the number of cigarettes the person used to smoke.

10. Overall mortality rates of former smokers are inversely proportional to the age at which the person began smoking.

11. Regardless of length of time smoked or number of cigarettes smoked, former smokers have lower mortality rates than continuing smokers, provided they are not ill at the time of cessation.

12. Overall mortality ratios for cigar smokers are somewhat higher than for nonsmokers. The U.S. Veterans Study showed a mortality ratio of 1.16, compared to 1.0 for nonsmokers. The overall mortality ratio was 39 percent higher than the ratio in nonsmokers for men smoking nine or more cigars a day. A positive dose-response relationship exists between cigar smoking and mortality.

13. Overall mortality ratios for male cigar smokers are inversely proportional to the age at which the individual began smoking.

14. Overall mortality ratios for pipe smokers are only slightly higher than for nonsmokers. The mortality ratio in the U.S. Veterans Study was 1.07. Overall mortality ratios were 21 percent

higher than nonsmokers for men who smoked 20 or more pipefuls a day than for nonsmokers. A positive dose-response relationship exists between pipe smoking and mortality.

15. Overall mortality ratios of men who smoke cigarettes in combination with pipes and/or cigars are intermediate between those who smoke pipes or cigars only and those who smoke cigarettes only. Cigarette smokers who also smoke cigars or pipes have overall mortality rates approximately 30 percent higher than nonsmokers.

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Appendix

Smoking and Disease — What Must Be Done

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HOW SMOKING CAUSES DISEASE

Since the early 1950s, when cigarette smoking was first implicated as a major cause of lung cancer in men, further research into the relationship between smoking and ill health has provided substantial additional data that support various theories about the mechanisms caused or enhanced by smoking, with regard to both mortality and morbidity. The following five mechanisms have been proposed:

(1) Cigarette smoking starts a disease process that progressively produces irreversible damage, the end-effect of which is more or less proportional to the total dosage accumulated during the years of smoking. Cessation of smoking leaves the individual with functional impairments that neither improve appreciably nor, of themselves, continue to deteriorate—except perhaps as a result of aging or exposure to other harmful agents. Owing to the interference with normal mechanisms for clearing the respiratory tract and the destruction of peripheral airways, this kind of process probably accounts for the high rates of chronic obstructive lung disease in cigarette smokers. A similar process seems to explain the high levels of atherosclerosis found in cigarette smokers; the almost continuously elevated level of carboxyhaemoglobin found in the blood of moderate to heavy smokers interacts with high levels of cholesterol to produce increased formation of atherosclerotic plaques.

(2) Cigarette smoking starts a disease process characterized by continual repair and recovery until a critical point is reached when the process is no longer reversible. The total effect is related to cumulative exposure over the years, so that several short periods of heavy smoking could lead to the point of irreversibility. Unless this point has been reached, cessation of smoking results in a rapid decrease in risk. A mechanism of this kind probably accounts for both the high dose-response relationship in lung cancer and the rapid relative reduction in risk of lung cancer among populations of ex-smokers. Other sites of cancer related to cigarette smoking probably also react in this way, which would correlate with the evidence that tobacco smoke contains both cancer-initiating and cancer-promoting substances.

(3) Cigarette smoking promotes rather than starts the disease process, either by directly supporting a developing pathological condition or by diminshing the body's normal capacity to defend itself against disease. By this mechanism, cigarette smoking could promote a subclinical disease to a clinically recognizable state or a mild disease to a more severe form or even increase the fatality rates of certain diseases. This mechanism might account for the slightly increased mortality rates for influenza or tuberculosis among smokers, although cigarette smoking itself is not the cause of these diseases. Furthermore, unless severe chronic obstructive lung disease or high levels of atherosclerosis have already developed, stopping smoking both lessens the severity of heart attacks and improves the recovery rates from them.

(4) Cigarette smoking induces temporary conditions favouring a critical combination of events, which leads to disease, disability, and possible fatal consequences. For example, there is substantial evidence to support a theory that each cigarette can increase the probability of myocardial damage. This comes about through an increased demand for oxygen in response to the nicotine in cigarette smoke, at the same time that the carbon monoxide in the smoke has decreased the supply of oxygen by raising the carboxyhaemoglobin levels in the blood. Once this imbalance of supply and demand for oxygen is alleviated, the probability of myocardial damage would presumably revert to normal levels; in this instance, stopping smoking should bring about an almost immediate and sharp decline both in associated morbidity and mortality.

(5) Cigarette smoking may be artificially related to excess disability or death because of a close association with some other condition, which occurs at a high level in smokers and is itself responsible for the disease. The generally accepted example of this mechanism at work is cirrhosis of the liver. Because many heavy drinkers of alcohol are also heavy smokers, the high rate of cirrhosis among cigarette smokers has sometimes been attributed to smoking. Some evidence does suggest that high levels of exposure to both cigarette smoking and alcohol produce an effect greater than that for alcohol exposure alone.

Implications for action

The different mechanisms described above are important for the evaluation of potential public health benefits that could result from programmes aimed at (i) inducing smokers to stop smoking, (ii) dissuading young nonsmokers from starting to smoke, or (iii) changing the ingredients of cigarettes to make their smoke less harmful. For some types of associated morbidity and mortality there would be no benefits from any of these actions; for others, rather small benefits or substantial benefits taking place rather

rapidly or substantial benefits taking place slowly over a long period of time. For example, the greatest long-term benefits would result from dissuading youngsters from taking up smoking, but more immediate, albeit smaller, benefits could be derived from persuading adults to stop smoking, provided the programme reaches many of the individuals at greatest risk.

In addition to taking these mechanisms into account in designing control efforts, there are certain epidemiological findings of special importance in this respect. First and foremost is the evidence that cigarette smoking seems to act in concert with many other risk factors so that the combined risk for almost any disease, on which cigarette smoking by itself has an effect, is sharply increased. For example, the radioactivity to which uranium miners under current mining conditions are exposed appears to have relatively little effect on lung cancer rates among nonsmokers; for smokers, however, it appears to produce far higher lung cancer rates than those for smokers who are not exposed to radioactivity.

Similarly, certain forms of chronic obstructive lung disease caused by sustained inhaling of particles and fibres are more common and severe in those who smoke. This applies equally to byssinosis (caused by inhaling cotton fibres) and the fungus-produced respiratory problems experienced by pigeon breeders. Both smokers and nonsmokers exposed to asbestos fibres show elevated rates of asbestosis, but only the smokers manifest extremely high rates of lung cancer. With ischaemic heart disease also, cigarette smoking appears to combine with other generally accepted risk factors, i.e., hypertension and hypercholesterolaemia, to produce a multiplicative, rather than simply an additive effect. On the other hand, there is evidence to suggest that certain endogenous factors, such as inherited susceptibility, can have an effect opposite to that of the exogenous factors just noted. Among women, for example, whose rates of ischaemic heart disease and chronic obstructive lung disease appear to be lower than those of men in most national and ethnic groups, even among nonsmokers, the effect of smoking at apparently equivalent dosage levels seems to be less.

In sum, then, the design of specific control programmes needs to take into account the effect of smoking as an interaction of three influences:

–dosage, i.e., the effective level of exposure to noxious substances in cigarette smoke, both accumulated and current

–exposure to other elements that contribute to or produce the same disease process

–susceptibility to the disease in the host population, presumably determined by genetic factors.

As smoking habits may be more amenable to control than other important risk factors or high levels of host susceptibility, measures

aimed at reducing exposure to cigarettes can be expected to produce substantial benefits. But whether to concentrate on short-term programmes for helping adults whose accumulated exposure may be approaching the critical point or longer-term efforts aimed at the youth or some combination of both requires careful identification of the groups that will benefit most from the planned control measures.

SMOKING BEHAVIOUR IN THE INDIVIDUAL

Cigarette smoking represents a category of health problems that can be called *personal choice health behaviour.* This class of behaviour includes many normal ways of increasing the enjoyment of life or coping with its problems; it includes useful, frequently necessary, forms of behaviour that have varying degrees of social acceptability. For a more complete understanding of this sort of behaviour as it applies to smoking, it is helpful to look at its four stages: *initiation, establishment, maintenance,* and *cessation or other modification.*

The *initiation* of smoking usually occurs with young people, frequently rather young children, and depends on how available cigarettes are to them, the degree of their curiosity about what smoking is like, and their need to conform with the behaviour of others—whether parents, older siblings, or peers—or to rebel against what seems like unreasonable proscriptions against smoking. Accordingly, smoking is much more common among children of parents who are themselves regular smokers. As cigarette smoking becomes widespread in a society, it tends to be taken up with increasing frequency by successive generations of young people. Many older people may also turn to it, especially if it serves as a substitute for a previously well-established behaviour pattern as was the case when many males switched to cigarettes from cigars and pipes in the years between 1920 and 1950.

The *establishment* of smoking as a continuing habit in adolescents can be influenced by three groups of factors: a cost-benefit balance, common perceptual stereotypes, and psychological personal structure and integration. The *costs* may be either those to the individual or to society and may reflect health concerns or economic or aesthetic values. The *benefits* are similarly varied, ranging from easing social contacts and reducing tension to enhancing the sense of pleasure. The *perceptual stereotypes* have to do with the mythology of what smoking is like, what smokers are like, and why people smoke, and are derived from both the brand-name advertising of cigarettes and the counter-publicity of antismoking groups. No one pattern of *psychological forces* dominates the reasons either for or against smoking. Either smoking or *not* smoking can be a way of expressing the conflict between satisfying one's own desires and conforming to the demands and expectations of society

and its leading figures. Similarly, these opposite kinds of behaviour may reflect the individual's relative need to maintain control over his own behaviour and destiny as opposed to being subject to the control of others or the vagaries of chance.

The *maintenance* of smoking behaviour is usually supported by the development of habituation or dependence—*habituation* tending to reflect simply repetitive behaviour and *dependence* an increasing desire or need for the effects produced by the behaviour. In either case, prior to 1950, confirmed smokers tended to continue smoking unless they became too ill or had their supply of cigarettes interrupted by wartime shortages or economic deprivation. Since then, the threat to health posed by cigarette smoking has become sufficiently well known to millions of smokers to influence many of them towards trying to give up cigarettes or modifying their smoking in some way that would minimize its potential hazards.

Whether a smoker considers the idea of *cessation or other modification* of his smoking habits and how successful he will be in this effort depends largely on a number of factors, such as his perception of the threat posed by his continued smoking, how psychologically useful his smoking is to him, and the environmental forces that either encourage or interfere with his efforts at behavioural change. Not only must the smoker be aware of a threat to his health, but he must perceive this as important and personally relevant, as well as feel able to alter his behaviour and accept as valuable the results of such alterations. Psychologically, the smoker in the process of quitting must be able to deal both with the absence of the stimulation provided by cigarettes and with the sense of craving (for tobacco) and other withdrawal symptoms. In this, he can be aided by social forces, interpersonal influences and mass communications, plus influences generated by health workers and other key groups in encouraging behavioural change. When these influences become significant to enough people, action will be taken through legislation, changes in regulations, and changes in customs. A good example is the growing movement to "protect the rights of the non-smoker" by reducing his exposure to tobacco smoke produced by others.

SMOKING BEHAVIOUR IN A SOCIETY

New fashions in smoking tend typically to appear first among the younger, more affluent members of the adult population who form part of the upper classes of the society. In most developed countries cigarette smoking increased sharply during the years between 1910 and 1920 because of the switch to this form of tobacco use by young males taking up the habit for the first time and by older men who had hitherto smoked pipes and cigars. The increase in cigarette smoking was temporarily halted in many countries during

the Second World War because of tobacco shortages but soon resumed its upward course after the war and quickly made up for lost time. Also contributing to this increase were the larger numbers of women who began smoking cigarettes during and immediately after the 1940s. As with men thirty years earlier, cigarette smoking among women was at first confined mainly to the upper and upper-middle classes, but rapidly moved down the social scale to include a substantial number of middle and lower-class women.

By the mid-1950s, when new information about the harmful effects of cigarette smoking began to receive widespread publicity, the growth of cigarette smoking began to be curtailed, first among men in the upper classes, then among males in the other social classes, and finally among adult women by the late 1960s. Of particular interest is the phenomenon observed in the USA where the percentage of adolescent boys taking up cigarette smoking has gradually dropped, apparently in response to the intensive educational efforts begun in the late 1950s, while the percentage of adolescent girls taking it up has gradually risen. By 1974 the rates for boys and girls were almost identical and it seems likely that the continuous increase in the proportion of young girls taking up smoking has probably reached its limit, perhaps because "equality" in smoking with boys seems to have been achieved. However, despite the substantial numbers of adults who no longer smoke cigarettes, this increase in smoking by younger women in developed countries—at rates far higher than for their mothers and grandmothers—has caused the *per capita* consumption of cigarettes to continue to rise in these countries.

The growth of cigarette smoking in developing countries is a subject on which there is as yet little information. We do know that there have been large relative increases in smoking in some countries with low pre-1950 rates, but there are few reliable statistics to indicate the exact rate of growth. From anecdotal material, however, it is clear that cigarette smoking tneds to be taken up first by persons having the closest first-hand association with people from the developed countries, i.e., the professional, political, and business leaders of those countries. Although the relatively high cost of cigarettes and the low standards of living in many developing countries may have prevented cigarette smoking from increasing as rapidly as it might otherwise have done, recent improvements in the economic conditions of some of these countries have provided a strong incentive for cigarette makers to launch aggressive marketing campaigns aimed at offsetting the more static markets for cigarettes in developed countries, brought on in part by changed attitudes toward smoking. Although there is no scientifically acceptable evidence to prove that advertising has contributed to the growth of cigarette use, and although cigarette smoking has, in fact, grown sharply in

some countries without the help of advertising, the overwhelming aura of respectability and social acceptance conveyed by widespread advertising has almost certainly been an important factor in stimulating increased smoking.

BARRIERS TO SUCCESSFUL CONTROL

The main barriers to the successful design and implementation of control programmes are the following:

(1) *Gaps in medical and epidemiological knowledge.* At present, the knowledge of the effect of smoking on health and of how this manifests itself is sufficiently complete to convince the overwhelming majority of medical scientists and nearly as much of the general public in developed countries of the hazards involved. However, to direct control actions toward persons and groups that would benefit most from them, we need better means of identifying those at greater risk. At the moment our means of doing this are limited to identifying persons at the highest level of dosage exposure, those with concurrent exposure to other risk factors that increase the likelihood of lung cancer, ischaemic heart disease, or chronic obstructive lung disease, and those from ethnic groups with a high prevalence of these smoking-related diseases. Thus, earlier and more precise measurement of the effect of cigarette smoking on an individual or a group of individuals would provide an important basis for sharpening the direction of control action.

(2) *Economic and political conflicts.* In the early years after cigarette smoking was identified as a serious health problem, the economic and political influence of tobacco farmers and the importance of receipts from the sales and taxation of cigarettes undoubtedly impeded the development of political support in this area from governments. However, as the medical and epidemiologcal case against smoking became clearer and the costs to society in death and early disability were better identified, these economic and political barriers to control action have begun to be lowered, albeit rather slowly. Similarly, the importance of individual rights has grown, at first in preventing control actions that would infringe on the rights of smokers and, more recently, in restricting smoking in public places so as to protect the rights of nonsmokers.

On another front, efforts to develop less harmful substitutes for tobacco have recently resulted in the marketing of cigarettes partially made from such substitute materials. With these cigarettes the problem in health terms is the difficult one of ensuring that they are at least no more harmful than cigarettes made wholly from tobacco. In economic and political terms, they pose a significant threat to tobacco as an agricultural product because if they became

widely accepted they could cause the world demand for tobacco to shrink by as much as fifty per cent.

(3) *Lack of knowledge on smoking behaviour.* Because of gaps in our knowledge of smoking behaviour, we are unable to be more helpful in assisting individuals who wish to quit smoking. In the USA, for example, during the decade from the early 1960s to the early 1970s, when the climate of social support for giving up smoking improved sharply, the spontaneous success rates for those who tried to give up smoking more or less permanently nearly trebled to about 40%. However, even in this favourable climate, only about one person in three who tried to stop smoking was successful.

These figures do not include the many persons who did not even try to give up smoking; although they accepted the fact that they would be better off if they did so, they were unwilling to expose themselves to the risk of failure. Despite the numerous attempts that have been made to develop systematic therapeutic programmes for helping people to quit smoking, on either an individual or a group basis, these have had no better results than the spontaneous success rates just mentioned, a record probably influenced by the tendency of these programmes to attract smokers with a history of previous failure, with whom the prospects of success are quite low. Much the same can be said of attempts to develop low-cost self-aids for individuals, as a substitute for costly professional therapy, and of pharmacological aids; although these aids have had some success, their effects have been limited and they are in need of further improvement.

Another area suffering from a lack of knowledge is our ignorance of the full potential of the effect of various regulatory and legislative aids such as increasing the price of cigarettes, differential taxation to promote one type of cigarette as against another, restrictions on places where smoking is permitted, restrictions on the ease of purchase and general availability of cigarettes, and the effect of reducing or banning cigarette advertising and promotional activities. Although there is some evidence to suggest that these actions are useful, the benefits achieved have not been adequately evaluated under controlled conditions.

A third area affected by the lack of knowledge is health education of the young and the development of more successful programmes to dissuade young people from taking up smoking. Although much is known about some of the principles contributing to effective health education of the young, these have not yet been incorporated into programmes, which could provide convincing evidence of their ability to reduce smoking. Without such evidence, it is difficult to gain support for making widespread and expensive changes in educational programmes.

(4) *Lack of communication and coordination.* Occasional international conferences and sporadic reviews of the smoking problem, no matter how well thought out, are no substitute for a continuing system of communication and information exchange. The three international conferences on smoking that were held in 1967, 1971 and 1975 and the resolutions on the subject adopted by the World Health Assembly in 1970, 1971, 1975 and 1976 represent efforts to support and encourage international action, but they have not resulted in any system for ensuring that this takes place. National programmes that have attempted to deal with the total problem, such as the National Clearinghouse for Smoking and Health in the USA, have provided systematic annual bibliographical publications and literature reviews, which have made this task easier, but such programmes must be augmented by systematic attempts to facilitate communication and enhance cooperative efforts.

WHAT IS TO BE DONE?

In the face of these obstacles and the indifferent success of control efforts to date, it is clear that a much more systematic and multifaceted international attack will have to be mounted on the hazards of smoking if this public health problem is to be reduced; equally, this attack must be a coordinated one so that maximum benefit is derived from separate national efforts against different aspects of the problem. In its coordinating role on international health matters, WHO is ideally situated to undertake this task. Some of the key areas in need of immediate attention are:

- *Expert advice.* Because of the multidisciplinary nature of the problem, current control efforts are too often fragmented and piecemeal. What is needed is a small panel of international experts, operating under the aegis of WHO and comprised of behavioural scientists, economists, sociologists, toxicologists, pharmacologists, etc., in addition to public health workers, to provide national, regional and international programmes with ready access to the best available advice on the probable effectiveness of various measures.

- *Monitoring the problem.* Far too little is known about the various factors that affect smoking and smoking behaviour in different countries; the available information is often collected in sufficiently different ways to make comparisons and extrapolations from national experience impossible. There is thus the need not only for greatly expanded collection activities but also for countries to be informed about what sort of information to collect and in what way so that national efforts will reinforce one another and provide the basis for global analyses.

- *Information exchange.* In addition to the dearth of information, there is not enough cross-dissemination of available data to permit making the best use of it. This gap could be filled by periodic newsletters, compiled by WHO from national contributions, and by occasional regional and international conferences.

- *Economic implications.* If cigarette smoking is reduced by a substantial amount or the use of tobacco substitutes in cigarettes is found to be safe and is widely adopted, then the economies of tobacco-producing countries will be adversely affected. Although we are far from this point at present, it is none too early to begin considering alternative employment of tobacco lands and farmers and the other economic effects of this process.

- *Research.* Virtually all aspects of the programme to control smoking can benefit from more systematic research—ranging from the epidemiological aspects that would identify better predictive measures of dosage, through research into why people smoke and what educational and other methods are best calculated to limit smoking, to the development of various aids and methods to help people stop smoking. In the latter instance, to cite just one example, there has been no reliable or systematic testing of the usefulness of the various commercial products that claim to help a person stop smoking.