13. OTHER FORMS OF TOBACCO USE.

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Introduction

This review of the health effects of tobacco use other than cigarette smoking includes a revision of the chapter on pipes and cigars from the 1973 *Health Consequences of Smoking* and information on tobacco chewing and snuff dipping. Because these forms of tobacco are used mainly by men in the United States, most studies report data based only on male populations. This information can be applied to the small numbers of women who use other forms of tobacco only with caution because there is some difference in the impact of cigarette smoking on men and on women.

Pipes and Cigars

Prospective epidemiologic studies show that individuals who smoke only pipes and cigars have overall mortality rates slightly higher than nonsmokers, but lower than cigarette smokers. Pipe and cigar smokers have only slightly elevated cause-specific mortality rates for coronary heart disease, lung cancer, and chronic obstructive pulmonary disease when compared to nonsmokers, but their mortality rates for oral cavity cancers often equal or exceed those of cigarette smokers. Examination of the combined use of cigarettes and pipes or cigars is complex and may lead to confusion in two areas.

First, overall mortality rates of those who smoke pipes, cigars, or both in combination with cigarettes appear to be intermediate between the high mortality rates of cigarette smokers and the lower rates of those who smoke only pipes or cigars. This should not be taken to suggest that smoking pipes or cigars in combination with cigarettes diminishes the harmful effects of cigarette smoking. Analysis of mortality associated with smoking combinations of cigarettes, pipes, and cigars should be standardized for the level of consumption of each of the products smoked in terms of the amount and duration of smoking and the depth and degree of inhalation. For example, cigar smokers who also smoke a pack of cigarettes a day might be expected to have mortality rates somewhat higher than those who smoke only a pack of cigarettes a day, assuming that both groups smoke cigarettes in the same way. Mixed smokers who inhale pipe or cigar smoke in a manner similar to the way they smoke cigarettes might be expected to have higher mortality rates than mixed smokers who do not inhale cigars and pipes and resist inhaling cigarettes. Unfortunately, little published material on mixed cigarette, pipe, and cigar smoking contains these types of analyses or controls.

Second, a paradox seems to exist between reduced mortality rates for ex-smokers of cigarettes, compared to continued smokers, and increased mortality rates for ex-smokers of pipes and cigars. Ex-cigarette smokers experience a relative decline in overall and certain specific causes of mortality following cessation. This decline is

important but indirect evidence that cigarette smoking is a major cause of elevated mortality rates experienced by current cigarette smokers.

In contrast to this finding, several prospective epidemiological investigations, Hammond and Horn (*52*), Best (*11*), Kahn (*69*), and Hammond (*50*), have reported higher death rates for ex-pipe and ex-cigar smokers than for current pipe and cigar smokers. This phenomenon was analyzed by Hammond and Garfinkel (*51*). They found that the development of ill health often results in a cigarette smoker giving up the habit, reducing his daily tobacco consumption, switching to pipes or cigars, or choosing a cigarette low in tar and nicotine. In many instances, a smoking-related disease is the cause of ill health. Thus, the group of ex-smokers includes people who are already ill from smoking-related diseases and who therefore have higher overall and specific mortality rates. With the passage of time after cessation of cigarette smoking, a relative decrease in mortality is observed due to decreased mortality rates in those who quit smoking for reasons other than ill health and in the dwindling number of ill ex-smokers.

The beneficial effects of cessation tend to be obscured by the high mortality rates of those who quit smoking for reasons of illness. A similar principle operates for ex-pipe and ex-cigar smokers; because of the lower initial risk of smoking these forms and the smaller margin of benefit following cessation, the effect produced by the ill ex-smokers creates a larger and more persistent impact on the mortality rates than is seen in cigarette smoking. For these reasons, a detailed analysis of mortality among ex-pipe and ex-cigar smokers will not be undertaken in this review.

For specific causes of death, the tables below summarize the mortality and relative risk ratios reported in major prospective and retrospective studies of pipe and cigar smokers. The smoking categories used include: cigar only, pipe only, total pipe and cigar, cigarette only, and mixed. Mortality and relative risk ratios are calculated relative to nonsmokers.

Prevalence of Pipe, Cigar, and Cigarette Usage

Prevalence of pipe, cigar, and cigarette smoking in the United States was estimated by the National Clearinghouse for Smoking and Health from population surveys conducted in 1964, 1966, 1970, and 1975 (*90, 91, 92*). In each survey, over 2,500 interviews were conducted on a national probability sample stratified by type of population and geographic area. The use of these products among adults aged 21 and older, summarized in Table 1, reflects the continued decline in the percentage of the population using tobacco products. Table 2 shows the use of different tobacco products by age group.

TABLE 1.—Percent distribution of U.S. male smokers aged 21 and older by type of tobacco used for the years 1964, 1966, 1970, and 1975

Forms used	1964 (percent)	1966 (percent)	1970 (percent)	1975 (percent)
Total pipe	18.7	19.2	17.9	12.4
Total cigar	29.9	26.7	21.2	19.9
Total cigarette	52.9	52.4	42.3	39.3

SOURCE: National Clearinghouse for Smoking and Health (*90,91,92*).

TABLE 2.—Percent distribution of U.S. male smokers by type of tobacco used and age, for 1970

Forms used	Age groups				
	21 to 34	35 to 44	45 to 54	55 to 64	65 to 75+
1. Cigar only	3.7	6.5	4.7	6.7	9.3
2. Pipe only	4.3	3.5	3.0	3.2	3.6
3. Pipe and cigar	3.8	3.3	5.2	4.4	6.9
4. Cigarette only	28.8	29.0	27.1	24.3	13.6
5. Cigarette and cigar	6.8	10.4	5.5	5.2	4.2
6. Cigarette and pipe	6.6	4.4	5.6	4.0	3.8
7. Cigarette, pipe, and cigar	5.8	4.8	5.0	4.0	1.4
8. Nonsmoker	40.2	38.1	43.9	48.2	57.2
Total	100.0	100.0	100.0	100.0	100.0
Number of persons in sample	1,009	528	523	405	388
Total pipe users	20.5	16.0	18.8	15.6	15.7
Total cigar users	20.1	25.0	20.4	20.3	21.8
Total cigarette users	48.1	48.6	43.3	37.5	23.0

SOURCE: National Clearinghouse for Smoking and Health (*91*).

TABLE 2.—continued. Prevalence of snuff use and tobacco chewing in the United States

	1970		1975	
	Male	Female	Male	Female
Snuff	2.9	1.4	2.5	1.3
Chewing	5.6	0.6	4.9	0.6

SOURCE: National Clearinghouse for Smoking and Health (*91,92*)

The Definition and Processing of Cigars, Cigarettes, and Pipe Tobaccos

Cigarettes

The U.S. Government has defined tobacco products for tax purposes. Cigarettes are defined as "(1) Any roll of tobacco wrapped in paper or in any substance not containing tobacco, and (2) any roll of tobacco wrapped in any substance containing tobacco which, because of its appearance, the type of tobacco used in the filler, or its packaging and labeling, is likely to be offered to, or purchased by, consumers as a cigarette described in subparagraph (1)." Cigarettes are further classified by size, but virtually all cigarettes sold in the United States are "small cigarettes" which by definition weigh "not more than 3 pounds per thousand," which is not more than 1.361 grams per cigarette (*44, 130, 141*).

Cigars

Cigars have been defined for tax purposes as: "Any roll of tobacco wrapped in leaf tobacco or in any substance containing tobacco (other than any roll of tobacco which is a cigarette within the meaning of subparagraph (2) of the definition for cigarette)" (*141*). In order to clarify the meaning of "substance containing tobacco," the Treasury Department has stated that, "The wrapper must (1) contain a significant proportion of natural tobacco; (2) be within the range of colors normally found in natural leaf tobacco; (3) have some of the other characteristics of the tobaccos from which produced; e.g., nicotine content, pH, taste, and aroma; and (4) not be so changed in the reconstitution process that it loses all the tobacco characteristics" (*131*). Further, "To be a cigar, the filler must be substantially of tobaccos unlike those in ordinary cigarettes and must not have any added flavoring which would cause the product to have the taste or aroma generally attributed to cigarettes. The fact that a product does not resemble a cigarette (such as many large cigars do not) and has a distinctive cigar taste and aroma is of considerable significance in making this determination" (*45, 131*).

Pipe Tobaccos

The definition of pipe tobacco used by the U.S. Government was repealed in 1966, and there is no Federal tax on pipe tobaccos. The most popular pipe tobaccos are made of Burley; however, many pipe tobaccos are blends of different types of tobacco. A few contain a significant proportion of midrib parts that are crushed between rollers. "Saucing" material, or casings containing licorice, sweetening agents, sugars, and other flavoring materials are added to improve the flavor, aroma, and smoke taste. These additives modify the characteristics of smoke components (*141*).

Conclusion

Because of the curing and processing methods used in the production of cigar and pipe tobaccos, there are significant physical and chemical differences between pipe and cigar tobaccos and those used in cigarettes. The extent to which these changes may alter the health consequences of smoking pipes and cigars can best be estimated by an analysis of the potentially harmful chemical constituents found in the smoke of these tobaccos, the tumorigenic activity of smoke condensates in experimental animals, and a review of the epidemiological data which have accumulated on the health effects of pipe and cigar smoking.

Chemical Analysis of Cigar Smoke

Only a few studies have been conducted that compare the chemical constituents of cigar smoke with those found in cigarette smoke. Hoffmann, et al. (*60*) compared the yields of several chemical components in the smoke from a plain 85 mm cigarette, two types of cigars, and a pipe. The particulate matter, nicotine, benzo(a)pyrene, and phenols were determined quantitatively in the smoke of these tobacco products. One cigar tested was a 135-mm-long, 7.8-g, U.S.-made cigar. The other was a handmade Havana cigar 147 mm long weighing 8.6 g. The relative content of nicotine in the particulate matter produced by the cigars was similar to that of the cigarette tars. The benzo(a)pyrene and phenol concentrations in the cigar condensate was two to three times greater than in cigarette tar. Kuhn (*78*) compared the alkaloid and phenol content in condensates from an 80-mm bright-blend cigarette sold commercially in Austria with that obtained from 103-mm cigars. These were tested with and without the use of a cellulose acetate filter. The concentrations of total alkaloids and phenol in the cigar smoke condensate were essentially the same as in the cigarette condensate, but pyridine values were about 2 1/2 times higher in the cigar condensate.

Campbell and Lindsey (*21*) measured the polycyclic hydrocarbon levels in the smoke of a small popular-type cigar 8.8 cm long, weighing

TABLE 3.—A comparison of several chemical compounds found in the mainstream smoke of cigars, pipes, and cigarettes

Compound	Micrograms per 100 g. of tobacco consumed		
	Cigars	Pipes[1]	Cigarettes
Acenaphthylene	1.6	29.1	5.0
Anthracene	11.9	110.0	10.9
Pyrene	17.6	75.5	12.5
3,4-benzpyrene	3.4	8.5	.9

[1]With a light pipe tobacco.
SOURCE: Campbell, J.M., (*21*).

1.9 g. Significant quantities of anthracene, pyrene, fluoranthene, and benzo(a)pyrene were detected in the unsmoked cigar tobacco, in concentrations much greater than those found in Virginia cigarettes but of the same order as those found in some pipe tobaccos. The smoking process contributed considerably to the hydrocarbon content of the smoke. Table 3 compares the concentrations in the mainstream smoke of cigarettes, cigars, and pipes of four hydrocarbons frequently found in condensates. The authors reported that the mainstream smoke from a popular brand of small cigar contained the polycyclic aromatic hydrocarbons: acenaphthylene, phenanthrene, anthracene, pyrene, fluoranthene, and benzo(a)pyrene. The concentrations of these hydrocarbons in the mainstream smoke were greater than those found in Virginia cigarette smoke.

Osman, et al. (*94*) analyzed the volatile phenol content of cigar smoke collected from a 7-g American-made cigar with domestic filler. After quantitative analysis of phenol, cresols, xylenols, and meta and para ethyl phenol, the authors concluded that the levels of these compounds were generally similar to those reported for cigarette smoke. Osman and Barson (*93*) also analyzed cigar smoke for benzene, toluene, ethyl benzene, m-, p-, and o-xylene, m- and p-ethyltoluene, 1,2,4-trimethylbenzene, and dipentene and generally found levels within the range of those previously reported for cigarette condensates.

Brunnemann and Hoffmann (*18*) found that the mainstream smoke from regular and small cigars contains more carbon monoxide per puff and per gram of tobacco burned than filtered or unfiltered cigarettes. This greater production of carbon monoxide was confirmed by Harke (*54*).

In summary, available evidence suggests that cigar smoke contains many of the same chemical constituents, including nicotine and other

alkaloids, phenols, and polycyclic aromatic hydrocarbons as are found in cigarette smoke. Most of these compounds are found in concentrations which equal or exceed levels found in cigarette tar.

Mortality

Overall Mortality

Several large prospective studies have examined the health consequences of various forms of smoking and the results of these investigations have been reviewed in previous reports of the Surgeon General in which the major emphasis was on cigarette smoking and its effect on overall and specific mortality and morbidity. The following pages present a current review of the health consequences of smoking pipes and cigars. Data from the prospective investigations of Dunn, et al. (*40*), Buell, et al. (*20*), Hirayama (*58*), and Weir and Dunn (*134*) are not cited because in these studies a separate category for pipe and cigar smokers was not established.

The smoking habits and mortality experience of 187,783 white men between the ages of 50 and 69, followed for 44 months, were reported by Hammond and Horn (*53*). The overall mortality rates of men who smoked pipes or cigars were slightly higher than the rates of men who never smoked. The overall mortality rate of cigar smokers was slightly higher than that of pipe smokers.

Doll and associates (*34, 35, 38*) followed the mortality of 41,000 British physicians for 20 years and reported an overall mortality ratio of 1.09 for men who smoked only pipes and cigars and who had never been cigarette smokers. When compared to nonsmokers, the mortality ratio for mixed smokers of cigarette, pipe, and cigar was 1.20. This represents a slight increase in the ratios since the report of the 10-year follow-up. Best (*11*), in a study of 78,000 Canadian veterans, reported overall mortality rates of pipe and cigar smokers slightly above those of nonsmokers. Rogot (*104*), in an update of Kahn's study of over 293,000 U.S. veterans, found that pipe smokers had only a minimally increased risk of death when compared to nonsmokers, but the risk for cigar smokers was substantially higher. The risk for combined pipe and cigar smoking was between the risks of either one separately. Hammond (*50*) examined the smoking habits of and mortality rates experienced by 440,559 men and found that pipe smokers experienced mortality rates similar to those of men who never smoked regularly, whereas cigar smokers had death rates somewhat higher than men who never smoked regularly. Table 4 summarizes some of the results of those studies.

Thus, data from the major prospective epidemiological studies demonstrate that the use of pipes and cigars results in a small but definite increase in overall mortality. Cigar smokers have somewhat higher death rates than pipe smokers, and mixed smokers who use

TABLE 4.—Mortality ratios for total deaths by type of smoking (males only)

Author, reference	Smoking type							
	Non-smoker	Cigar only	Pipe only	Cigar and pipe	Cigarette and cigar	Cigarette and pipe	Mixed (cigarette and other)	Cigarette only
Hammond and Horn[1] (*52*)	1.00	1.22	1.12	1.10	1.36	1.50	1.43	1.68
Doll and Peto (*38*)	1.00	....	....	1.09	....	....	1.20	1.64
Best (*11*)	1.00	1.06	1.05	.98	1.22	1.26	1.13	1.54
Kahn (*69*)	1.00	1.10	1.07	1.08	....	....	1.51	1.84
Hammond[2] (*50*)	1.00	1.25	1.19	1.01	....	....	1.57	1.86

[1]Only mortality ratios for ages 50 to 69 are presented.
[2]Only mortality ratios for ages 55 to 64 are presented.

cigarettes in addition to pipes and cigars appear to experience an intermediate level of mortality that approaches the mortality experience of cigarette smokers.

Mortality and Dose-Response Relationships

A consistent association exists between overall mortality and the total dose of smoke a cigarette smoker receives. The methods most frequently used to measure dosage of tobacco products are: amount smoked, degree of inhalation, duration of smoking experience, age at initiation, and the amount of tar in a given tobacco product. For cigarette smokers, the higher the dose as measured by any of these parameters, the greater the mortality. The significance of the small increase in overall mortality that occurs for the entire group of pipe and cigar smokers can be analyzed by examining the mortality of subgroups defined by similar measures of dosage as used in the study of cigarette smokers.

Amount Smoked

Hammond and Horn (*52*) reported an increase in the overall mortality of pipe and cigar smokers with an increase in the amount smoked. Individuals who smoked more than four cigars a day or more than two pipefuls a day had death rates significantly higher than men who never smoked ($P < 0.05$ for cigar smokers and $P < 0.05$ for pipe smokers) (Table 5). Cigar and pipe users who smoked less than this amount experienced an overall mortality similar to men who never smoked. The study of Canadian veterans (*11*) also contained evidence of a dose-response in mortality by amount smoked for cigar smokers. No dose-response relationship was observed among pipe smokers (Table 6). Kahn (*69*) reported a consistent increase in overall mortality with an increase in the amount smoked for both pipe and cigar smoke

TABLE 5.—Mortality ratios for total deaths of cigar and pipe smokers by amount smoked

Amount smoked	Number of deaths		
	Observed	Expected	Mortality ratio
Nonsmoker	1,664	1,664	1.00
Cigar only:			
Total	653	598	1.09
1 to 4 cigars	410	400	1.03
> 4 cigars	229	185	1.24
Pipe only:			
Total	609	560	1.09
1 to 10 pipefuls	391	374	1.05
> 10 pipefuls	204	172	1.19

SOURCE: Hammond, E.C., Horn, D. (*52*).

(Table 7). Hammond (*50*) found no consistent relationship between overall mortality and the number of cigars or pipefuls smoked (Table 8).

The above evidence suggests that a dose-response relationship may exist between the number of cigars and pipefuls smoked and overall mortality. However, because of the high-mortality rate of ex-smokers of cigars and pipes, it is difficult to interpret the data presented without including this group with the continuing smokers. Without data which examine patterns of both daily rate of smoking and inhalation at various age levels, no firm conclusions can be drawn as to the nature of this dosage relationship.

Inhalation

Inhalation of tobacco smoke directly exposes the bronchi and the lungs to smoke and results in the absorption of the soluble constituents of the gas and particulate phases. Without inhalation, tobacco smoke reaches mainly the oral cavity and some upper digestive and respiratory tracts but it does not reach the lungs where further direct effects and systemic absorption of various chemical compounds can occur.

The condensate of pipe and cigar smoke is generally found to be alkaline when the pH is measured by suspending a Cambridge filter in CO_2-free water. Cigarette condensate is slightly acidic as measured by this method. Since alkaline smoke is more irritating to the respiratory

TABLE 6.—Mortality ratios for total deaths of cigar and pipe smokers by amount smoked

Amount smoked	Number of deaths		
	Observed	Expected	Mortality ratio
Nonsmoker	—	—	1.00
Cigar only:			
Total	90	82.07	1.10
1 to 2 cigars	64	56.05	1.14
3 to 10 cigars	23	19.40	1.19
> 10 cigars	1	1.59	.63
Pipe only:			
Total	570	566.99	1.00
1 to 10 pipefuls	374	370.09	1.01
10 to 20 pipefuls	141	140.84	1.00
> 20 pipefuls	36	35.90	1.00

SOURCE: Best, E.W.R. (*11*).

tract, it has been assumed that the more alkaline smoke of pipes and cigars was in part responsible for the lower levels of inhalation reported by pipe and cigar smokers. Brunnemann and Hoffmann (*19*) have analyzed the pH of whole, mainstream smoke of cigarettes and cigars on a puff-by-puff basis using a pH electrode suspended in mainstream smoke. Smoke from several U.S. brands of cigarettes was found to be acidic throughout the entire length of the cigarette. Of interest was the finding that cigar smoke also had an acidic pH for the first two-thirds of the cigar and became alkaline only in the last 20 to 40 percent of the puffs from the cigar. Epidemiological evidence indicates that most cigar smokers do not inhale the smoke while most cigarette smokers do. The fact that smoke from the first half or more of a cigar is acidic, near the range of pH values commonly found in cigarette smoke, and becomes alkaline only toward the end of the cigar might suggest that the pH of the smoke of a tobacco product may not be the only factor that influences inhalation patterns. Perhaps tar and nicotine levels as well as the concentration of other irritating chemicals also affect the degree to which a tobacco smoke will be inhaled.

Nicotine is rapidly absorbed into the blood stream from the lungs when tobacco smoke is inhaled. The amount of nicotine absorbed from the lungs is primarily a function of the nicotine concentration in the

TABLE 7.—Mortality ratios for total deaths of cigar and pipe smokers by age and amount smoked

Amount smoked	Mortality ratio, age	
	55 to 64	65 to 74
Nonsmoker	1.00	1.00
Cigar only:		
Total	1.01	1.08
1 to 4 cigars per day	.89	1.00
5 to 8 cigars per day	1.14	1.23
> 8 cigars per day	1.65	1.28
Pipe only:		
Total	1.08	1.06
1 to 4 pipefuls per day	1.16	.91
5 to 19 pipefuls per day	1.04	1.10
> 19 pipefuls per day	1.04	1.18

SOURCE: Kahn, H.A. (*69*).

TABLE 8.—Mortality ratios for total deaths of cigar and pipe smokers by amount smoked

Amount smoked	Mortality ratio	Amount smoked	Mortality ratio
Nonsmoker	1.00	Current pipe smokers:	
Current cigar smokers:		Total	1.04
Total	1.09	1 to 9 pipefuls per day	1.08
1 to 4 cigars per day	1.03	> 9 pipefuls per day	.92
> 4 cigars per day	1.18		

SOURCE: Hammond, E.C. (*50*)

smoke and the depth of inhalation. Some nicotine may also be absorbed through the mucous membranes of the mouth. This is more likely to occur under alkaline conditions when nicotine is unprotonated (*4, 19, 108*). This suggests that cigar smokers may absorb some nicotine through the oral cavity without inhaling, particularly during the time

that the smoke from the cigar is alkaline. With the development of sensitive measures of serum nicotine levels (*65*), the extent to which nicotine is absorbed through the membranes of the mouth in pipe and cigar smokers can be more accurately determined.

Inhalation patterns of smokers were determined in several of the large prospective and some of the retrospective epidemiological studies. Inhalation was usually determined by the administration of a questionnaire that required a subjective evaluation of one's own patterns of inhalation. Although the accuracy of these questionnaires has not been confirmed by an objective measure of inhalation, such as carboxyhemoglobin or serum nicotine levels, their reliability is supported by mortality data which demonstrate higher overall and specific death rates with self-reported increases in the depth of inhalation.

Doll and Hill (*34*) and Hammond (*50*) presented information on inhalation patterns of pipe, cigar, and cigarette smokers. Some 80 to 90 percent of cigarette smokers reported inhaling, the majority inhaling moderately or deeply, whereas more pipe and cigar smokers denied inhaling at all. For each type of smoking, less inhalation was reported by older smokers. This change may represent less awareness of inhalation, differences in smoking habits of successive cohorts of smokers, or it may reflect the operation of selective factors which favor survival of noninhalers.

The Tobacco Research Council of the United Kingdom has, since 1957, periodically reported the use of tobacco products by the British. Recent reports edited by Todd have contained data on the inhalation pattern of cigar, pipe, and cigarette smokers (*126*, *127*, *128*). Table 9 shows that most cigarette smokers inhale a "lot" or "fair amount" whereas most pipe and cigar smokers do not inhale at all or "just a little." Little change is observed in the inhalation patterns of a given product since 1968.

Carbon monoxide is poorly absorbed by the oral mucosa and, therefore, carboxyhemoglobin levels represent a good measure of the degree of inhalation of a given smoker. Several investigators (*22*, *68*, *101*) have found that pipe and cigar smokers have lower levels of carboxyhemoglobin than cigarette smokers and that the levels in pipe and cigar smokers who have never smoked cigarettes approach the levels found in nonsmokers.

The overall mortality rates of current pipe smokers who inhaled at least slightly were reported by Hammond (*50*) as being somewhat higher than for men who never smoked regularly. The overall mortality rates of current cigar smokers who reported inhaling at least slightly were appreciably higher than for men who never smoked regularly.

Evidence indicates that cigarette smokers inhale smoke to a greater degree than smokers of cigars or pipes. Once a smoker has learned to

TABLE 9.—The extent of inhaling pipes, cigars, and cigarettes by British males aged 16 and over in 1968 and 1971

Amount of inhalation	Tobacco product					
	Cigars		Pipes		Cigarettes	
	1968	1971	1968	1971	1968	1971
Inhale a lot	23	19	8	8	47	47
Inhale a fair amount	16	19	10	8	31	30
Inhale just a little	27	27	24	26	13	15
Do not inhale at all	34	35	59	58	9	8
Total	100	100	100	100	100	100

SOURCE: Todd, G.F. (*127,128*)

inhale cigarettes, however, there appears to be a tendency also to inhale the smoke of other tobacco products. For cigars, this is evidently true whether one smokes both cigarettes and cigars or switches from cigarettes to cigars.

Bross and Tidings (*17*) examined the inhalation patterns of smokers of large cigars and cigarettes and those who switched from one tobacco product to another. Nearly 75 percent of those currently smoking only cigarettes reported inhaling "almost every puff" and only 7 percent never inhaled. The opposite was true for persons who had always smoked only cigars, among whom 4 percent reported inhaling almost every puff and 89 percent saying they never inhaled. Cigar smokers who also smoked cigarettes reported intermediate levels of inhalation between the cigar-only and cigarette-only categories. Inhalation patterns were similar whether the individual continued to smoke both products, stopped smoking cigarettes but continued smoking cigars, or stopped smoking cigarettes and switched to cigars. In all three groups, about 20 percent reported inhaling "almost every puff." This suggests that, once an individual's inhalation patterns are established on cigarettes, he may be more likely to inhale cigar smoke if he switches to cigars or uses both cigars and cigarettes than the cigar smoker who has not smoked cigarettes.

Todd (*128*) reported similar data for a sample of smokers in the United Kingdom. The prevalence of inhaling a "lot" or "fair amount" of smoke was highest among cigarette smokers who were currently smoking cigarettes (77 percent) and lowest among current cigar smokers who had previously smoked only cigars or pipes (18 percent). Individuals who switched from cigarettes to cigars maintained somewhat higher levels of cigar smoke inhalation than those cigar smokers who had never smoked cigarettes (30 percent).

TABLE 10.—Mortality ratios for total cancer deaths in cigar and pipe smokers. A summary of prospective epidemiological studies

Author, reference	Type of smoking				
	Nonsmoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only
Hammond and Horn (*52*)....	1.00	1.34	1.44	....	1.97
Best (*11*).....	1.00	1.13	1.38	....	2.06
Hammond (*50*).....	1.00	....	....	1.21	1.76
Kahn (*69*).....	1.00	1.22	1.25	1.25	2.21

Todd (*127*) examined further the relationship between the inhalation of cigarette and cigar smoke. In general, cigarette smokers who switched to cigars were much less likely to report inhaling cigar smoke than cigarette smoke; however, those who in the past reported inhaling cigarette smoke a "lot" or "fair amount" were much more likely to report inhaling cigar smoke to the same degree than those ex-cigarette smokers who in the past did not inhale the smoke of their cigarettes.

This evidence has been confirmed by measuring carboxyhemoglobin levels in former cigarette smokers who now smoke cigars or pipes. Castleden and Cole (*22*) found that men who had smoked cigars or a pipe, but who had not previously smoked cigarettes, had carboxyhemoglobin levels similar to urban nonsmokers. However, men who had switched from cigarettes to pipes or cigars had levels comparable to cigarette smokers. This was true even in those pipe and cigar smokers who denied inhaling. Cowie, et al. (*25, 26*) found similar results in eight subjects who had recently switched to cigars; seven subjects had similar carboxyhemoglobin levels before and after switching from smoking cigarettes to cigars. Smokers who inhale cigars have been found to have carboxyhemoglobin levels even higher than those found in cigarette smokers who inhale (*46, 68*).

Specific Causes of Mortality

Cancer

Several prospective epidemiological studies have shown a significantly higher overall cancer mortality among pipe and cigar smokers compared to the cancer mortality of nonsmokers (Table 10).

Pipe and cigar smokers have much higher rates of cancer at certain sites than at others. The upper airway and upper digestive tracts appear to be the most likely target organs. The relationship of pipe and

cigar smoking to the development of specific cancers is summarized below.

Cancer of the Lip

Approximately 1,500 new cases of cancer of the lip are reported each year. Because of the possibility of early detection and surgical accessibility of cancers in this area, there are less than 200 deaths from cancer of the lip each year in the United States. Some of the earliest scientific investigations exploring the association between tobacco use and disease examined the smoking patterns of individuals with cancer of the lip.

Broders (*16*) in 1920 examined the smoking habits of patients in a retrospective study of 526 cases of epithelioma of the lip and 500 controls. Of the cancer cases, 59 percent smoked pipes, whereas this was true for only 28 percent of the controls. No association was found between cigar or cigarette smoking and cancer of the lip.

In a retrospective study of 439 clinic patients with cancer of the lip and 300 controls conducted in Sweden, Ebenius (*41*) reported a significant association between pipe smoking and cancer of the lip. A total of 61.8 percent of the lip cancer cases smoked pipes, while only 22.9 percent of the controls smoked pipes. No association was found between the use of cigarettes, cigars, or chewing tobacco and cancer of the lip.

In other retrospective studies, Levin, et al. (*80*) and Sadowsky, et al. (*105*) reviewed cases of cancer of the lip. In both studies, a strong association was found between pipe smoking and cancer of the lip but no significant association was found between the use of tobacco in other forms and cancer at this site. Other studies support their findings (*70, 121, 142*).

In summary, it appears that there are several factors involved in the etiology of cancer of the lip. Among the various forms of tobacco use, pipe smoking, either alone or in combination with other forms of smoking, seems to be a cause of cancer of the lip. Table 11 summarizes the results of these retrospective studies.

Oral Cancer

The lips, oral cavity, and pharynx are the sites most consistently exposed to tobacco smoke. Data from the epidemiological studies suggest that little difference exists between the smoking of cigarettes, pipes, or cigars and the risk of developing oral cancer.

Hammond and Horn (*52*) examined the association between smoking in various forms and cancer of the combined sites of lip, mouth, pharynx, larynx, and esophagus. The mortality ratios were 5.00 for cigar smokers, 3.50 for pipe smokers, and 5.06 for cigarette smokers, compared to nonsmokers.

TABLE 11.—Relative risk of lip cancer for men, comparing cigar, pipe, and cigarette smokers with nonsmokers. A summary of retrospective studies

Author, reference	Number		Relative risk ratio and percentage of cases and controls by type of smoking					
			Non-smoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only	Mixed
Broders (*16*):		Relative risk	1.0	0.8	4.3	....	0	....
Cases	537	Percent cases	7	19	41	....	1	....
Controls	500	Percent controls	4	16	6	....	26	....
Ebenius (*41*):		Relative risk	1.0	.7	4.1	0.5	....	....
Cases	439	Percent cases	49	6	41	4	....	....
Controls	300	Percent controls	65	12	13	10	....	....
Levin (*80*):		Relative risk	1.0	1.9	2.9	....	1.4	....
Cases	143	Percent cases	15	27	48	....	45	....
Controls	554	Percent controls	22	20	24	....	46	....
Sadowsky (*105*):		Relative risk	1.0	1.1	4.3	2.6	1.4	0.4
Cases	571	Percent cases	8	2	18	6	44	22
Controls	615	Percent controls	13	3	7	4	53	19
Wynder [1] (*142*):		Relative risk	0	.8	1.8	....	1.0	2.2
Cases	14	Percent cases	0	7	29	....	36	29
Controls	115	Percent controls	24	9	16	....	36	13
Staszewski (*121*):		Relative risk	1.0	....	....	2.1	2.4	....
Cases	394	Percent cases	7	....	....	12	73	....
Controls	912	Percent controls	13	....	....	11	61	....
Keller (*70*):		Relative risk	1.0	1.4	4.0		2.6	
Cases	301	Percent cases	7	2	6	1	60	6
Controls	265	Percent controls	17	4	3	0	53	0

[1]Percentage based on less than 20 patients. Ratios: relative to cigarette smokers.

Doll and Peto (*38*) reported the mortality for all respiratory cancers except lung and found mortality ratios of 9 for pipe and cigar smokers who had never smoked cigarettes, 10 for pipe and cigar smokers who had smoked cigarettes, and 14 for cigarette smokers.

A detailed analysis of oral cancer was presented by Kahn (*69*) who differentiated between cancer of the oral cavity and cancer of the pharynx. The mortality ratios for oral cancers were 1.00 for those who never smoked, 3.89 for all pipe and cigar smokers, and 4.09 for cigarette smokers. A further breakdown of the pipe and cigar smokers demonstrated a mortality ratio of 4.11 for cigar smokers, 3.12 for pipe smokers, and 3.89 for smokers of pipes and cigars. For cancer of the pharynx, the mortality ratios were 1.00 for those who never smoked, 3.06 for all pipe and cigar smokers, and 12.5 for cigarette smokers. No deaths occurred among those who smoked only cigars. The mortality ratio was 1.98 for pipe smokers. Hammond (*50*) combined cancers of

TABLE 12.—Mortality ratios for oral cancer in cigar and pipe smokers. A summary of prospective epidemiological studies

Author, reference	Smoking type					
	Non-Smoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only	Mixed
Hammond and Horn[1] (*52*)	1.00	5.00	3.50	....	5.06	....
Doll and Hill[2] (*38*).....	1.00	....	....	[3]9.00	14.00	10.00
Hammond (*50*)	1.00	....	....	4.94	9.90[3]	....
Kahn (*69*):						
Oral[4]	1.00	4.11	3.12	3.89	4.09	....
Pharynx	1.00	....	1.98	3.06	12.54	....

[1]Combines data for oral, larynx, and esophagus.
[2]Figures for all non-lung respiratory cancers.
[3]Mortality ratios for ages 45 to 64 only are presented.
[4]Excludes pharynx.

the lip, oral cavity, and pharynx. The pipe and cigar smokers had a mortality ratio of 4.94 and the cigarette smokers a mortality ratio of 9.90 compared to nonsmokers.

These studies are summarized in Table 12. They demonstrate that smokers experience a large and significant risk of developing cancer of the oral cavity compared to nonsmokers. This risk seems to be about the same for all smokers whether an individual uses a pipe, cigar, or cigarette.

Several epidemiological investigations have demonstrated an association between the combined use of alcohol and tobacco and the development of oral cancer. A few of these studies (*71, 82, 83, 138*) contain data on pipe and cigar smokers. Heavy smoking and heavy drinking are associated with higher rates of oral cancer than are seen with either habit alone.

Cancer of the Larynx

Because of its proximity to the oral cavity, the larynx probably has an exposure to smoke drawn through the mouth similar to that of the buccal cavity and pharynx. Tobacco smoke that is not inhaled may still reach as far as the larynx and upper trachea. Pipe and cigar smokers develop cancer of the larynx at rates comparable to those of cigarette smokers, i.e., several times those of nonsmokers. The similarity of the mortality ratios of cancer of the larynx for smoking in various forms

suggests that the carcinogenic potentials of the smoke from cigars, pipes, and cigarettes are quite alike at this site.

Several of the prospective epidemiological studies include data on deaths from cancer of the larynx for pipe and cigar smokers as well as for cigarette smokers. Hammond and Horn (*52*) combined data for cancer of the larynx with cancer of the esophagus and oral cavity. The mortality ratios compared to nonsmokers were 5.00 for cigar smokers, 3.50 for pipe smokers, and 5.06 for cigarette smokers. There were no deaths from carcinoma of larynx among nonsmokers in the study of British physicians by Doll and Hill (*34*), but the death rate for cancer of the larynx among pipe and cigar smokers was 0.10 per 1,000 while the death rate for cigarette smokers was 0.05 per 1,000. Kahn (*69*) reported mortality ratios for cancer of the larynx of 10.33 for cigar-only smokers, 9.44 for individuals smoking both pipes and cigars but not cigarettes, 7.28 for all pipe and cigar categories combined, and 9.95 for cigarette-only smokers. No deaths from cancer of the larynx occurred in pipe smokers. Hammond (*50*) reported a mortality ratio of 3.37 for all pipe and cigar smokers and a mortality ratio of 6.09 for cigarette smokers in the age category 45 to 64. Wynder, et al. (*137*, *142*) distinguished between intrinsic and extrinsic larynx cancers.

Histologic changes of the larynx in relation to smoking in various forms were described by Auerbach, et al. (*7*). Microscopic sections of the larynx from 942 subjects were examined for the presence of atypical nuclei and proliferation of cell rows. Sections were taken from four separate areas of the larynx in each case. Among those who smoked cigars and pipes but not cigarettes, only 1 percent had no atypical cells and more than 75 percent of the subjects had lesions with 50 to 69 percent atypical cells. Four of the cigar and pipe smokers had carcinoma *in situ*, and in one of these four cases early invasion was seen in three of the sections. Of those who never smoked regularly, 75 percent had no atypical cells. The cigar and pipe smokers had a percentage of cells with atypical nuclei similar to that of cigarette smokers who smoked one to two packs per day.

Cancer of the Esophagus

The esophagus is not directly exposed to tobacco smoke drawn into the mouth but it does have contact with tobacco smoke that is condensed on the mucous membranes of the mouth and pharynx and then swallowed. The esophagus is also exposed to a portion of tobacco smoke deposited in the mucus cleared from the lung by the ciliary mechanism or by coughing. Variations in inhalation of a tobacco product may not appreciably alter the exposure the esophagus receives from smoke dissolved in mucus and saliva. This possibility receives support from the prospective and retrospective epidemiological studies which demonstrate similar mortality rates for cancer of the esophagus in smokers of cigars, pipes, and cigarettes.

TABLE 13.—Mortality ratios for cancer of the esophagus in cigar and pipe smokers. A summary of prospective epidemiological studies

Author, reference	Smoking type					
	Non-smoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only	Mixed
Hammond and Horn[1] (*52*)	1.00	5.00	3.50	....	5.06	....
Doll and Peto (*38*)	1.00	....	....	3.70	4.70	9.0
Hammond (*50*)	1.00	....	....	3.97	4.17[2]	....
Kahn (*69*)	1.00	5.33	1.99	4.05	6.17	....

[1]Combines data for oral, larynx, and esophagus.
[2]Mortality ratio for ages 45 to 64.

In the prospective epidemiological studies, cigar, pipe, and cigarette smokers had similar mortality ratios for cancer of the esophagus. Hammond and Horn (*52*) combined the categories of carcinoma of the esophagus, larynx, pharynx, oral cavity, and lip and described mortality ratios of 5.00 for cigar smokers, 3.50 for pipe smokers, and 5.06 for cigarette smokers. The 20-year followup of British physicians (*38*) showed mortality ratios for cancer of the esophagus of 3.7 for pipe and cigar smokers, 4.7 for cigarette smokers, and 9.0 for mixed smokers.

Kahn (*69*) reported the following mortality ratios for smoking in various forms compared to nonsmokers: cigar only, 5.33; pipe only, 1.99; pipe and cigar but not cigarettes, 4.17; all pipes and cigars combined, 4.05; and cigarettes only, 6.17. The results of these prospective studies are summarized in Table 13.

Several retrospective investigations have also examined the association between smoking in various forms and cancer of the esophagus. These studies suggest that cigar, pipe, and cigarette smokers develop cancer of the esophagus at rates substantially higher than those seen in nonsmokers and that little difference exists between these rates observed in smokers of pipes and cigars and cigarettes.

Histologic changes in the esophagus in relation to smoking in various forms were investigated by Auerbach, et al. (*9*).

Several retrospective studies conducted in the United States and other countries have examined the synergistic roles of tobacco use and heavy alcohol intake on the development of cancer of the esophagus. Four of these investigations contain data on pipe and cigar smoking (*15, 82, 83, 136*). It appears that smoking in any form in combination

TABLE 14.—Relative risk of cancer of the esophagus for men, comparing cigar, pipe, and cigarette smokers with nonsmokers. A summary of retrospective studies

Author, reference	Number		Relative risk ratio and percentage of cases and controls by type of smoking					
			Non-smoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only	Mixed
Sadowsky (*105*):		Relative risk	1.0	4.8	3.8	5.1	3.8	3.3
Cases	104	Percent cases	4	5	8	6	60	18
Controls	615	Percent controls	13	3	7	4	53	19
Wynder (*142*):		Relative risk	1.0	3.1	2.1	....	2.6	.4
Cases	39	Percent cases	13	15	18	....	51	3
Controls	115	Percent controls	24	9	16	....	36	13
Pernu (*99*):		Relative risk	1.0	....	3.0	....	2.7	5.9
Cases	202	Percent cases	17	....	7	....	59	18
Controls	713	Percent controls	39	....	5	....	50	7
Schwartz (*113*):		Relative risk	1.0	....	2.6	....	11.7	8.6
Cases	249	Percent cases	2	....	2	....	88	7
Controls	249	Percent controls	18	....	7	....	67	7
Wynder and Bross (*136*):		Relative risk	1.0	3.6	9.0	6.0	2.8	3.7
Cases	150	Percent cases	5	19	9	4	51	11
Controls	150	Percent controls	15	16	3	2	55	9
Bradshaw and Schonland (*15*):		Relative risk	1.0	....	4.8	....	2.3	....
Cases	117	Percent cases	15	....	41	....	63	....
Controls	366	Percent controls	32	....	18	....	58	....
Martinez (*82*):		Relative risk	1.0	2.0	....	....	1.5	2.2
Cases	120	Percent cases	8	9	....	....	31	43
Controls	360	Percent controls	14	8	....	....	34	34
Martinez[1] (*83*):		Relative risk	1.0	2.0	2.8	....	1.7	2.5
Cases	346	Percent cases	21	10	15	....	34	34
Controls	346	Percent controls	22	9	1	....	36	25

[1]This study combines data for oral cancer and cancer of the esophagus.

with heavy drinking results in especially high rates of cancer of the esophagus.

Lung Cancer

Several prospective epidemiological studies have demonstrated higher lung cancer mortality ratios for pipe and cigar smokers than for nonsmokers, but the risk of developing lung cancer for pipe and cigar smokers is less than for cigarette smokers. Table 15 presents a summary of these prospective studies.

TABLE 15.—Mortality ratios for lung cancer deaths in male cigar and pipe smokers. A summary of prospective studies

Author, reference	Smoking type					
	Non-smoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only	Mixed
Hammond and Horn (*52*).	1.00	1.02	3.00	....	10.73	7.63
Doll and Peto (*38*).....	1.00	....	....	5.80	14.00	8.20
Best (*11*).....	1.00	2.94	4.35	....	14.91	....
Kahn (*69*).....	1.00	1.59	1.84	1.67	12.14	....

TABLE 16.—Lung cancer death rates for cigar and pipe smokers by amount smoked

Smoking type	Death rate per 100	Number of deaths
Nonsmoker.....	0.07	3
Cigar and pipe:		
1 to 14 g per day.....	.42	12
15 to 24 g per day.....	.45	6
24 g per day.....	.96	3
Cigarette only.....	.96	143

SOURCE: Doll, R., (*34*)

Dose-response relationships such as those that helped demonstrate the nature of the association between cigarette use and lung cancer could not be as thoroughly studied for pipe and cigar smokers because of the relatively few smokers in these categories. Although the number of deaths were few, Doll and Hill (*34*) reported increased death rates from lung cancer for pipe and cigar smokers with increasing tobacco consumption (Table 16). Kahn (*69*) also demonstrated a dose-response relationship for lung cancer by the amount smoked (Table 17).

A few of the retrospective studies contained enough smokers to allow an examination of dose-response relationships for pipe and cigar smoking and lung cancer (*1, 81, 100, 105*). These are summarized in Table 18. An increased risk of developing lung cancer was demonstrated with the increased use of pipes and cigars as measured by amount smoked and inhalation. The retrospective investigation of