TABLE 25.—*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						
			Nonsmoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only	Mixed
Sadowsky, et al. (*77*):		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, et al. (*113*):		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 (*73*):		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, et al. (*84*):		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 (*107*):		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

TABLE 25—*Relative risk of cancer of the esophagus for men, comparing cigar, pipe, and cigarette smokers with nonsmokers. A summary of retrospective studies.*—Continued

Author reference	Number	Relative risk ratio and percentage of cases and controls by type of smoking					
			Nonsmoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only	Mixed
Bradshaw and Schonland (*12*):		Relative risk	1.0	----------	4.8	--------	2.3	----------
Cases	117	Percent cases	15	----------	41	--------	63	----------
Controls	366	Percent controls	32	----------	18	--------	58	----------
Martinez (*62*):		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] (*63*):		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.

Lung Cancer

Abundant evidence has accumulated from epidemiological, experimental, and autopsy studies establishing that cigarette smoking is the major cause of 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 26 presents a summary of these prospective studies. 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 (*26*) reported increased death rates from lung cancer for pipe and cigar smokers with increasing tobacco consumption (table 27). Kahn (*50*) also demonstrated a dose-response relationship for lung cancer by the amount smoked (table 28).

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*, *61*, *74*, *77*). 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 Abelin and Gsell (*1*) is of particular interest. The smoking habits of 118 male patients with cancer of the lung from a rural area of Switzerland were compared with those reported in a survey of all male inhabitants of a town in the same region. About 20 percent of the population of this area were regular cigar smokers, the most popular cigar being the Stümpen, a small Swiss-made machine-manufactured cigar cut at both ends with an average weight of 4.5 g. In this investigation, cigar smokers experienced a risk of developing lung cancer that was similar to the risk of cigarette smokers. A dose-response relationship was demonstrated for inhalation and amount smoked. These data suggest that the heavy smoking of certain cigars may result in a risk of lung cancer that is similar to that experienced by cigarette smokers.

Several pathologists have reported histologic changes in the bronchial epithelium in relation to smoking in various forms. Knudtson (*57*) examined the bronchial mucosa of 150 lungs removed at autopsy and correlated the histologic changes noted with the history of smoking, age, occupation, and residence. Specimens obtained from the six cigar and pipe smokers demonstrated basal cell hyperplasia; however, there was no squamous or atypical proliferative metaplasia as is frequently seen in the heavy cigarette smokers.

Sanderud (*78*) examined histologic sections from the bronchial tree of 100 male autopsy cases for the presence of squamous epithelial

metaplasia. In this study, 39 percent of the population were nonsmokers, 20 percent were pipe smokers, and 38 percent smoked cigarettes. A total of 80 percent of the pipe smokers and cigarette smokers demonstrated squamous metaplasia of the bronchial tree, whereas only 54 percent of the nonsmokers had this abnormality.

Auerbach, et al. (*6*) examined 36,340 histologic sections obtained from 1,522 white adults for various epithelial lesions including: presence or absence of ciliated cells, thickness or number of cell rows, atypical nuclei, and the proportion of cells of various types. The pathologic findings in the bronchial epithelium of pipe and cigar smokers are compared to those found in nonsmokers and cigarette smokers (table 25). Pipe and cigar smokers had abnormalities that were intermediate between those of nonsmokers and cigarette smokers, although cigar smokers had pathologic changes that in some categories approached the changes seen in cigarette smokers.

TABLE 26.—*Mortality ratios for lung cancer deaths in male cigar and pipe smokers. A summary of prospective studies*

Author, reference	Type of smoking					
	Non-smoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only	Mixed
Hammond and Horn (*40*)	1.00	3.35	8.50	----	23.12	19.71
Doll and Hill (*26, 27*)	1.00	----	----	6.14	13.29	7.43
Best (*9*)	1.00	2.94	4.35	----	14.91	----
Hammond (*38*)	1.00	1.85	2.24	1.97	9.20	7.39
Kahn (*50*)	1.00	1.59	1.84	1.67	12.14	----

TABLE 27.—*Lung cancer death rates for cigar and pipe smokers by amount smoked—Doll and Hill*

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., Hill, A. B. (*26*).

TABLE 28.—*Lung cancer mortality ratios for cigar and pipe smokers by amount smoked—Kahn*

Smoking type	Mortality ratio	Number of deaths
Nonsmoker	1. 00	78
Cigar smokers:		
<5 cigars per day	1. 14	12
5 to 8 cigars per day	2. 64	11
>8 cigars per day	2. 07	2
Pipe smokers:		
<5 pipefuls per day	. 77	2
5 to 19 pipefuls per day	2. 20	12
>19 pipefuls per day	2. 47	3
Cigar and pipe:		
8 or less cigars, 19 or less pipefuls	1. 62	18
>8 cigars, >19 pipefuls	2. 19	2

Source: Kahn, H. A. (*60*).

TABLE 29.—*Relative risk of lung 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					
			Nonsmoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only	Mixed
Levin, et al. (*60*):		Relative risk	1.0	0.7	0.8	----------	2.1	----------
Cases	236	Percent cases	15	11	14	----------	66	----------
Controls	481	Percent controls	22	23	25	----------	44	----------
Schrek, et al. (*81*):		Relative risk	1.0	.6	.7	----------	1.7	----------
Cases	82	Percent cases	15	4	5	----------	61	----------
Controls	522	Percent controls	22	23	11	----------	59	----------
Wynder and Graham (*111*):		Relative risk	1.0	5.1	3.6	----------	15.7	----------
Cases	605	Percent cases	1	4	4	----------	91	----------
Controls	780	Percent controls	15	8	12	----------	65	----------
Doll and Hill (*25*):		Relative risk	1.0	----------	5.1	----------	9.6	----------
Cases	1,357	Percent cases	.5	----------	4	----------	74	----------
Controls	1,357	Percent controls	5	----------	7	----------	69	----------
Koulumies (*56*):		Relative risk	1.0	----------	9.6	----------	29.3	----------
Cases	812	Percent cases	.6	----------	2	----------	77	----------
Controls	300	Percent controls	18	----------	6	----------	76	----------
Sadowsky, et al. (*77*):		Relative risk	1.0	2.4	1.4	----------	3.7	5.6
Cases	477	Percent cases	4	2	3	----------	57	31
Controls	615	Percent controls	13	3	7	----------	53	19

Wynder and Cornfield (*110*):		Relative risk	1.0	2.5	4.0		8.5		
Cases	63	Percent cases	4	13	6		77		
Controls	133	Percent controls	21	27	8		45		
Randig (*74*):		Relative risk	1.0	5.3	5.0		5.0		
Cases	415	Percent cases	1	21	11		67		
Controls	381	Percent controls	6	19	11		64		
Mills and Porter (*65*):		Relative risk	1.0			6.0	5.4		
Cases	444	Percent cases	7			37	55		
Controls	430	Percent controls	31			26	43		
Mills and Porter (*66*):		Relative risk	1.0			2.8	4.5		
Cases	484	Percent cases	8			13	78		
Controls	1,588	Percent controls	28			16	57		
Schwartz and Denoix (*82*):		Relative risk	1.0		4.7		13.5		
Cases	430	Percent cases	1		6		96		
Controls	430	Percent controls	11		14		78		
Stocks (*89*):		Relative risk	1.0		3.1		5.0		
Cases	2,101	Percent cases	2		9		89		
Controls	5,960	Percent controls	9		13		78		
Lombard and Snegireff (*61*):		Relative risk	1.0			1.7	8.1		
Cases	500	Percent cases	2			4	95		
Controls	1,839	Percent controls	10			15	75		
Pernu (*73*):		Relative risk	1.0		4.2		9.2		11.1
Cases	1,477	Percent cases	7		4		77		13
Controls	713	Percent controls	39		5		50		7

TABLE 29.—*Relative risk of lung cancer for men, comparing cigar, pipe, and cigarette smokers with nonsmokers. A summary of retrospective studies*—Continued

Author, reference	Number		Relative risk ratio and percentage of cases and controls by type of smoking					
			Nonsmoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only	Mixed
Wicken (*106*):		Relative risk	1. 0	---	---	2. 2	4. 3	4. 2
Cases	803	Percent cases	4	---	---	10	78	7
Controls	803	Percent controls	14	---	---	16	64	6
Abelin and Gsell (*1*):		Relative risk	1. 0	30. 7	21. 8	39. 9	31. 0	24. 7
Cases	118	Percent cases	2	28	7	58	25	24
Controls	524	Percent controls	35	19	6	31	17	10
Wynder, et al. (*115*):		Relative risk	1. 0	---	---	2. 0	12. 4	---
Cases	210	Percent cases	3	---	---	5	92	---
Controls	420	Percent controls	21	---	---	15	47	---

TABLE 30.—*Changes in bronchial epithelium of male cigar, pipe, and cigarette smokers as compared to nonsmokers*

Group	Number of subjects	Sections with epithelium	Percent sections with epithelial lesions	Percent 3 plus cell rows with cilia	Percent atypical cells present	Total sections	Percent hyperplasia and goblet cells in glands
1st set (none vs. pipe vs. cigarette—matched on 1:1 basis):							
Nonsmoker	20	985	21. 7	11. 2	2. 6	1, 031	10. 3
Pipe only	20	924	65. 5	38. 1	37. 0	979	35. 9
Cigarette only	20	914	96. 8	88. 6	95. 2	982	72. 1
2d set (none vs. pipe vs. cigarette—matched on frequency basis):							
Nonsmoker	25	1, 246	22. 9	13. 4	. 7	1, 277	11. 5
Pipe only	25	1, 164	68. 7	38. 7	38. 2	1, 247	37. 9
Cigarette only	25	1, 126	96. 3	88. 7	89. 5	1, 237	75. 5
3d set (none vs. cigar vs. cigarette):							
Nonsmoker	35	1, 706	27. 4	12. 7	. 8	1, 748	15. 3
Cigar only	35	1, 733	90. 8	40. 0	73. 6	1, 828	52. 5
Cigarette only	35	1, 526	99. 0	92. 7	97. 8	1, 693	80. 2

Source: Auerbach et al. (*6*).

Tumorigenic Activity

The tumorigenic activity of tobacco smoke can be modified in both a quantitative and qualitative sense. Physical or chemical changes in tobacco that result in a reduction of total particulate matter upon combusion of a given quantity of tobacco may result in a reduction of carcinogenic potential. Such factors as tobacco selection, treatment, blending, cut, and additives may quantitatively alter tar production. Wrapper porosity and filtration may also affect tar production.

Quantitative changes in the tumorigenic activity of tobacco tar on a gram-for-gram basis can be produced by the selection and treatment of tobacco, the use of additives or tobacco sheets, or adjustments in the cut and packing density.

Combustion temperature can also produce quantitative changes in the particulate matter of tobacco smoke. Although high-temperature burning produces less particulate matter in the smoke, it appears that tumorigenic components occur in higher concentration when tobacco is pyrolized at temperatures higher than 700° centigrade (*34*).

Cigars, pipes, and cigarettes are similar in that they are smoked orally and have a common site of introduction to the body. The tissues of the mouth, larynx, pharynx, and esophagus appear to receive approximately equal exposure to the smoke of these products. Inhalation causes smoke to be drawn deeply into the lungs and also allows for systemic absorption of certain constituents of tobacco smoke which then can be carried further to other organs.

Pipe tobacco and cigars vary from cigarettes in a number of characteristics that can produce both quantitative and qualitative changes in the total particulate matter produced by their combustion. Experimental evidence suggests that although there is some difference in the amount and quality of tar produced by cigars, this cannot account for the reduced mortality observed in cigar smokers compared to cigarette smokers.

Experimental Studies

Several experimental investigations have been conducted to examine the relative tumorigenic activity of tobacco smoke condensates obtained from cigarettes, cigars, and pipes. Most of these studies were standardized in an attempt to make the results of the cigar and pipe experiments more directly comparable with the cigarette data and most used the shaved skin of mice for the application of tar. Tars from cigars, pipes, and cigarettes were usually applied on an equal weight basis so that qualitative differences in the tars could be determined. In several experiments, the nicotine was extracted from the pipe and cigar condensates in an attempt to reduce the acute toxic effects that resulted in animals from the high concentrations of nicotine frequently found in these products.

Wynder and Wright (*117*) examined the differences in tumorigenic activity of pipe and cigarette condensates. Tars were obtained by the smoking of a popular brand of king-size cigarettes and the same cigarette tobacco smoked in 12 standard-grade briar bowl pipes. Both the cigarettes and pipes were puffed three times a minute with a 2-second puff and a 35-ml. volume. Both the cigarettes and pipes attained similar maximum combustion zone temperatures; however, the use of cigarette tobacco in the pipe resulted in a combustion chamber temperature that averaged about 150° centigrade higher than temperatures achieved when pipe tobacco was used. Chemical fractionation was accomplished and equal concentrations of the neutral fraction were applied in three weekly applications to the shaved skin of CAF_1 and Swiss mice. The results indicate that neutral tar obtained from cigarette tobacco smoked in pipes is more active than that obtained in the usual manner from cigarettes. About twice as many cancers were obtained in both the CAF_1 and the Swiss mice, and the latent period was about 2 months shorter.

Extending these data, Croninger, et al. (*20*) examined the biologic activity of tars obtained from cigars, pipes, and cigarettes. Each form of tobacco was smoked as it was manufactured in a manner to simulate human smoking or to maintain tobacco combustion. The whole tar was applied in dilutions of one-to-one and one-to-two with acetone to the shaved backs of female CAF_1 and female Swiss mice using three applications each week for the life-span of the animal. The nicotine was extracted from the pipe and cigar condensates to reduce the acute toxicity of the solutions. The Swiss mice, pipe, cigar, and cigarette tars produced both benign and malignant tumors. The incidence rates of malignant tumors given as percents were: 44, 41, and 37, respectively. These results suggested a somewhat higher degree of carcinogenic activity for cigar and pipe tars than for cigarette tar.

Similar results were reported by Kensler (*53*) who applied condensates obtained from cigars and cigarettes to the shaved skin of mice. The incidence of papillomas produced by cigar smoke concentrate was no different from that of the cigarette smoke condensate. Similarly, there was no difference between cigar and cigarette smoke condensates when carcinoma incidences were compared.

Homburger, et al. (*45*) prepared tars from cigar, pipe, and cigarette tobaccos that were smoked in the form of cigarettes. In this way, all tobaccos were smoked in an identical manner and uniform combustion temperatures were achieved. Because of this standardization, differences in tumor yield could be attributed to tobacco blend and not the manner in which the tars were prepared. The whole tars were diluted one-to-one with acetone and applied to the shaved skin of CAF_1 mice three times a week for the lifespan of the test animal. Skin cancers were produced more quickly with pipe and cigar smoke condensates than with cigarette smoke condensates. This suggests that the smoking

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of pipe and cigar tobaccos in the form of cigarettes does not alter the condensates to any significant degree.

Davies and Day (*22*) prepared tars from small cigars especially manufactured from a composite blend of cigar tobacco representing small cigar brands smoked in the United Kingdom, cigarettes especially manufactured from the same tobacco used for the cigars described above, and plain cigarettes especially manufactured from a composite blend of flue-cured tobacco representing the major plain cigarette brands smoked in the United Kingdom. The whole tar was diluted to four concentration levels and applied to the shaved backs of female albino mice for their lifespan using four dosing regimens. A statistically significant increase in mouse skin carcinogenicity was shown with the cigar smoke condensate compared with the tars obtained from either flue-cured or cigar tobacco cigarettes. These results are consistent with those of the previously reported investigations.

The effect of curing on carcinogenicity was examined by Roe, et al. (*76*). Bright tobacco grown in Mexico was either flue-cured or air-cured and bulk fermented. Both flue-cured and air-cured tobaccos were made into cigarettes standardized for draw resistance and were smoked under similar conditions. Condensates from these cigarettes were applied to mouse skin three times each week in an acetone solution. The development of skin tumors was higher in mice treated with the flue-cured condensate than in mice treated with the air-cured condensate ($P<0.01$). The difference may have been due to the use of equal weights of condensate rather than the use of extracts from an equal number of cigarettes. The air-cured cigarettes produced a greater weight of condensate than did the flue-cured cigarettes. A chemical analysis of the two tobaccos and two condensates revealed only small differences in composition. Evidently air curing of Bright tobacco in the method used is not associated with a loss of reducing sugars.

A more detailed analysis of these experimental studies is presented in table 31.

These experimental data suggest that cigar and pipe tobacco condensates have a carcinogenic potential that is comparable to cigarette condensates. This is supported by human epidemiological data for those sites exposed equally to the smoke of cigars, pipes, and cigarettes. The partially alkaline smoke derived from pipes and cigars is generally not inhaled, and as a result there appears to be a lower level of exposure of the lungs and other systems to the harmful properties of pipe and cigar smoke than occurs with cigarette smoking. It is anticipated that modifications in pipe tobacco or cigars which would result in a product that was more readily inhalable would eventually result in elevated mortality from cancer of the lung, bronchitis and emphysema, arteriosclerotic cardiovascular diseases, and the other conditions which have been clearly associated with cigarette smoking.

TABLE 31.—*Tumorigenic activity of cigar, pipe, and cigarette smoke condensates in skin painting experiments on animals*

[Key: A=Method. B=Frequency. C=Duration. D=Material.]

Author, reference	Animal	Activity	Treatment	Number	Percent	
					Papillomas	Carcinomas
Wynder and Wright (*117*).	CAF_1 and Swiss mice.	A. Painting shaved skin. B. 3 times a week. C. Lifespan (24 months). D. Neutral fraction tar from cigarettes and cigarette tobacco smoked in pipes.	CAF_1: Pipe (cigarette tobacco) Cigarette Swiss: Pipe (cigarette tobacco) Cigarette	30 30 30 30	60 30 63 63	20 3 50 33
Croninger, et al. (*20*).	Female Swiss mice.	A. Painting shaved skin. B. 3 times a week. C. Lifespan. D. Whole tar diluted in acetone.	Cigar, nicotine free (1:1) Pipe, nicotine free (1:1) Cigar (1:2) Pipe, nicotine free (1:2) Cigarette (1:1) Acetone controls	46 45 78 89 86 23	65 71 33 30 47 0	41 44 18 16 37 0
Kensler (*53*)	Swiss mice	A. Painting shaved skin. B. 3 times a week. C. Lifespan. D. Whole tar diluted in acetone.	Cigar tar (J) 100 mg. per week Cigarette tar (G) 100 mg. per week. Cigarette tar (E) 100 mg. per week.	100 100 100	42 40 34	41 28 34

TABLE 31.—*Tumorigenic activity of cigar, pipe, and cigarette smoke condensates in skin painting experiments on animals*—Continued

[Key: A=Method. B=Frequency. C=Duration. D=Material.]

Author, reference	Animal	Activity	Treatment	Number	Percent	
					Papillomas	Carcinomas
Homburger, et al. (*45*).	CAF_1 mice	A. Painting shaved skin. B. 2 to 3 times a week. C. Lifespan (2 years). D. Whole tar diluted 50 percent in acetone.	Cigar tobacco cigarettes [1] 65 mg. per week.	100	37. 5	19
			Pipe tobacco cigarettes [1] 64 mg. per week.	100	23	20
			Cigarettes [1] 62 mg. per week	100	15	23
			Acetone controls	100	0	0
Davies and Day (*22*).	Female albino mice.	A. Painting shaved skin. B. Varied. C. 116 weeks. D. Whole tar in 150 mg. acetone.	Cigars, small 83 mm. long 150 per week.	144	44	27
			Cigar tobacco cigarettes 150 per week.	72	32	14
			Cigarettes 150 per week	144	28	13
Roe, et al. (*76*).	Female Swiss mice.	A. Painting shaved skin. B. 3 times a week. C. Lifespan. D. Whole tar diluted in acetone.	Flue-cured Bright tobacco 180 mg. per week.	400	52	30
			Air-cured Bright tobacco 180 mg. per week.	400	68	23
			Acetone controls 0.75 cc. per week.	400	1. 3	0. 5

[1] Cigar, pipe, and cigarette tobacco smoked as cigarettes at similar combustion temperatures.

Cardiovascular Diseases

The majority of deaths in the United States each year are due to cardiovascular diseases. Cigarette smoking has been identified as a major risk factor for the development of coronary heart disease (CHD). However, pipe and cigar smokers experience only a small increase in mortality from coronary heart disease above the rates of nonsmokers. Cigarette smokers have higher death rates from cerebrovascular disease than nonsmokers, whereas pipe and cigar smokers have cerebrovascular death rates that are only slightly above the rates of nonsmokers. Table 32 summarizes the major prospective epidemiological investigations that examined the association of smoking in various forms and total cardiovascular diseases, coronary heart disease, and cerebrovascular disease. Doll and Hill. (*28*), Best (*9*), and Kahn (*50*) examined dose-response relationships for pipe and cigar smokers and reported a slight increase in mortality from coronary heart disease with an increase in the number of cigars or pipefuls smoked.

Other prospective epidemiological studies have also examined the relationship of smoking in various forms to coronary heart disease and related risk factors. Jenkins, et al. (*49*) in the Western Collaborative Group Study of coronary heart disease, reported an incidence of coronary heart disease in men aged 50 to 59 who were pipe and cigar smokers that was intermediate between the rates seen in cigarette smokers and nonsmokers. No increase in incidence of coronary heart disease was seen among the pipe and cigar smokers in the younger age groups. Shapiro, et al. (*85*), in a study of the health insurance plan (HIP) population, reported incidence rates for myocardial infarction, angina pectoris, and possible MI, in pipe and cigar smokers that were similar to the incidence rates seen in cigarette smokers. These rates were considerably higher than those of nonsmokers. Data from the pooling project (*47*) suggested that the incidence of CHD deaths, sudden death, and the first major coronary event in pipe and cigar smokers was intermediate between the incidence experienced by cigarette smokers and nonsmokers. In contrast to these studies, Doyle, et al. (*30*) reported no increase in CHD deaths, myocardial infarction, or angina pectoris in pipe and cigar smokers over the rates of nonsmokers in the Framingham study.

The retrospective studies of Mills and Porter (*64*), Villiger and Heyden-Stucky (*104*), Schimmler, et al. (*80*), and Hood, et al. (*46*) contained data suggesting that pipe and cigar smokers experience mortality rates from coronary heart disease that are essentially similar to those experienced by cigarette smokers. The retrospective study of Spain and Nathan (*86*) reported lower rates of coronary heart disease in all smoking categories than were found in nonsmokers.

Van Buchem (*103*) and Dawber, et al. (*23*) examined serum cholesterol levels in groups of individuals classified according to smoking

habits. In these two studies, pipe and cigar smokers had serum cholesterol levels that were nearly identical with the levels found in nonsmokers.

Tibblin (*91*) and Dawber, et al. (*23*) investigated the effect of smoking on blood pressure. The proportion of smokers decreased in groups with higher blood pressures, although this was not as dramatic for pipe and cigar smokers as it was for cigarette smokers.

In an experimental study using anesthetized dogs, Kershbaum and Bellet (*54*, *55*) examined the effects of inhaled and noninhaled cigarette, cigar, and pipe smoke on serum free fatty acid levels and urinary catecholamine and nicotine excretion. In this study, inhalation of tobacco smoke from all these sources resulted in similar increases in serum free fatty acids and in catecholamine and nicotine excretion.

TABLE 32.—*Mortality ratios for cardiovascular deaths in male cigar and pipe smokers. A summary of prospective epidemiological studies*

Author, reference	Category	Type of smoking					
		Non-smoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only	Mixed
Hammond and Horn (*40*).	Cardiovascular total.	1.00	1.26	1.07	------	1.57	------
	Coronary	1.00	1.28	1.03	------	1.70	------
	Cerebrovascular	1.00	1.31	1.23	------	1.30	------
Doll and Hill (*26*, *27*).	Cardiovascular total.	1.00	-----	------	0.99	1.26	1.13
	Coronary	1.00	-----	------	.94	1.23	1.18
	Cerebrovascular	1.00	-----	------	.95	1.13	.97
Best (*9*)	Cardiovascular total.	1.00	1.14	.95	------	1.52	------
	Coronary	1.00	.99	1.00	------	1.60	------
	Cerebrovascular	1.00	1.28	.85	------	.88	------
Hammond [1] (*38*).	Cardiovascular total.	1.00	-----	------	1.06	1.90	------
	Coronary	1.00	1.35	1.19	------	1.84	1.58
	Cerebrovascular	1.00	-----	------	1.09	1.41	1.40
Kahn (*50*)	Cardiovascular total.	1.00	1.05	1.06	1.05	1.75	------
	Coronary	1.00	1.04	1.08	1.05	1.74	------
	Cerebrovascular	1.00	1.08	1.09	1.06	1.52	------

[1] Mortality ratios for ages 55 to 64 only are presented.

CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

Chronic bronchitis and pulmonary emphysema account for most of the morbidity and mortality from chronic respiratory disease in the United States. Cigarette smokers have higher death rates from these

diseases and have more pulmonary symptoms and impaired pulmonary function than nonsmokers. Cigarette smokers also have more frequent and more severe respiratory infections than nonsmokers. The relationship between smoking pipes and cigars and these diseases is summarized in this chapter. The major prospective epidemiological studies are summarized in table 33.

In a retrospective study of 1,189 males and matched controls in Northern Ireland, Wicken (*106*) investigated smoking in various forms and mortality from bronchitis. The relative risk ratios compared to nonsmokers for mortality from chronic bronchitis were 1.98 for all smokers, 1.55 for pipe and cigar smokers, 2.25 for cigarette smokers, and 1.49 for mixed smokers.

From a review of these prospective and retrospective studies, it appears that pipe and cigar smokers experience mortality rates from bronchitis and emphysema that are higher than the rates of nonsmokers. Although these morality rates approach those of cigarette smokers, in most instances they are intermediate between the rates of cigarette smokers and nonsmokers.

Pipe and cigar smokers have significantly more respiratory symptoms and illnesses than nonsmokers. Those studies which contain data on pipe and cigar smoking as related to respiratory symptoms are summarized in table 34.

Only a few studies have examined pulmonary function in pipe and cigar smokers. There appears to be little difference in pulmonary function values for pipe and cigar smokers as compared to nonsmokers (table *35*).

Naeye (*67*) conducted an autopsy study on 322 Appalachian coal workers who were classified according to the type of coal mined and tobacco usage. Emphysema was slightly greater in cigarette smokers, as were anatomic evidences of chronic bronchitis and bronchiolitis. Those changes found in pipe and cigar smokers were intermediate between those of cigarette smoking miners and nonsmoking miners.

Changes in pulmonary histology in relation to smoking habits and age were examined by Auerbach, et al. (*8*). Fibrosis, alveolar rupture, thickening of the walls of small arteries, and thickening of the walls of the pulmonary arterioles were found to be highly related to the smoking habits of the 1,340 male subjects examined. The 91 pipe and cigar smokers over the age of 60 were found to have somewhat more alveolar rupture than the men of the same age distribution who never smoked regularly. However, pipe and cigar smokers as a group had far less rupture than cigarette smokers. The same relations as described above were found for fibrosis, thickening of the walls of the arterioles and small arteries, and padlike attachments to the alveolar septums.

Tobacco smoke has been shown experimentally to have a ciliostatic effect on the respiratory epithelium. The interval between puffs, the

amount of volatile and particulate compounds in the smoke, and the exposure volume have been shown to influence the toxic effect of tobacco smoke. Dalhamn and Rylander (*21*) exposed the upper trachea of anesthetized cats to the smoke of cigarettes and cigars, observing the effect on ciliary activity through an incident-light microscope. A chemical analysis of the gas and particulate phases revealed that the cigar smoke was more alkaline and, in general, contained higher concentrations of isoprene, acetone, acetonitrile, toluene, and total particulate matter compared to cigarette smoke. The average number of puffs required to arrest ciliary activity was found to be 73 for the cigarette smoke and 114 for the cigar smoke. The difference is statistically significant ($P < 0.01$). Of the two smokes, the smoke with the highest concentration of volatile compounds was found to be the least ciliostatic. This suggests that the degree of ciliotoxicity of a smoke is not necessarily correlated to the level of one or several of the substances found in the smoke.

Passey, et al. (*70, 71, 72*) studied the effect of smoke from flue-cured cigarette tobacco cigarettes and air-cured cigar tobacco cigarettes on the respiratory system of rats. In two separate but similar experiments, a total of 48 animals were exposed to English cigarette tobacco smoke, 48 were exposed to air-cured cigar tobacco smoke, and 12 were exposed to an air-cured Burley tobacco smoke. The rats in groups were exposed to the specific smoke in a smoke-filled cabinet. Animals exposed to the smoke from air-cured tobaccos remained healthy throughout the experiments, even at high levels of smoke exposure. The three deaths that occurred within this group were from nonrespiratory causes. In both experiments, the rats exposed to cigarette tobacco smoke began to die within 1 or 2 months, and in each experiment most of the animals died within a week or two of the first deaths. At autopsy the rats exposed to flue-cured tobacco smoke on gross examination were found to have greatly enlarged lungs, the trachea was often full of mucus, and there was evidence of pneumonia. On microscopic examination it was found that the trachea and bronchi contained purulent cellular exudates, evidence of metaplastic changes, an absence of cilia, and goblet cell hpyerplasia. Typically, the cause of death was a lobar or bronchopneumonia. The author concluded that, "the smokes of flue-cured tobaccos are more dangerous to man and to animals than those of air-cured tobaccos."

Unfortunately, few details were published concerning the method used to expose the animals to the different types of smoke. The frequency and duration of exposure were not specified, and the extent of actual inhalation of smoke by the different groups of rats was either not determined or not reported. It is also difficult to determine the effect of smoke exposure on the frequency and severity of respiratory infections when animals are exposed to smoke in groups where common exposure occurs. The rat strain used was not identified, but it was noted that animals appeared to suffer from an endemic rat bronchiectasis. It is not known to what extent epidemics of respiratory infections occurred among these animals. Because of these difficulties, no firm conclusion can be drawn concerning the effect of smoking flue-cured or air-cured tobaccos on the incidence of respiratory infections in rats.

TABLE 33.—*Mortality ratios for chronic obstructive pulmonary deaths in male cigar and pipe smokers. A summary of prospective epidemiological studies*

Author, reference	Category	Type of smoking					
		Non-smoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only	Mixed
Hammond and Horn (*40*).	COPD total	1.00	1.29	1.77	-----	2.85	------
	Emphysema	----	-----	-----	-----	----------	
	Bronchitis	----	-----	-----	-----	----------	
Doll and Hill (*26, 27*).	COPD total	----	-----	-----	-----	----------	
	Emphysema	----	-----	-----	-----	----------	
	Bronchitis	1.00	-----	-----	4.00	7.00	6.67
Best (*9*)	COPD total	----	-----	-----	-----	----------	
	Emphysema	1.00	3.33	.75	-----	5.85	------
	Bronchitis	1.00	3.57	2.11	-----	11.42	------
Hammond (*38*)	COPD total	----	-----	-----	-----	----------	
	Emphysema	1.00	-----	-----	1.37	[1] 6.55	------
	Bronchitis	----	-----	-----	-----	----------	
Kahn (*50*)	COPD total	1.00	.79	2.36	.99	10.08	------
	Emphysema	1.00	1.24	2.13	1.31	14.17	------
	Bronchitis	1.00	1.17	1.28	1.17	4.49	------

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

TABLE 34.—*Prevalence of respiratory symptoms and illness by type of smoking*

Author, reference	Number and type of population	Illness	Percent prevalence			
			Non-smoker	Total pipe and cigar	Cigarette only	Mixed
Boake (*10*)	Parents of 59 families.	Cough	32	32	48	------
		Sputum production.	24	15	20	------
		Chest illness	5	4	5	------
Edwards, et al. (*33*).	1,737 male outpatients.	Chronic bronchitis	17	[1]19	31	14
Ashford, et al. (*4*).	4,014 male workers in 3 Scottish collieries.	Bronchitis	10	[1] 35	21	37
		Pneumoconiosis	11	[1] 34	14	2
Bower (*11*)	95 male bank employees.	Cough	0	0	29	------
		Sputum production.	8	15	33	------
		Wheeze	8	31	33	------
		Chest illness	15	54	40	------
Wynder, et al. (*114*).	315 male patients in New York and 315 male patients in California.	Cough (New York).	14	33	56	51
		Cough (California).	22	30	67	66
		Influenza (New York).	11	21	24	------
		Influenza (California).	28	24	31	------
		Chest illness (New York).	9	10	12	------
		Chest illness (California).	7	6	11	------
Densen, et al. (*24*).	5,287 male postal and 7,213 male transit workers in New York City.	Persistent cough	7	11	25	------
		Persistent sputum production.	11	16	26	------
		Dyspnea	16	19	26	------
		Wheeze	14	21	32	------
		Chest illness	13	16	18	------
Cederlof, et al. (*18*).	4,379 twin pairs, all U.S. veterans.	Cough	4	7	17	------
		Prolonged cough	2	4	11	------
		Bronchitis	2	3	10	------
Rimington (*75*).	41,729 male volunteers.	Chronic bronchitis	5	[1] 9	17	------

TABLE 34.—*Prevalence of respiratory symptoms and illness by type of smoking*—Continued

Author, reference	Number and type of population	Illness	Percent prevalence			
			Non-smoker	Total pipe and cigar	Cigarette only	Mixed
Comstock, et al. (*19*).	670 male telephone employees.	Persistent cough	10	16	41	------
		Persistent sputum.	13	20	42	------
		Dyspnea	33	39	44	------
		Chest illness in past 3 years.	14	18	20	------
Lefcoe and Wonnacott (*59*).	310 male physicians in London, Ontario.	Chronic respiratory disease.	9	18	44	------
		Chronic bronchitis	1	12	34	------
		Obstructive lung disease.	1	3	4	------
		Asthma	7	3	6	------
		Rhonchi	0	3	9	------

[1] Figures for pipe only.

TABLE 35.—*Pulmonary function values for cigar and pipe smokers as compared to nonsmokers*

Author, reference	Number and type of population	Function	Type of smoking			
			Non-smoker	Total pipe and cigar	Cigarette only	Mixed
Ashford, et al. (*4*).	4,014 male workers in 3 Scottish collieries.	$FEV_{1.0}$	3. 39	[1] 2. 59	3. 14	2. 62
Goldsmith, et al. (*37*).	3,311 active or retired longshoremen.	Puffmeter	313. 63	299. 26	303. 44	------
		$FEV_{1.0}$	2. 99	2. 80	2. 91	------
		TVC	3. 87	3. 68	3. 88	------
Comstock, et al. (*19*).	670 male telephone employees.	$FEV_{1.0}$	3. 12	3. 26	2. 82	------
Lefcoe and Wonnacott (*59*).	310 male physicians in London, Ontario.	$FEV_{1.0}$	3. 39	3. 17	3. 11	------
		MMFR liters per second.	4. 09	4. 17	3. 64	------

[1] Figures for pipe only.

Cigarette smokers have an increased prevalence of peptic ulcer disease and a greater peptic ulcer mortality ratio than is found in nonsmokers. These relationships are stronger for gastric ulcer than for duodenal ulcer. Cigarette smoking appears to reduce the effectiveness of standard peptic ulcer treatment regimens and slows the rate of ulcer healing. Cigar and pipe smokers experience higher death rates from peptic ulcer disease than nonsmokers. These rates are higher for gastric ulcers than for duodenal ulcers but are somewhat less than those rates experienced by cigarette smokers. Table 31 presents the mortality ratios for ulcer disease in cigar and pipe smokers as reported in the prospective epidemiological studies.

Retrospective or cross-sectional studies by Trowell (*95*), Allibone and Flint (*2*), Doll, et al. (*29*), and Edwards, et al. (*33*) contain data on ulcer disease in pipe smokers as well as cigarette smokers. No association was found between pipe smoking and ulcer disease in these investigations.

TABLE 36.—*Mortality ratios for peptic ulcer disease in male cigar and pipe smokers. Summary of prospective studies*

Author, reference	Illness	Type of smoking					
		Non-smoker	Cigar only	Pipe only	Total pipe and cigar	Cigarette only	Mixed
Hammond and Horn (*40*).	Duodenal ulcer	1.00	0.25	1.67	------	2.16	------
Doll and Hill (*26, 27*).	Gastric ulcer	1.00	-----	-----	4.00	7.00	5.30
Hammond (*38*)	Gastric ulcer	1.00	-----	-----	2.04	2.95	------
	Duodenal ulcer	1.00	-----	-----	.92	2.86	------
Kahn (*50*)	Gastric ulcer	1.00	2.90	2.84	2.48	4.13	------
	Duodenal ulcer	1.00	1.58	1.59	1.39	2.98	------

Little Cigars

In the past year, several new brands of little cigars (weighing 3 pounds or less per 1,000) have appeared on the national market. These cigarette-sized products are manufactured, packaged, advertised, and sold in a manner similar to cigarettes. Little cigars enjoy several legal advantages over cigarettes: They have access to television advertising; they are taxed by the Federal Government and by most States, at much lower rates than cigarettes, resulting in a significant price advantage;

and they do not carry the warning label required on cigarette packages and in cigarette advertising. A market appears to be developing for these products, as there has recently been a sharp increase in the shipment of little cigars destined for domestic consumption (table 37).

It is important to estimate the potential public health impact of these little cigars. An adequate epidemiological evaluation of the effect of little cigar smoking on health could take 10 or 15 years and is probably an impractical consideration; however, a review of the epidemiological, autopsy, and experimental data concerning the health consequences of cigarette, pipe, and cigar smoking summarized in this and previous reports is helpful in considering the potential impact on health of smoking little cigars. An analysis of the chemical constituents suggests that both cigarettes and cigars contain similar compounds in similar concentrations. Two exceptions are reducing sugars, which are not found in quantity in the fermented tobaccos commonly used in cigars, and the pH of the inhaled smoke. The pH of the smoke from U.S. commercial cigarettes is below 6.2 from the first to the last puff, whereas the smoke from the last half of a cigar may reach as high as pH 8 to 9. With increasing pH, nicotine is increasingly present in the smoke as the free base. Skin painting experiments in mice indicate that tumor yields with cigar or pipe "tars" are nearly identical with those obtained with cigarettes "tars". In addition, the epidemiological data suggest that depth of inhalation probably accounts for the fact that cigarettes are so much more harmful than cigars and pipes in contributing to the development of lung cancer, coronary heart disease, and nonneoplastic respiratory disease. For such diseases as cancer of the oral cavity, larynx, and esophagus, where smoke from cigars, pipes, and cigarettes is available to the target organ at comparable levels, the mortality ratios are very similar for all three forms of tobacco use. Several factors, including "tar," nicotine, and the pH of the smoke, probably operate to influence inhalation patterns of smokers. The relative contribution of individual factors to the inhalability of a tobacco product has not been determined.

Smoking those brands of little cigars which can be inhaled by a significant portion of the population in a manner similar to the present use of cigarettes would probably result in an increased risk of developing those pulmonary and cardiovascular diseases which have been associated with cigarette smoking. On the other hand, smoking those little cigars which are used like most large cigars whereby the smoke is rarely inhaled would probably result in lower rates of those pulmonary and cardiovascular diseases than would be found among cigarette smokers.

Only a limited analysis is available comparing the chemical compounds found in little cigars, cigarettes, and large cigars. The FTC analyzed the tar and nicotine content of all the little cigars (*34*) and cigarettes (*97*) currently available on the market. Little cigars have

generally a higher "tar" and nicotine level than cigarettes, although considerable overlap results in some little cigar brands having "tar" and nicotine levels comparable to those of some brands of cigarettes (figs. 4 and 5). Hoffmann and Wynder (*44*) recently compared three brands of little cigars with an unfiltered cigarette, a filtered cigarette, and a large cigar. They measured a number of smoke constituents, including: "tar," nicotine, carbon monoxide, carbon dioxide, reducing sugars, hydrogen cyanide, acetaldehyde, acrolein, pyridines, phenols, benz(a)anthracene, and benzo(a)pyrene (table 32). Cigarette A was the Kentucky reference cigarette, cigarette B was a popular brand of filter cigarette. Cigar A was an 85 mm. little cigar, cigar B was an 85 mm. little cigar, cigar C was a 95 mm. small cigar, and cigar D was a 112 mm. popular brand of medium sized cigar.

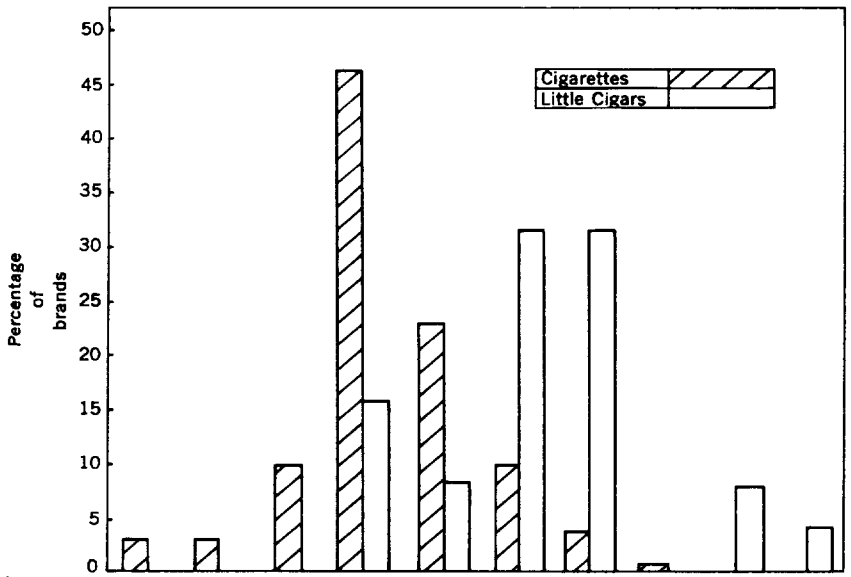
The smoke pH was analyzed puff by puff (table 39). Cigarette smoke was found to be acidic (pH less than 7) for the entire cigarette. The smoke from little cigars became alkaline only in the last puff or two, whereas about the last 40 percent of the puffs from the larger cigar were alkaline. Although the pH of the total condensate obtained from cigarettes is usually acidic and the total condensate obtained from cigars is usually alkaline, the above data indicate that smoke pH of tobacco products changes during the combustion process. Smoke from large cigars may be acidic during the first portion of the smoke and not become alkaline until the last half of the cigar is smoked.

Brunnemann and Hoffmann (*15*), using the same techniques described above, examined the effect of 60 leaf constituents on smoke pH. For several varieties of cigarette tobacco, they found a high correlation between the total aklaloid and nitrogen content and smoke pH. Stalk position also affected smoke pH. Tobacco leaves near the top of the plant, which contain high levels of tar and nicotine, yielded a smoke with a much higher pH than leaves lower on the plant. At present it is not known to what extent these factors influence the pH of the smoke of tobaccos commonly used in cigars or how these kinds of pH changes influence the inhalability of tobacco smoke.

The inhalation of smoke, however, appears to be the most important factor determining the impact a cigar will have on overall health. Those physical and chemical characteristics of a tobacco product which most influence inhalation of tobacco smoke have not been accurately determined. Nevertheless, it appears likely that the smoke of some brands of cigars may be compatible with inhalation by a significant portion of the smoking population, since: (*a*) Little cigars have tar and nicotine levels which, in some brands, are similar to the levels found in cigarettes, and (*b*) the pH of the smoke of some little cigar brands is acidic for the major portion of the little cigar and becomes alkaline only in the last puff or two.

It is reasonable to conclude that smoking little cigars may result in health effects similar to those associated with smoking cigarettes if little cigars are smoked in amounts and with patterns of inhalation similar to those used by cigarette smokers, for the reasons cited above, and these additional reasons: (*a*) In those little cigars for which preliminary data are available, the concentrations of carbon monoxide, hydrogen cyanide, acetaldehyde, acrolein, pyridine, phenol, and polycyclic hydrocarbon levels are comparable to those found in cigarettes; (*b*) cigarette smokers who switch to cigars appear to be more likely to inhale cigar smoke than cigar smokers who have always smoked cigars (*14*); and (*c*) cigarette smokers who switch to little cigars may be inclined to use them as they did cigarettes because of the physical similarities between the little cigars and cigarettes, including their size and shape, the number in a package, the burning rate, and the time it takes to smoke them.

Figure 4.—Percent distribution of 130 brands of cigarettes and 25 brands of little cigars by "tar" content.



Mg. "tar"	0	0	0	16.0	8.0	32.0	32.0	0	8.0	4.0
Cigarettes	0–4	5–9	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49
Little Cigars	3.1	3.1	10.0	46.2	23.1	10.0	3.9	0.8	0	0

SOURCE: U.S. Department of Health, Education, and Welfare (*97*) and Federal Trade Commission (*34*).