Disease Consequences of Cigar Smoking

Thomas G. Shanks and David M. Burns

This chapter is a review of the health effects of cigar use. It is an extension of chapters on pipes and cigars from the 1973 and 1979 Reports of the U.S. Surgeon General entitled the *Health Consequences of Smoking* and the *Smoking and Health* (DHHS 1973; DHHS 1979). Studies published during the last two decades are emphasized, and original analyses of the cigar smoking data subset from the CPS-I study are presented. The tables summarizing research on specific diseases include studies discussed in the previous publications. However, only the studies published since 1976 will be reviewed in this chapter.

Cigar smoking has largely been a male behavior in the US, and so most studies have exclusively utilized male populations. These data should be applied with caution to the increasing numbers of women who are smoking cigars.

Many epidemiological studies combine cigar and pipe smokers together, or combine **primary cigar smokers** [those without prior history of cigarette smoking] with **secondary cigar smokers** [those with varying histories of prior cigarette or pipe smoking] and **mixed smokers** [those who currently smoke cigars and cigarettes or pipes]. These combinations are often made necessary by the small number of cigar smokers present in these studies, but they make the resulting rate comparisons problematic in describing the effect of cigar use. Further, many of the cigar studies have been done in European countries, which have different traditions of cigar smoking, including different tobaccos, differing sizes of cigars, and different levels of inhalation.

DEFINITION OF TERMS The definition of a cigar is given in another section of this monograph (Chapter 3). For this chapter the term means any of the products which are purchased as cigars. **Cheroots**, which are classed with cigars in some studies, are small cigars, made of heavy-bodied tobaccos. For a more complete discussion of tobacco products, plant varieties and manufacture, see the IARC Monograph "Tobacco Smoking" (IARC, 1986; Chapter 3).

A **primary cigar smoker** is a smoker who smokes only cigars and who has never smoked cigarettes or a pipe; these subjects give us the purest estimation of the effect of cigar smoking. A **secondary cigar smoker** currently smokes only cigars, but previously smoked cigarettes and/or a pipe, either in combination with cigars or exclusively. Because of earlier use of other tobaccos, the health effects of cigar smoking derived from secondary cigar smokers may be affected by the earlier pattern of smoking.

The level of **exposure** to cigar smoke is usually measured in cigars per day, which is an imprecise measure because of the varying sizes of cigars. Some studies use a measure of grams smoked per day, weighting varying sizes of cigars differently. Others attempt to quantify lifetime cigar consumption,

using years of cigar smoking or equivalent pack-years of cigarettes, or some other cumulative measure. Level of exposure is also referred to as **intensity** of smoking and **dose**. The comparison of cigarette and cigar exposures is further complicated by the older age of initiation of cigar smoking in comparison to cigarette smoking (Chapter 2) and the profound effect of duration of exposure on disease risk.

Inhalation becomes a critical issue with cigar smoking, since degree of inhalation varies widely among cigar smokers. Many studies provide a self-reported measure of inhalation, such as: none, slightly, moderately, deeply. Such measures are shown to have a degree of validity by the, positive association with rates of some diseases, such as lung cancer. Further studies by Herling and Kozlowski (1988) and Wald and Watt (1997) have shown that self-reported inhalation predicts expired-air carbon monoxide and carboxyhaemoglobin levels, which argues for the validity of self-reported inhalation measures.

The expression $\log(x)$ means the natural log of x. Absolute rates are given in numbers of cases or deaths per 100,000 person-years. The abbreviation OR stands for odds ratio; RR, for risk ratio. Confidence intervals are given for the 95 percent range for the given statistic. When not otherwise indicated, the rates given are for mortality due to disease in the specified classification.

THE CPS-I STUDY The Cancer Prevention Study I of the American Cancer Society, conducted between 1959 and 1972, was one of the largest prospective cohort studies ever undertaken, following more than one million individuals for twelve years (Garfinkel, 1985). Many results from the CPS-I study have been previously published, but for cigar-related mortality rates, only summary rates from the first four years of the follow-up period have been published (Hammond, 1966). The ACS has made this data set available for a more detailed analysis. Because of the size of the data set, the detail of smoking behavior information gathered, and the relatively large number of cigar smokers among the subjects, this study provides an opportunity to consider the relationship of number of cigars per day and inhalation to mortality rates from many diseases. Data from CPS-I was used because of the larger number of cigar smokers in the study in comparison with the CPS-II.

The data gathered on each subject in the CPS-I study includes a smoking history, with age of initiation to cigarette smoking, number of cigarettes/ cigars/pipes smoked per day, and level of inhalation, though no information was gathered about age of initiation of smoking cigars or pipes. Since US mortality rates for blacks are different from those for whites and because blacks are under-represented in the CPS-I study, the analyses of CPS-I data which follow are restricted to white subjects. Further, there are few female cigar smokers in the data set, so the analyses are restricted to white males. The number of subjects in various smoking behavior groups in the CPS-I data set are given in Table 1.

In presenting results from the CPS-I data set, tables are constructed for Mortality Rate Ratios (MRR) for various diseases in order to provide
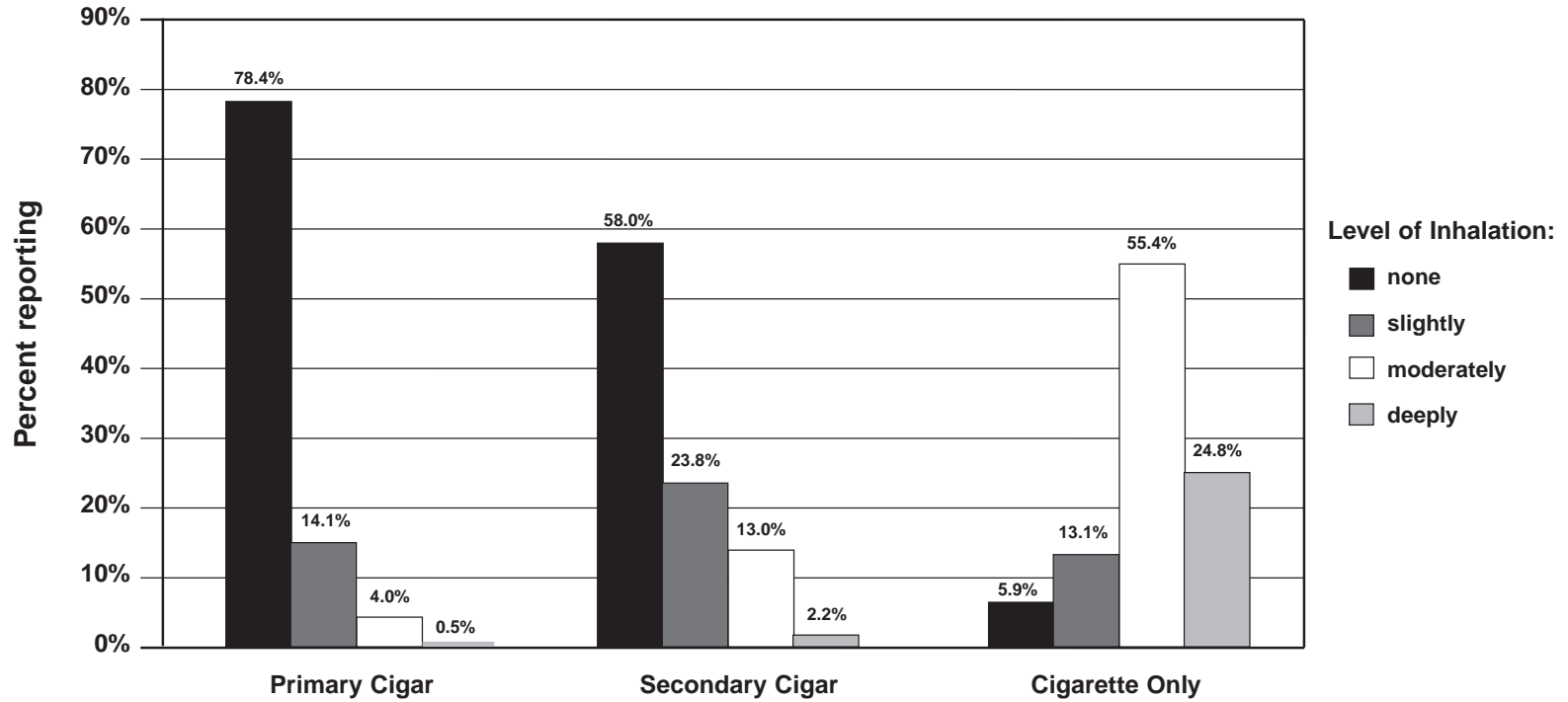
Table 1
Number of subjects in smoking groups in CPS-I Study, white male subjects

Smoking Group	N
Neversmokers	92,307
Current Primary Cigar Smokers	15,191
Current Primary Pipe Smokers	9,623
Current Cigarette Only Smoker	174,997
Current Cigar, Pipe & Cigarette Smokers	3,471
Current Mixed Cigar & Pipe Smokers	6,767
Current Mixed Cigar & Cigarette Smokers	10,294
Current Mixed Pipe & Cigarette Smokers	11,470
Current Secondary Cigar Smokers	7,404
Current Secondary Pipe Smokers	7,033
Former Primary Cigar Smokers	5,446
Former Primary Pipe Smokers	3,549
Former Cigarette Only Smokers	42,225
Former Mixed Cigar & Cigarette	4,649
Former Mixed Pipe & Cigarette	10,724
Former Mixed Cigar & Pipe	3,952
Former Cigar, Pipe & Cigarette Smokers	6,921
Total White Male Subjects	442,455

comparisons between smoking groups. All MRR's compare a smoking group to the neversmoker group and are age-standardized to the neversmoker age distribution from the study. See the appendix on methods for details. All rates given are rates of mortality, as specified by the primary cause of death from the death certificate.

In the tables presenting CPS-I rate ratios, primary and secondary cigar smokers are divided into levels of 1-2, 3-4, and 5 or more cigars per day. Smokers of both cigars and cigarettes have tobacco exposure information available for cigarettes only. Levels of inhalation for all smokers are subjectively reported by the subjects, using the following scale: none, slightly, moderately, deeply. The distribution of these responses for primary and secondary cigar smokers and cigarette only smokers is given in Figure 1 and reveals that cigarette smokers are much more likely to report deep inhalation than primary cigar smokers, with secondary cigar smokers having an intermediate pattern. These inhalation patterns show that primary and secondary cigar smoker rates, when not stratified by levels of inhalation, are dominated by individuals who inhale slightly or not at all; whereas, unstratified cigarette-only smoker rates are dominated by those who inhale moderately or deeply. Degree of inhalation is a continuum, with the subjective evaluation providing only an approximate measure.

Figure 1
Levels of inhalation from CPS-1 study

Table 2

All cause mortality and cigar smoking: mortality ratios by type of smoking (males only, except as noted)

Prospective Studies	Sample Size*	Never-Smoker	Cigar	Mixed, Cigar & Cigarette	Cigarette
			Rate Ratio (RR)		
Hammond & Horn (1958)	187,783	1.0	1.22	1.36	1.68
Doll & Peto (1976)	41,000	1.0	1.09**	1.20	1.64
Best (1966)	78,000	1.0	1.06	1.22	1.54
Kahn (1966)	293,000	1.0	1.10	1.51	1.84
Hammond (1966)	440,559	1.0	1.25	1.57	1.86
Carstensen (1987)	25,129/1,256/131	1.0	1.39 (1.16-1.65)		1.45 (1.36-1.54)
Sandler (1989)	46,926/1,671/504	1.0	1.20** (1.07-1.35)		1.41 (1.29-1.55)
Lange (1992) male	6,511/808/326	1.0	1.6 (1.3-2.0)		1.9 (1.6-2.4) plain 1.8 (1.4-2.3) filter
Lange (1992) female	7,703/770/185	1.0	1.8 (1.4-2.2)		2.4 (2.0-2.9) plain 1.7 (1.4-2.1) filter
Ben-Shlomo (1994) secondary	19,018/658/132	1.0	1.20 (1.01-1.43)		2.00 (1.92-2.07)
Wald & Watt (1997) primary	21,520/1,309/113	1.0	1.23**(0.99-1.75)		2.26 (1.97-2.58)
secondary	21,520/522/69		1.33**(1.03-1.73)		
CPS-I primary	442,455/15,072/3,754	1.0	1.08 (1.05-1.12)	1.47 (1.41-1.53)	1.66 (1.64-1.68)
secondary	442,455/7,349/1,462		1.12 (1.06-1.18)		

for prospective studies reviewed, the number of cigar smokers and number of deaths in this group are also given.
**cigar and pipe combined*

ALL CAUSE There is a consistent pattern of elevated overall mortality for all groups
MORTALITY of smokers, and a dose-response effect for increasing exposure to tobacco
smoke is present in the CPS-I data. The exposure is variously measured as
cigars/cigarettes/pipes per day, grams of tobacco per day, lifetime dose in
pack-years, duration of smoking, etc. and can be further modified by
describing the level of inhalation of smoke.

In a Swedish prospective mortality study which followed 25,129 men
from 1963 through 1979 (Carstensen, 1987), the All-Cause Mortality RR for
cigar-only smokers is 1.39 (1.16-1.65) compared to neversmokers, based on
131 deaths during the follow-up period. The corresponding RR for cigarette-
only smokers is 1.45 (1.36-1.54). The cigar only group is based on smoking
behavior at the time of the initial survey, and thus is a combination of
primary and secondary cigar smokers. The authors note that no information
is available on inhalation patterns of Swedish cigar smokers. Rates are
standardized by age and residence.

In a 12-year follow-up study of 46,926 individuals of both sexes in
Washington County, Maryland (Sandler, 1989) from 1963-1975, for pipe/
cigar smokers a RR of All Cause Mortality of 1.83 (1.13-2.96) was calculated
for men under 50 years of age and 1.13 (1.00-1.28) for men over 50 years of
age, providing an overall rate of 1.20 (1.07-1.35). These rates were adjusted for
age, housing quality, schooling, and marital status. Smoking categories were
based on usage at the time of the 1963 interview and do not reflect prior
history or changes during the follow-up.

Lange et al. (1992) report on the Copenhagen City Heart Study, a Danish
prospective population-based study of 6,511 men and 7,703 women, followed
from 1976 through 1989, which included 1,578 smokers of cheroots/cigars
of both sexes. The questionnaire included an inhalation question (yes/no).
Smoking groups are based on behavior at enrollment and do not distinguish
based on previous smoking. Thus cigar/cheroot includes both primary and
secondary cigar/cheroot smokers. This study found a RR of total mortality
for cigar/cheroot smokers of 1.8 (1.4-2.2) in women and 1.6 (1.3-2.0) in men,
age-adjusted and compared to neversmokers of the same sex. These rates are
somewhat lower than those found for smokers of unfiltered cigarettes, which
were 2.4 (2.0-2.9) for women and 1.9 (1.6-2.4) for men. Mortality rates for
cigar/cheroot smokers with self-reported inhalation were compared with
cigarette smokers who reported inhaling. For those cigar/cheroot smokers
with inhalation, the ratio of total mortality for women was 1.6 (1.2-2.2)
compared to female smokers of cigarettes who inhaled; and 1.0 (0.8-1.2) for
male cigar/cheroot smokers with inhalation compared to male smokers of
cigarettes with inhalation. For cigar/cheroot smokers who do not inhale,
the ratios as compared to inhaling cigarette smokers were 0.6 (0.5-0.8) for
women and 0.7 (0.6-0.8) for men, both significantly lower.

Ben-Shlomo et al. (1994) present smoking results from the Whitehall
prospective cohort study of 19,018 men from the British Civil Service
aged 40-69, with 18 years of follow-up beginning in 1967. Too few primary
cigar smokers (*n*=105) were available for reliable results. Secondary cigar

smokers (*n*=658) produced a significantly elevated age-adjusted RR for all-cause mortality of 1.20 (1.01-1.43) when compared to neversmokers, while current cigarette smokers (*n*=7,921) had a RR of 2.00 (1.92-2.07). The authors note that the RR for secondary cigar smokers is similar to that for former cigarette smokers who had a RR of 1.15 (1.08-1.23). Smoking categories are based on questions at the beginning of the study, with no reclassification during the 18 years of follow-up.

Wald and Watt (1997) compare primary cigar and pipe smokers and secondary cigar and pipe smokers who switched from cigarettes at least 20 years previously to neversmokers, former smokers, and cigarette smokers, using data from a prospective study of 21,520 professional men in London aged 35-64 years, recruited in 1975-82 and followed to October 1993. Compared to neversmokers, primary pipe/cigar smokers have an age-adjusted RR of mortality of 1.23 (0.99-1.75) and secondary pipe/cigar smokers who switched from cigarettes at least 20 years previously have a RR of 1.33 (1.03-1.73), while cigarette smokers have a RR of 2.26 (1.97-2.58). The study includes self-reported inhalation level and carboxyhaemoglobin saturation at initial exam. Comparison of these measures confirm the validity of self-reported inhalation measures; both demonstrate the relatively higher levels of inhalation of secondary cigar and pipe smokers compared to primary (never-cigarette) cigar and pipe smokers. Carboxyhaemoglobin saturation was found to be related to the risk of the three smoking related diseases investigated [coronary heart disease, lung cancer, and COPD] across all smoking categories, and in their analysis explained all of the variance related to smoking. A lower level of mean total tobacco consumption of 8.1 g/day is noted for both primary and secondary pipe and cigar smokers compared to 20.0 g/day for cigarette smokers. Group classification is based on data from the initial examination and does not reflect any changes in smoking behavior during the average 14.3 years of follow-up.

The All Cause Mortality ratios for the CPS-I data are given in Tables 3 and 4, by numbers of cigars/cigarettes per day and level of inhalation. Generally rates are significantly elevated as compared to neversmokers. Only the lowest level of smoking (1-2 cigars per day) fails to show significance in the risk for combined ages for primary and secondary cigar smokers. In every case MRR's are particularly elevated for smokers less than 65 years of age. There are positive gradients with numbers of cigars per day and with levels of inhalation. Rates for moderate and deep inhalers of cigars reach levels similar to cigarette smokers.

In order to assess the relative contributions of age, cigars per day, and inhalation level to the rates of all-cause mortality, the primary cigar smoker data was tabulated into cells by the factors of 5-year chronological age, number of cigars per day (1-2, 3-4, 5+), and level of inhalation (0,1,2,3, as coded for none, slightly, moderately, deeply). For each cell the absolute rate of mortality was calculated. These data were subjected to a step-wise multivariate Poisson regression with each factor and its log square and square root transforms included as factors. The strongest factors in this procedure are shown in Table 5. The purpose was to test the significance of each factor

Table 3
Rate ratio of all-cause mortality by level of cigar/cigarettes per day

Daily Use	Age (years)				Combined (95% CI)	Deaths*
	35-49	50-64	65-79	80+		
PRIMARY CIGAR						3,698/19667
1-2	0.72	1.10	1.02	0.97	1.02 (0.97, 1.07)	
3-4	1.98	1.18	1.10	0.95	1.08 (1.02, 1.15)	
5 +	1.64	1.38	1.17	0.98	1.17 (1.10, 1.24)	
Combined	1.32	1.21	1.09	0.97	1.08 (1.05, 1.12)	
SECONDARY CIGAR						1,452/19667
1-2	0.94	1.08	1.05	0.93	1.02 (0.93, 1.12)	
3-4	1.37	1.57	1.26	0.74	1.17 (1.07, 1.28)	
5 +	1.66	1.66	1.16	0.86	1.18 (1.08, 1.29)	
Combined	1.29	1.43	1.15	0.84	1.12 (1.06, 1.18)	
CIGAR & CIGARETTE						2,225/19667
1-19	1.65	1.68	1.29	1.06	1.31 (1.23, 1.39)	
20	2.73	2.09	1.55	1.49	1.66 (1.55, 1.78)	
21 +	2.73	2.15	1.99	1.11	1.78 (1.61, 1.97)	
Combined	2.30	1.91	1.44	1.15	1.47 (1.41, 1.53)	
CIGARETTE ONLY						38,220/19667
1-19	1.92	1.73	1.50	1.16	1.46 (1.43, 1.49)	
20	2.45	2.15	1.70	1.29	1.69 (1.66, 1.71)	
21 +	2.81	2.48	1.95	1.26	1.88 (1.85, 1.91)	
Combined	2.49	2.17	1.68	1.21	1.66 (1.64, 1.68)	

Based on data from CPS-I Study. Age-standardized rate ratio for smoking group compared to neversmokers.
* Number of deaths in subject group/neversmoker group.

as explanatory terms for the trend in the data, not to propose a model of biological action. More information about the procedure followed is given in the appendix.

Age is the strongest factor, reflecting the positive association of advancing age with mortality. For the inhalation factor, the square and square root transformation were assessed, in addition to the coded variable. The square of depth of inhalation is the most significant of these inhalation transforms, and is the most strongly significant factor in predicting the rate of mortality. The square of inhalation was a better fit than inhalation, emphasizing the effect of inhalation in increasing mortality rates. The number of cigars per day also is a significant factor, though the strength of the association is less than for age or inhalation.

Summary   Risk ratios of All Cause Mortality for cigar smokers are higher than rates for neversmokers, though generally lower than rates observed for cigarette smokers. Cigar smokers who inhale exhibit all cause mortality rates that are higher than the rates for cigar smokers who do not inhale, and the risk ratios for inhaling cigar smoke approach the rates for cigarette smokers. The risk ratios increase with increasing number of cigars smoked per day and increasing depth of inhalation.

Table 4
Rate ratio of all cause mortality by level of inhalation

Level of Inhalation	Age (years)				Combined (95% CI)		Deaths*
	35-49	50-64	65-79	80+			
PRIMARY CIGAR							3,580/19667
None	1.13	1.16	1.05	0.94	1.04	(1.00, 1.08)	
Slight	1.80	1.30	1.19	1.08	1.19	(1.09, 1.30)	
Moderate-deep	1.02	1.87	1.72	1.22	1.60	(1.38, 1.84)	
Combined	1.27	1.22	1.08	0.96	1.08	(1.04, 1.11)	
SECONDARY CIGAR							1,400/19667
None	1.45	1.11	1.13	0.81	1.04	(0.97, 1.11)	
Slight	1.01	1.57	1.18	0.83	1.16	(1.04, 1.29)	
Moderate-deep	1.30	2.18	1.30	0.77	1.33	(1.16, 1.51)	
Combined	1.32	1.40	1.16	0.81	1.11	(1.05, 1.17)	
CIGAR & CIGARETTE							2,344/19667
None, slight	1.98	1.64	1.31	1.07	1.32	(1.24, 1.40)	
Moderate	2.49	1.99	1.58	1.36	1.61	(1.51, 1.73)	
Deep	2.68	2.41	1.92	1.24	1.84	(1.66, 2.03)	
Combined	2.34	1.90	1.45	1.14	1.46	(1.41, 1.52)	
CIGARETTE ONLY							39,825/19667
None, slight	2.04	1.97	1.57	1.14	1.54	(1.50, 1.57)	
Moderate	2.45	2.14	1.68	1.22	1.65	(1.63, 1.67)	
Deep	2.75	2.42	1.92	1.44	1.90	(1.86, 1.94)	
Combined	2.49	2.18	1.68	1.20	1.66	(1.64, 1.68)	

Based on data from CPS-I Study. Age-standardized rate ratio for smoking group compared to neversmokers.
* Number of deaths in subject group/neversmoker group.

CAUSE SPECIFIC MORTALITY   The determination that cigar smoking can cause a specific disease is based on a review of all the available information and draws heavily on the similarities between the composition of cigar and cigarette smoke described in Chapter 3. Data on cigarette smoking and disease risks are much more extensive, and it is probably reasonable to assume that most of the diseases caused by the inhalation of tobacco smoke from cigarettes can be caused by the inhalation of tobacco smoke from cigars. However, this chapter examines the data for a number of causes of death and reaches

Table 5
Results of step-wise poisson regression of absolute all-cause mortality rates

Variable	Coeffecient	SE	F-test	Probability
(Constant)	1.2211	0.00165		
Age (years)	0.09559	0.0000217	1557.2	$<10^{-10}$***
Inhalation^2 (0-3)	0.09887	0.000100	64.5	$<10^{-10}$***
Cigars per day	0.02689	0.0000942	5.4	0.02*

***p<0.0001; **p<0.01; *p<0.05

conclusions about the evidence on cigar smoking and disease based on a number of criteria, including: the replication of a result in more than one study, the presence of a dose response relationship with number of cigars smoked per day and depth of inhalation, the demonstration of independent effects of inhalation and number of cigars per day in a regression modeling of the CPS-I data, and the presence of a relationship in larger and better controlled studies.

LUNG CANCER   The causal link between cigarette smoking and lung cancer has led to a number of studies examining a similar link between cigar and pipe smoking and lung cancer. These studies have demonstrated an elevated risk for lung cancer among cigar smokers, but the magnitude of the risk is lower than that for cigarette smokers. The 1979 review article provides references to studies up to that time (DHHS, 1979). Table 6 summarizes the case-control and prospective studies of lung cancer and cigar smoking.

Joly, Lubin, and Caraballoso (1983) conducted a case-control study of male and female lung cancer cases in Cuba, in part focused on differentiating level of risk between dark Cuban and lighter Virginia tobaccos. Analyses are provided for male cigar only and mixed cigar and cigarette smokers. No separation is made between primary and secondary cigar smokers. Controls are a mixed group of hospital non-tobacco-related cases and neighborhood matches. For cigar-only smokers an OR of 4.4 (2.3-8.2) is reported overall; for mixed smokers a OR of 15.0 (9.0-24.9) is reported, comparing to the OR of 14.1 (8.8-22.6) for male cigarette smokers. There was a significant increase in lung cancer risk with increasing duration of smoking for both groups of cigar smokers, but the level of daily consumption was not significantly related to risk. Depth of inhalation for cigar-only smokers is reported, noting a significant positive trend in OR with increasing depth and frequency of inhalation. There was a significant trend for mixed smokers of cigars and cigarettes to inhale more frequently and more deeply than cigar-only smokers.

Lubin, Richter, and Blot (1984) present the cigar and pipe subset of a larger case-control study of western European male lung cancer cases, with 6,920 cases and 13,460 controls. Controls matched hospital patients whose admission was not for a tobacco-related illness. There were 37 cases with cigar-only smoking with an estimated RR of 2.90 (2.1-4.0) and 180 mixed cigarette and cigar cases with a RR of 6.87 (5.5-8.5). Tables in the paper present the trend with years of cigar smoking (not significant) and number of cigars per day (significant), which increases to a RR of 8.93 (6.8-11.1) for smokers of 7 or more cigars per day. A table presents significant increasing risk with both frequency and depth of inhalation for cigar only smokers, though the same table for mixed cigar and cigarette smokers is not significant. When smoking cigars, mixed cigar/cigarette smokers were more likely to inhale than cigar-only smokers; and when smoking cigarettes, less likely to inhale than cigarette-only smokers.

Benhamou, Benhamou, and Flamant (1986) present analysis of the cigar smoking subset of 1,529 French lung cancer cases: 9 are exclusive cigar smokers and 68 are mixed cigar and cigarette smokers, compared to exposure

Table 6

Lung cancer and cigar smoking: mortality ratios by type of smoking (males only except as noted)

Prospective Studies	Sample Size*	Never-Smoker	Odds Ratio (OR)		
			Cigar	Mixed, Cigar & Cigarette	Cigarette
Levin (1950)	236/481		0.7		2.1
Schrek (1950)	82/522		0.6		1.7
Wynder & Graham (1950)	605/780		5.1		15.7
Sadowsky (1953)	477/615		2.4	5.6	3.7
Wynder & Cornfield (1953)	63/133		2.5		8.5
Randig (1954)	415/381		5.3		5.0
Mills & Porter (1950)	444/430		6.0**		5.4
Mills & Porter (1957)	484/1588		2.8**		4.5
Lombard & Snegireff (1959)	500/1839		1.7**		8.1
Wicken (1966)	803/803		2.2**	4.2	4.3
Abelin & Gsell (1967)	118/524		3.4		5.7
Wynder (1970)	210/420		2.0**		12.4
Joly (1983)	607/1,108		4.4 (2.3-8.2)	15.0 (9.0-24.9)	14.1 (8.8-22.6)
Lubin (1984)	6,920/13,460/37		2.90 (2.1-4.0)	6.87 (5.5-8.5)	9.03 (7.9-10.3)
Benhamou (1986)	1,529/2,899		5.6 (2.3-13.5)	8.5 (5.4-13.6)	13.3 (9.3-19.1)
Higgins (1988)	2,085/3,948		3.1 (1.8-5.6)	10.5 (7.8-14.4)	16.0 (12.2-20.9)
10+ cigars/day			25.1 (7.2-87.4)		

Table 6 (continued)

Prospective Studies	Sample Size*	Never-Smoker	Rate Ratio (RR)		
			Cigar	Mixed, Cigar & Cigarette	Cigarette
Hammond & Horn (1958)	187,783	1.0	1.02	7.63	10.73
Doll & Peto (1976)	41,000	1.0	5.80**	8.20	14.00
Best (1966)	78,000	1.0	2.94		14.91
Kahn (1966)	293,000	1.0	1.59		12.14
Carstensen (1987)	25,129/1,256/11	1.0	7.6 (3.7-13.6)		7.4 (5.8-9.3)
Lange (1992) male	6,511/808/47	1.0	6.0 (2.2-17)		7.3 (2.6-20) plain
					6.0 (2.2-19) filter
Lange (1992) female	7,703/770/14	1.0	4.9 (3.0-12)		7.9 (2.9-21) plain
					4.8 (1.7-13) filter
Ben-Shlomo (1994) secondary	19,018/658/20	1.0	7.64 (4.6-11.8)		11.92 (10.7-13.2)
Wald & Watt (1997) primary	21,520/1,309/6	1.0	3.19** (1.07-9.50)		16.4 (7.55-44.2)
secondary	21,520/522/9		8.64** (3.19-23.3)		
CPS-I primary	442,455/15,072/73	1.0	2.10 (1.63-2.65)	11.31 (9.72-13.07)	12.39 (11.97-12.83)
secondary	442,455/7,349/86		6.29 (5.01-7.79)		

*For prospective studies reviewed, the number of cigar smokers and number of deaths in this group are also given.

**Cigar and pipe combined.

data from 2,899 matched hospital controls. In comparison to non-smokers, this study yields an OR of 5.6 (2.3-13.5) for the cigar only smokers and 8.5 (5.4-13.6) for the mixed cigar and cigarette smokers, as compared to an OR of 13.3 (9.3-19.1) for the cigarette only smokers. A test of secondary-cigar smokers yielded lower risk (RR=0.40, p<.01) compared to cigarette only smokers after adjustment for combined duration of smoking. The authors explain this lower risk as an effect of reduction in inhalation reported when changing from cigarettes to cigars, cigar-only smokers reporting lower rates of inhalation than mixed cigar and cigarette smokers, and cigarette-only smokers reporting highest levels of inhalation.

Higgins, Mahan, and Wynder (1988) present the cigar and pipe subset of a lung cancer case-control study involving 24 hospitals in 6 cities of the United States, including 2,085 cases and 3,948 matched hospital controls. Cigar-only smokers have a lung cancer OR of 3.1 (1.8-5.6), based on 18 cases. Former cigar only smokers have an OR of 2.5 (1.3-4.8), based on 12 cases quit for at least one year. Mixed smokers, comprised of cigarette and cigar, cigarette and pipe, or smokers of all three products, have an OR of 10.5 (7.8-14.4). The authors also examine the change in lung cancer risks among cigarette smokers who switch to cigars, as compared to those who quit smoking all tobacco products. A table, partially reproduced in Figure 2, shows the continuing risk for secondary cigar and/or pipe smokers broken into decades of years since switching from cigarettes to cigar/pipe smoking. Figure 2 shows uniformly higher risks for secondary cigar/pipe smokers than for former cigarette smokers who have stopped all smoking, suggesting that the benefits of cessation or cigarette smoking are diminished in the presence of continued cigar use. Analyses of dosage, duration of smoking and inhalation were performed combining primary cigar and pipe smokers (never smoked cigarettes), by weighting each cigar or pipeful as one unit. This comparison showed smokers of fewer than 5 cigars/pipefuls per day as not different from neversmokers with an OR of 0.8 (0.3-2.1), but smokers of 5-9 cigars/pipefuls per day have an OR of 3.2 (1.6-6.3) and smokers of 10 or more cigars/pipefuls per day an OR of 6.7 (3.4-13.3). The group smoking ten or more cigars per day excluding pipe smokers, has an OR of 25.1 (7.2-87.4). The risk with duration of smoking is significant after 30 years of smoking. Rates are significantly elevated for cigar/pipe smokers who inhale, with OR of 12.3 (4.0-37.7) compared to an OR of 2.3 (1.4-3.8) for those who do not inhale.

In a large prospective study of 25,129 Swedish men from 1963 through 1979, as reported by Carstensen, Pershagen, and Eklund (1987), approximately 5 percent of the study population were cigar smokers. For lung cancer, an age-adjusted RR of 7.6 (3.7-13.6) is reported for cigar only smokers, which is similar to the overall risk of 7.4 (5.8-9.3) for cigarette smokers. The test for trend by grams/day of any tobacco is highly significant. There is a similar linear trend in RR for lung cancer by grams/day of tobacco smoked for cigarette, pipe and cigar comsumption, with the RR for cigars slightly lower. Tobacco use habits were only recorded at the beginning of the study and do not account for changes in smoking pattern during the 17 years of the study.

Figure2
Decreasing odds ratio for lung cancer by years of cessation of cigarette smoking, by quitting or switching to cigars/pipe (Higgins, 1988).
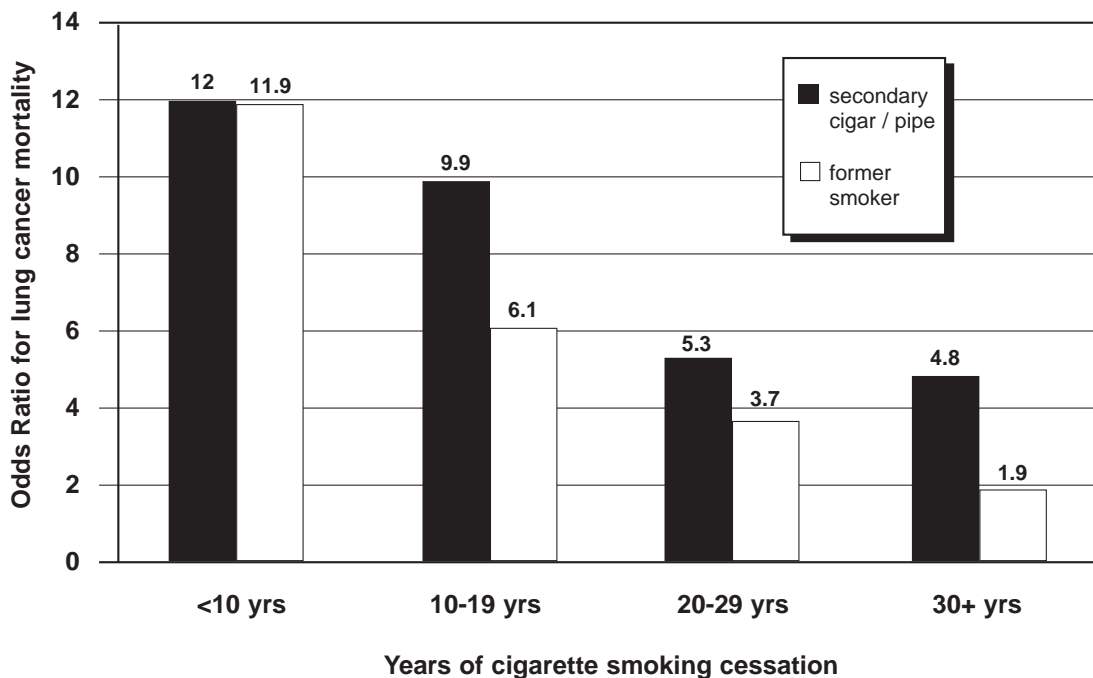
In the Danish prospective study previously discussed (Lange, 1992), overall mortality from lung cancer for male smokers of cheroots/cigars was reported at an age-adjusted RR of 6.0 (2.2-17) versus neversmokers, compared to the RR of 7.3 (2.6-20) for smokers of non-filter cigarettes and 6.0 (2.2-19) for smokers of filter cigarettes. For females, the corresponding RRs are 4.9 (3.0-12) for cheroot/cigar-only smokers, 7.9 (2.9-21) for plain cigarettes, and 4.8 (1.7-13) for filter cigarettes. In comparing mortality rates by inhalation level, the inhaling cigarette smoker is used as the comparison group. The RR for inhaling cigar/pipe smokers is 1.1 (0.7-1.6); for non-inhaling cigar/pipe smokers, 0.4 (0.3-0.6). Cigarette smokers who do not inhale are reported at 0.2 (0.1-0.8), also significantly lower than inhaling cigarette smokers. For females, the Risk Ratio of inhaling cigar/cheroot smokers compared to inhaling cigarette smokers is 1.5 (0.5-3.7); the comparison of non-inhaling cigar/cheroot smokers to inhaling cigarette smokers, 0.4 (0.2-0.9); and non-inhaling cigarette smokers to inhaling cigarette smokers, 0.3 (0.1-0.8). The categories of tobacco use are a snapshot of the habits at enrollment in the study and do not reflect prior useage or changes during the period of follow-up. Consequently, primary and secondary cigar smokers are pooled, and reported rates may be higher than would be found for primary cigar/cheroot smokers. Conversely, any cessation or reduction in smoking during the period of the study would not be reflected in these statistics.

Wald and Watt (1997) report an age-adjusted RR of lung cancer of 3.19 (1.07-9.50) for primary cigar/pipe smokers and 8.64 (3.19-23.3) for secondary cigar/pipe smokers who switched from cigarettes at least 20 years before the beginning of the study, compared to a RR of 16.4 (7.55-44.2) for current cigarette smokers. These rate differences are consistent with the pattern of total tobacco consumption and levels of inhalation noted earlier.

Tables 7 and 8 present age-standardized lung cancer mortality ratios from the CPS-I study by level of cigars/cigarettes per day and by level of inhalation. Generally these tables show a positive gradient with quantity smoked. The gradient in Table 8 for levels of inhalation is strongly positive, with highest rates for the deepest inhalation level.

To assess the strength of association of the factors of numbers of cigars per day and level of inhalation to rates of lung cancer deaths, the absolute rates of lung cancer for primary cigar smokers were subjected to a step-wise Poisson analysis of variance. For details, see the appendix. The results are summarized in Table 9.

Depth of inhalation shows the strongest association with rates of lung cancer deaths. The values for inhalation are an arbitrary scale for the responses: 'none', 'slight', 'moderate', and 'deeply'. The square and square root transform of the values were also tested in the regression, with the square transformation testing as the strongest factor. The chronological age variable is also highly significant, but in contrast to the analysis of all cause mortality, age is a less powerful predictor of lung cancer risk than inhalation. The number of cigars per day is also significant in predicting rates, with a positive slope.

Age specific lung cancer death rates from CPS-I for cigar smokers of various numbers of cigars smoked per day and different inhalation patterns can be modeled to compare the effects of number of cigars smoked per day and inhalation on lung cancer death rates. Figure 3 is a graph of the modeled rates of lung cancer deaths for several cigar smoking groups, in comparison to smokers of 20 cigarette per day rates and neversmokers. All rate curves are based on Poisson regression of observed absolute rates. The rates for cigar smokers vary depending on the parameters of smoking behavior. Cigar smokers smoking five or more cigars per day with moderate inhalation approach the rates of smokers of 20 cigarette per day; cigar smokers smoking one or two cigars per day with no inhalation are near rates for neversmokers. The modeled rates in Figure 3 present a pattern of disease risk for cigar smokers that increases with increasing exposure of the lung to cigar smoke. As the number of cigars smoked per day increases and more importantly, as the depth of inhalation increases, the risk of developing lung cancer increases from those of someone who has never smoked to those of someone who has smoked 20 cigarettes per day.

Summary   Studies of lung cancer mortality among cigar smokers provide a convincing pattern of elevated lung cancer risks for cigar smokers. Lung cancer mortality ratios increase with increasing number of cigars smoked per day and with

Table 7
Rate ratio of cancer of the lung and bronchus by level of cigar/cigarettes per day

Daily Use	Age (years)				Combined (95% CI)		Deaths*
	35-49	50-64	65-79	80+			
PRIMARY CIGAR							73/191
1-2		0.83	1.27	0.66	0.9	(0.54,1.66)	
3-4		2.35	3.02	1.02	2.36	(1.49,3.54)	
5 +	13.71	3.86	3.19	2.10	3.40	(2.34,4.77)	
Combined	4.04	2.24	2.34	1.09	2.10	(1.63,2.65)	
SECONDARY CIGAR							83/191
1-2	7.86	2.18	3.20	4.16	3.18	(1.78,5.24)	
3-4		6.78	10.84	6.54	8.52	(5.87,11.97)	
5 +		11.92	5.97		7.21	(5.02,10.03)	
Combined	2.93	6.98	6.54	4.98	6.29	(5.01,7.79)	
CIGAR & CIGARETTE							182/191
1-19	5.35	6.92	8.22	7.57	7.64	(5.87,9.77)	
20	12.03	14.31	17.24	19.69	16.73	(13.24,20.85)	
21 +	8.56	19.18	15.46		13.37	(9.55,18.21)	
Combined	8.51	11.81	11.78	9.69	11.31	(9.72,13.07)	
CIGARETTE ONLY							3,166/191
1-19	5.17	7.17	8.38	2.39	6.75	(6.18,7.37)	
20	12.51	13.03	14.72	8.15	12.86	(12.14,13.60)	
21 +	13.09	19.48	23.36	14.62	20.23	(19.20,21.30)	
Combined	11.18	13.97	14.28	5.61	12.39	(11.97,12.83)	

Based on data from CPS-I Study. Age-standardized rate ratio for smoking group compared to neversmokers.
* Number of deaths in subject group/neversmokers group.

increasing depth of inhalation. When depth of inhalation and number of cigars per day are examined together, depth of inhalation is more powerful in predicting lung cancer risk than number of cigars smoked per day. Limited data exist on risks for those who switch from smoking cigarettes to smoking only cigars, but the data that do exist suggest that lung cancer risks of switching to cigars is substantially above that for cigarette smokers who stop smoking all tobacco products.

Overall, lung cancer risks for cigar smokers may be similar to those seen in cigarette smokers once they are adjusted for differences in level of inhalation and quantity of tobacco smoked per day. The data clearly establish cigar smoking as a cause of lung cancer.

ORAL CANCERS   Both primary and secondary cigar smokers are less likely to inhale deeply than are cigarette smokers (Figure 1), and this difference in inhalation patterns is a major determinant of the differences in lung cancer risks that occur due to smoking cigars and cigarettes. However, the mouth and oral cavity are exposed to the carcinogens in smoke whether the smoke is inhaled or not.

Table 8
Rate ratio of cancer of the lung and bronchus by level of inhalation

Level of Inhalation	Age (years)				Combined (95% CI)		Deaths*
	35-49	50-64	65-79	80+			
PRIMARY CIGAR							69/191
None		1.94	2.30	1.16	1.97	(1.48,2.57)	
Slight		2.90	1.02		1.89	(0.81,3.72)	
Moderate-deep		6.96	5.90		4.93	(1.80,10.72)	
Combined	4.09	2.36	2.27	1.15	2.11	(1.64,2.67)	
SECONDARY CIGAR							83/191
None		5.30	5.99	4.78	5.41	(3.93,7.27)	
Slight	11.25	7.00	6.78	10.22	7.63	(4.66,11.78)	
Moderate-deep		12.79	12.35		9.77	(5.88,15.25)	
Combined	2.99	6.93	6.87	5.15	6.47	(5.15,8.01)	
CIGAR & CIGARETTE							183/191
None, slight		10.29	11.65	4.86	9.64	(7.75,11.85)	
Moderate	10.48	10.04	8.50	28.16	12.92	(9.81,16.70)	
Deep	18.80	17.90	23.12		16.84	(12.08,22.85)	
Combined	8.22	11.50	11.84	9.53	11.20	(9.66,12.92)	
CIGARETTE ONLY							3,162/191
None, slight	7.68	11.76	10.72	2.47	9.33	(8.61,10.10)	
Moderate	9.95	14.01	15.07	7.46	13.13	(12.53,13.75)	
Deep	15.14	16.26	19.22	13.58	17.11	(16.00,18.28)	
Combined	11.27	14.18	14.24	5.62	12.44	(12.02,12.88)	

Based on data from CPS-I Study. Age-standardized rate ratio for smoking group compared to neversmokers.
* Number of deaths in subject group/neversmokers group.

Spitz (1988) presented a case-control study of 185 squamous cell carcinoma of the upper aerodigestive tract, including larynx, tongue, orohypopharynx, floor of mouth, and other cancers of the oral cavity, demonstrating an OR of 2.8 (1.5-5.5) for cigar use for all oral cancer sites combined. The cigar category appears to include both primary and secondary cigar smokers, and non-smokers may include ex-smokers.

Blot et al. (1988) report a case-control study of 1,114 oral and pharyngeal cancer cases, excluding salivary and nasopharyngeal carcinoma, with 1,268

Table 9
Results of step-wise poisson regression of absolute rates of lung cancer deaths

Variable	Coeffecient	SE	F-test	Probability
(Constant)	−2.4107	0.0119		
Inhalation^2 (0-3)	0.3557	0.000523	37.2	$<10^{-7}$***
Age (years)	0.07514	0.000159	27.7	$<10^{-5}$***
Cigars per Day	0.2324	0.000727	11.7	0.001**

***p<0.0001; **p<0.01; *p<0.05

Figure 3

Lung cancer death rates for cigar smokers with different patterns of inhalation and number of cigars per day compared with one pack per day cigarette smokers
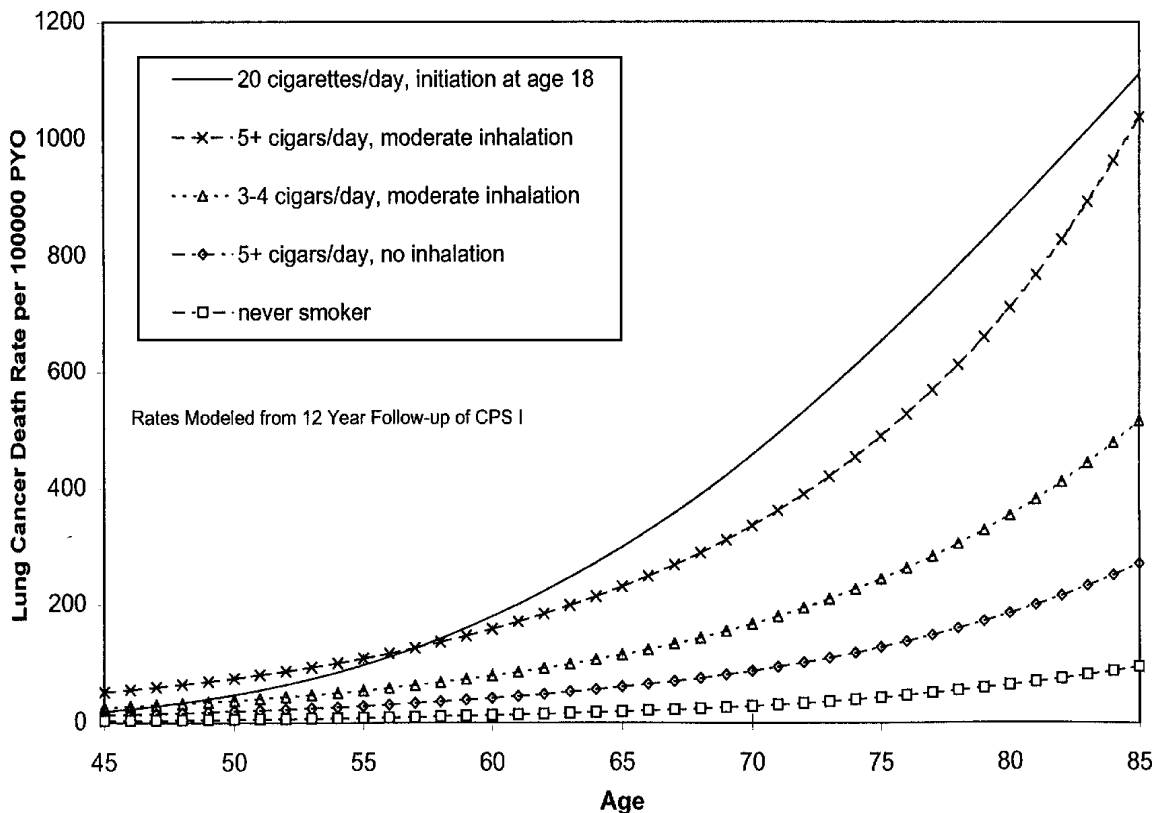
population-based controls. Pooling primary cigar and/or pipe smokers they report an OR of 1.9 (1.1-3.4) adjusted for age and alcohol consumption, which rises to 16.7 (3.7-76.7) for men smoking 40 or more cigars per week, but this ratio is based on only 14 cases and 1 control. A positive gradient in risk is also shown with increasing consumption of alcohol. An OR of 1.9 for cancer of the tongue and 1.6 for cancer of the pharynx among pipe/cigar smokers as compared to neversmokers is reported, but neither confidence intervals nor the data to calculate them are provided.

Merletti et al. (1989) report a case-control study of cancer of the oral cavity-oropharynx in Torino, Italy, with 122 cases of both sexes and 606 population-based controls. Male cigar smokers, with or without the combination of other tobacco products, have a higher risk than cigarette-only smokers based on 11 cases, with OR = 14.6 (4.7-45.6), compared to an OR of 3.9 (1.6-9.4) for cigarette smokers. OR's are age-adjusted and based on male neversmokers rates.

Table 10
Oral cancer and cigar smoking: rate ratios by type of smoking (males only)

Case-Control Studies	Sample Size*	Never-Smoker	Odds Ratio (OR) Cigar	Mixed, Cigar & Cigarette	Cigarette
Lip					
Broders (1920)	537/500		0.8		0.0
Ebenius (1943)	439/300		0.7		
Levin (1950)	143/554		1.9		1.4
Sadowsky (1953)	571/615		1.1	0.4	1.4
Wynder (1957)	14/115		0.8	2.2	1.0
Staszewski (1960)	394/912		2.1**		2.4
Keller (1970)	301/265		1.4		2.6
Oral					
Spitz (1988) incl larynx	185/185		2.8 (1.5-5.5)		4.5 (2.4-8.5)
Blot (1988)	1,114/1,268		1.9** (1.1-3.4)		1.9 (1.3-2.9)
40+ cigars/week	12/7		16.7 (3.7-76.7)		
Merletti (1989)	86/385			14.6 (4.7-45.6)	3.9 (1.6-9.4)
Franceschi (1990)	157/1,272		20.7** (5.6-76.3)		11.1 (3.4-34.8)
Franceschi (1992) mouth	104/726		21.9** (3.8-125.6)		11.8 (3.6-38.4)
Tongue					
Franceschi (1992)	102/726		3.4** (0.3-39.1)		10.5 (3.2-34.1)

Prospective Studies		Never-Smoker	Rate Ratio (RR) Cigar	Mixed, Cigar & Cigarette	Cigarette
Hammond & Horn (1958)	187,783	1.0	5.00		5.06
Doll & Hill (1976)	41,000	1.0	9.00**	10.00	14.00
Hammond (1966)	440,559	1.0	4.94**		9.90
Kahn (1966) oral	293,000	1.0	4.11		4.09
pharyngeal		1.0	3.06**		12.54
Chow (1993) nasopharyngeal	248,046/2	1.0	1.0** (0.2-5.2)	3.9 (1.5-10.3)	
CPS-I combined oral	442,455/15,072/26	1.0	7.92 (5.12-11.69)	10.72 (6.24-17.17)	8.23 (7.17-9.40)

*For prospective studies reviewed, the number of cigar smokers and number of deaths in this group are also given.
**Cigar and pipe combined.

Franceschi et al. (1990) present the results of a case-control study in northern Italy of 157 male oral cavity cancers, 134 pharyngeal cancers, and 162 laryngeal cancers, with 1,272 male controls composed of matched hospital inpatients with conditions unrelated to tobacco and alcohol. For smokers of cigars or pipes only, they found an age-adjusted OR of 20.7 (5.6-76.3) for oral cavity cancer based on 6 cases and an OR of 2.8 (0.3-26.1) for laryngeal cancer based on 1 case, in comparison to neversmokers. Franceschi et al. (1992) also reported a case-control study of 102 men with cancer of the tongue and 104 patients with cancer of the mouth, compared to 726 hospital controls. For cigar or pipe only smokers an OR of 3.4 (0.3-39.1) is calculated for tongue cancer based on 1 case, and an OR of 21.9 (3.8-125.6) for cancer of the mouth based on 5 cases, both compared to neversmokers.

Chow et al. (1993) report the 26-year follow-up of 250,000 US veterans. They do not find any increased risk of nasopharyngeal cancer among cigar and pipe-only smokers with an age-adjusted RR of 1.0 (0.2-5.2), but they do report a RR of 3.9 (1.5-10.3) for all current cigarette smokers taken together, compared to neversmokers.

Analyses from the CPS-I study for combined buccal and pharyngeal cancers are presented in Tables 11 and 12. These tables include deaths coded for lip, tongue, floor of mouth, mouth unspecified and mouth other, oral mesopharynx, nasopharynx, hypopharynx and pharynx unspecified. Cancer of the salivary glands is not included in this grouping because separate analyses show that these cancers do not appear to be related to tobacco consumption. Table 16 is included to demonstrate this lack of relationship between cigarette smoking and cancer of the salivary glands. There are insufficient data to provide a similar table for cigar smokers and cancer of the salivary glands, but the lack of deaths in the cigar smoking group provides evidence of the lack of relationship between this cancer and cigar exposure. Rates for combined oral/pharyngeal cancers for primary and secondary cigar smokers are approximately equal to rates for cigarette smokers (Table 11). A positive gradient is seen with number of cigars/cigarettes per day. Rates for smokers of 5+ cigars per day are higher than rates for smokers of 21+ cigarettes per day. Table 12 shows a positive gradient for inhalation among cigar-only and cigarette-only groups, with very high rates for moderate-deep inhalation of cigars. The cigar and cigarette group does not show this effect, but the data on inhalation here is complicated, involving two tobacco products, and the coding for this study does not allow separate indication of inhalation for cigars and cigarettes.

Tables 13 and 14 provide a more focused look at the pharyngeal cancers, combining codings for oral mesopharynx, nasopharynx, hypopharynx and pharynx unspecified. Elevated rates are observed for these cancers among all smokers, with a strong positive gradient for numbers of cigars/cigarettes per day and level of inhalation. Rates for cigar and cigarette smokers are approximately equivalent, with highest rates for smokers of both cigars and cigarettes. There is not enough data on secondary cigar smokers to generate a table. A step-wise Poisson regression analysis confirmed a significant

Table 11
Rate ratio of buccal and pharyngeal cancer combined by level of cigars/cigarettes per day*

Daily Use	Age (years) 35-49	50-64	65-79	80+	Combined (95% CI)	Deaths**
PRIMARY CIGAR						25/18
1-2			2.33		2.12 (0.43,6.18)	
3-4		7.06	6.56		8.51 (3.66,16.77)	
5 +		10.54	15.50		15.94 (8.71,26.75)	
Combined		5.33	7.37		7.92 (5.12,11.69)	
SECONDARY CIGAR						8/18
1-2					4.39 (0.06,24.45)	
3-4						
5 +		5.23	19.62		13.73 (5.50,28.30)	
Combined		1.85	6.89		6.58 (2.83,12.97)	
CIGAR & CIGARETTE						17/18
1-19		9.16	6.93		7.29 (2.66,15.86)	
20		12.00	15.41		13.42 (5.78,26.44)	
21 +			39.04		23.86 (4.80,69.71)	
Combined		8.32	13.01		10.72 (6.24,17.17)	
CIGARETTE ONLY						216/18
1-19		5.98	4.99		5.93 (4.28, 8.02)	
20		10.74	4.34		6.85 (5.37, 8.62)	
21 +		13.41	12.21		12.04 (9.81,14.63)	
Combined		10.52	6.49		8.23 (7.17, 9.40)	

Based on data from CPS-I study. Age-standardized rate ratio for smoking group compared to neversmokers.
 * *Includes: lip, tongue, floor of mouth, other parts of mouth, mouth unspecified, oral mesopharynx, nasopharynx, hypopharynx, pharynx unspecified, not including salivary glands.*
 ** *Number of deaths in subject group/neversmoker group.*

association of absolute rates of pharyngeal cancers for primary cigar smokers with age (F=20.5, p<.0001), inhalation (F=7.7, p<.01), and a marginally significant association with cigars per day (F=3.6, p=.07).

The data on cancer of the tongue is summarized in Table 15, providing comparisons based on numbers of cigars/cigarettes and depth of inhalation. Primary and secondary cigar smokers are pooled to provide enough data. These tables show highly elevated rates of tongue cancer for all smokers, with a strong positive gradient by numbers of cigars/cigarettes per day and depth of inhalation. These rates must be considered as approximate, since they are based on only two deaths among the neversmoker comparison group, and nine deaths among the cigar smokers.

Summary   The risk of oral and pharyngeal cancers are similar for cigar smokers and cigarette smokers, with an overall risk seven to ten times higher than for neversmokers. Positive gradients are observed when rates are stratified by numbers of cigars per day, demonstrating a dose-response relationship between cigar smoke exposure and risk of these cancers. Further, the level of inhalation affects the rates of these cancers, with highest rates for cigar smokers who inhale moderately or deeply. No relationship between smoking

Table 12
Rate ratio of combined buccal and pharyngeal cancer by level of inhalation*

Level of Inhalation	Age (years)				Combined (95% CI)	Deaths**
	35-49	50-64	65-79	80+		
PRIMARY CIGAR						25/18
None		4.12	5.85		6.98 (4.13,11.03)	
Slight		6.92	9.04		7.83 (1.57,22.88)	
Moderate-deep		22.36	33.43		27.88 (5.60,81.46)	
Combined		5.40	7.07		7.85 (5.03,11.68)	
SECONDARY CIGAR						8/18
None		3.08	3.67		3.27 (0.66, 9.56)	
Slight			14.32		8.75 (1.76,25.58)	
Moderate-deep			13.24		24.19 (2.72,87.32)	
Combined		1.89	7.08		6.77 (2.92,13.34)	
CIGAR & CIGARETTE						17/18
None, slight		8.90	12.27		10.47 (4.78,19.87)	
Moderate		3.42	9.62		7.02 (1.89,17.97)	
Deep		15.15	14.08		13.65 (3.67,34.95)	
Combined		8.01	12.31		10.20 (5.94,16.33)	
CIGARETTE ONLY						227/18
None, slight		8.81	5.44		6.26 (4.47, 8.53)	
Moderate		11.09	5.68		8.43 (7.00,10.06)	
Deep		12.33	8.66		12.48 (9.61,15.94)	
Combined		10.91	6.23		8.32 (7.27, 9.48)	

*Based on data from CPS-I Study. Age-standardized rate ratio for smoking group compared to neversmokers.
**Number of deaths in subject group/neversmokers group.

Table 13
Rate Ratio of pharyngeal cancer by level of cigars/cigarettes per day*

Daily Use	Age (years)				Combined (95% CI)	Deaths**
	35-49	50-64	65-79	80+		
PRIMARY CIGAR						12/10
1-2			6.40		3.81 (0.77,11.13)	
3-4		4.23	13.51		7.52 (2.02,19.26)	
5 +		4.22	19.54		9.92 (3.20,23.16)	
Combined		2.52	12.19		6.73 (3.47,11.75)	
CIGAR & CIGARETTE						10/10
1-19			13.40		5.36 (0.60,19.35)	
20		9.60	35.02		18.81 (6.87,40.93)	
21 +			79.42		31.77(3.57,114.69)	
Combined		3.30	26.94		12.43 (5.95,22.86)	
CIGARETTE ONLY						101/10
1-19		3.16	5.65		4.91 (2.95, 7.67)	
20		5.77	7.38		6.04 (4.27, 8.29)	
21 +		6.72	15.88		9.91 (7.20,13.31)	
Combined		5.46	8.53		6.90 (5.62, 8.39)	

* Includes: oral mesopharynx, nasopharynx, hypopharynx, and pharynx unspecified. Based on data from CPS-I study. Age-standardized rate ratio for smoking group compared to neversmokers.
** Number of deaths in subject group/neversmoker group.

Table 14
Rate ratio of pharyngeal cancer by level of inhalation*

Level of Inhalation	Age (years) 35-49	50-64	65-79	80+	Combined (95% CI)	Deaths**
PRIMARY CIGAR						12/10
None		3.20	11.31		6.86 (3.28,12.61)	
Slight			12.43		4.97 (0.06,27.66)	
Moderate-deep			38.67		15.47 (0.20,86.07)	
Combined		2.55	12.52		6.91 (3.56,12.07)	
CIGAR & CIGARETTE						10/10
None, slight			28.61		11.44 (3.69,26.70)	
Moderate		4.11	9.83		5.99 (0.67,21.62)	
Deep		9.09	38.71		20.03 (4.03,58.52)	
Combined		3.18	25.45		11.77 (5.64,21.65)	
CIGARETTE ONLY						111/10
None, slight		5.92	7.06		5.79 (3.58, 8.84)	
Moderate		6.04	8.98		8.16 (6.24,10.49)	
Deep		6.53	8.40		9.59 (6.42,13.78)	
Combined		6.04	8.24		7.34 (6.04, 8.84)	

*Based on data from CPS-I study. Age-standardized rate ratio for smoking group compared to neversmokers.
**Number of deaths in subject group/neversmoker group.

and salivary gland cancer was observed. The data clearly establish cigar smoking as a cause of oral cancer.

CANCER OF THE LARYNX Burch et al. (1981) report a case-control study of 204 laryngeal cancer cases between 1977 and 1979 in southern Ontario compared to matched neighborhood controls. The summary RR for cigar smokers, estimated by logistic regression, is reported as 2.9, compared to 6.1 (3.0-12.5) for cigarette smokers. But the criterion for the cigar category (primary, secondary, or ever-cigar) is not stated, and the confidence interval for cigar smokers is not reported and cannot be estimated since the numbers of cases are not given.

Freudenheim et al. (1992) conducted a case-control study of 250 cases of laryngeal cancer and matched neighborhood controls in western New York. No significant trend related to cigar use is shown. Cigar use is reported in cigar-years, without distinguishing between heavy use for a shorter period and light use over many years. The categories of tobacco use (ever-cigarette/ever-cigar/ever-pipe) appear to overlap, not distinguishing between mixed cigarette and cigar smokers, secondary cigar smokers, etc; the overlapping categories prevent clear conclusions with respect to cigar use.

Muscat and Wynder (1992) report a case-control study of laryngeal cancer with 194 subjects and 184 age-matched hospital controls between 1985 and 1990, a subset of a larger study. Compared to neversmokers, an OR of 4.3 (1.7-16.4), adjusted for age and alcohol use, is reported for combined pipe and cigar smokers, apparently primary and secondary cigar/pipe smokers combined.

Table 15
Rate ratio of cancer of the tongue*

	Age (years)				Combined (95% CI)	Deaths**
	35-49	50-64	65-79	80+		
By Level of Cigars/Cigarettes per Day						
PRIMARY & SECONDARY CIGAR						9/2
1-2						
3-4		13.67			22.51	(4.52,65.76)	
5 +		23.96	45.91		34.94	(12.76,76.05)	
Combined		11.91	14.83		18.14	(8.37,34.82)	
CIGARETTE ONLY						61/2
1-19		14.16	6.85		10.51	(5.03,19.32)	
20		14.07	7.89		15.54	(8.69,25.63)	
21 +		33.67	41.38		37.53	(26.28,51.96)	
Combined		21.24	14.97		19.61	(15.00,25.19)	
By Level of Inhalation						
PRIMARY & SECONDARY CIGAR						9/2
None		5.23	9.61		13.72	(4.42,32.02)	
Slight		21.92	23.80		22.86	(2.57,82.53)	
Moderate-deep		45.03			22.51	(0.29,125.26)	
Combined		12.09	11.40		16.98	(7.31,33.45)	
CIGARETTE ONLY						61/2
None, slight		12.83	9.29		11.06	(4.76,21.79)	
Moderate		22.26	13.61		17.93	(12.56,24.83)	
Deep		24.57	23.06		36.72	(21.75,58.03)	
Combined		21.12	14.32		19.11	(14.65,24.50)	

*Based on data from CPS-I study. Age-standardized rate ratio fro smoking group compared to neversmokers.
**Number of deaths in subjet group.neversmoker group.

Table 16
Rate ratio of cancer of the salivary glands*

	Age (years)				Combined (95% CI)	Deaths**
	35-49	50-64	65-79	80+		
By Level of Cigars/Cigarettes per Day						
CIGARETTE ONLY						14/11
1-19		3.90	1.36		1.33	(0.43, 3.11)	
20	1.03	1.38	2.64		1.18	(0.43, 2.57)	
21 +		3.92			0.36	(0.07, 1.04)	
Combined	0.40	2.86	1.55		1.13	(0.62, 1.90)	
By Level of Inhalation						
CIGARETTE ONLY						15/11
None, slight		2.54	2.42		1.61	(0.52, 3.76)	
Moderate	0.67	3.93	0.82		0.72	(0.31, 1.41)	
Deep		1.71	0.88		0.47	(0.05, 1.71)	
Combined	0.39	3.22	1.47		1.12	(0.62, 1.84)	

*Based on data from CPS-I study. Age-standardized rate ratio fro smoking group compared to neversmokers.
**Number of deaths in subjet group.neversmoker group.

Table 17

Cancer of the larynx and cigar smoking : mortality ratios by type of smoking (males only)

Studies	Sample Size*	Never-Smoker	Cigar	Mixed, Cigar & Cigarette	Cigarette
Case-Control				Odds Ratio (OR)	
Burch (1981)	204/204 ever		2.9		6.1 (3.0-12.5)
Freudenheim (1992)	250/250		NS		
Muscat (1992)	194/184		4.3*	(1.7-16.4)	13.8 (2.3-27.1)
Prospective				Rate Ratio (RR)	
Kahn	293,000	1.0	10.33		9.95
CPS-I	442,455/15,072/7	1.0	10.02 (4.0-20.6)	19.09 (7.7-39.3)	19.68 (16.1-23.8)

 * For prospective studies reviewed, the number of cigar smokers and number of deaths in this group are also given.
** Cigar and pipe combined

The CPS-I results for laryngeal cancer are given in Tables 18 and 19. The RRs for combined levels of cigars per day and combined levels of inhalation are lower than for cigarette smokers, but the RRs for smokers of five or more cigars per day, and the RRs for those cigar smokers reporting deep inhalation, are markedly elevated. However, these rates are determined by small numbers of cases in both the cigar smokers and neversmokers, and therefore the confidence intervals on these rates are wide, though generally strongly significant.

Summary   The risk of laryngeal cancer is significantly elevated among cigar smokers, approaching the RR for cigarette smokers for smokers of five or more cigars per day or cigar smokers who inhale moderately or deeply. The data, while limited by the number of deaths from laryngeal cancer, support a positive relationship between number of cigars smoked per day and laryngeal cancer risk. The data taken as a whole support cigar smoking as a cause of laryngeal cancer.

CANCER OF   The esophagus is exposed to the carcinogens from tobacco smoke
THE ESOPHAGUS   which collect on the surface of the mouth and are swollowed with saliva. It is also exposed to smoke which is deposited in the mucus cleared from the lung and swallowed, as well as to systemically absorbed carcinogens.

The Franceschi et al. study (1990), noted above, includes a case-control comparison of 288 esophageal cancer cases. The 7 cigar and pipe smoker cases produce an OR of 6.7 (2.3-19.8) compared to neversmokers; cigarette smokers have an OR of 3.8 (2.2-6.6) in this study.

Tables 21 and 22 provide the rates of esophageal cancer for the cigar smoking categories and cigarette-only smokers from the CPS-I data. The rates are comparable across cigars and cigarettes, with a positive gradient for numbers of cigars/cigarettes smoked each day. A step-wise Poisson regression analysis confirmed a significant association of absolute rates of pharyngeal cancers for primary cigar smokers with age (F=19.3, p<.0001), inhalation (F=12.1, p=.001), and cigars per day (F=7.3, p=.01).

Summary   The risk of esophageal cancer is several times higher among cigar smokers than among neversmokers, with RR of occurrence similar to that for cigarette smokers. A dose-response effect is confirmed with higher rates for cigar smokers with higher numbers of cigars per day or with deeper inhalation. The data establish cigar smoking as a cause of esophageal cancer.

BLADDER AND   In a case-control study of 75 bladder cancer cases of both sexes
URINARY SYSTEM   in northern New Jersey primarily focused on industrial chemical
CANCERS   exposure, Najem et al. (1982) found a significant risk of bladder cancer for individuals with a history of cigarette smoking with an OR of 2.0 (1.1-3.7) compared to neversmokers. They found no relationship between cigar smoking and risk for bladder cancer.

In a Danish case-control study of bladder cancer cases of both sexes, 165 male and 47 female, matched to 165 male and 94 female randomly-

Table 18
Rate ratio of cancer of the larynx by level of cigar/cigarettes per day*

Daily Use	Age (years) 35-49	50-64	65-79	80+	Combined (95% CI)		Deaths**
PRIMARY CIGAR							7/4
1-2			6.64		6.45	(0.72,23.27)	
3-4							
5 +		21.08	28.22		26.03	(8.39,60.74)	
Combined		6.76	10.75		10.02	(4.01,20.64)	
CIGAR & CIGARETTE							7/4
1-19		19.89	15.48		12.71	(1.43,45.90)	
20		24.00	20.28		16.14	(1.81,58.26)	
21 +		94.58	32.53		39.91	(8.02,116.61)	
Combined		33.72	21.31		19.09	(7.65,39.33)	
CIGARETTE ONLY							105/4
1-19		12.24	7.66		8.70	(4.75,14.59)	
20		29.36	27.58		25.69	(18.66,34.48)	
21 +		43.58	25.38		23.59	(17.33,31.37)	
Combined		30.65	19.34		19.68	(16.10,23.83)	

Based on data from CPS-I study. Age-standardized rate ratio fro smoking group compared to neversmokers.
**Number of deaths in subjet group.neversmoker group.*

Table 19
Rate ratio of cancer of the larynx by level of inhalation*

Level of Inhalation	Age (years) 35-49	50-64	65-79	80+	Combined (95% CI)		Deaths**
PRIMARY CIGAR							7/4
None		8.70	9.53		10.60	(3.87,23.07)	
Slight							
Moderate-deep			106.52		53.26	(0.70,296.32)	
Combined		6.84	10.99		10.32	(4.13,21.26)	
CIGAR & CIGARETTE							7/4
None, slight		54.83	10.30		18.86	(5.07,48.28)	
Moderate		22.38			5.59	(0.07,31.13)	
Deep			161.85		80.93	(9.09,292.18)	
combined		32.44	20.08		18.15	(7.27,37.40)	
CICARETTE ONLY							107/4
None, slight		28.19	18.94		22.19	(14.74,32.07)	
Moderate		27.88	13.03		13.49	(10.01,17.78)	
Deep		30.59	39.79		27.54	(18.44,39.56)	
Combined		29.21	19.57		19.36	(15.87,23.39)	

Based on data from CPS-I Study. Age-standardized rate ratio for smoking group compared to neversmokers.
**Number of deaths in subject group/neversmoker group.*

Table 20
Esophageal cancer and cigar smoking: rate ratios by type of smoking (males only)

Studies	Sample Size*	Never-Smoker	Rate Ratio Cigar	Rate Ratio Mixed, Cigar & Cigarette	Rate Ratio Cigarette
Case-Control					
Sadowsky (1953)	104/615		4.8	3.3	3.8
Wynder (1957)	39/115		3.1	0.4	2.6
Pernu (1960)	202/713			5.9	2.7
Schwartz (1961)	249/249			8.6	11.7
Wynder & Bross (1961)	150/150		3.6	3.7	2.8
Martinez (1969)	120/360		2.0	2.2	1.5
Martinez (1970)	346/346		2.0	2.5	1.7
Franceschi (1990)	288/1,272		6.7** (2.3-19.8)		3.8 (2.2-6.6)
Prospective			Rate Ratio (RR)		
Hammond & Horn (1958)	187,783	1.0	5.00		5.06
Doll & Peto (1976)	41,000	1.0	3.70**	9.0	4.70
Hammond (1966)	440,559	1.0	3.97**		4.17
Kahn (1966)	293,000	1.0	5.33		6.17
CPS-I	442,455/15,072/20	1.0	3.60 (2.2-5.6)	3.57 (2.3-5.2)	3.966 (3.4-4.6)

For prospective studies reviewed, the number of cigar smokers and number of deaths in this group are also given.
*** Cigar and pipe combined.*

Table 21
Rate ratio of cancer of the esophagus by level of cigar/cigarettes per day*

	Age (years)				Combined (95% CI)		Deaths**
Daily Use	35-49	50-64	65-79	80+			
PRIMARY CIGAR							19/30
1-2		1.86	2.62		2.28	(0.74, 5.33)	
3-4		4.71	2.46	7.73	3.93	(1.43, 8.55)	
5 +		2.34	7.19		5.19	(2.23,10.22)	
Combined		2.80	3.94	4.72	3.60	(2.17, 5.62)	
SECONDARY CIGAR							7/30
1-2					2.64	(0.03,14.67)	
3-4			3.12		1.56	(0.02, 8.68)	
5 +		10.44	4.99		5.63	(1.81,13.14)	
Combined		3.73	2.70		3.52	(1.41, 7.25)	
CIGARETTE ONLY							162/30
1-19	1.83	2.69	2.73		2.41	(1.61, 3.46)	
20	1.03	4.47	5.24		4.30	(3.32, 5.48)	
21 +	0.98	6.23	5.55		5.60	(4.35, 7.10)	
Combined	1.18	4.67	4.44	1.80	3.96	(3.37, 4.62)	

*Based on data from CPS-I study. Age-standardized rate ratio fro smoking group compared to neversmokers.
**Number of deaths in subjet group.neversmoker group.

Table 22
Rate ratio of cancer of the esophagus by level of inhalation*

	Age (years)				Combined (95% CI)		Deaths*
Level of Inhalation	35-49	50-64	65-79	80+			
PRIMARY CIGAR							19/30
None		2.59	4.27	2.93	3.40	(1.90, 5.61)	
Slight					1.90	(0.02,10.58)	
Moderate, deep		14.91	10.31		14.84	(2.98,43.37)	
Combined		2.84	4.01	4.98	3.69	(2.22, 5.76)	
SECONDARY CIGAR							7/30
None		4.29	2.69		4.15	(1.34, 9.68)	
Slight			4.45		2.22	(0.03,12.37)	
Moderate, deep		8.95			2.69	(0.04,14.94)	
Combined		3.81	2.78		3.62	(1.45, 7.46)	
CIGARETTE ONLY							170/30
None, slight		3.21	3.22	2.21	2.94	(1.97, 4.23)	
Moderate	1.36	5.18	4.92		4.06	(3.30, 4.94)	
Deep	1.30	4.86	5.18		4.95	(3.55, 6.72)	
Combined	1.15	4.75	4.46	1.66	3.97	(3.39, 4.61)	

*Based on data from CPS-I Study. Age-standardized rate ratio for smoking group compared to neversmokers.
**Number of deaths in subject group/neversmoker group.

Table 23
Bladder and urinary system cancer: mortality rate ratio by type of smoking (males only, except as noted)

| | Sample Size* | Never-Smoker | Odds Ratio (OR) | | |
			Cigar	Mixed, Cigar & Cigarettes	Cigarette
Najem (1982)	75/142		ns		2.0 (1.1-3.7)
Mommsen (1983) male	165/165		2.3 (0.7-7.4)		3.5 (1.5-7.9)
Mommsen (1983) female					3.2 (1.3-7.7)
Morrison (1984) male	1435/1852		ns		1.9 (1.2-2.7)
Morrison (1984) female					2.4 (1.6-3.2)
Hartge (1985)	2982/5782		1.33 (.92-1.94)		3.36 (2.8-4.0)
Jensen (1987)	388/787		2.5 (0.2-28.4)	3.6 (2.2-5.8)	2.9 (1.8-4.8)
Slattery (1988	332/686		2.46 (1.01-5.95)		3.69 (2.58-5.26)
Burch (1989)	826/792		0.97 (.69-1.36) ever		2.65 (1.82-3.86)
Kunze (1992) highest consumption category	531/531		1.4 (0.9-2.4)		3.6 (2.4-5.4)

Prospective Studies			Rate Ratio (RR)		
Kahn (1966)	293,000	1.0	0.94		2.15
CPS-I primary	442,455/15,072/26	1.0	1.38 (0.89-2.04)	2.48 (1.42-4.03)	3.17 (2.83-3.54)
CPS-I secondary	442,455/7,349/9	1.0	1.23 (0.56-2.33)		

For prospective studies reviewed, the number of cigar smokers and number of deaths in this group are also given.

selected matched contols, Mommsen and Aagaard (1983) found significant risk associated with current cigarette smoking, with OR's: male, 3.5 (1.5-7.9); female, 3.2 (1.3-7.7). The reference group is not indicated, and may be neversmokers or not-current-smokers of cigarettes. For cigars or cigarillos only, an OR of 2.3 (0.7-7.4) is indicated for men, with insufficient data for women. If previous and current smoking habits are both included, the OR associated with cigar/cigarillo smoking becomes 1.4 (0.9-2.2) for men and 3.3 (1.3-8.5) for women; combining men and women results in a OR of 1.9 (1.3-2.8). The OR for women and combined sexes are significant, but the OR for men is not significant.

Morrison et al. (1984) reported a large international case-control study of 1,435 bladder cancer cases in Boston, Manchester UK, and Nagoya Japan, with controls matched by sex and age in electoral registers. They found significant risk associated with ever cigarette smoking across the three sites with an OR approximately twice that for neversmokers, an OR of 1.9 (1.2-2.7) for men and 2.4 (1.6-3.2) for women. There was a marked trend with number of cigarettes per day. This study found no relationship between cigar smoking and bladder cancer. Data for numbers of cigar smoking cases and controls is not provided.

Hartge, Hoover and Kantor (1985) report on a large case-control study of bladder cancer, with 2,972 patients and 5,782 controls, cases from 10 geographic areas of the US and controls randomly selected from the general population weighted to age, sex, and geographic distribution of cases. The focus of this study was risk related to pipes, cigars, and smokeless tobacco. For primary cigar smokers (never smoked cigarettes) an OR of 1.33 (0.92-1.94) was calculated in comparison to neversmokers, adjusted for race, age, and residence; for primary pipe smokers, an OR of 1.23 (0.75-2.00); for smokers of pipes and cigars but no cigarettes, an OR of 1.40 (1.01-1.93). In comparison, an OR of 3.36 (2.8-4.0) was observed for current cigarette smokers. Further explorations among the primary cigar smokers regarding level of inhalation, duration of cigar smoking, weekly consumption, and lifetime dose are inconclusive, without trend and not significant.

Similarly, Jensen et al. (1987), reporting on a case-control study of 388 bladder cancer cases of both sexes in Copenhagen, Denmark, found no significant relationship between cigar/cigarillo smoking and bladder cancer, for ever cigar/cigarillo smokers, cigar/cigarillo only smokers, or by amount of cigars/cigarillos smoked per day. An overall OR of 2.9 (1.8-4.8) was found for cigarette-only smokers of both sexes combined.

Slattery et al. (1988) conducted a population based case-control study of 332 white men compared to 686 controls selected by random digit dialing and matched by age and sex; all were residents of Utah. This study focused on the effect of cigarette smoking on the risk of bladder cancer associated with coffee, tea, alcohol and other forms of tobacco. Strong associations were found for cigarette smoking and bladder cancer, including positive trends with duration of smoking, cigarettes per day, lifetime packs, and inhalation, with an OR of about 4.0 for heavy users. These values were

similar for both current and ex-smokers of cigarettes. For primary cigar smokers who had never smoked cigarettes, an OR of 2.46 (1.01-5.95) was calculated; whereas, for those cigar smokers who had ever smoked cigarettes, an OR of 0.99 (0.61-1.60) was determined.

Burch et al. (1989) report a case-control study in Alberta and Ontario, Canada between 1979 and 1982, comparing 826 cases and 792 neighborhood controls matched for age and sex. They found significant associations for cigarette smoking with an OR of 2.65 (1.82-3.86) for current cigarette smokers. Gradients are reported with age first smoked, duration, cigarettes per day and total pack years. The only cigar comparison reported is ever/never smoked cigars, without stratifying by cigarette history; this comparison provides an OR of 0.97 (0.69-1.36), with no trend indicated.

In a case-control study of 531 male and 144 female matched pairs in Germany, Kunze et al. (1992) found smoking of cigars did not alter the risk of bladder cancer. Controlling for cigarette smoking, the rates by lifetime consumption of cigars shows positive trend, but the OR's are not significant.

The results of the tabulations for bladder cancer in the CPS-I data are given in Tables 24 and 25, with tables by level of consumption and level of

Table 24
Rate ratio of cancer of the urinary bladder and urinary system, by level of cigar/cigarettes per day*

Daily Use	Age (years)				Combined (95% CI)		Deaths**
	35-49	50-64	65-79	80+			
PRIMARY CIGAR							25/102
1-2		1.29	0.79		0.78	(0.29, 1.71)	
3-4		1.63	1.44	2.42	1.68	(0.77, 3.18)	
5 +		2.75	1.42	3.32	2.03	(0.97, 3.73)	
Combined		1.87	1.18	1.72	1.38	(0.89, 2.04)	
SECONDARY CIGAR							9/102
1-2		4.79	0.65		1.02	(0.20, 2.97)	
3-4		9.02	0.63		2.36	(0.76, 5.50)	
5 +			0.52		0.32	(0.00, 1.80)	
Combined		4.30	0.59		1.23	(0.56, 2.33)	
CIGAR & CIGARETTE							16/102
1-19			0.77	4.00	1.42	(0.38, 3.65)	
20			6.00	3.57	4.84	(2.41, 8.66)	
21 +				1.75	1.10	(0.01, 6.10)	
Combined		1.99	1.82	4.60	2.48	(1.42, 4.03)	
CIGARETTE ONLY							318/102
1-19		2.98	1.97	3.11	2.35	(1.85, 2.94)	
20	1.03	4.94	2.95	3.80	3.39	(2.82, 4.03)	
21 +	3.94	5.46	3.72	4.63	4.16	(3.43, 4.99)	
Combined	1.99	4.67	2.76	3.50	3.17	(2.83, 3.54)	

*Based on data from CPS-I study. Age-standardized rate ratio for smoking group compared to neversmokers.
**Number of deaths in subject group/neversmoker group.

Table 25

Rate ratio of cancer of the urinary bladder and urinary system, by level of inhalation*

Level of Inhalation	Age (years) 35-49	50-64	65-79	80+	Combined (95% CI)		Deaths*
PRIMARY CIGAR							24/102
None		3.02	1.20	1.83	1.57	(1.00, 2.36)	
Slight							
Moderate-deep				2.42	1.52	(0.02, 8.44)	
Combined		2.42	1.12	1.56	1.38	(0.88, 2.05)	
SECONDARY CIGAR							9/102
None		2.97	0.63		0.77	(0.21, 1.98)	
Slight		3.57	0.82		2.87	(0.58, 8.40)	
Moderate-deep		11.41			1.45	(0.16, 5.25)	
Combined		4.40	0.61		1.26	(0.58, 2.40)	
CIGAR & CIGARETTE							17/102
None, slight		1.31	2.68		2.30	(1.15, 4.12)	
Moderate		3.44	0.61	12.74	3.82	(1.23, 8.92)	
Deep					4.58	(0.06,25.46)	
Combined		1.91	1.73	5.49	2.62	(1.53, 4.20)	
CIGARETTE ONLY							331/102
None, slight	6.08	3.17	2.14	3.00	2.51	(1.98, 3.15)	
Moderate	1.35	4.49	2.73	5.02	3.48	(2.98, 4.03)	
Deep	1.30	6.46	3.71	2.15	3.67	(2.92, 4.55)	
Combined	1.93	4.74	2.68	3.70	3.17	(2.84, 3.53)	

*Based on data from CPS-I study. Age-standardized rate ratio for smoking group compared to neversmokers.
**Number of deaths in subject group/neversmoker group.

inhalation respectively. Generally the age-adjusted rates calculated for cigars are not significant. There is a positive trend with numbers of cigars for primary cigar smokers, but no trend is seen with increasing depth of inhalation. On the other hand, we do see significant rates and significant trends for cigarette-only smokers, both cigarettes per day and inhalation presenting a convincing pattern of increasing risk with increasing exposure.

Summary   Although a few studies have indicated a significant relationship between cigar smoking and bladder cancer, several other studies have not found convincing evidence that smoking cigars increases the risk of bladder cancer.

PANCREATIC CANCER   Farrow and Davis (1990) conducted a case-control study of 148 married male pancreatic cancer cases from three counties in Washington state, compared to 188 controls also married men, matched by age and selected by a random digit dialing procedure. For current cigarette smokers, an OR of 3.2 (1.8-5.7) was found, compared to neversmokers. Ever use of cigars produced an OR of 0.7 with confidence interval that included 1.0. No data are shown for primary cigar-only smokers.

Bueno de Mesquita et al. (1991) carried out a population-based case-control study of 176 pancreatic cancer cases of both sexes matched to 487 controls from the Netherlands. For combined categories of cigarette smokers,

Table 26
Pancreatic cancer and cigar smoking: rate ratios by type of smoking (males only, except as noted)

| | Sample Size* | Never-Smoker | Odds Ratio (OR) | | |
			Cigar	Mixed, Cigar & Cigarettes	Cigarette
Case-Control Studies					
Farrow (1990)	148/188		NS		3.2 (1.8-5.7)
Bueno de Mesquita (1991)					
ever cigar	176/487		0.8 (0.5-1.3)		2.0 (1.2-3.1)
Muscat (1997) male	484/954		3.1 (1.4-6.9)		1.6 (1.1-2.4)
female					2.3 (1.4-3.5)
Prospective Studies			Rate Ratio (RR)		
Kahn (1966)	293,000	1.0	1.52		1.84
CPS-I primary	442,455/15,072/57	1.0	1.62 (1.22-2.11)	2.43 (1.72-3.34)	2.07(1.90-2.25)
secondary	442,455/7,349/20	1.0	1.80 (1.10-2.78)		

For prospective studies reviewed, the number of cigar smokers and number of deaths in this group are also given.

an OR of 1.96 (1.23-3.12) was found, compared to neversmokers. Ever use of cigars by 36 subjects produced an OR of 0.8 (0.5-1.3), not providing any evidence of increased risk.

Muscat et al. (1997) gathered case-control data on 484 male and female pancreatic cancer cases and 954 non-tobacco related matched hospital controls at several hospitals. Their results include for current male cigarette smokers an OR of 1.6 (1.1-2.4) and current female cigarette smokers 2.3 (1.4-3.5), compared to same-sex neversmokers. Trend with increasing consumption is shown, particularly for women. For male pipe/cigar smokers an overall OR of 2.1 (1.2-3.8) was determined. For male cigar only smokers a OR of 3.1 (1.4-6.9) was determined, compared to never and former cigarette smokers combined. These cigar only smokers may include former cigarette smokers, as well as lifetime cigar only smokers.

Tables 27 and 28 present the results of tabulation of pancreatic cancer cases in the CPS-I data. Overall significance is shown for cigar-only and secondary cigar smokers, as well as for cigarette smokers. For all groups, positive trend is shown with numbers of cigars per day and levels of inhalation. The levels of cigars/cigarettes per day in Table 27 and levels of inhalation in Table 28 show values for cigar smokers similar to those for cigarette smokers. A step-wise Poisson regression analysis confirmed

Table 27
Rate ratio of pancreatic cancer, by level of cigar/cigarettes per day*

Daily Use	Age (years)				Combined (95% CI)		Deaths**
	35-49	50-64	65-79	80+			
PRIMARY CIGAR							56/198
1-2		1.52	0.78	1.79	1.18	(0.69, 1.89)	
3-4			2.03	2.76	1.51	(0.86, 2.45)	
5 +		2.71	2.72		2.21	(1.40, 3.32)	
Combined		1.48	1.72	1.69	1.62	(1.22, 2.11)	
SECONDARY CIGAR							20/198
1-2		0.51			0.56	(0.06, 2.01)	
3-4		0.64	3.36		1.90	(0.82, 3.74)	
5 +		1.56	2.12	12.23	3.71	(1.78, 6.83)	
Combined		0.92	1.74	3.60	1.80	(1.10, 2.78)	
CIGAR & CIGARETTE							38/198
1-19	10.71	1.79	3.02	2.74	2.67	(1.67, 4.04)	
20			1.66	2.44	1.74	(0.83, 3.20)	
21 +		2.13	3.35		2.35	(0.86, 5.12)	
Combined	4.26	1.81	2.89	2.10	2.43	(1.72, 3.34)	
CIGARETTE ONLY							549/198
1-19	3.75	1.85	1.77	1.07	1.69	(1.41, 2.00)	
20	3.58	2.34	2.34	1.30	2.17	(1.89, 2.47)	
21 +	3.95	2.39	2.67	1.59	2.41	(2.08, 2.77)	
Combined	3.76	2.24	2.24	1.20	2.07	(1.90,2.25)	

Based on data from CPS-I study. Age-standardized rate ratio for smoking group compared to neversmokers.
**Number of deaths in subject group/neversmoker group.*

Table 28
Rate ratio of pancreatic cancer by level of inhalation*

Level of Inhalation	Age (years) 35-49	50-64	65-79	80+	Combined	(95% CI)	Deaths**
PRIMARY CIGAR							56/198
None		1.43	1.60	1.67	1.55	(1.12, 2.07)	
Slight		2.05	2.45		2.16	(0.99, 4.10)	
Moderate-deep		2.26	3.09		2.26	(0.45, 6.60)	
Combined		1.59	1.76	1.60	1.66	(1.25, 2.16)	
SECONDARY CIGAR							19/198
None		1.24	1.41	2.59	1.55	(0.80, 2.72)	
Slight				1.86	1.92	(0.52, 4.92)	
Moderate-deep		1.04	4.37		2.53	(0.51, 7.39)	
Combined		0.94	1.79	2.80	1.69	(1.02, 2.64)	
CIGAR & CIGARETTE						40/198	
None, slight	10.55	1.73	3.14	2.64	2.69	(1.72, 4.00)	
Moderate		1.80	1.72		1.42	(0.68, 2.62)	
Deep		1.60	5.80		3.42	(1.25, 7.45)	
Combined	4.11	1.74	2.95	1.88	2.40	(1.71, 3.27)	
CIGARETTE ONLY							569/198
None, slight		2.41	2.14	0.95	1.99	(1.66, 2.36)	
Moderate	3.71	2.16	2.24	1.01	2.01	(1.79, 2.25)	
Deep	5.05	2.19	2.24	2.95	2.38	(1.98, 2.83)	
Combined	3.66	2.22	2.25	1.19	2.06	(1.90, 2.24)	

Based on data from CPS-I study. Age-standardized rate ratio for smoking group compared to neversmokers.
**Number of deaths in subject group/neversmoker group.*

a significant association of absolute rates of pancreatic cancers for primary cigar smokers with age ($F=32.1$, $p<10^{-6}$), inhalation ($F=17.5$, $p<.0001$), and cigars per day ($F=5.0$, $p=.03$).

Summary   Cigar smokers have higher rates of pancreatic cancer than nonsmokers, particularly those who smoke higher number of cigars per day. Regression analysis confirms significant relationships with the factors of age, inhalation, and cigars per day for primary cigar smokers. These data suggest that cigar smoking is a cause of pancreatic cancer.

CORONARY HEART DISEASE   Matroos, Magnus and Strackee (1979) report a case-control study conducted in the Netherlands comparing 397 cases of acute myocardial infarction and 102 cases of fatal coronary attack, which taken together are referred to as acute coronary events, to 891 neighborhood controls matched by sex and age. Compared to noncurrent smokers (neversmokers plus former smokers), cigar smokers as a group had an OR of 3.1 (2.0-5.1); the OR for cigarette smokers of 1 pack/day was 2.1 (1.5-2.8) and for 2 packs/day was 2.0 (1.0-3.8), both lower than cigar smokers. The OR of coronary events for cigar inhalers compared to non-current smokers was 3.4 (1.8-7.1); the OR for non-inhaling cigar smokers was 2.9 (1.8-5.2). For cigar smokers, OR's for coronary events were not significantly different when

Table 29

Coronary heart disease and cigar smoking: rate ratios by type of smoking (males only)

	Sample Size*	Never-Smoker	Cigar		Mixed, Cigar & Cigarettes	Cigarette	
Case-Control Studies			Odds Ratio (OR)				
Matroos (1979) coronary events	499/891		3.1	(2.0-5.1)		2.1	(1.5-2.8)
Kaufman (1987) MI, age 40-54	572/934						
Primary cigar 1-4 cigars/day			0.9	(0.3-2.7)			
5+ cigars/day			1.7	(0.6-4.8)			
Secondary cigar 1-4 cigars/day			1.5	(0.6-3.6)			
5+ cigars/day			4.5	(2.2-9.2)			
Prospective			Rate Ratio (RR)				
Hammond & Horn (1958)	187,783	1.0	1.28			1.70	
Doll & Peto (1976)	41,000	1.0	1.03**		1.28	1.62	
Best (1966)	78,000	1.0	0.99			1.60	
Hammond (1966) age 45-54	440,559	1.0	1.15			2.81	
age 55-64			1.35			1.84	
age 65-74			0.93			1.45	
age 75-84			1.10			1.24	
Kahn (1966)	293,000	1.0	1.04			1.74	
Gyntelberg (1981) first MI	5,212						
Cigar Smokers	427	1.0	2.4	(1.4-3.8)		2.1	(1.7-2.7)
Cheroot	1,208	1.0	2.8	(2.1-3.6)			
>6 Cheroots/day	315	1.0	4.2	(2.6-6.3)			
Jajich (1984) elderly	2,674/265/32	1.0	1.67	(1.13-2.36)		1.94 (1.59-2.34)	
Carstensen (1987)	25,129/1,256/42	1.0	1.16	(0.83-1.57)		1.48 (1.33-1.64)	
Nyboe (1991) first MI	12,196		(see Table 30)				
Ben-Shlomo (1994) secondary	19,018/658/42	1.0	0.91	(0.65-1.23)		1.74 (1.63-1.86)	
Wald & Watt (1997) primary	21,520/1,309/33	1.0	0.98**	(0.67-1.44)		2.27 (1.81-2.84)	
secondary	21,520/522/25		1.29**	(0.88-1.99)			
CPS-I primary	442,455/15,072/1527	1.0	1.05	(1.00-1.11)	1.29 (1.21-1.38)	1.54 (1.52-1.57)	
secondary	442,455/7,349/612	1.0	1.09	(1.01-1.18)			

 * For prospective studies reviewed, the number of cigar smokers and number of deaths in this group are also given.

 ** Cigar and pipe combined.

hypertension was present or absent. An association between angina and coronary events was not demonstrated for cigar smokers.

Kaufman et al. (1987) analyzed interview data in a case-control study of 572 men with non-fatal first myocardial infarction compared to 934 hospital controls with non-tobacco related hospital admissions. Subjects and controls were restricted to ages 40-54; both subjects and controls had to be either never-cigarette smokers or to have stopped smoking cigarettes for at least 2 years. Thus a comparison was afforded between primary and secondary pipe and cigars smokers. The estimated RR's of MI for subjects who had never smoked cigarettes were elevated but not significant for smokers of 5 or more cigars per day, pipe only, or cigars and pipe. For former cigarette smokers, those who had smoked 5 or more cigars per day showed an elevated RR of 4.5 (2.2-9.2); the RR for those who had smoked fewer than 5 cigars or pipes were slightly elevated but not significant.

In a prospective study of 5,249 Danish men followed for 7 years, Gyntelberg et al. (1981) found the highest rates of myocardial infarction for smokers of 6 or more cheroots/day (315 subjects), with a RR of 4.2 (2.6-6.3), compared to neversmokers. Overall, cheroot smokers (1,208 subjects) had a RR of 2.8 (2.1-3.6), all cigarette smokers (2,125 subjects) 2.1 (1.7-2.7), and smokers of more than 10 cigarettes/day (875 subjects) 2.5 (1.2-5.2). A multiple logistic regression analysis showed that cheroot smoking was a significant factor for risk of MI. No information on previous smoking habits was obtained, and smoking categories were allowed to overlap, so the cheroot smokers would include both former and present cigarette and pipe smokers. The authors also note that 75 percent of cheroot smokers indicate inhalation, comparable to the rate of inhalation among cigarette smokers (74 percent). The RR's presented do not appear to be age adjusted.

Jajich, Ostfeld and Freeman (1984) report on a prospective mortality study of coronary heart disease in 2674 Chicago residents, aged 65 through 74, balanced for sex and black/white races drawn from a probability sample of persons receiving old age assistance, followed for 4.5 years during 1965-1970. Crude mortality ratios show a significant RR of 1.67 (1.13-2.36) for cigar/pipe smokers in comparison to neversmokers, while current cigarette smokers had a significant RR of 1.94 (1.59-2.34). However, when the analysis was adjusted for other factors, cigar/pipe smoking was not significant, though current cigarette smoking was significant.

In the Swedish prospective study (Carstensen 1987, see lung cancer) an age-adjusted RR of 1.16 (0.83-1.57) for ischaemic heart disease is calculated for cigar-only smokers compared to 1.48 (1.33-1.64) for cigarette smokers. There is no trend for increased risk with increasing consumption of cigars, given in grams/day. Though inhalation data was recorded, no analysis is presented for cigar smokers. Categorization as cigar only smokers is made by present behavior at the time of the initial survey questionaire, and may include former cigarette and pipe smokers.

Nyboe et al. (1991) studied the risk of first acute myocardial infarction in a population-based prospective study of 12,196 Danish subjects of both sexes, aged 30 or more. Their analysis finds highly significant effects related to amount of tobacco per day and inhalation of smoke. There was no statistically significant difference related to type of tobacco, whether plain or filtered cigarettes, cigars/cheroots or pipes. They found no relationship to duration of smoking in the past. Rates for former smokers were the same as for neversmokers, and did not decrease with length of time since cessation of smoking. The overall rates by grams/day (all tobacco) and inhalation are reproduced in Table 30. The conversion rates used were 1 cigarette = 1 gm, 1 cheroot = 3 gm, 1 cigar = 5 gm, and pipe tobacco by weight. The RR's in Table 30 are not stated to be age adjusted; the RR's for women are higher not because absolute rates are higher, but because the rate for the comparison neversmoker group is lower.

In the British prospective study discussed above (Ben-Shlomo et al., 1994, see all-cause mortality) the secondary cigar smoker group (*n*=658) produced an age-adusted RR for death from coronary heart disease of 0.91 (0.65-1.23) when compared to neversmokers, while current cigarette smokers (*n*=7,921) had a RR of 1.74 (1.63-1.86). Smoking categories are based on questions at the beginning of the study, with no reclassification during the 18-years of follow-up.

Wald and Watt (1997), in the follow-up study of 21,520 men discussed previously, report a RR of ischaemic heart disease of 0.98 (0.67-1.44) for primary cigar/pipe smokers and 1.29 (0.88-1.99) for secondary cigar/pipe smokers who switched from cigarettes at least 20 years before the beginning of the study, compared to a RR of 2.27 (1.81-2.84) for current cigarette smokers. These rates are consistent with total tobacco consumption, levels of inhalation, and carboxyhaemoglobin levels reported.

The tables for Coronary Heart Disease from the CPS-I data (Tables 31 and 32) show rate ratios compared to neversmokers by numbers of cigars/

Table 30
Estimated effect of tobacco smoking (all forms) on risk of acute myocardial infarction among females and males*

	RR of First Acute MI	
Smoking group	Females	Males
Nonsmokers	1.0	1.0
Noninhalers	1.5	1.2
Inhalers		
1-14 gm/day	3.6	1.6
15-29 gm/day	4.6	2.1
$\geq$30 gm/day	9.4	2.9

*Nyboe, 1991, p.444.

Table 31
Rate ratio of coronary heart disease by level of cigar/cigarettes per day*

Daily Use	Age (years)				Combined (95% CI)		Deaths**
	35-49	50-64	65-79	80+			
PRIMARY CIGAR							1,505/8,202
1-2	0.72	0.97	0.99	0.99	0.98	(0.91, 1.07)	
3-4	2.08	1.09	1.05	1.02	1.06	(0.96, 1.16)	
5 +	3.07	1.33	1.11	0.94	1.14	(1.03, 1.24)	
Combined	1.77	1.12	1.04	0.99	1.05	(1.00, 1.11)	
SECONDARY CIGAR							609/8,202
1-2	0.44	1.11	1.19	0.76	1.06	(0.92, 1.21)	
3-4	1.67	1.22	1.24	0.68	1.10	(0.95, 1.27)	
5 +	2.43	1.60	1.07	0.69	1.10	(0.96, 1.26)	
Combined	1.46	1.32	1.17	0.72	1.09	(1.01, 1.18)	
CIGAR & CIGARETTE							862/8,202
1-19	0.90	1.63	1.06	0.93	1.15	(1.04, 1.27)	
20	4.02	2.15	1.31	1.08	1.47	(1.31, 1.64)	
21 +	2.29	1.82	1.55	1.51	1.61	(1.36, 1.89)	
Combined	2.34	1.84	1.19	0.98	1.29	(1.21, 1.38)	
CIGARETTE ONLY							1,5659/8,202
1-19	3.10	1.80	1.36	1.08	1.40	(1.36, 1.45)	
20	3.92	2.15	1.48	1.21	1.58	(1.54, 1.62)	
21 +	4.58	2.28	1.53	1.22	1.65	(1.60, 1.69)	
Combined	4.01	2.11	1.45	1.14	1.54	(1.52, 1.57)	

*Based on data from CPS-I Study. Age-standardized rate ratio for smoking group compared to neversmokers.
**Number of deaths in subject group/neversmoker group.

cigarettes per day and by level of inhalation. The lowest levels of each table for cigar smokers are not significantly different from neversmokers; however, the rates for higher levels of cigars per day and moderate and deep inhalation are significantly elevated.

The coronary heart disease data for primary cigar smokers from the CPS-I study was subjected to a Poisson step-wise regression analysis in order to test the association of the factors of chronological age, reported inhalation level, and number of cigars per day. The independent variable tested was the absolute rates of coronary heart disease mortality. The analysis produced the following significant factors (Table 33): The level of inhalation is significant in determining the rate of coronary disease. The square and square root transformations of this arbitrary scale for inhalation were also tried, but in this case the flat scale (0,1,2,3) fit best. The number of cigars per day was also marginally significant, in this case the log transformation of the data fit better than the flat scale of number of cigars.

Summary The studies of cigar smoking and coronary events present a pattern of slightly elevated rates among cigar smokers who smoke heavily or inhale deeply. The Danish study (Nyboe, 1991) and the CPS-I data provide evidence of increasing rates with increasing numbers of cigars smoked each day; these

Table 32
Rate ratio of coronary heart disease by level of inhalation*

Level of Inhalation	Age (years)				Combined (95% CI)		Deaths*
	35-49	50-64	65-79	80+			
PRIMARY CIGAR							1461/8202
None	1.65	1.13	1.01	0.90	1.01	(0.96, 1.07)	
Slight	2.79	1.10	1.13	1.51	1.23	(1.07, 1.41)	
Moderate-deep		0.82	1.61	1.44	1.37	(1.07, 1.75)	
Combined	1.79	1.11	1.04	0.99	1.05	(1.00, 1.11)	
SECONDARY CIGAR							586/8,202
None	1.54	1.06	1.11	0.79	1.02	(0.92, 1.13)	
Slight	0.69	1.55	1.23	0.47	1.10	(0.93, 1.30)	
Moderate-deep	2.44	1.91	1.30	0.42	1.23	(0.99, 1.51)	
Combined	1.49	1.31	1.15	0.69	1.08	(0.99, 1.17)	
CIGAR & CIGARETTE							910/8,202
None, slight	1.42	1.42	1.03	1.05	1.12	(1.02, 1.24)	
Moderate	3.57	2.12	1.43	0.74	1.43	(1.28, 1.58)	
Deep	1.99	2.33	1.66	0.90	1.62	(1.37, 1.90)	
Combined	2.37	1.83	1.20	0.97	1.29	(1.21, 1.38)	
CIGARETTE ONLY							16,241/8,202
None, slight	3.46	1.94	1.40	1.06	1.45	(1.41, 1.50)	
Moderate	3.88	2.03	1.43	1.17	1.52	(1.49, 1.55)	
Deep	4.46	2.43	1.56	1.27	1.71	(1.66, 1.76)	
Combined	4.00	2.11	1.44	1.13	1.53	(1.51, 1.56)	

*Based on data from CPS-I Study. Age-standardized rate ratio for smoking group compared to neversmokers.
**Number of deaths in subject group/neversmoker group.

Table 33
Results of step-wise poisson regression of absolute rates of coronary heart disease deaths

Variable	Coeffecient	SE	F-test	Probability
(Constant)	–0.05063	0.00269		
Age (years)	0.09950	0.0000345	651.6	$<10^{-10}$***
Inhalation (0-3)	0.2258	0.000397	20.8	0.00002***
Cigars per day	0.1443	0.000589	3.9	0.05*

***p<0.0001; **p<0.01; *p<.005.

studies, plus those by Wald and Watt (1997) and Gyntelberg (1981), present evidence for elevated rates for those inhaling cigar smoke. These data establish that cigar smokers who smoke several cigars per day or who inhale are at increased risk for coronary heart disease.

CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

Data from the prospective Cophenhagen City Heart Study (Lange 1992, see all-cause mortality) provides Chronic Obstructive Pulmonary Disease (COPD) rates for male and female smokers of cigars and cheroots, with neversmokers as the comparison group. Cheroots are commonly smoked by women as well as men in Denmark.

Table 34

COPD and cigar smoking: rate ratios by type of smoking (males only except as noted)

Prospective Studies	Sample size*	Never-Smoker	Primary Cigar	Mixed, cigar & cigarette	Cigarette
Hammond & Horn (1958)	187,783	1.0	1.29		2.85
Doll & Peto (1976)	41,000	1.0	9.33**	11.33	24.67
Best (1966) emphysema	78,000	1.0	3.33		5.85
bronchitis	78,000	1.0	3.57		11.42
Hammond (1966) emphysema	440,559	1.0	1.37**		6.55
Kahn (1966)	293,000	1.0	0.79		10.08
Lange (1992) male	6,511/808/4	1.0	3.7 (1.1-12)		6.4 (2.0-20) plain
Lange (1992) male					7.9 (2-3-27) filter
Lange (1992) female	7703/770/4	1.0	10 (2.3-48)		15 (3.1-65) plain
Lange (1992) female					16 (3.6-70) filter
Ben-Shlomo (1994) secondary	19,018/658/10	1.0	1.43 (0.68-2.63)		3.24 (2.86-3.65)
CPS-I primary	442,455/15,072/30	1.0	1.42 (1.0-2.0)	7.95 (6.1-10.2)	11.70 (11.1-12.3)
CPS-I secondary	442,455/7,349/33	1.0	4.39 (3.0-6.2)		

For prospective studies reviewed, the number of cigar smokers and number of deaths in this group are also given.
*** cigar and pipe combined*

The overall RR for women cigar and cheroot smokers for mortality due to COPD is 10 (2.3-48) and for men 3.7 (1.1-12). These rates are calculated to be 0.7 and 0.5 of the rate for cigarette smokers, both significantly lower. However, when considering only those subjects reporting inhalation of cigars/cheroots, the rate compared to smokers of cigarettes with inhalation is 2.1 times greater for women (0.8-5.3) and 0.9 (0.5-1.6) for men.

In the Whitehall prospective study (Ben-Shlomo, 1994), the secondary cigar smoker group (*n*=658) produced an age-adusted RR for death from COPD of 1.43 (0.68-2.63) when compared to neversmokers, while current cigarette smokers (*n*=7,921) had a RR of 3.24 (2.86-3.65). Smoking categories are based on questions at the beginning of the study, with no reclassification during the 18 years of follow-up.

Tables 35 and 36 show the rate ratio for COPD for the various smoking groups by numbers of cigars/cigarettes per day and by inhalation in the CPS-I data. There is a positive gradient of rates with levels of inhalation across all groups. The trend of increasing rates with increasing numbers of cigars/ cigarettes is less convincing, except for cigarettes where inhalation is usual. The confidence intervals for rates of COPD for all primary cigar combinations

Table 35
Rate ratio of COPD by level of cigars/cigarettes per day*

Daily Use	35-49	50-64	65-79	80+	Combined (95% CI)		Deaths**
PRIMARY CIGAR							30/119
1-2			1.61	1.84	1.39	(0.74, 2.38)	
3-4		2.02	1.44	2.27	1.78	(0.89, 3.18)	
5 +		1.00	1.16		1.03	(0.37, 2.23)	
Combined		0.88	1.43	1.74	1.42	(0.96, 2.03)	
SECONDARY CIGAR							33/119
1-2		1.48	3.19		2.64	(1.06, 5.44)	
3-4		1.84	6.16		4.33	(2.07, 7.97)	
5 +		8.96	5.03	8.39	6.68	(3.82,10.85)	
Combined		4.25	4.79	3.71	4.39	(3.02, 6.16)	
CIGAR & CIGARETTE							63/119
1-19		7.04	3.27	9.87	5.82	(3.77, 8.60)	
20		12.12	10.39	16.50	12.44	(8.26,17.98)	
21 +		9.01	9.76		6.84	(3.27,12.58)	
Combined		8.92	6.09	10.83	7.95	(6.11,10.17)	
CIGARETTE ONLY							1,376/119
1-19		6.89	9.71	8.32	8.86	(7.96, 9.84)	
20		12.06	13.57	10.72	12.51	(11.48,13.60)	
21 +		13.92	18.61	8.99	15.04	(13.73,16.45)	
Combined		11.45	13.09	9.18	11.70	(11.09,12.34)	

Age (years) spans the 35-49, 50-64, 65-79, 80+ columns.

*Based on data fromCPS-I study. Age-standardized rate ratio for smoking group compared to neversmokers.
**Number of deaths in subject group/neversmoker group.

Table 36
Rate ratio of COPD by level of inhalation.*

Level of Inhalation	Age (years)				Combined (95% CI)		Deaths**
	35-49	50-64	65-79	80+			
PRIMARY CIGAR							27/119
None			1.00	1.94	1.09	(0.66, 1.70)	
Slight		1.98	3.15		2.05	(0.66, 4.77)	
Moderate-deep		6.39	6.31		4.52	(0.91,13.22)	
Combined		0.61	1.38	1.65	1.32	(0.87, 1.92)	
SECONDARY CIGAR							32/119
None		2.72	4.65		3.36	(1.96, 5.39)	
Slight		2.21	4.46	17.14	7.68	(3.31,15.14)	
Moderate-deep		11.51	7.07		5.84	(2.34,12.02)	
Combined		3.79	4.93	3.84	4.42	(3.02, 6.24)	
CIGAR & CIGARETTE							65/119
None, slight		4.05	4.22	6.78	4.92	(3.08, 7.45)	
Moderate		13.34	7.89	8.99	9.17	(6.09,13.25)	
Deep		12.77	9.26	41.19	19.00	(10.63,31.34)	
Combined		8.96	6.06	9.69	7.61	(5.87, 9.70)	
CIGARETTE ONLY							1,445/119
None, slight		8.17	9.10	8.46	8.80	(7.85, 9.85)	
Moderate		11.52	13.69	10.00	12.28	(11.42,13.18)	
Deep		14.41	19.51	10.62	16.07	(14.49,17.78)	
Combined		11.56	13.06	9.29	11.74	(11.14,12.36)	

*Based on data from CPS-I Study. Age-standardized rate ratio for smoking group compared to neversmokers.
**Number of deaths in subject group/neversmoker group.

include 1.0, so none of these rates are significantly different from the rate for neversmokers, though the trend with inhalation is marked.

The CPS-I data was subjected to a step-wise Poisson analysis of variance for each combination of factors in order to assess the association of the various factors to the absolute rates of mortality caused by COPD. This analysis yielded the following significant factors (Table 37): There is a strongly significant effect related to age. The square of inhalation was a stronger factor than inhalation or square root of inhalation, showing a highly significant relationship to the rates of mortality. The analysis does not show an effect related to numbers of cigars per day.

Summary   The Lange study (1992) and the regression analysis of the CPS-I data support the hypothesis that rates of COPD for cigar smokers who inhale are significantly elevated. From the CPS-I analysis, the number of cigars smoked daily is less significant in determining risk of COPD than the degree of inhalation. The data taken as a whole support the conclusion that cigar smoking can cause COPD in smokers who inhale deeply.

Table 37
Results of step-wise poisson regression of absolute rates of COPD

Variable	Coeffecient	SE	F-test	Probability
(Constant)	−9.6843	0.0226		
Age (years)	0.1763	0.000291	46.5	$<10^{-8}$***
Inhalation^2 (0-3)	0.7509	0.00117	39.4	$<10^{-7}$***
Cigars per day	—		0.2	0.89 NS

***p<0.0001; **p<0.01; *p<0.05.

CEREBRO-VASCULAR DISEASE (CVD)   The Whitehall prospective study (Ben-Shlomo, 1994), produced a RR of CVD of 1.00 (0.77-1.28) for the secondary cigar smoker group, compared to neversmokers, while current cigarette smokers had a RR of 1.74 (1.64-1.83).

In a prospective study of 7,735 British men followed for 12.75 years, Wannamethee et al. (1995) found elevated rates of major stroke events (fatal and non-fatal) in both primary pipe or cigar smokers and secondary smokers. The age-adjusted RR for primary pipe or cigar smokers was 2.4 (0.8-7.6). For secondary pipe or cigar smokers the RR was 3.2 (1.5-6.8). Both are similar to the rates for light cigarette smokers 3.6 (1.8-6.9) (1-19 cigarettes per day). For comparison, the cigarette-only smokers show a RR of stroke of 4.1 (2.2-7.4). When the secondary pipe or cigar smokers are stratified into normotensive and hypertensive groups, the RR for the normotensive group is 7.8 (2.1-30.0) and for the hypertensive group 1.9 (0.7-5.2), compared to neversmokers in the same normotensive/hypertensive group.

Haheim et al. (1996) report on risk of fatal stroke in the Oslo study, analyzing data on 16,173 men followed for 18 years, beginning in 1972. In their analysis, all smoking groups have significantly increased risk of stroke. The RRs adjusted for age, diastolic blood pressure and blood glucose level were 3.6 (1.05-12.3) for cigar/pipe only smokers; 6.7 (2.4-18.5) for cigarette-only smokers; 9.8 (3.3-29.6) for smokers of cigarettes and pipe/cigar. Smoking groups were divided according to smoking habits at the beginning of the study, so the cigar/pipe group includes some proportion of secondary smokers who formerly smoked cigarettes. No information is presented on inhalation habits.

The results of the tabulations of CPS-I data for cigar smokers are given in Tables 39 and 40. None of the cigar tables are convincing—neither the RR's for primary cigar smokers by level of cigars per day nor the RR's by depth of inhalation for primary cigar smokers are significant or show any trend, though the results for cigarette-only smokers are significantly elevated.

Summary   It is difficult to reconcile the results from the European studies and the CPS-I results. The analyses for the Wannamethee (1995) and Haheim (1996) studies present strong evidence that there is increasing stroke frequency related to smoking cigars and pipes. These RRs are adjusted for age as well

Table 38
Cerebrovascular disease and cigar smoking: rate ratios by type of smoking (males only)

Prospective Studies	Sample Size*	Rate Ratio (RR)			
		Never-Smoker	Cigar	Mixed, Cigar & Cigarette	Cigarette
Hammond & Horn (1958)	187783	1.0	1.31	1.30	
Doll & Peto (1976)	41000	1.0	1.15*	1.21	1.34
Best (1966)	78000	1.0	1.28	0.88	
Hammond (1966)	440559	1.0	1.09*	1.40	1.41
Kahn (1966)	293000	1.0	1.08	1.52	
Ben-Shlomo (1994) secondary	19018/658/64	1.0	1.00 (0.77-1.28)		
Wannamethee (1995) primary	7735/187/4	1.0	2.4*† (0.8-7.6)		4.1 (2.2-7.4)
secondary	7735/561/16	1.0	3.2*† (1.5-6.8)		
Haheim (1996)	16173/1623/7	1.0	3.6* (1.05-12.3)	9.8* (3.3-29.6)	6.7 (2.4-18.5)
CPS-I, primary	442455/15072/435	1.0	0.96 (0.87-1.06)	1.12 (0.97-1.29)	1.24 (1.20-1.29)
secondary	442455/7349/134	1.0	0.92 (0.77-1.09)		

* For prospective studies reviewed, the number of cigar smokers and number of deaths in this group are also given.
** Cigar and pipe combined
† Major stroke event—fatal or non-fatal

Table 39
Rate ratio of cerebrovascular disease, by level of cigar/cigarettes per day*

Daily Use	Age (years)				Combined (95% CI)		Deaths**
	35-49	50-64	65-79	80+			
PRIMARY CIGAR							431/2,556
1-2	1.87	1.24	1.02	0.95	1.01	(0.88, 1.17)	
3-4	3.30	1.35	1.10	0.89	1.05	(0.88, 1.23)	
5 +		0.74	0.81	0.79	0.79	(0.64, 0.97)	
Combined	1.64	1.11	0.98	0.90	0.96	(0.87, 1.06)	
SECONDARY CIGAR							133/2,556
1-2		1.46	0.93	0.88	0.95	(0.71, 1.26)	
3-4		1.95	0.94	0.69	0.92	(0.67, 1.24)	
5 +	3.42	1.06	0.93	0.79	0.89	(0.64, 1.22)	
Combined	1.17	1.45	0.93	0.79	0.92	(0.77, 1.09)	
CIGAR & CIGARETTE							190/2,556
1-19	2.14	1.76	1.15	0.62	0.99	(0.80, 1.20)	
20	2.41	2.49	1.19	1.39	1.40	(1.08,1.79)	
21 +	10.16	2.72	1.26	1.94	1.71	(1.16, 2.45)	
Combined	4.32	2.19	1.15	0.82	1.12	(0.97, 1.29)	
CIGARETTE ONLY							2,932/2,556
1-19	2.99	1.67	1.30	0.96	1.19	(1.12, 1.27)	
20	3.16	2.03	1.26	0.97	1.22	(1.15, 1.29)	
21 +	3.66	2.47	1.38	0.87	1.27	(1.19, 1.36)	
Combined	3.32	2.11	1.31	0.95	1.24	(1.20, 1.29)	

Based on data from CPS-I study. Age-standardized rate ratio for smoking group compared to neversmokers.
**Number od deaths in subject group/neversmoker group.*

as other factors such as diastolic blood pressure and body mass, whereas the CPS-I results presented are only age-adjusted. The Haheim cigar data is probably mixed primary and secondary cigar/pipe smokers. The CPS-I primary cigar data are primarily individuals who report that they do not inhale (78 percent), while inhalation information is not provided by the other studies. If inhalation rates are much higher in the European studies, this could explain some of the differences found in the RR of stroke between the two groups of studies.

AORTIC ANEURYSM   Risk ratios of aortic aneurysm are shown to be elevated for both cigarette-only and cigar-only smokers by two prospective studies. The results for the CPS-I data are given in Tables 42 and 43, by level of cigars/cigarettes per day and by level of inhalation. Though the trend with increasing level for cigar smokers is not clear, the overall result is highly significant: 1.76 (1.29-2.35) for primary cigar smokers, 2.82 (1.91-4.00) for secondary cigar smokers, 3.32 (2.34-4.58) for cigar and cigarette smokers, and 4.96 (4.62-5.31) for cigarette only smokers. The cigarette-only smokers do show a strong positive trend both with increasing consumption of cigarettes per day and with increasing levels of inhalation.

Table 40
Rate ratio of cerebrovascular disease by level of inhalation

Level of Inhalation	Age (years)				Combined (95% CI)		Deaths*
	35-49	50-64	65-79	80+			
PRIMARY CIGAR							410/2,556
None	1.13	0.86	0.95	0.88	0.91	(0.82, 1.02)	
Slight		2.11	1.00	0.90	1.06	(0.79, 1.39)	
Moderate-deep	13.98	1.69	1.08	1.16	1.22	(0.74, 1.91)	
Combined	1.65	1.10	0.96	0.89	0.95	(0.86, 1.04)	
SECONDARY CIGAR							132/2,556
None		0.81	1.09	0.84	0.95	(0.76, 1.18)	
Slight	4.50	2.31	0.60	0.72	0.83	(0.55, 1.20)	
Moderate-deep		2.86	0.80	0.54	0.88	(0.52, 1.38)	
Combined	1.20	1.49	0.95	0.79	0.93	(0.78, 1.11)	
CIGAR & CIGARETTE							202/2,556
None, slight	4.22	2.00	1.17	0.64	1.03	(0.85, 1.25)	
Moderate	4.19	1.88	1.08	1.42	1.31	(1.01, 1.67)	
Deep	3.54	3.58	1.22	0.86	1.30	(0.88, 1.86)	
Combined	4.18	2.21	1.15	0.82	1.12	(0.97, 1.29)	
CIGARETTE ONLY							3,083/2,556
None, slight	2.81	2.12	1.34	1.04	1.29	(1.21, 1.38)	
Moderate	3.25	2.07	1.26	0.83	1.16	(1.10, 1.22)	
Deep	3.66	2.25	1.35	1.08	1.33	(1.22, 1.43)	
Combined	3.31	2.12	1.31	0.96	1.25	(1.20, 1.29)	

Baed on data from CPS-I study. Age-standardized rate ratio for smoking group compared to neversmokers.
*Number od deaths in subject group/neversmoker group.

The step-wise Poisson analysis of absolute rates of mortality due to aortic aneurysm of primary cigar smokers in the CPS-I study shows a significant effect for the factors of age (F=66.1, $p<10^{-10}$) and the square of inhalation (F=45.3, $p<10^{-8}$), but no significant effect for number of cigars per day (F=2.1, p=.15). The moderate-deep inhalers for primary cigar do show an elevated effect of RR=4.94 (1.59-11.52) in Table 43, a rate similar to the level for cigarette-only smokers.

Summary   The CPS-I study provides evidence that the risks of aortic aneurysm are elevated for smokers, both for cigar smokers and cigarette smokers. Among cigar smokers, the RR's for inhalers approach the risks observed for cigarette smokers. The data from CPS-I support cigar smoking as a cause of aortic aneurysm.

Table 41

Aortic aneurysm and cigar smoking: rate ratios by type of smoking (males only)

Prospective Stufies	Sample Size*	Never-Smoker	Cigar	Mixed, Cigar & Cigarette	Cigarette
			Rate Ratio (RR)		
Kahn (1966)	293,000	1.0	2.06		5.24
CPS-I primary	442,455/15,072/46	1.0	1.76 (1.29-2.35)	3.32 (2.34-4.58)	4.96 (4.62-5.31)
CPS-I secondary	442,455/7,349/31	1.0	2.82 (1.91-4.00)		

*For prospective studies reviewed, the number of cigar smokers and number of deaths in this group are also given.

Table 42
Rate ratio of aortic aneurysm by level of cigar/cigarettes per day*

Daily Use	Age (years)				Combined (95% CI)		Deaths**
	35-49	50-64	65-79	80+			
PRIMARY CIGAR							46/149
1-2		2.67	1.69	1.35	1.82	(1.11, 2.81)	
3-4			0.96	1.57	0.88	(0.35, 1.82)	
5 +		3.44	2.17	2.87	2.62	(1.58, 4.09)	
Combined		2.17	1.61	1.76	1.76	(1.29, 2.35)	
SECONDARY CIGAR							31/149
1-2		2.78	3.62		3.03	(1.51, 5.43)	
3-4		4.60	3.39		2.80	(1.34, 5.16)	
5 +		5.59	2.64		2.64	(1.26, 4.85)	
Combined		4.31	3.14		2.82	(1.91, 4.00)	
CIGAR & CIGARETTE							37/149
1-19		3.23	4.07	2.59	3.48	(2.13, 5.38)	
20		2.24	3.49		2.32	(1.15, 4.14)	
21 +		3.68	5.58		3.72	(1.36, 8.10)	
Combined		2.97	4.17	1.99	3.32	(2.34, 4.58)	
CIGARETTE ONLY							805/149
1-19	3.78	3.11	4.38	3.03	3.75	(3.25, 4.31)	
20	7.11	4.23	6.15	3.94	5.17	(4.62, 5.77)	
21 +	4.93	5.33	8.28	4.50	6.65	(5.90, 7.46)	
Combined	5.54	4.36	5.92	3.49	4.96	(4.62, 5.31)	

*Based on data from CPS-I study. Age-standardized rate raio for smoking group compared to neversmokers.
**Number of deaths in subject group/neversmoker group.

Table 43
Rate ratio of aortic aneurysm by level of inhalation

Level of Inhalation	Age (years)				Combined (95% CI)		Deaths*
	35-49	50-64	65-79	80+			
PRIMARY CIGAR							45/149
None		2.06	1.59	1.78	1.73	(1.22, 2.39)	
Slight		1.23	1.39		1.00	(0.20, 2.92)	
Moderate-deep		7.93	4.02		4.94	(1.59,11.52)	
Combined		2.20	1.65	1.68	1.77	(1.29, 2.37)	
SECONDARY CIGAR							30/149
None		2.82	2.97		2.18	(1.22, 3.59)	
Slight		8.00	3.28		3.52	(1.69, 6.47)	
Moderate-deep		3.87	3.99		2.94	(0.95, 6.87)	
Combined		4.41	3.23		2.67	(1.80, 3.82)	
CIGAR & CIGARETTE							37/149
None, slight		2.57	2.15	2.49	2.32	(1.30, 3.82)	
Moderate		3.08	6.71		4.17	(2.38, 6.77)	
Deep		3.01	8.20		4.92	(1.80,10.72)	
Combined		2.85	3.93	1.78	3.12	(2.20, 4.31)	
CIGARETTE ONLY							827/149
None, slight		2.84	3.73	3.59	3.46	(2.94, 4.06)	
Moderate	6.76	4.50	6.55	2.87	5.17	(4.71, 5.65)	
Deep	5.19	4.83	8.17	4.88	6.57	(5.68, 7.55)	
Combined	5.39	4.26	5.85	3.45	4.89	(4.56, 5.23)	

Based on data from CPS-I study. Age-standardized rate raio for smoking group compared to neversmokers.
*Number of deaths in subject group/neversmoker group.

CONCLUSIONS

1. Regular cigar smoking causes cancer of the lung, oral cavity, larynx, esophagus, and probably cancer of the pancreas.

2. Heavy cigar smokers, and those who inhale deeply, are at increased risk for coronary heart disease and can develop chronic obstructive pulmonary disease (COPD). Data from CPS-I suggest that cigar smokers have an increased risk for aortic aneurysm.

3. On average, cigar smokers are less likely to inhale cigar smoke than are cigarette smokers to inhale cigarette smoke, and this reduced inhalation of tobacco smoke probably explains the lower risks of coronary heart disease, COPD, and lung cancer seen among cigar smokers compared to cigarette smokers.

4. The risks of cancers of the oral cavity and esophagus are similar among cigarette and cigar smokers, probably due to the similar doses of tobacco smoke delivered to these areas by smoking cigars and cigarettes.

5. Former cigarette smokers who currently smoke cigars are more likely to inhale deeply than cigar smokers who have never smoked cigarettes, and their risks are intermediate between cigarette smokers and cigar smokers who have never smoked cigarettes.

6. Cigarette smokers who switch to smoking only cigars have lung cancer risks that are lower than continuing cigarette smokers, but these risks appear to be substantially greater than those for individuals who have quit smoking all tobbaco products.

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Appendix: Methods Used
In Analyzing CPS-I data.

AGE STANDARDIZATION   Many tables are presented which provide mortality risk ratios (RR) comparing observed rates for a particular disease for a smoking group to rates for neversmokers. In all these tables, age standardization has been carried out (Rothman, 1986). The differences in the age composition of different subject groups would affect these comparisons if no standardization were applied. For example, in the CPS-I data the age distribution of primary cigar smokers is somewhat older than that of cigarette-only current smokers, because of changing patterns in uptake over time, and perhaps because of effects of differential mortality (NCI, 1997). In order to make the groups comparable, all CPS-I rates and ratios for combined age groups have been standardized to the age profile of the neversmoker group, because the neversmokers are used as the reference comparison group in determining the risk ratio for the various smoking groups. The neversmoker subject group was selected as the reference group in preference to a USA Population standard because the population standard is skewed to younger age groups, where smoker mortality is lower and data from this study are sparse. Thus, using a USA population standard would make rates of disease for smokers appear to be lower and increase variability. In each case rates are calculated for 5-year age groups (... 55.0-59.99, 60.0-64.99, ...) and are standardized by weighting the contribution of the 5-year aged group according to the proportion of the neversmoker population in that age group. All rates given are rates of primary cause of mortality, as specified by the primary cause of death from the death certificate. Confidence intervals are calculated using the methods described in Breslow and Day (1980, p. 131; 1987, p. 69).

STEP-WISE POISSON REGRESSION   To test for a significant association of the factors of numbers of cigars per day, level of inhalation, and chronological age to rates of mortality for a specific disease, the absolute rates for each combination of factors were subjected to a step-wise regression analysis using Poisson regression (Breslow and Day, 1987). The objective of the regression analyses was not to propose a biological model or predict rates of mortality, but to assess the relative significance of factors and combinations of factors.

The factors were grouped as follows:

cigars per day	value used in analysis
1-2 cpd	2
3-4 cpd	4
5+ cpd	7

depth of inhalation	value used in analysis
none	0
slightly	1
moderately	2
deeply	3

chronological age	value used in analysis
40-44.99	42.5
45-49.99	47.5
50-54.99	52.5
55-59.99	57.5

Age was advanced during the 12 years of follow-up, with the data tabulated into cells of current combinations of values. If smoking behavior changed at the time of follow-up interviews, subjects were reclassified or deleted from subject groups appropriately. All cells with at least 20 person-years-of-observation (PYO) were retained for the analyses. For the primary cigar subjects, there were typically 60-70 cells of combinations of factors which met the minimum criteria for inclusion. Some portion of these cells had at least one death, and hence a positive rate estimate for the disease. When no death had occured for a combination of factors, no rate estimate was possible, but these cells were also included with a 0.0 rate used. All cells, including those with no deaths, were included in the regression in order not to overestimate rates.

Several transformations of each variable were included, in order to test the significance of possible variations. For the variable age, both the flat values and log(*age*) were tested. For *cigars per day*, both the flat values and log(*cpd*) were tested. For depth of *inhalation*, the flat values, as well as the square and square root transformations, were tested. All regressions were weighted to the square root of the observed PYO for the cell, thereby weighting each cell in proportion to the confidence attached to the estimate provided by that cell.

Data preparation was done in SAS; tabulation into cells of factors, calculation of rates and standardization was done in Pascal; statistical analysis of data was done in S-Plus.