Preface

The recent increase in cigar consumption began in 1993 and was dismissed by many in public health as a passing fad that would quickly dissipate. Recently released data from the U.S. Department of Agriculture (USDA) suggests that the upward trend in cigar use might not be as temporary as some had predicted. The USDA now projects a total of slightly more than 5 billion cigars were consumed last year (1997) in the United States. Sales of large cigars, which comprise about two-thirds of the total U.S. cigar market, increased 18 percent between 1996 and 1997. Consumption of premium cigars (mostly imported and hand-made) increased even more, an astounding 90 percent last year and an estimated 250 percent since 1993. In contrast, during this same time period, cigarette consumption declined 2 percent.

This dramatic change in tobacco use raises a number of public health questions: Who is using cigars? What are the health risks? Are premium cigars less hazardous than regular cigars? What are the risks if you don't inhale the smoke? What are the health implications of being around a cigar smoker?

In order to address these questions, the National Cancer Institute (NCI) undertook a complete review of what is known about cigar smoking and is making this information available to the American public. This monograph, number 9 in a series initiated by NCI in 1991, is the work of over 50 scientists both within and outside the Federal Government. Thirty experts participated in the multi-stage peer review process (see acknowledgments). The conclusions presented in the monograph represent the best scientific judgment, not only of the NCI, but also of the larger scientific community.

There is sufficient evidence to conclude that a causal relationship exists between regular cigar use and cancers of the lung, larynx, oral cavity, and esophagus. Heavy cigar smoking, particularly for those who inhale, causes an increased risk of coronary heart disease and chronic obstructive pulmonary disease. There is also suggestive evidence for a relationship between cigar smoking and cancer of the pancreas, but the evidence is insufficient at this time to draw a causal inference. The data in this monograph strengthen and extend the conclusions on disease risks contained in several reports of the Surgeon General on smoking and health.

After a careful assessment of the available scientific evidence, the following overall conclusions are warranted:

> *Cigar smoking can cause oral, esophageal, laryngeal, and lung cancers. Regular cigar smokers who inhale, particularly those who smoke several cigars per day, have an increased risk of coronary heart disease and chronic obstructive pulmonary disease.*

Regular cigar smokers have risks of oral and esophageal cancers similar to those of cigarette smokers, but they have lower risks of lung and laryngeal cancer, coronary heart disease, and chronic obstructive pulmonary disease.

Cigar use in the U.S. has increased dramatically since 1993. Adult prevalence of cigar use in California has increased predominantly among occasional cigar smokers. A substantial number of adult former and never smokers of cigarettes are currently smoking cigars. In contrast to cigarettes, much of the increased use of cigars by adults appears to be occurring among those with higher incomes and greater educational attainment.

Adolescent cigar use is occurring at a substantial level and is currently higher than that recorded for young adults prior to 1993. Currently, cigar use among adolescent males exceeds the use of smokeless tobacco in several states. This use of cigars is occurring among both males and females.

Some in the cigar trade have made the claim that cigar smokers experience little or no increased disease risk. This claim is not supported by the available scientific evidence and misleads cigar smokers to believe that cigar smoke is less harmful than cigarette smoke. We believe an accurate statement is that **the risks of tobacco smoke exposure are similar for all sources of tobacco smoke, and the magnitude of the risks experienced by cigar smokers is proportionate to the nature and intensity of their exposure.**

Differences in the intensity of tobacco smoke exposure between cigarette and cigar smokers result from differences in the inhalation of the smoke and differences in the proportion of smokers who smoke every day. While almost all cigarette smokers inhale, the majority of cigar smokers do not. This may be due to differences in the pH of the smoke produced by these two products. Cigar smoke contains a substantial fraction of its nicotine as free nicotine, which can be readily absorbed across the oral mucosa. In contrast, cigarette smoke is more acidic, and the protonated form of nicotine it contains is much less readily absorbed by the oral mucosa. As a result, cigarette smokers must inhale to get their desired quantity of nicotine, whereas cigar smokers can ingest sufficient quantities of nicotine without inhaling. This reduction in inhalation is one of the reasons for the difference in disease risks between cigarette and cigar smokers.

However, even those who do not inhale have disease risks higher than those who have never smoked any tobacco product. As this monograph clearly demonstrates, regular cigar smokers who have never smoked cigarettes, even those who do not inhale, experience significantly elevated risks for cancers of the larynx, oral cavity (including pharynx), and esophagus.

[1] For the California survey, current prevalence among adults was defined as a positive response to: 1) Have you ever smoked cigars? and 2) Do you now smoke cigars every day or some days?

Another reason for a difference in risk between cigarette and cigar smokers is a difference in the frequency with which the two products are used. Most cigarette smokers smoke every day. In contrast, as many as three-quarters of cigar smokers smoke only occasionally, and some may only smoke a few cigars per year. This difference in frequency of exposure translates into lower disease risks.

We do not know the risk of addiction posed by cigar smoking. But the difference in smoking patterns suggests a potential difference in addictive properties between cigarettes and cigars.

Of special concern are the risks for those individuals who are mixed smokers (current smokers of both cigars and cigarettes), or who switch to smoking cigars from smoking cigarettes. A sizable fraction of today's cigar smokers are current or past cigarette smokers. These individuals are much more likely to continue to inhale when they switch to smoking cigars, and may therefore remain at much higher risk for all the major smoking related diseases than are cigar smokers who have never smoked cigarettes.

To those individuals who may be thinking about smoking cigars, our advice is — don't. Cigars are not safe alternatives to cigarettes and *may* be addictive.

To those cigarette smokers who are thinking of switching to cigars, don't be misled. Unless you substantially reduce your exposure to smoke, your risks will remain unchanged.

To those currently smoking cigars, quitting is the only way to eliminate the documented harm that can result from cigar smoking.

Once regular tobacco use is established, no matter whether it's cigarettes, cigars, or smokeless tobacco, quitting *may* become extremely difficult.

To all smokers and nonsmokers, tobacco smoke contains over 4,000 compounds, including dozens of carcinogens. Because of their greater mass, cigars generate much higher levels of many of these indoor pollutants than do cigarettes. Smoke from a single cigar burned in a home can require 5 hours to dissipate, thereby exposing other household members to a sizable involuntary health risk.

A special concern generated by the data in this monograph is the rate of cigar use among adolescents. Prior to the current upswing in cigar use, most cigar smokers were middle aged or older men, and they began smoking cigars as adults. In contrast, several studies now report cigar smoking prevalence rates among adolescent males that are more than double the rates of smokeless tobacco use. In a 1996 survey of Massachusetts school students in grades 6 through 12, prevalence of current cigar use among males ranged from 3.2 percent in 6th graders to 30 percent in high school. Adolescent girls also report surprisingly

high rates of cigar use, with 6-7 percent of girls in high school reporting they smoked cigars in the past 30 days. Similar findings are reported in other studies.

This high rate of cigar use among adolescents raises significant public health questions and has serious implications for public health programming. Will these high rates of cigar use continue as these youth move into adulthood? Will nicotine addiction develop in these adolescent users and thereby influence their inhalation and consumption patterns? Will cigar smoking transition large numbers of youth into regular cigarette use later in life? If regular cigar use develops, will quitting prove as difficult for cigars as it is for cigarettes?

It is premature to label cigar use as the next tobacco epidemic in the making; but we would be wise to remember that a similar problem of smokeless tobacco use confronted us in the late 1970's, and it was a number of years before the public health community became concerned. Now, 20 years later, consumption of smokeless tobacco, especially moist snuff, has reached record levels — 60 million pounds last year, and shows no sign of waning. The vast majority of all snuff users are younger-age adults and adolescents, a pattern not dissimilar to the current pattern of cigar use.

This monograph provides us with a snapshot of a rapidly changing pattern of behavior with important potential public health consequences. I commend the authors for providing the nation with clear and invaluable information about this disturbing change in tobacco use.

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HOW THIS MONOGRAPH WAS PREPARED

This volume is the ninth in the series of Smoking and Tobacco Control monographs published by the National Cancer Institute (NCI) since their inception in 1991. One of the major reasons for establishing the monograph series was to provide a mechanism for the rapid, systematic, and timely dissemination of information important to the research and public health communities about emerging issues in smoking and tobacco use control. While the focus of the monographs has primarily centered on topics related to public health interventions, this volume is somewhat of a departure in that it is the first comprehensive examination of what we know about current trends in cigar use and resultant health implications.

CIGARS: Health Effects and Trends, is being published, in part, because of the growing and sustained interest in cigars as reflected by the countless inquiries received over the past two years about the topic by NCI's Office of Cancer Communications.

Prior to 1994, smoking of cigars had declined by 60 percent in the United States, a downward trend which started in the mid-1960's. Surveys conducted from the mid-1950's through the early 1990's confirmed that cigar smoking was declining. The public health community assumed, incorrectly it now appears, that cigar smoking would continue to decline in popularity and did not warrant further investigation. But starting in the early 1990's, the downward trend in cigar use began to reverse; and between 1993 and 1997, cigar consumption increased almost 50 percent with consumption of large, premium cigars increasing nearly 250 percent.

Public interest, spurred by new magazines devoted entirely to cigars and cigar smoking, and the social environment that cigar smoking purportedly involves, was enough to rapidly increase the consumption of cigars. Unfortunately, the public has been led to believe that cigar smoking is far less of a threat to an individual's health than cigarette smoking simply because it is a cigar. The present monograph is an attempt to dispel this misconception and put the risks of cigar smoking into their proper context.

The Smoking Tobacco and Control Program (STCP) staff continually monitors the consumption of all forms of tobacco products, and consequently, the recent interest and increased consumption of cigars was considered important enough to the nation's health to prepare a health oriented publication regarding cigar smoking.

Once the decision was made by the STCP Coordinator to look into the matter of cigar smoking, a broad outline was developed showing the major chapters or topics to be covered in the monograph. A three-person scientific editorial team was established, consisting of the Senior Scientific Editor, David M. Burns, Professor of Medicine, University of California San Diego, California, and two

Consulting Scientific Editors, Dietrich Hoffmann, Associate Director, American Health Foundation, Valhalla, New York, and K. Michael Cummings, Senior Research Scientist, Roswell Park Cancer Institute, Buffalo, New York. After a more detailed outline was developed, potential authors were identified and contacted to determine their willingness to write individual chapters or sections of the monograph.

A one-day meeting was convened in the Washington, D.C. area in February 1997 involving the entire monograph team. Each lead author presented an overview of his/her assignment, including how they proposed approaching their particular chapter, potential sources to be used, the need for primary or secondary data analysis, and gaps or overlaps in coverage. Discussions and recommendations followed each presentation.

PEER REVIEW Preliminary draft chapters were delivered to the NCI approximately 4 months following the initial meeting in Washington. The senior scientific editor, in consultation with the other science editors, reviewed all chapter drafts for scientific and technical content and advised authors if revisions were needed. All chapter drafts were distributed to two or more outside experts knowledgeable in the subject area of the chapter. All review comments received were considered and a new iteration of the monograph was generated. The revised version of the entire monograph was sent to a select list of 12 senior level reviewers as well as to a number of Public Health Service agency heads, for review and comments. All comments received from this review cycle were also integrated and a third version of the volume was generated. A total of 30 outside experts participated in the peer review.

CIGARS: Health Effects and Trends was the work of dozens of individuals, and is organized into 8 chapters:

Chapter 1: Cigar smoking: Overview and current state of the science.

Chapter 2: Trends in cigar consumption and smoking prevalence.

Chapter 3: Chemistry and toxicology.

Chapter 4: Disease consequences of cigar smoking.

Chapter 5: Indoor air pollution from cigar smoke.

Chapter 6: Pharmacology and abuse potential of cigars.

Chapter 7: Marketing and promotion of cigars.

Chapter 8: Policies regulating cigars.

Contents

Cigar Smoking: Overview and Current State of the Science

David M. Burns

Cigars were one form of Native American tobacco use observed by Columbus and early European settlers. A long, thick bundle of twisted tobacco leaves wrapped in a dried palm or maize leaf was used by Native Americans as a primitive cigar. Smoking of cigars is recorded on artifacts of the Mayas of the Yucatan region of Mexico, and the Mayan verb "sikar," meaning to smoke, became the Spanish noun "cigarro."

Among early English colonists of the 1600's, tobacco was used predominantly in the form of smokeless tobacco or smoked in pipes, although tobacco was also smoked as cigars at this time. Records dating from the late 1700's suggest that most cigars were imported from the West Indies and Cuba during the Colonial period.

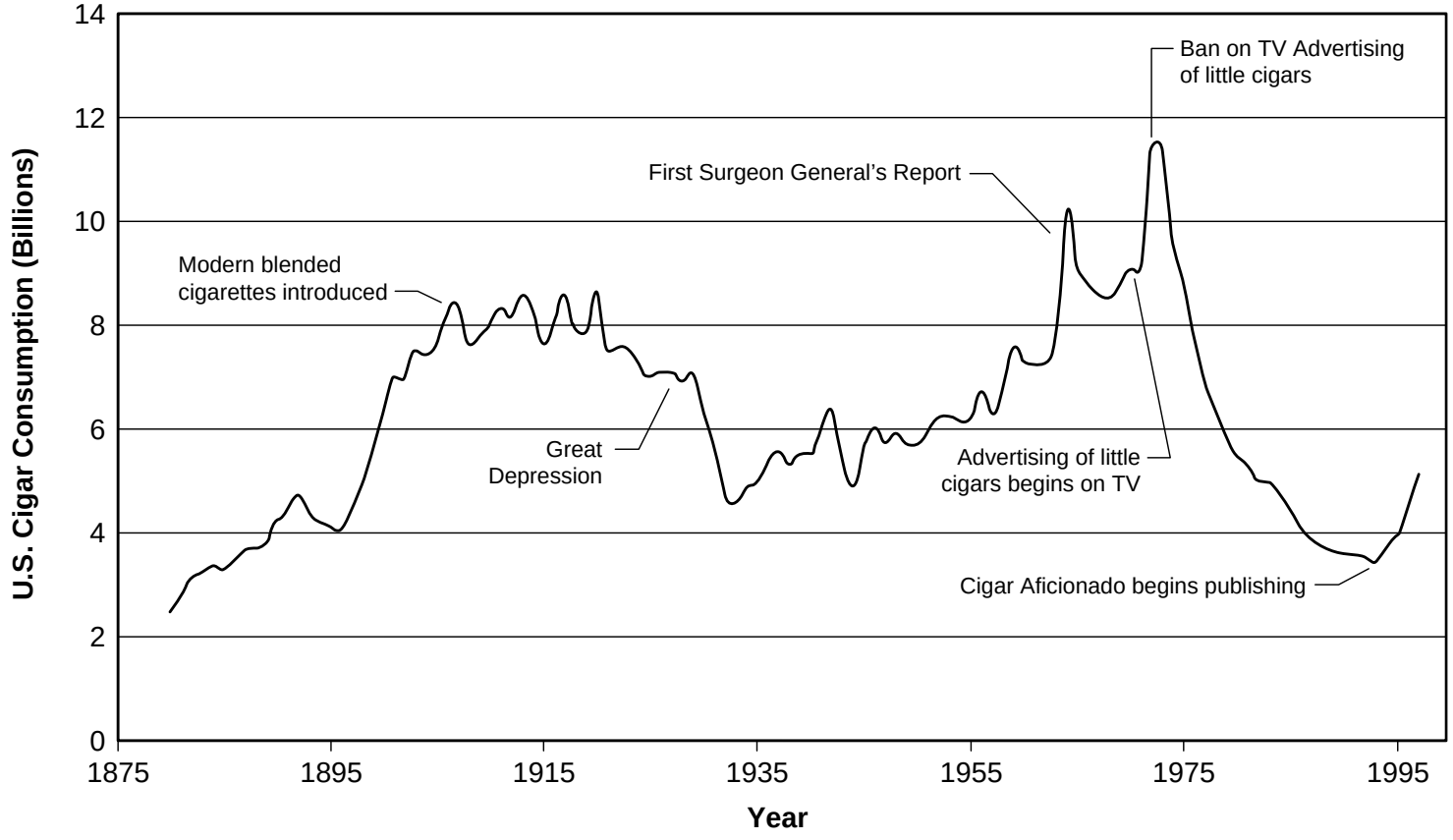
The first U.S. cigar factory was established in Connecticut in 1810. Cigar manufacturing spread to other parts of the U.S. as cigar use slowly gained in popularity. Through the 1880's and early 1900's, cigars remained a popular form of tobacco use, with most cigars made of locally grown tobacco and marketed locally. By 1900, tobacco used in the form of cigars accounted for 2.0 of the 7.5 pounds of tobacco consumed per adult in the U.S., second only to chewing tobacco's 3.5 pounds per adult (USDA 1997, Burns et al 1997). However, the amount of tobacco consumed as cigars declined as the popularity of cigarettes increased around the time of World War I.

Tobacco used to manufacture cigars is different from that used in cigarettes and other tobacco products. Tobacco contained in cigar filler, binder and wrappers is predominantly air-cured tobacco in contrast to the flue-cured tobacco common in cigarettes. Cigar tobacco is then aged and subjected to a multi-step fermentation process that can last several months, and this process is largely responsible for the flavor and aroma characteristic of cigars. Small cigars on the U.S. market have straight bodies and weigh between 1.3 and 2.5 grams each. Large cigars vary markedly in size and shape, with the most common dimensions being 110-150 mm long and up to 17 mm in diameter, and they contain between 5 and 17 grams of tobacco (Chapter 3). By contrast, the most popular brands of cigarettes are 85 mm long and contain less than one gram of tobacco.

TRENDS IN CONSUMPTION

Since 1993, cigar sales in the U.S. have increased by almost 50%, with the largest increase occurring in sales of large cigars (USDA, 1997). Figure 1 presents U.S. cigar consumption from 1880 through 1997 and shows that cigar consumption declined following the introduction and marketing of modern blended cigarettes in 1913, and this decline was accelerated by the Great Depression beginning in 1929. Cigar consumption remained below that found at the turn of the century until 1964 when it increased dramatically, possibly as a response to the publication of the first Surgeon General's report with its warning about the disease risks of smoking cigarettes.

Figure 1
Total U.S. cigar consumption 1880-1997 and significant events in the use of cigars



A loop-hole in the 1969 law banning advertising of cigarettes on television and radio allowed the introduction and television advertising of small cigars, which look and smoke much like cigarettes. Small cigar consumption increased rapidly until these ads were also banned from television and radio in 1973, and cigar consumption then began a steady decline lasting almost 20 years. Marketing approaches to cigar sales linking cigar smoking to wealth and success as portrayed in magazines such as Cigar Aficionado, and utilizing events such as cigar nights at popular restaurants, gained widespread prominence beginning in 1992. Sales of cigars, particularly large cigars, have increased substantially since that time. Accompanying this marketing has been the suggestion that cigars, particularly premium cigars, have minimal if any disease risk associated with their use as long as they are used in "moderation" (Shanken, 1997).

The recent change in tobacco use raises a number of important public health questions. What are the disease consequences of cigar smoking? What is the risk of addiction to nicotine from this form of tobacco use? Are the marketing practices that underlie this change in cigar consumption resulting in adolescent use of cigars? What are the risks of environmental tobacco smoke exposure from cigar smoking?

DISEASE RISKS The smoke from both cigars and cigarettes is formed largely from the incomplete combustion of tobacco, and therefore it comes as no surprise that cigar smoke is composed of the same toxic and carcinogenic constituents found in cigarette smoke (Chapter 3). Cigars have more tobacco per unit; and correspondingly, take longer to smoke and generate more smoke per unit. Additionally, the lower porosity of cigar wrappers results in more of carbon monoxide per gram of tobacco burned; and the higher nitrate content of cigar tobacco results in higher concentrations of nitrogen oxides, carcinogenic N-nitrosamines and ammonia. When bioassayed in animals, the tar of cigar smoke is more carcinogenic than cigarette smoke tar (Davies and Day, 1969). There is little evidence from what is known about the tobacco content and manufacture of premium cigars to suggest that they are less hazardous than other cigars. Clearly, cigar smoke is as, or more, toxic and carcinogenic than cigarette smoke; and differences in disease risks produced by using cigarettes and cigars relate more to differences in patterns of use, and differences in inhalation, deposition and retention of cigarette and cigar smoke than to the differences in smoke composition.

The similarities of cigar and cigarette smoke suggest that similar patterns of diseases should occur among individuals with similar intensities and durations of smoke exposure. When cigar smokers who have never used other tobacco products are compared to individuals who have never used any tobacco product, a clear pattern of excess disease emerges that can be related to the frequency of cigar use and the pattern of inhalation (Chapter 4). Demonstration of a close association between the intensity of cigar smoke exposure and rates of excess disease provide compelling evidence for a causal association between cigar smoking and disease occurrence. Most of the cancers caused by cigarette smoking occur at increased rates among

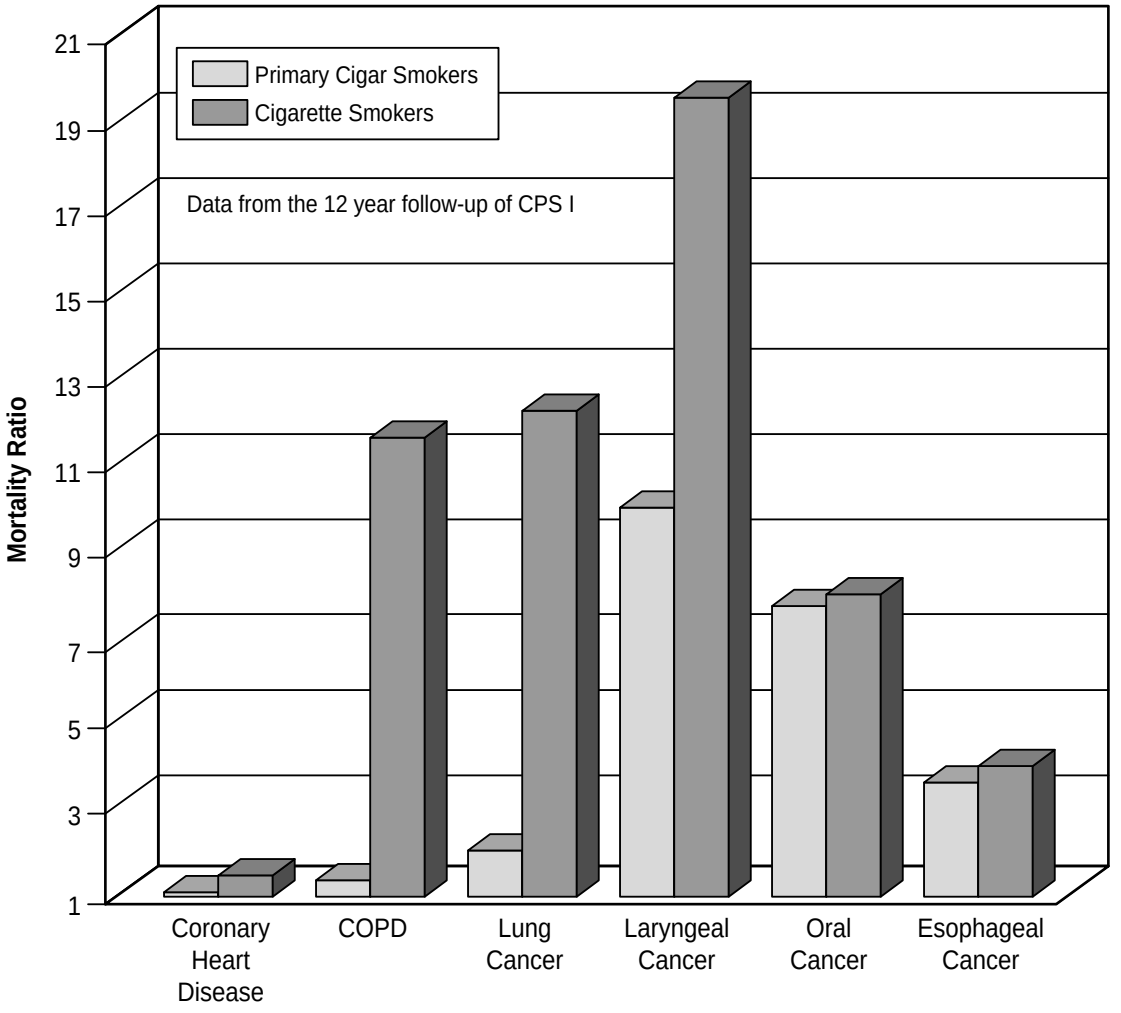
regular cigar smokers. Cigar smokers who inhale deeply, particularly those who smoke several cigars per day, have higher rates of coronary heart disease and chronic obstructive pulmonary disease (COPD).

Figure 2 presents mortality ratios (ratio of the death rate in smokers compared to never smokers) among male cigar and cigarette smokers for some of the diseases associated with cigarette smoking. The ratios presented are for smokers of all numbers of cigarettes or cigars combined. The mortality data were derived from the American Cancer Society Cancer Prevention Study I (CPS-I) a twelve year follow-up of over 1 million men and women (Garfinkel, 1985). These data were provided by the American Cancer Society and define relative risks for those who have smoked exclusively cigars and those who have smoked exclusively cigarettes, with each group of smokers being compared to those who have never smoked any tobacco product. All of these mortality ratios, except those for COPD, are statistically significantly increased among cigar smokers (Chapter 4). The figure demonstrates that tobacco smoke generated by cigars can lead to many of the same diseases produced by tobacco smoke from cigarettes.

However, the pattern of excess disease risk among cigar smokers is not identical to that observed in cigarette smokers. Mortality ratios among cigarette smokers are much higher than those among cigar smokers for coronary heart disease, COPD and lung cancer. In contrast, mortality ratios for oral and esophageal cancer are similar among cigarette and cigar smokers. The mortality ratio for laryngeal cancer is intermediate between these two patterns. Table 1 presents mortality ratios, and their 95 percent confidence intervals, for the major causes of excess mortality among cigar smokers. The risk ratios are presented by number of cigars smoked per day and depth of inhalation to demonstrate the dose-response relationships evident for cigar smoking and these diseases; and similar data are presented for cigarette smokers to allow comparison of the magnitude of the effects.

INHALATION An explanation for the difference in mortality pattern between cigarette smokers and cigar smokers lies in differences in the depth and likelihood of inhalation of tobacco smoke between these two groups of smokers. Most cigarette smokers report inhaling the smoke into their lungs, while over three-quarters of the males in CPS-I who have only smoked cigars report that they never inhale (Chapter 4). This difference in inhalation is likely due to the more acidic pH of cigarette smoke. The smoke of most cigars has an alkaline pH; and as a result, nicotine contained in the smoke can be readily absorbed across the oral mucosa without inhalation into the lung (Chapter 3). The more acidic pH of cigarette smoke produces a protonated form of nicotine which is much less readily absorbed by the oral mucosa, and the larger absorptive surface of the lung is required for the smoker to receive his or her desired dose of nicotine. As a result, cigarette smokers must inhale to ingest substantial quantities of nicotine, the active agent in smoke, whereas cigar smokers can ingest substantial quantities of nicotine without inhaling. Inhalation substantially increases the exposure of lung tissue to tobacco smoke and increases absorption of many smoke constituents, most notably carbon monoxide (Turner et al., 1977; Wald et al., 1981).

Figure 2
Mortality ratios for tobacco induced diseases among male cigar and cigarette smokers in comparison with never smokers



The oral mucosa is exposed to similar amounts of smoke by those who do and those who do not inhale deeper into the respiratory tract. In contrast, the lung is much more heavily exposed in those who inhale; and absorption of many smoke constituents into the blood is greater among those who inhale. This difference in exposure to smoke by different tissues is the most likely explanation for the differences in mortality pattern among cigar and cigarette smokers. Cigar smokers who do not inhale receive a high smoke exposure to the mouth and tongue, and smoke constituents in their saliva are swallowed down their esophagus, producing the observed increased risks of oral and esophageal cancers. The lung and systemic organs such as the heart receive much less exposure to smoke constituents in those cigar

Table 1

Mortality ratios, and 95% confidence intervals, for select causes of death in male cigar only vs cigarette only smokers by amount smoked daily and depth of inhalation Cancer Prevention Study I, 12 year follow-up

		Amount Smoked Daily					
		Cigars per Day			Cigarettes per Day		
Cause of death	Nonsmoker	1-2 cigars	3-4 cigars	5+ cigars	<1 pack	1 pack	>1 pack
All causes of death	1.0	1.02 (.97-1.07)	1.08 (1.02-1.15)	1.17 (1.10-1.24)	1.46 (1.43-1.49)	1.69 (1.66-1.71)	1.88 (1.85-1.91)
Cancer of buccal cavity & pharynx combined*	1.0	2.12 (0.43-6.18)	8.51 (3.66-16.77)	15.94 (8.71-26.75)	5.93 (4.28-8.02)	6.85 (5.37-8.62)	12.04 (9.81-14.63)
Cancer of esophagus	1.0	2.28 (0.74-5.33)	3.93 (1.43-8.55)	5.19 (2.23-10.22)	2.41 (1.61-3.46)	4.3 (3.32-5.48)	5.6 (4.35-7.10)
Cancer of larynx	1.0	6.46 (0.72-23.27)	—	26.03 (8.39-60.74)	8.7 (4.75-14.59)	25.69 (18.66-34.48)	23.59 (17.33-31.37)
Cancer of lung	1.0	0.99 (0.54-1.66)	2.36 (1.49-3.54)	3.40 (2.34-4.77)	6.75 (6.18-7.37)	12.86 (12.14-13.60)	20.23 (19.20-21.30)
Cancer of pancreas	1.0	1.18 (0.69-1.89)	1.51 (0.86-2.45)	2.21 (1.40-3.32)	1.69 (1.41-2.00)	2.17 (1.89-2.47)	2.41 (2.08-2.77)
COPD	1.0	1.39 (0.74-2.38)	1.78 (0.89-3.18)	1.03 (0.37-2.23)	8.86 (7.96-9.84)	12.51 (11.48-13.60)	15.04 (13.73-16.45)
Coronary heart disease	1.0	0.98 (0.91-1.07)	1.06 (0.96-1.16)	1.14 (1.03-1.24)	1.4 (1.36-1.45)	1.58 (1.54-1.62)	1.65 (1.60-1.69)

Table 1 *(continued)*

Cause of death	Nonsmoker	Self-Reported Depth of Inhalation					
		Cigars			Cigarettes		
		None	Slight	Moderate to Deep	None, Slight	Moderate	Deep
All causes of death	1.0	1.04 (1.00-1.08)	1.19 (1.09-1.30)	1.6 (1.38-1.84)	1.54 (1.50-1.57)	1.65 (1.63-1.67)	1.9 (1.86-1.94)
Cancer of buccal cavity & pharynx combined*	1.0	6.98 (4.13-11.03)	7.83 (1.57-22.88)	27.88 (5.60-81.46)	6.26 (4.47-8.53)	8.43 (7.00-10.06)	12.48 (9.61-15.94)
Cancer of esophagus	1.0	3.4 (1.90-5.61)	1.9 (0.02-10.58)	14.84 (2.98-43.37)	2.94 (1.97-4.23)	4.06 (3.30-4.94)	4.95 (3.55-6.72)
Cancer of larynx	1.0	10.6 (3.87-23.07)	—	53.26 (0.70-296.32)	22.19 (14.74-32.07)	13.49 (10.01-17.78)	27.54 (18.44-39.56)
Cancer of lung	1.0	1.97 (1.48-2.57)	1.89 (0.81-3.72)	4.93 (1.80-10.72)	9.33 (8.61-10.10)	13.13 (12.53-13.75)	17.11 (16.00-18.28)
Cancer of pancreas	1.0	1.55 (1.12-2.07)	2.16 (0.99-4.10)	2.26 (0.45-6.60)	1.99 (1.66-2.36)	2.01 (1.79-2.25)	2.38 (1.98-2.83)
COPD	1.0	1.09 (0.66-1.70)	2.05 (0.66-4.77)	4.52 (0.91-13.22)	8.8 (7.85-9.85)	12.28 (11.42-13.18)	16.07 (14.49-17.78)
Coronary heart disease	1.0	1.01 (0.96-1.07)	1.23 (1.07-1.41)	1.37 (1.07-1.75)	1.45 (1.41-1.50)	1.52 (1.49-1.55)	1.71 (1.66-1.76)

**excludes salivary gland*

smokers who do not inhale; and correspondingly, non-inhaling cigar smokers have lower rates of coronary heart disease, COPD and lung cancer than inhaling cigar smokers or cigarette smokers. The larynx, which connects the lung and oral cavity, has a pattern of disease intermediate between that of the lung and the mouth.

The importance of dose and inhalation for lung cancer risk among cigar smokers are presented in Figure 3 where modeled lung cancer risk data from CPS-I for cigar smokers of different numbers of cigars per day and different patterns of inhalation are compared to the risks for a one pack per day cigarette smoker (Chapter 4). When cigar smokers don't inhale or smoke few cigars per day, the risks are only slightly above those of never smokers. Risks of lung cancer increase with increasing inhalation and with increasing number of cigars smoked per day, but the effect of inhalation is more powerful than that for number of cigars per day. When 5 or more cigars are smoked per day and there is moderate inhalation, the lung cancer risks of cigar smoking approximate those of a one pack per day cigarette smoker. As the tobacco smoke exposure of the lung in cigar smokers increases to approximate the frequency of smoking and depth of inhalation found in cigarette smokers, the difference in lung cancer risks produced by these two behaviors disappears.

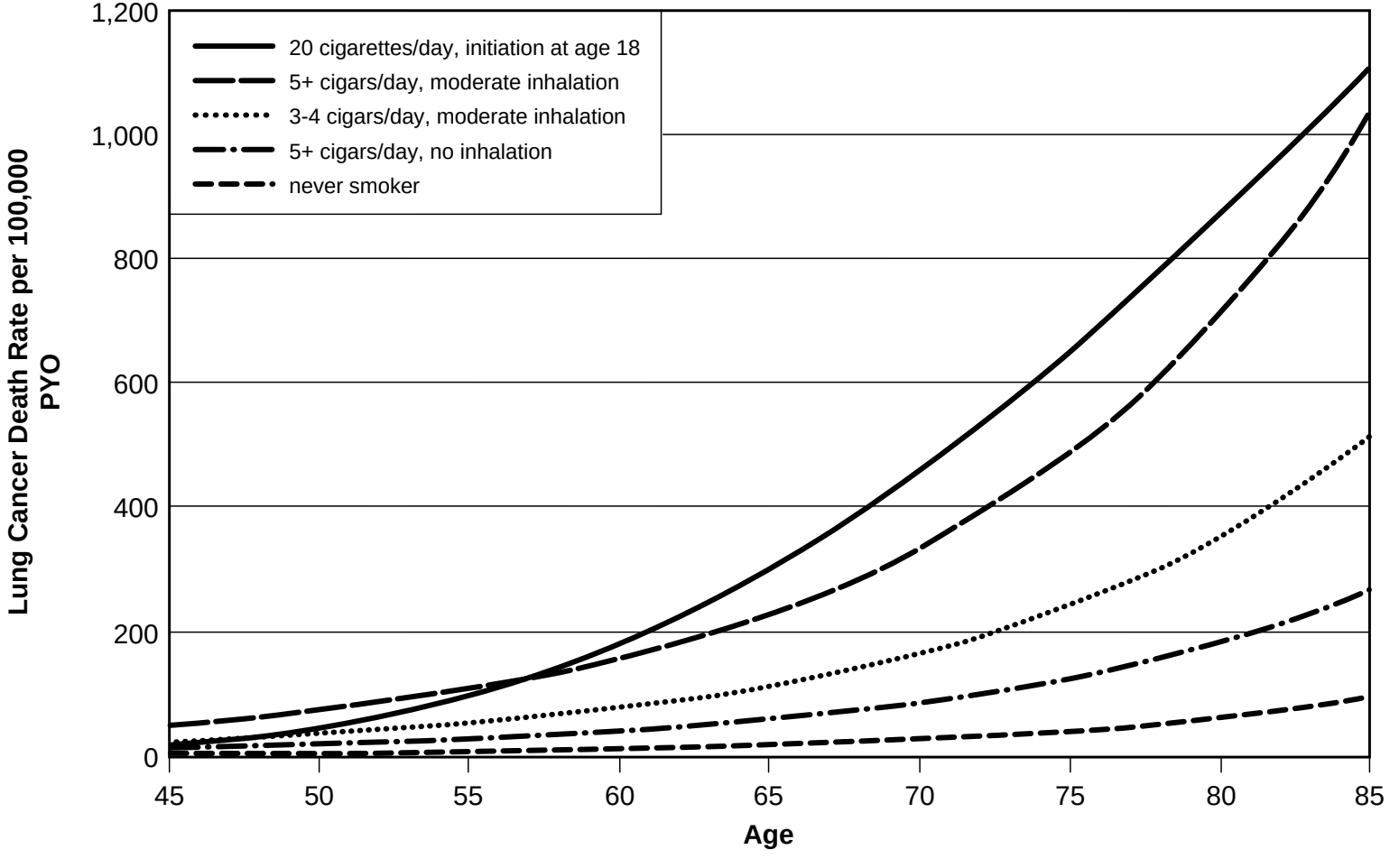
The claim has been made that cigar smokers who smoke few cigars or do not inhale have no increased risk of disease (Shanken, 1997). A more accurate statement would be that the risks experienced by cigar smokers are proportionate to their exposure to tobacco smoke.

Among regular cigar smokers who had never smoked cigarettes in the CPS-I study and who did not inhale, statistically significant increased risks for cancers of the lung, oral cavity, larynx, pancreas and esophagus are observed (Chapter 4). Risks for coronary heart disease are significantly elevated only for smokers of 3 or more cigars per day or those who inhale. Relative risks for COPD increase with increasing inhalation, but the risks do not reach statistical significance for the CPS-I data. It should also be noted that increased risks of lung cancer and heart disease have been reported for nonsmokers at levels of tobacco smoke that occur with environmental tobacco smoke exposure (EPA, 1992; Cal EPA, 1997).

Risks among occasional cigar smokers are difficult to measure because of the wide variability in frequency of smoking among occasional cigar smokers and the marked variation in the amounts of tobacco contained in different cigars. However, it is reasonable to assume that the risks for occasional cigar smokers lie somewhere between those for individuals whose only exposure to tobacco smoke is environmental tobacco smoke and those of regular cigar smokers. As occasional cigar smokers smoke more frequently or inhale more deeply, their exposure to tobacco smoke increases, and with that increased exposure comes a proportionate increase in disease risks.

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



The relationship of cigar smoking and alcohol consumption, particularly for oral cancers, has not been evaluated; but the established interaction between cigarette smoking and alcohol consumption for oral cancers and the frequent association of cigar smoking with alcohol consumption raise the question of an increased risk from the combination of these two behaviors.

Cigarette Smokers Who Switch to Cigars

As described earlier, a number of cigarette smokers may have switched to cigars in response to health warnings following release of the first Surgeon General's Report in the belief that smoking cigars resulted in a lower disease risk (Chapter 2). Data from the CPS-I study demonstrate the limitations of this approach to risk reduction. Cigar smokers who have previously been cigarette smokers report higher rates of inhalation of tobacco smoke than do cigar smokers who have never smoked cigarettes (Chapter 4). These former cigarette smokers also have higher rates of most smoking induced diseases in CPS-I than do cigar smokers who have never smoked cigarettes, and their rates remain above those for smokers who stop using all tobacco products (Higgins et al., 1988). It is not possible to define the independent contributions of their past cigarette smoking and current cigar smoking behaviors with regard to these disease risks, but it is clear that the risks remain above those for cigar smokers who have never smoked cigarettes. Existing data suggest that any reductions in disease risks that accompany switching from smoking cigarettes to smoking cigars are conditional on a reduction in exposure to tobacco smoke with the change in tobacco product smoked. Individuals who have previously smoked cigarettes are more likely to inhale cigar smoke when they switch to smoking cigars, and this increased inhalation may reduce or eliminate any risk reduction with the change from cigarettes to cigars, particularly if cigars are smoked daily or as a means of satisfying an addiction to nicotine.

Risks Among Women

Almost all of the disease risk data for cigar smoking are based on observations among males, but it is reasonable to assume that risks among females would also be proportionate to the intensity and duration of their exposure. In several European countries where women have smoked cigars for many years, it appears that the risks for smoking related diseases are similar for male and female cigar smokers. The lower prevalence and frequency of use among females in the U.S. would be expected to translate into lower rates of chronic disease due to cigar smoking in the female population, particularly given the long duration of use required to produce these diseases. However, cigarette smoking among women has been shown to increase the fetal and maternal complications of pregnancy (USDHHS, 1990), and these complications result from smoking during the comparatively short duration of the pregnancy. Data on the risks of cigar smoking during pregnancy are not sufficient to define the risks, but there is no reason to expect that cigar smoke would be any less toxic for the mother or fetus. Regular cigar smoking, particularly with inhalation, should be presumed to have risks similar to that of cigarette smoking for the pregnant smoker.

NICOTINE ADDICTION Cigars can deliver nicotine to the smoker in concentrations comparable to those delivered by cigarettes and smokeless tobacco (Chapter 6). However, the alkaline pH of cigar smoke, and the tendency of cigar smokers not to inhale, result in the nicotine being absorbed predominantly across the oral mucosa rather than in the lung. This route of absorption leads to a slower rise and lower peak of the arterial levels of nicotine delivered to the brain compared to the absorption that occurs across the alveolar-capillary surface of the lung in most cigarette smokers. The rapidity of absorption and rate of rise in arterial nicotine levels may be important determinants of the potential for nicotine ingestion to lead to addiction (Jasinski et al., 1984). However, nicotine absorbed across the oral mucosa is capable of forming a powerful addiction as demonstrated by the large number of individuals addicted to smokeless tobacco (USDHHS 1988); and cigar smoke can be inhaled into the lung where it would be absorbed as readily as cigarette smoke

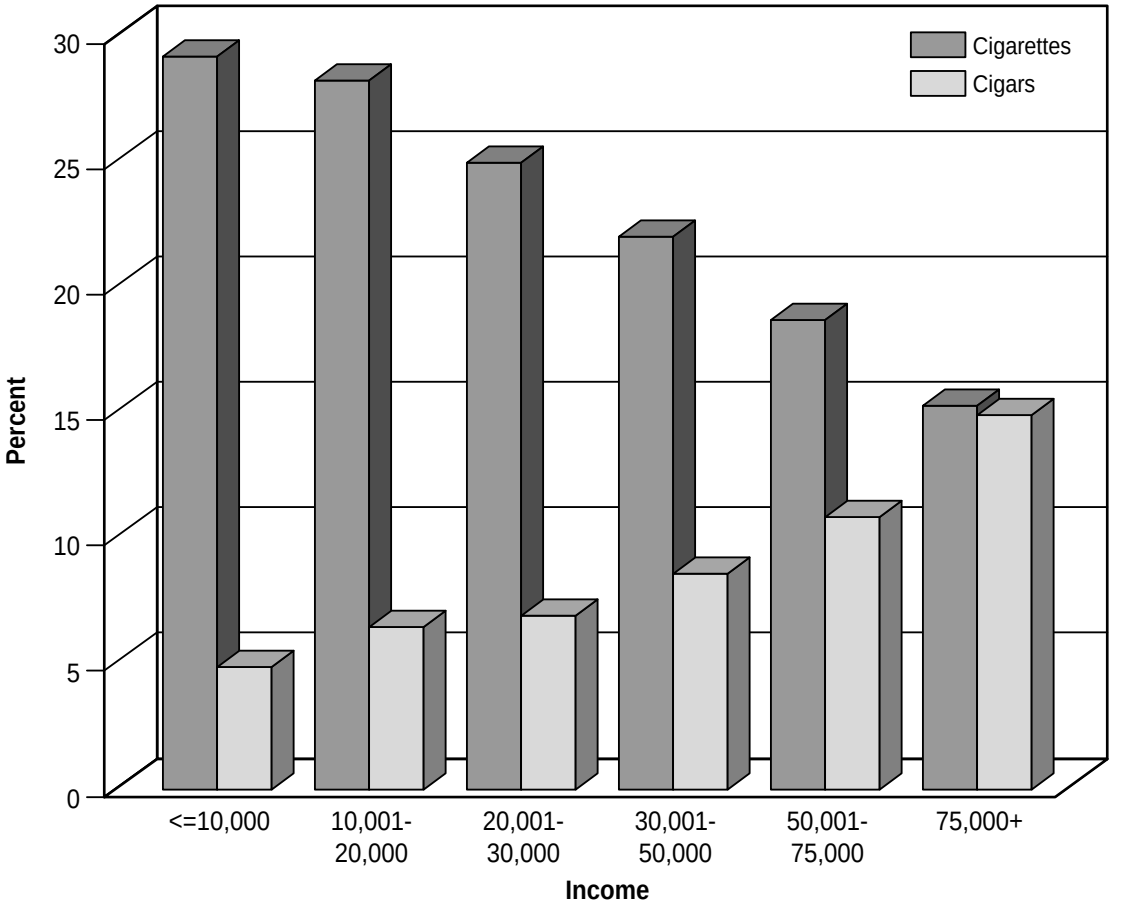
ADULT USE The pattern of use of cigars also sheds some light on the addictive nature of cigar smoking in comparison with other forms of tobacco use, at least for adults. The fraction of adult cigar smokers who smoke cigars every day is much smaller than the fraction of cigarette or smokeless tobacco users who use every day (Chapter 2). This suggests that cigar smoking among adults, while probably able to cause addiction to nicotine, is less likely to do so than cigarette smoking or smokeless tobacco use. Data from California, which show that the recent change in cigar use among adults is largely an increase in occasional use, also suggests that the addictive potential of cigars is lower than that for cigarettes (Gerlach et al., 1998).

Whatever reassurance is provided by the largely occasional use of cigars among adults must be tempered by spread of this behavior among groups who have traditionally had low rates of cigarette use. The prevalence of current cigar and cigarette smoking by income level for adult males in California is presented in Figure 4, and it is apparent that the recent increase in cigar smoking is largely among the affluent in contrast to the marked decline in cigarette smoking that occurs with increasing income (Chapter 2). A similar picture is evident with educational attainment, with the highest rates of cigar use and lowest rates of cigarette use occurring among those with the highest educational attainment. Increasing numbers of women, who historically have had very low rates of cigar use, are also currently smoking cigars.

The spread of cigar smoking into groups with low rates of cigarette use is accompanied by a dramatic increase in cigar use among never smokers. Among adult California males in 1996, forty percent of current cigar smokers have smoked less than 100 cigarettes in their entire life which is the definition typically used to define a never smoker.

Increasing cigar use among upper income and educational level adults raises concern that the success in reducing smoking among these groups may be at risk of reversal. This may be particularly true if the use of cigars by these groups enhances the norms created by cigar marketers that portray cigar use as a socially acceptable, sophisticated and relatively safe behavior. Anecdotal

Figure 4
Prevalence of current cigarette and cigar smoking among California males of different incomes, 1996



observation suggests that cigars are currently smoked in situations where cigarette smokers are reluctant to light up, a marked reversal of the norm banning cigar smoking even in environments where cigarette smoking was allowed.

Use of cigars by adults who have never used cigarettes, or by former cigarette smokers, raises a concern that use of cigars and the nicotine ingestion that accompanies cigar smoking may lead to cigar smokers initiating or relapsing to cigarette smoking. The fraction of tobacco used as cigarettes expanded rapidly in the early years of this century at the expense of pipes, cigars and smokeless tobacco, in part because cigarettes were a convenient method of getting a rapid intense dose of nicotine in a short interval of time (Burns et al., 1997). The potential for current cigar smokers to begin seeking the psychoactive effects of nicotine on a more regular basis through the more convenient form of a cigarette is a real risk based on our

historical experience with these two tobacco products. Concern about relapse to cigarette smoking by former cigarette smokers who start smoking cigars is heightened by the observation in California adults that among those who were former cigarette smokers one year ago, cigar smokers are twice as likely to have relapsed to smoking cigarettes as former cigarette smokers who do not use cigars (Chapter 2). This observation does not separate the likelihood that cigar smoking leads to relapse of cigarette smoking from the possibility that relapsing cigarette smokers take up smoking cigars as well, but it raises a concern that cigar use may place former cigarette smokers at risk of relapse.

Of equal concern is the observation that the fraction of male adult never smokers who began smoking cigarettes in the last two years is over two times higher among current cigar smokers than among those who don't smoke cigars (Chapter 2). Again, it is impossible to separate the likelihood of cigar smoking leading to initiation of cigarette smoking from the possibility that those who initiate cigarette smoking are also likely to smoke cigars; but the commonality in both of these behaviors is nicotine ingestion, and it would not be surprising if use of cigars predisposed an individual to the use of cigarettes.

ADOLESCENT USE

Data on cigar use among adolescents is also alarming (Chapter 2). Few data on past adolescent cigar use are available, largely because it was a behavior felt to be uncommon enough not to be worthy of examination until recently. However, several recent surveys of adolescents show a substantial fraction of both male and female adolescents who report both ever and current use of cigars (CDC, 1997a; Chapter 2). Male cigar smoking prevalence still exceeds that for females among adolescents, but the gender difference is less than for adults. Table 2 presents the prevalence of cigar use among adolescents in Massachusetts by educational grade level, and it is clear that there is a substantial level of cigar use, even prior to high school.

Addiction to nicotine is a process that occurs almost exclusively during adolescence and young adulthood (USDHHS, 1994). The age of initiation of cigar smoking, prior to the recent increase in cigar use, was much older than that for cigarette smoking (Chapter 2); and this difference in age of initiation may be partially responsible for the lower addictive potential of cigars, as manifest by the high rate of occasional, as compared to daily, cigar smoking among adults. Now that initiation of cigar smoking is common among adolescents, whatever resistance to addiction is offered by an older age of initiation would be expected to disappear. The reassurance provided by the low rate of daily cigar smoking among adults may be illusionary now that initiation of cigar smoking is extending into those age groups where development of addiction to nicotine is common. Several generations of adolescents have become addicted to tobacco products that allow nicotine to be absorbed through the lung (cigarettes) and to tobacco products that allow nicotine to be absorbed through the oral mucosa (smokeless tobacco). Cigars can deliver nicotine through both of these routes, and large numbers of adolescents are currently being exposed to nicotine through use of cigars. It is premature to conclude that current generations of adolescents who are

Table 2
Prevalence of cigar use in the last year, and all forms of tobacco use in the last 30 days by school grade, Massachusetts, 1996

	Grade						
	6	**7**	**8**	**9**	**10**	**11**	**12**
Past Year Use of Cigars	5.0 (4.2-5.8)	8.3 (6.6-10.0)	20.3 (17.7-22.9)	20.6 (18.1-23.1)	29.6 (26.9-32.3)	31.8 (28.7-34.8)	31.3 (28.2-34.4)
Past 30-Day Use of Cigars	2.0 (1.1-2.9)	4.4 (1.3-7.5)	10.9 (8.9-12.9)	10.4 (8.5-12.3)	16.0 (13.8-18.2)	18.4 (15.9-20.9)	13.4 (11.0-15.8)
Males							
Cigarettes	10.7 (8.0-13.4)	13.7 (10.7-16.7)	24.6 (20.8-28.4)	27.2 (23.2-31.2)	32.2 (28.3-36.1)	35.5 (31.0-40.0)	45.1 (40.3-49.9)
Smokeless	2.6 (1.2-4.0)	2.5 (1.2-3.8)	5.7 (3.7-7.7)	4.4 (2.5-6.3)	10.9 (8.3-13.5)	14.3 (11.0-17.6)	13.6 (10.3-16.9)
Cigars	3.2 (1.6-4.8)	4.3 (2.6-6.0)	13.0 (10.0-16.0)	14.9 (11.7-18.1)	24.9 (21.3-28.5)	30.3 (25.9-34.7)	23.7 (19.6-27.8)
Females							
Cigarettes	5.7 (3.7-7.7)	19.0 (15.5-22.5)	27.5 (23.3-31.7)	33.0 (29.1-36.9)	35.3 (31.1-39.5)	42.0 (37.6-46.4)	36.6 (32.2-41.0)
Smokeless	0.1 (-0.8-1.0)	0.2 -0.2-0.6)	0.8 (0.0-1.6)	1.3 (0.4-2.2)	1.2 (0.2-2.2)	0.5 (-0.1-1.1)	0.6 (-0.1-1.3)
Cigars	0.8 (-1.5-3.1)	4.6 (2.7-6.5)	8.4 (5.8-11.0)	6.6 (4.5-8.7)	6.1 (4.0-8.2)	7.7 (5.3-10.1)	4.1 (2.3-5.9)

ingesting nicotine from cigars will not become addicted simply because older generations of cigar smokers, who began smoking as adults, were less likely to become addicted.

Current cigarette smoking prevalence rates among adults have remained relatively unchanged over the last few years (CDC, 1997b), ending four decades of decline in prevalence; and the prevalence of cigarette smoking among adolescents has increased recently (CDC, 1996). The contribution of increasing cigar use among both adults and adolescents to these trends remains unexplored, but the temporal association of these two phenomena suggests that it should be a high priority for future investigation.

MARKETING Recent marketing efforts have promoted cigars as symbols of a luxuriant and successful lifestyle. Endorsements by celebrities including athletes, elaborate cigar smoking events and the resurgence of cigar smoking in movies have all contributed to the increased visibility of cigar smoking in society and probably have lowered barriers to cigar use in public. Publication of cigar lifestyle magazines such as “Cigar Aficionado”, which began in 1992, antedate

the increase in cigar consumption which began in 1993. Linkage of cigar smoking to an opulent and powerful lifestyle, and the featuring of highly visible women smoking cigars, is a core element of cigar promotion; and it has been successful in increasing cigar consumption among men and initiating cigar smoking as a behavior among women (Chapter 7).

Evaluation of the effects of cigar promotional efforts on adolescent cigar smoking is only just beginning due to the recent nature of this phenomenon, but cigars are not the first tobacco product to be heavily promoted in ways likely to influence adolescent use. Celebrity endorsements by popular heroes, including athletes, were a prominent part of the mass marketing of cigarettes during the first half of this century (Kluger, 1996).

By the late 1940's and early 1950's, print and television advertising commonly featured athletes and movie stars describing the pleasures of smoking individual brands of cigarettes (Figure 5). The individuals portrayed here are only a tiny fraction of those who endorsed cigarette smoking. In response to the concern about the disease consequences of smoking, the tobacco industry adopted a voluntary code of advertising during the mid 1960's that prohibited the use of endorsements by athletes and other celebrities perceived to appeal to youth (USDHHS, 1994). Denied celebrity

Figure 5
Popular sport figures in tobacco advertisements circa 1940's-1960's

endorsement in their advertising, the cigarette companies developed lifestyle and image related advertising, most notably the Marlboro cowboy and "Smooth Joe Camel" ads that have allowed these two brands to capture the majority of adolescent smokers (CDC, 1994). Virginia Slims advertisements linked cigarette smoking to independence and power as well as to thinness. Cigarette promotion through events like the Cool Jazz Festival and Formula One auto racing linked cigarettes to a glamorous and exciting lifestyle, while sponsorship of cultural events linked cigarettes to sophistication and provided borrowed credibility. One outcome of these marketing approaches is that the overwhelming majority of cigarette smokers begin smoking, and become addicted, during adolescence (USDHHS, 1994).

Intensive marketing of smokeless tobacco began in the 1970's and was followed by a dramatic rise in use of these products (USDHHS, 1993). Smokeless tobacco products were marketed then, as cigars are being marketed now, despite strong scientific evidence that they cause disease. The difference in risk between the enormous risks of cigarette smoking and the more moderate risks of smokeless tobacco and cigar use is touted to reassure the users that the products "used in moderation" have little risk. At the same time, advertising in the print media and on television (where cigarette advertising was banned) featured endorsements by celebrities and athletes, and smokeless tobacco promoted lifestyle and image related events that linked smokeless tobacco use with rodeo and auto racing. Once again, adolescent males responded to these promotional approaches; and it was only after a generation of young males became addicted to smokeless tobacco that endorsement by athletes was discontinued because of its appeal to youth. Again, the advertisement for smokeless tobacco portrayed here (Figure 6) represents only a few of the athletes that promoted smokeless tobacco use.

Figure 6

Having twice demonstrated that image related advertising and celebrity endorsement could create a new market for little used tobacco products, it should not be surprising that those involved in the cigar trade would utilize the same approaches. The use of celebrities like Demi Moore and Arnold Schwarzenegger (Figure 7) to endorse cigar smoking along with the images of Michael Jordan and Madonna smoking cigars are an important part of creating a lifestyle image for cigar use (Chapter 7). Athletes are also once again endorsing cigar use including such prominent super stars as Wayne Gretzky (Figure 8). Having demonstrated the success of this approach in influencing adolescent tobacco use twice in this century, we should not be surprised by the current high rates of cigar use among adolescent males and females.

Figure 7

Figure 8

The use of endorsements to allay health fears associated with cigar smoking is also as old as the Camel Campaign that touted "More doctors smoke Camels". The eerie similarity of two quotes sixty years apart in time make the point that the message of reassurance is the same, it is only the product that is different.

"For a good sense of deep-down contentment – just give me Camels. After a good man-sized meal, that little phrase 'Camels set you right' covers the way I feel. Camels set me right whether I'm eating, working – or just enjoying life. All the years I've been playing, I've been careful about my physical condition. Smoke? I smoke and enjoy it. My cigarette is a Camel."

Baseball Legend Lou Gehrig, The Saturday Evening Post of April 24, 1937

"The enjoyment of a cigar after a hard week gives me a feeling of well-being and relaxation that a Valium could not match. While there may be a more ideal form of stress reduction, I haven't yet discovered anything else as effective and easy"

Ear Nose and Throat Surgeon M. Hal Pearlman, M.D., Cigar Aficionado, Spring 1993

Marketing a product is intended to increase the use of the product, and it is probably naïve to assume that cigar manufacturers would not adopt marketing approaches proven to increase the use of other tobacco products, absent a regulatory prohibition. The "intent" of the marketers may be to reach adults, but it is hard to ignore the fact that twice before in this century this same "intent" to reach adults has grabbed children.

ENVIRONMENTAL TOBACCO SMOKE

One highly visible approach to cigar marketing has been the cigar smoking event. These events commonly include meals and entertainment, and are marketed as a means of experiencing fine cigars (Chapter 7). Individuals attending these events may smoke cigars only at the event and may smoke only a few cigars per year. However, employees who work these events, and who are exposed to the environmental tobacco smoke generated at them, may have much more frequent exposure. These events, and the re-emergence of cigar smoking in public areas frequented by nonsmokers, raise the question of the contribution of cigar smoking to environmental tobacco smoke (ETS) exposure.

Comparison of the contribution of cigarettes and cigars to ETS requires consideration of three issues: Differences in the composition of cigarette and cigar smoke, differences in the emission rates per minute between cigarettes and cigars, and differences in the mass of tobacco burned (and corresponding duration of smoking) between cigars and cigarettes. Tobacco smoke produced by cigars contains most of the same toxic and carcinogenic constituents found in cigarette smoke (Chapter 3). There is marked variation in the relative

concentrations of these constituents present in cigar smoke across different types and sizes of cigars. In general however, large cigars produce more carbon monoxide, as well as higher amounts of nitrogen oxides and carcinogenic N-nitrosamines, per gram of tobacco burned, and the free ammonia in tobacco smoke is higher due to the more alkaline pH of the smoke (Chapter 3). It is likely this difference in free ammonia that results in the more pungent smell of cigar smoke.

Cigars generate slightly lower amounts of respirable suspended particulates (RSP) per minute compared to cigarettes (Chapter 5), but somewhat higher amounts of carbon monoxide (CO). The major difference between cigarettes and cigars is the amount of tobacco contained in each product. Cigarettes generally contain less than one gram of tobacco and are smoked for about 7-8 minutes, with a substantial interval between cigarettes. Large cigars commonly contain 5-17 grams of tobacco, and are smoked over intervals as long as 60-90 minutes. Thus cigars, while generating similar amounts of ETS per minute compared to cigarettes, continue generating smoke for a much longer period of time; and therefore, the total amount of ETS generated by a single large cigar is much greater than that by a single cigarette.

Continued generation of ETS by cigar smoking may be of particular importance at cigar smoking events where most of the attendees smoke cigars. It is likely that the number of individuals generating ETS at any point in time would be higher at these events because of the longer time required to finish a cigar. The shorter time required to finish a cigarette, and the interval between cigarettes, would result in fewer individuals smoking at any point in time.

Concern about increased generation of smoke at cigar events is born out by measurements of smoke constituents at these events. Levels of CO in the air at these events are similar to those on a crowded California freeway (Repace et al., 1998). These data confirm the belief that cigars can contribute substantial amounts of tobacco smoke to the indoor environment; and, when large numbers of cigar smokers congregate together in a cigar smoking event, the amount of ETS produced is sufficient to be a health concern for those regularly required to work in those environments (Chapter 5).

REGULATION AND TAXATION

Cigars are treated separately from cigarettes and smokeless tobacco for purposes of taxation and often for purposes of regulation. Traditionally they have been taxed at lower rates, and are not covered by the currently proposed FDA regulations for tobacco (Chapter 8). In contrast, cigar smoking was eliminated in airplanes and other locations well ahead of the time that cigarette smoking was eliminated. More recently, a number of States have increased the taxes on cigars; but the norms against cigar smoking in public locations seem to be changing in favor of allowing cigar smoking in more areas, including areas where cigarette smoking is not considered acceptable.

OVERALL CONCLUSIONS

1. Cigar smoking can cause oral, esophageal, laryngeal and lung cancers. Regular cigar smokers who inhale, particularly those who smoke several cigars per day, have an increased risk of coronary heart disease and chronic obstructive pulmonary disease.

2. Regular cigar smokers have risks of oral and esophageal cancers similar to those of cigarette smokers, but they have lower risks of lung and laryngeal cancer, coronary heart disease and chronic obstructive pulmonary disease.

3. Cigar use in the U.S. has increased dramatically since 1993. Adult prevalence of cigar use in California has increased predominantly among occasional cigar smokers. A substantial number of former and never smokers of cigarettes are currently smoking cigars. In contrast to cigarettes, much of the increased use of cigars appears to be occurring among those with higher incomes and greater educational attainment.

4. Adolescent cigar use is occurring at a substantial level and is currently higher that that recorded for young adults prior to 1993. Currently, cigar use among adolescent males exceeds the use of smokeless tobacco in several states. This use is occurring among both males and females.

REFERENCES

Burns D., Lee L., Shen Z., Gilpin B., Tolley D., Vaughn J. and Shanks T. *Cigarette Smoking Behavior in the United States (Chapter 2)*. In: Changes in Cigarette-Related Disease Risks and Their Implication for Prevention and Control, Monograph No. 8, Burns D., Garfinkel L. and Samet J., Editors, USDHHS NIH NCI, Bethesda, MD, U.S. Department of Health and Human Services, National Institutes of Health, NIH Publication #97-4213, pp 13-112, 1997.

California Environmental Protection Agency. Health Effects of Exposure to Environmental Tobacco Smoke. California Environmental Protection Agency, 1997.

CDC Changes in the Cigarette Brand Preferences of Adolescent Smokers — United States, 1989— 1993. *MMWR* 1994 43(32): 577-581, 1994.

CDC Tobacco Use and Usual Source of Cigarettes Among High School Students — United States, 1995. *MMWR,* 45(20): 413-418, 1996.

CDC Cigar smoking among teenagers—United States, Massachusetts and New York, 1996. *MMWR* 46(20): 433-440, 1997a.

CDC Cigarette Smoking Among Adults—United States, 1995. *MMWR*, 46(51): 1217-1220, 1997b.

Connolly, G.N. *Policies Regulating Cigars (Chapter 8)*. In: Cigars: Health Effects and Trends, Monograph No. 9. Burns D., Cummings, K. M., Hoffmann, D., Editors, USDHHS NIH NCI, Bethesda, MD, U.S. Department of Health and Human Services, National Institutes of Health, 1998.

Davies, R.F., Day. T.D. A study of the comparative carcinogenicity of cigarette and cigar smoke condensate on mouse skin. *British Journal of Cancer* 23:363-368, 1969.

Environmental Protection Agency. Respiratory Health Effects of Passive Smoking: lung cancer and other disorders. Environmental Protection Agency EPA/600/6-90/006F, 1992.

Fant, R.V., Henningfield, J.E. *Pharmacology and Abuse Potential of Cigars (Chapter 6)*. In: Cigars: Health Effects and Trends, Monograph No. 9. Burns D., Cummings, K. M., Hoffmann, D., Editors, USDHHS NIH NCI, Bethesda, MD, U.S. Department of Health and Human Services, National Institutes of Health, NIH Publication, 1998.

Garfinkel, L. Selection, Follow-up, and Analysis in the American Cancer Society Prospective Studies. National Cancer Institute Monograph 67:49–52, 1985.

Gerlach, K.K., Cummings, K.M., Hyland, A., Gilpin, E. A., Johnson, M. D., Pierce, J. P. *Trends -in Cigar Consumption and Smoking Prevalence (Chapter 2)*. In: Cigars: Health Effects and Trends, Monograph No. 9. Burns D., Cummings, K. M., Hoffmann, D., Editors, USDHHS NIH NCI, Bethesda, MD, U.S. Department of Health and Human Services, National Institutes of Health, NIH Publication, 1998.

Higgins, I.T.T., Mahan, C.M., Wynder, E.L. Lung cancer among cigar and pipe smokers. *Preventive Medicine* 17:116-128, 1998.

Hoffmann, D., Hoffmann, I. *Chemistry and Toxicology (Chapter 3)*. In: Cigars: Health Effects and Trends, Monograph No. 9. Burns D., Cummings, K. M., Hoffmann, D., Editors, USDHHS NIH NCI, Bethesda, MD, U.S. Department of Health and Human Services, National Institutes of Health, NIH Publication, 1998.

Jasinski, D. R., Johnson, R. E., Henningfield, J. E. Abuse liability assessment in human subjects. Trends in Pharmacological Science, 5: 196-200, 1984.

Kluger, R. Ashes to ashes: America's hundred-year cigarette war, the public health, and the unabashed triumph of Philip Morris. New York: Alfred A. Knopf, 1996.

Repace, J.L., Ott, W.R., Klepeis, N.E. *Indoor Air Pollution from Cigar Smoke (Chapter 5)*. In: Cigars: Health Effects and Trends, Monograph No. 9. Burns, D., Cummings, K. M., Hoffmann, D., Editors, USDHHS NIH NCI, Bethesda, MD, U.S. Department of Health and Human Services, National Institutes of Health, NIH Publication, 1998.

Shanken M.R. Scare Tactics. Cigar Aficionado 5 (4):19, 1997.

Shanks T, Burns D. *Disease Consequences of Cigar Smoking (Chapter 4)*. In: Cigars: Health Effects and Trends, Monograph No. 9. Burns D., Cummings, K. M., Hoffmann, D., Editors, USDHHS NIH NCI, Bethesda, MD, U.S. Department of Health and Human Services, National Institutes of Health, NIH Publication, 1998.

Slade, J. *Marketing and Promotion of Cigars (Chapter 7)*. In: Cigars: Health Effects and Trends, Monograph No. 9. Burns D., Cummings, K. M., Hoffmann, D., Editors, USDHHS NIH NCI, Bethesda, MD, U.S. Department of Health and Human Services, National Institutes of Health, NIH Publication, 1998.

Turner, J.A., Sillett, R.W., McNicol, M.W. Effect of cigar smoking on carboxyhemoglobin and plasma nicotine concentrations in primary pipe and cigar smokers and in cigarette smokers. *British Medical Journal* 2:1387-1389, 1997.

U.S. Department of Agriculture. Tobacco Situation and Outlook Report. U.S. Department of Agriculture, Economic Research Service, series TBS-239, September 1997.

USDHHS The Health Consequences of Smoking: Nicotine Addiction: A Report of the Surgeon General, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, Office on Smoking and Health. (DHHS publication No. [CDC] 88-8406). Washington DC: U.S. Government Printing Office, 1988.

USDHHS Smokeless Tobacco or Health, Smoking and Tobacco Control Monograph No. 2, Stotts R.C., Schroeder K.L., D., and Burns D., Editors, USDHHS NIH NCI, Bethesda, MD, U.S. Department of Health and Human Services, National Institutes of Health, NIH Publication No. 93-3461, 1993.

USDHHS The Health Benefits of Smoking Cessation. US Dept of Health and Human Services, Public Health Service, Centers for Disease Control, Office on Smoking and Health. DHHS Publication No (CDC) 90-8416, 1990.

USDHHS Preventing Tobacco Use Among Young People: A Report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1994.

Wald, N.J., Idle, M., Boreham, J., Bailey, A. Carbon monoxide in breath in relation to smoking and carboxyhemoglobin levels. *Thorax* 36:366-369, 1981.

Trends in Cigar Consumption and Smoking Prevalence

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INTRODUCTION The use of cigars appears to be on the increase in the United States based on reports in the popular press and the emergence of cigar bars and cigar events (Chapter 7). This chapter examines trends in cigar smoking prevalence and patterns of cigar use. Data on cigar sales are examined to assess overall trends in cigar use, while national and regional survey data on self-reported cigar use are used to evaluate changing patterns of cigar use among different age, gender, and racial groups.

Trends in Cigar Production, Sales, and Consumption Figure 1 depicts tobacco consumption in the United States by major product category for the period 1880 through 1997 (Milmore and Conover, 1956; U.S. Department of Agriculture, 1996, 1997). These data are expressed in pounds of tobacco consumed per adult rather than in individual units such as cigars or cigarettes, so that direct comparisons between product categories can be made. Cigars accounted for a larger percentage of overall tobacco consumption in the early decades of the twentieth century than they do currently. By the mid-1920's, cigar consumption began to decline as cigarettes became the predominant form of tobacco consumed. Cigar consumption increased slightly in the early 1950's and again in the mid-1960's, possibly as a result of male cigarette smokers switching to cigars in response to publicity about the health dangers of cigarettes.

From 1964 until 1993, cigar consumption declined by 66 percent in the United States (U.S. Department of Agriculture, December 1996), however between 1993 and 1997, overall cigar consumption increased nearly 50 percent. The recent upturn in cigar smoking since 1993 is due mainly to an increase in the sale of large cigars, which increased by 68 percent from 1993 to 1997 (Table 1). Despite the recent growth in cigar sales, cigars still constitute only a small fraction of the tobacco market in comparison with other tobacco products.

Figure 2 summarizes consumption data for United States of large cigars and cigarillos and small cigars between 1950 and 1997 (U.S. Department of Agriculture, September 1997). Before 1971, small cigars made up only a tiny fraction of cigar sales. However, the sale of small cigars increased by 254 percent between 1971 and 1972 (U.S. Department of Agriculture, December 1996) in conjunction with an increase in television advertising. The increased television advertising resulted from a loophole in the federal law (The Public Health

Figure 1
Per-capita consumption of different forms of tobacco in the US 1880-1997

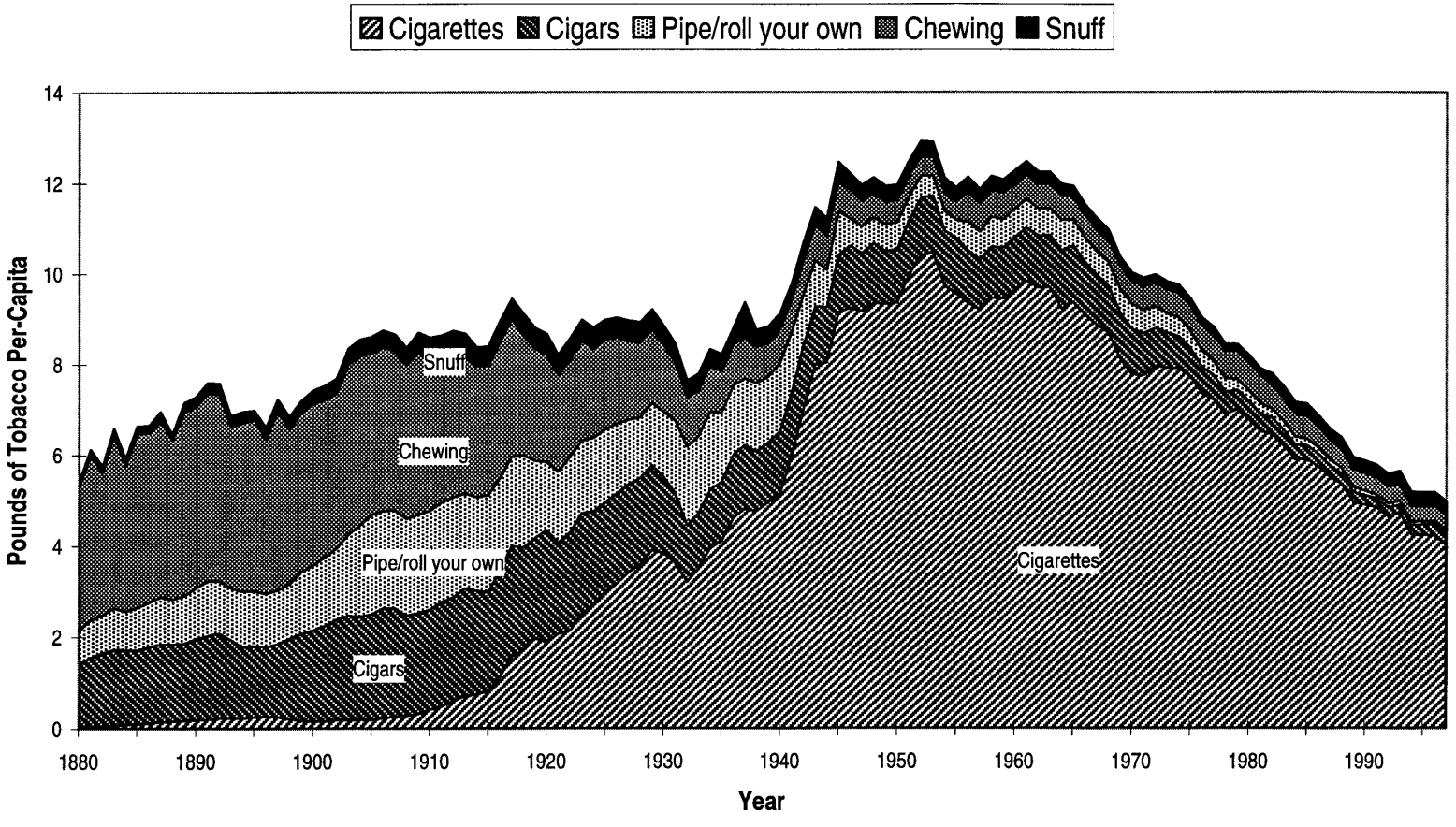
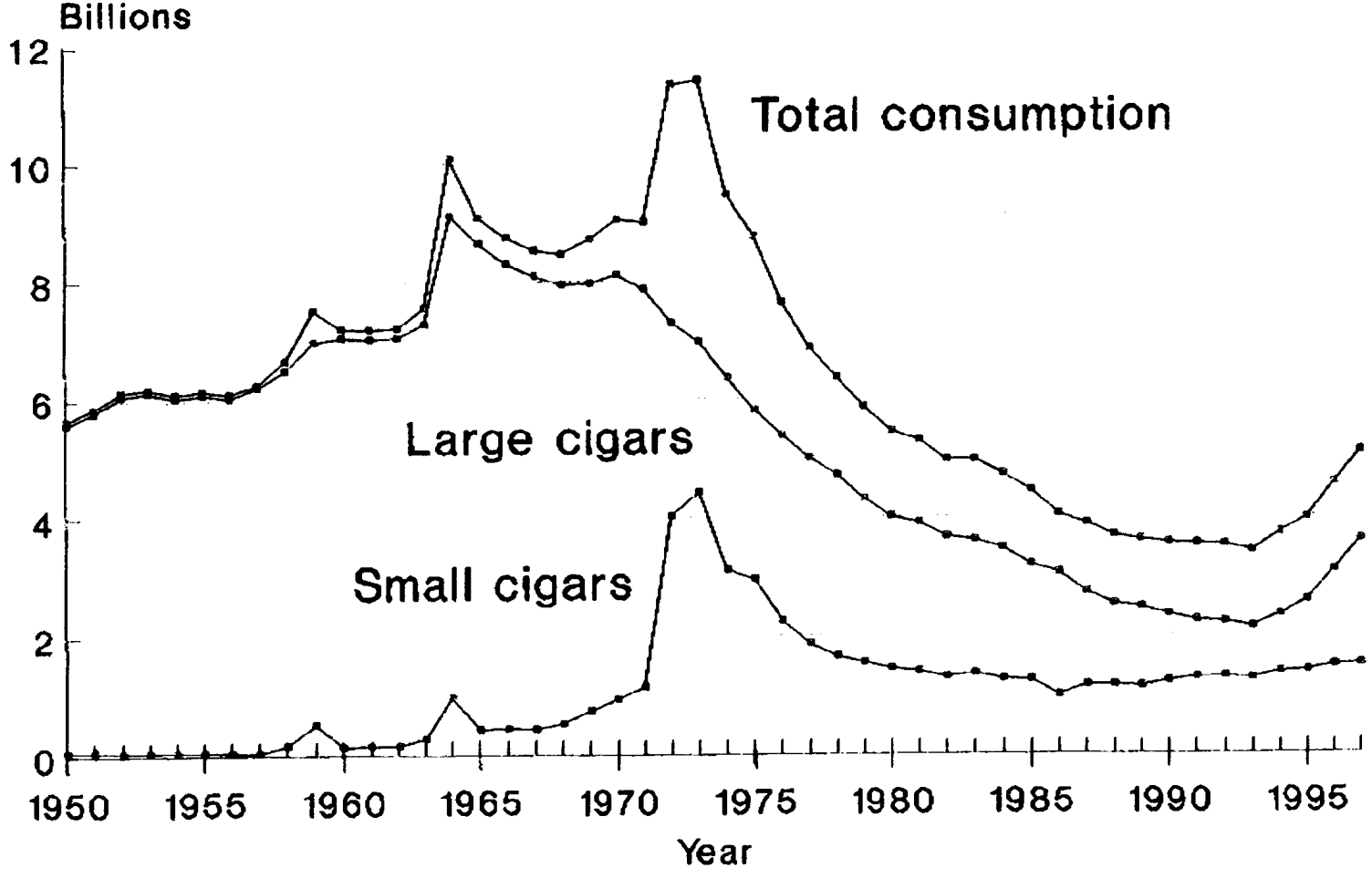


Figure 2
U.S. estimated consumption of cigars 1950 to 1997



Cigarette Smoking Act of 1969) that prohibited cigarette advertising on radio and television, but which did not prohibit the advertising of cigars (U.S. Department of Health and Human Services, 1989). Television advertising by manufacturers of small cigars increased dramatically in 1972 and 1973 filling the void left by cigarette advertisers, and sales of small cigars soared. In September 1973, Congress passed a law banning the broadcast advertising of small cigars (The Little Cigar Act - PL93-109) (U.S. Department of Health and Human Services, 1989); and the consumption of small cigars dropped steadily until the early 1990's when it rebounded slightly.

As seen in Figure 2, the consumption of large cigars and cigarillos enjoyed a resurgence in 1964, possibly due to cigarette smokers switching from cigarettes to cigars following the first report to the U.S. Surgeon General on smoking and health (U.S. Public Health Service, 1964). After 1965, consumption of large cigars and cigarillos steadily declined until 1992. Since 1993, consumption of cigars of all types (i.e., small, large, and large premium cigars) has increased (Maxwell, 1997); but by far the largest percentage increase has been in the consumption of premium cigars. Between 1993 and 1996, sales of premium cigars increased by nearly 154 percent.

Recent Trends in Self-reported Use

The recent upward trend in cigar sales in the United States may signal an increase in the prevalence of cigar smoking, an increase in the number of cigars smoked among current users, or some combination. This chapter examines national and regional survey data on self-reported cigar use in an attempt to evaluate trends in the patterns of cigar use among different age, gender, and racial groups.

Table 1.
Cigar consumption in the United States, 1993-1997

Cigar type	millions of cigars consumed	millions of cigars consumed	% change (1993-1997)
	(1993)	(1997)	
large	2,138	3,589	67.9
small	1,280	1,447	13.0
total	3,418	5,036	47.3

Source: U.S. Department of Agriculture *Tobacco Situation and Outlook Report,* December 1997, TSB-240.

Data Sources

The principal sources of nationally representative survey data to estimate trends in cigar use by adults are the 1970, 1987, 1991, and 1992 National Health Interview Surveys (NHIS), the 1986 Adult Use of Tobacco Survey (AUTS), and the 1992/93 and 1995/96 Current Population Surveys (Table 2a). Additionally, some non-national surveys have included questions that can be used to estimate recent trends in cigar smoking prevalence among adults. These surveys include the

Table 2a
Data sources for adult cigar smoking prevalence

Survey	Type of Survey	Method of Administration	Sample Characteristics and Sample Size	Questions Asked
1970 National Health Interview Survey (NHIS)	cross-sectional nationally representative	in home; some telephone	18+ years old;	Has ___ smoked at least 50 cigars during his entire life? If yes, then: Does ___ smoke cigars now? If yes, then: About how many cigars a day does ___ usually smoke? ___ number per day (Follow-up question: What size cigars does ___ usually smoke: Full-sized cigars, the small cigars sometimes called cigarillos or the very small cigars about the size of a cigarette?) If less than 1 per day, then: 3-6 per week (Follow-up question: What size cigars does ___ usually smoke: Full-sized cigars, the small cigars sometimes called cigarillos or the very small cigars about the size of a cigarette?) Less than 3 per week (Follow-up question: How long has it been since ___ smoked 3 or more cigars a week)
1986 Adult Use of Tobacco Survey (AUTS)	cross-sectional nationally representative	telephone interviews	18+ years old; 12,479	Have you ever smoked cigars? If yes, then: Do you smoke cigars now? If yes, then: Do you smoke cigars: at least once a day at least once a week, or less than once a week?
1987 NHIS	cross-sectional nationally representative	in-person interviews	18+ years old; 43,526	Have you ever smoked cigars? If yes, then: Have you smoked at least 50 cigars in your lifetime? If no, skipped out. If yes, then: How old were you when you first smoked cigars? Do you smoke cigars now? Altogether, about how long [did you smoke/have you smoked] cigars? On the average, how many days per month [did/do] you smoke cigars? On the days you smoke(d) cigars, how many [did/do] you smoke?

Table 2a (*Continued*)
Data sources for adult cigar smoking prevalence

1991 NHIS	cross-sectional nationally representative	in-person interviews	18+ years old; 43,151	Have you ever smoked cigars? If yes, then: Have you smoked at least 50 cigars in your entire life? If yes, then: Do you smoke cigars now? Do you smoke cigars every day or some days? Do you smoke cigars "not at all" or "some days"?
1992 NHIS	cross-sectional nationally representative	in-person interviews	18+ years old; 11,827	Have you ever smoked cigars? If yes, then: Have you smoked at least 50 cigars in your entire life? If no, skipped out. If yes, then: Do you smoke cigars now? If yes, then: On the average, how many days per month do you smoke cigars?
1992-1993 Current Population Survey (CPS)	cross-sectional nationally representative	telephone and in-person interviews	18+ years old; 227,639	Have you ever used pipes, cigars, chewing tobacco or snuff on a regular basis? yes..... Which ones? pipes cigars chewing tobacco snuff If yes to any of the above then: Do you now use pipes, cigars, chewing tobacco or snuff? Yes ..... Which ones? pipes cigars chewing tobacco snuff
1995-1996 CPS	cross-sectional nationally representative	telephone and in-person interviews	18+ years old; 186,476	Have you ever pipes, cigars, chewing tobacco or snuff on a regular basis? Yes..... Which ones? pipes cigars chewing tobacco snuff If yes to any of the above then: Do you now use pipes, cigars, chewing tobacco or snuff? yes..... Which ones? pipes cigars chewing tobacco snuff

Table 2a (*Continued*)
Data sources for adult cigar smoking prevalence

Community Intervention Trial for Smoking Cessation baseline survey, 1989 (COMMIT)	cohort and cross-sectional	telephone interviews	18+ years old; 8,417	Do you smoke cigars on a regular basis (regular 3-4 times per week)?
1993 COMMIT	cohort and cross-sectional	telephone interviews	18+ years old; 26,379	Do you smoke cigars on a regular basis (regular 3-4 times per week)? Have you smoked cigars in the past 6 months?
California Tobacco Use Survey, 1990	cross-sectional	telephone interviews	18+ years old; 24,296	Have you ever smoked cigars? Have you smoked at least 50 cigars in your entire life? Do you now smoke cigars every day, some days, or not all?
California Tobacco Use Survey, 1996	cross-sectional	telephone interviews	18+ years old; 18,616	Have you ever smoked cigars, cigarillos, or small cigars? Have you smoked at least 50 cigars in your entire life? Do you now smoke cigars every day, some days, or not all?

1990 and 1996 California Adult Tobacco Use survey, and the cross-sectional and cohort surveys conducted in 22 North American communities in 1989 and 1993 as part of the National Cancer Institute's Community Intervention Trial for Smoking Cessation (COMMIT) project (U.S. Public Health Service, 1995; Hyland et.al, 1997) (Table 2a). Surveys that examine cigar smoking among adolescents are included in Table 2b. It is important to note that differences in survey methodology and the measures used to define cigar use make it difficult to reliably compare trends in cigar use behavior between surveys. For example, some surveys have restricted their definition of current cigar use to individuals who report having smoked at least 50 cigars in their lifetime. Other surveys have asked about "regular" use of cigars without defining the frequency of cigar smoking. Few surveys have questioned cigar smokers about the quantity and type of cigars typically consumed.

Prevalence of Ever Smoking Cigars Among Adults

Prevalence of ever smoking cigars was assessed by each of the national adult surveys (Table 3). Cigar smoking is predominantly a male behavior. The overall male ever cigar smoking prevalence declined slightly from 1986 to 1991, and then increased slightly in 1992. This change in prevalence may also have occurred among females, but the prevalence among females is so low that it is difficult to define a change with confidence.

Table 2b
Data sources for adolescent cigar smoking prevalence

Survey	Type of Survey	Method of Administration	Sample Characteristics and Sample Size	Questions Asked
Robert Wood Johnson Foundation National Study of Tobacco Price Sensitivity, Behavior and Attitudes among Teenagers, 1996	cross-sectional nationally representative	self-administered questionnaire	14–19 years old; 16,417	How many cigars, if any, have you smoked in the past year?
Massachusetts Department of Public Health, 1996	cross-sectional	self-administered questionnaire	Grades 6–12; 6,844	How often have you smoked cigars in your lifetime? How often have you smoked cigars during the last 12 months? How often have you smoked cigars during the last 30 days?
Roswell Park Cancer Institute Survey of Alcohol, Tobacco and Drug Use (New York), 1996	census of students in two counties in New York state	self-administered questionnaire	Grade 9; 9,916 students in Erie County, 1,677 students in Chautauqua County	In the past 30 days, did you smoke a cigar?
California Tobacco Use Survey, 1996	cross-sectional	telephone interviews	12–17 years old; 6,252	Have you ever tried cigars, cigarillos, or little cigars? Do you think you will ever smoke a cigar, cigarillo, or little cigar? On how many of the past 30 days did you smoke cigars, cigarillos, or little cigars?

The prevalence estimates from the Current Population Surveys are significantly lower than those from the other national surveys, and this may be due to differences in wording of the questions on cigar smoking in these surveys. Respondents to the Current Population Survey were asked whether they had "ever regularly used" cigars, but respondents in the Adult Use of Tobacco Survey (AUTS) and in the NHIS were asked whether they had "ever smoked" cigars. Use of the words "regular use" on the Current Population Survey may have implied a more frequent use of cigars, and, therefore, those respondents who had smoked cigars infrequently may have been less likely to respond affirmatively to this question.

Table 3
Cigar ever smoking prevalence from national surveys

	1986 AUTS	1987 NHIS	1991 NHIS	1992 NHIS	1992-93 CPS	1995-96 CPS
Total Male	43.0±1.5	38.0±1.0	35.5±1.0	40.2±1.8	7.9±0.2	7.3±0.2
Age						
18–24	31.5±4.2	24.7±2.0	22.3±2.3	29.5±4.8	2.3±0.3	3.0±0.3
25–34	37.9±3.2	30.0±1.5	25.8±1.5	34.4±3.2	3.3±0.3	3.4±0.3
35–44	46.3±3.3	39.4±2.0	36.5±1.8	39.1±3.3	6.5±0.4	5.4±0.3
45–64	11.3±0.4	9.7±0.4				
45-54	52.8±4.1	44.5±2.3	45.3±2.3	45.8±4.2		
55–64	50.5±4.1	48.3±2.4	45.7±2.4	49.6±4.7		
65+	49.8±4.3	49.5±2.0	44.4±2.1	48.4±4.1	17.0±0.7	15.2±0.07
Hispanic Origin*						
Hispanic	34.7±6.5	22.5±2.6	21.3±3.0	25.5±4.7	3.5±0.4	3.0±0.4
Non-Hispanic White	43.6±1.6	39.2±1.1	36.8±1.0	41.5±1.8	9.0±0.2	8.4±0.2
Race						
White	45.3±1.6	39.9±2.4	37.5±1.1	42.2±1.9		
Black	29.7±5.1	26.6±3.3	25.2±2.5	32.0±4.7	5.6±0.5	4.8±0.5
Asian or PI	21.4±9.3	15.5±3.7	17.0±4.7	15.2±6.5	2.4±0.6	1.9±0.5
Other**	40.5±12.0	41.4±7.2	25.4±6.2	32.4±12.8	7.8±2.2	8.8±2.3
Educational Level						
<12	44.6±3.5	42.5±2.1	37.6±2.1	38.9±3.4	9.6±0.5	7.9±0.5
12	43.7±2.6	37.9±1.4	35.4±1.5	41.1±2.9	7.8±0.3	7.3±0.3
13–15	41.3±3.1	35.4±1.8	33.7±2.2	41.6±3.3	7.2±0.4	7.0±0.4
16+	41.6±3.1	36.2±1.7	35.3±1.7	38.6±3.2	7.7±0.4	7.1±0.4

	1986 AUTS	1987 NHIS	1991 NHIS	1992 NHIS	1992-93 CPS	1995-96 CPS
Total Female	3.5±0.6	3.8±0.3	3.1±0.2	3.7±0.5	0.29±0.04	0.28±0.04
Age						
18–24	2.2±1.3	4.5±0.9	2.7±0.7	5.0±1.7	0.16±0.07	0.16±0.08
25–34	4.2±1.2	4.7±0.6	3.0±0.6	4.7±1.2	0.23±0.07	0.26±0.08
35–44	5.1±1.4	4.2±0.6	4.3±0.6	3.2±0.9	0.36±0.09	0.35±0.09
45–64	0.42±0.09	0.35±0.08				
45–54	4.4±1.7	4.3±0.9	3.5±0.6	4.1±1.5		
55–64	2.9±1.4	3.0±0.6	3.3±0.7	3.2±1.3		
65+	2.0±1.1	1.7±0.4	1.6±0.5	2.2±0.9	0.21±0.07	0.21±0.07
Hispanic Origin*						
Hispanic	6.6±3.6	2.7±0.9	1.7±0.6	2.9±1.3	0.23±0.11	0.18±0.10
Non-Hispanic White	3.3±0.6	3.9±0.3	3.2±0.3	3.8±0.5	0.32±0.04	0.30±0.04
Race						
White	3.7±0.6	3.9±0.4	3.3±0.3	4.1±3.5		
Black	1.9±1.3	2.9±0.6	1.6±0.4	1.8±0.9	0.23±0.09	0.21±0.09
Asian or PI	7.2±7.3	2.0±1.8	1.6±1.4	1.1±1.6	0.05±0.09	0.19±0.16
Other**	6.5±6.3	5.5±4.3	7.3±5.8	7.1±6.2	0.78±0.67	1.40±0.85
Educational Level						
<12	3.4±1.3	3.6±0.5	2.7±0.5	3.2±1.0	0.38±0.10	0.32±0.09
12	3.3±0.9	3.6±0.4	3.1±0.4	3.2±0.8	0.25±0.05	0.24±0.05
13–15	3.9±1.1	4.7±0.6	3.2±0.5	4.7±1.4	0.30±0.07	0.28±0.07
16+	3.9±1.4	3.6±0.6	3.3±0.6	4.3±1.0	0.31±0.09	0.32±0.08

*The White and Black categories in NHIS included those of Hispanic origin whereas in the CPS, all Hispanics are included in the Hispanic category.
**The 1995/96 CPS category “Other” contains only American Indians. All other respondents were assigned to existing categories.

The prevalence of cigar smoking by age and gender shows that, in surveys conducted between 1986-1992, older males were more likely than younger males to have ever smoked cigars. Ever cigar smoking did not vary by age among females. The prevalence of ever smoking was lower in every age group in the Current Population Surveys, but the pattern of ever cigar smoking by age group among males in the Current Population Surveys was similar to that seen with the other national surveys. Older males showed a significant decline in ever smoking prevalence between 1992/93 and 1995/96 in the Current Population Surveys. However, this decline was not evident among younger males, and there was a small but statistically significant increase among males 18-24 years of age.

Non-Hispanic males were more likely than Hispanic males to have ever smoked cigars. This pattern was seen on all national surveys. There were no differences between Hispanic and non-Hispanic females. White males were more likely than black males to report ever having smoked cigars. Rates for white and black males decreased slightly from 1986 to 1991, but then rose again in 1992. White females were somewhat more likely than black females to have ever smoked cigars, but the rates for females did not vary by race from 1986 to 1992.

In 1987, males with fewer than 12 years of education were more likely than males with greater than 12 years of education to report ever smoking cigars. This difference by education is the opposite of that seen in more recent surveys. There were no differences in ever cigar smoking rates by education among women.

Data for the state of California can also be used to compare cigar smoking in 1990 with that in 1996. Table 4 presents the ever cigar smoking prevalence for the State of California in 1990 and 1996 and shows an overall decline in ever smoking prevalence among males, with no change among females. The prevalence of ever smoking among males in California increased substantially with age in the 1990 survey; but, between 1990 and 1996, the prevalence of ever smoking declined among older age groups and increased in the 18-24 year old group, resulting in a flattening in the gradient of ever smoking with age. Ever smoking prevalence among women showed little change with age in 1990; but in 1996, there was a decline in ever smoking prevalence among older age groups and an increase in the 18-24 year old group sufficient to produce an inverse gradient with age.

Prevalence of Current Cigar Smoking

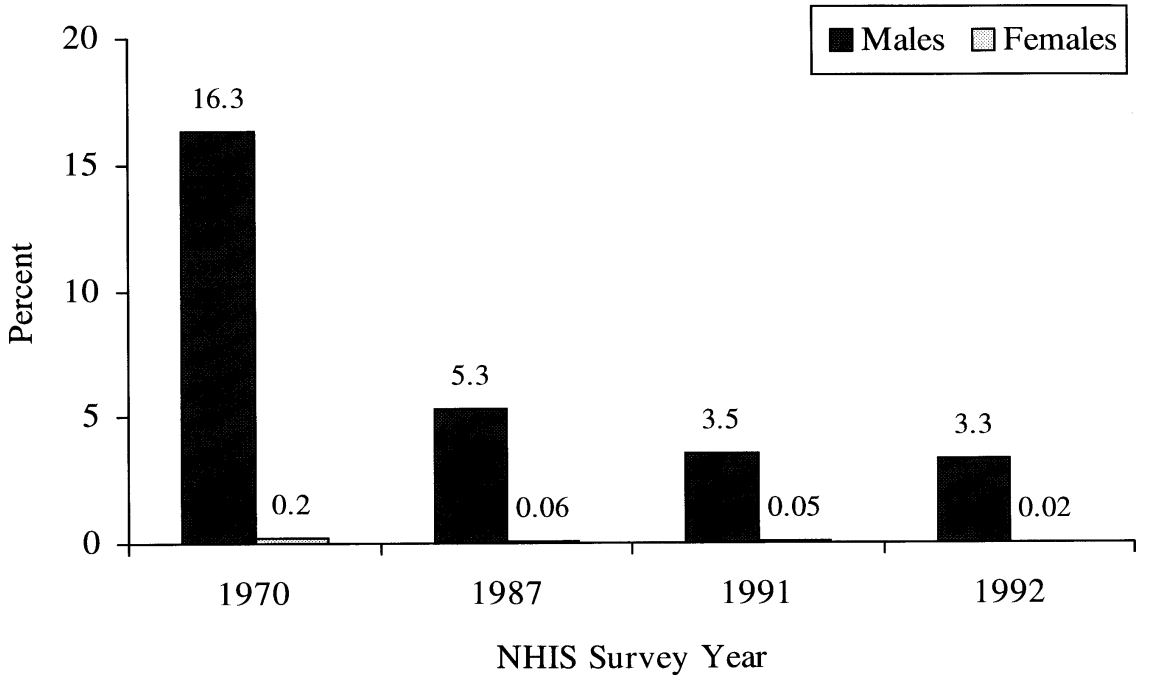
Figure 3 shows changes in the percentage of adult current cigar users among males and females in the United States between 1970 and 1992 using data collected from the NHIS. These data reveal that cigar use has always been predominantly a male behavior. Between 1970 and 1992, the prevalence of cigar use among adult males declined by 80 percent. The decline in cigar use by males was evident in all age and racial groups (data not shown). The highest prevalence of cigar use was among males between the ages of 35 and 64 years. Male and female prevalence of current cigar smoking among adults nationally also declined between 1986-1992 for all races (Table 5). Except for 1987, there were no significant differences among the races in current cigar smoking prevalence. By 1992, cigar use was a behavior rarely seen among

Table 4
Current and ever cigar smoking prevalence among California adults, 1990 and 1996

	1990 Current Cigar (%)	1996 Current Cigar (%)	1990 Ever Smoked Cigars (%)	1996 Ever Smoked Cigars (%)
Male Total	4.8±0.6	8.8±0.8	42.7±1.6	35.2±1.1
Age				
18–24	4.2±1.8	12.4±2.7	29.4±3.8	32.5±3.8
25–44	5.3±0.7	10.9±1.3	39.4±1.8	32.8±2.2
45–64	4.7±1.0	6.2±1.3	52.5±2.2	38.1±2.8
65+	3.4±1.3	1.8±1.2	56.4±4.9	41.2±5.2
Race/Ethnicity				
Non-Hispanic White	5.7±0.6	11.5±1.2	52.5±1.9	47.5±1.7
African-American	2.5±1.4	6.3±2.2	27.9±6.1	28.7±4.2
Hispanic	3.3±1.2	5.6±1.8	25.0±2.6	17.9±2.6
Asian/PI	2.0±0.7	2.9±1.4	28.0±4.9	16.4±3.6
Other	14.6±7.7	8.1±4.0	58.0±12.1	26.2±9.1
Education				
<12	4.9±1.3	3.9±1.5	37.1±4.6	19.1±3.0
12	4.5±1.0	9.2±1.8	41.1±2.6	35.4±2.3
13–15	5.1±1.0	9.2±1.3	46.9±2.6	39.5±2.5
16+	4.6±0.8	11.4±1.6	46.0±2.2	42.5±2.0
Income				
≤10,000	4.0±1.4	4.7±2.0	36.4±5.0	20.8±4.7
10,001–20,000	4.1±1.1	6.3±1.7	34.4±4.6	27.7±4.7
20,001–30,000	4.9±1.7	6.6±1.9	40.9±3.8	30.9±4.3
30,001–50,000	5.6±1.3	8.4±2.2	48.2±3.7	37.5±3.3
50,001–75,000	4.7±1.0	10.8±2.1	47.0±3.8	39.4±3.9
75,000+	6.0±1.7	14.8±2.1	47.8±4.2	47.6±3.3
Unknown	3.5±1.1	5.1±2.2	38.0±4.0	28.1±4.7

	1990 Current Cigar (%)	1996 Current Cigar (%)	1990 Ever Smoked Cigars (%)	1996 Ever Smoked Cigars (%)
Female Total	0.2±0.1	1.1±0.3	6.4±0.7	5.5±0.6
Age				
18–24	0.3±0.3	3.0±1.4	5.9±1.8	8.4±2.0
25–44	0.3±0.2	1.4±0.5	7.1±0.7	6.4±1.0
45–64	0.2±0.2	0.3±0.2	6.9±1.3	4.7±0.8
65+	0.1±0.1	.	3.9±1.0	1.9±0.9
Race/Ethnicity				
Non-Hispanic White	0.2±0.1	1.3±0.4	7.9±0.8	7.4±0.9
African-American	0.0±0.1	2.5±2.0	4.5±2.7	5.4±2.7
Hispanic	0.4±0.0	0.6±0.5	3.0±0.9	2.9±1.0
Asian/PI	0.2±0.4	0.5±0.5	4.7±2.4	2.1±1.0
Other	0.4±0.5	0.5±0.5	11.7±4.4	5.9±3.3
Education				
<12	0.4±0.4	0.7±0.7	5.9±1.7	2.7±1.2
12	0.2±0.1	0.9±0.4	5.4±1.0	4.1±0.8
13–15	0.2±0.1	1.3±0.6	6.8±0.9	6.6±1.0
16+	0.2±0.3	1.5±0.7	8.4±2.0	8.2±1.6
Income				
≤10,000	0.1±0.2	0.7±0.4	5.6±1.8	4.6±1.7
10,001–20,000	0.8±0.8	1.0±0.6	6.6±1.7	4.5±1.3
20,001–30,000	0.2±0.2	0.8±0.6	5.8±1.2	4.1±1.3
30,001–50,000	0.1±0.2	1.3±0.8	6.5±1.4	6.3±1.5
50,001–75,000	0.3±0.3	1.5±1.0	7.1±1.4	6.1±1.6
75,000+	0.1±0.1	1.6±1.0	8.4±1.9	8.6±2.2
Unknown	0.1±0.1	0.5±0.3	5.4±1.3	3.3±1.4

Figure 3
Percentage of adults (18+ years of age) who currently use cigars* by sex, National Health Interview Surveys, 1970, 1987, 1991, and 1992



* Current use identified those persons who had smoked 50+ cigars in their lifetime who currently smoke cigars

females of any age or among men under the age of 25 years.Data from the 1992/93 and 1995/96 Current Population Surveys confirm the overall low prevalence of cigar use among both men and women. In 1992/93, only 1.7 percent of males and 0.5 percent of females reported current regular use of cigars. However, the reported regular use of cigars increased slightly among males (i.e., to 2 percent) and females (i.e., to 0.6 percent) in 1995/96 suggesting a reversal in the 2-decade long decline in cigar use among adults in the United States.

Data from the longitudinal tracking survey of adults conducted between 1989 and 1993 in 22 North American communities as part of the NCI's COMMIT project also point to an increase in cigar use (Hyland et.al, in press). The 1989 and 1993 surveys asked whether the respondent regularly smoked cigars or cigarillos (regular was defined as 3-4 times/week). Averaged across the 22 communities, the prevalence rate of regular cigar use increased 133 percent from 0.9 percent in 1989 to 2.1 percent in 1993. The reported increase in regular cigar use was observed in all 22 communities and seen in every gender, age, race, income, and smoking status category. The 1993 data show that both regular and occasional cigar use were more frequently reported by younger respondents and current cigarette smokers. The higher prevalence of cigar use among younger adults represents a dramatic change from earlier surveys of cigar users.

Table 5
Cigar current smoking prevalence from national surveys

	1986 AUTS	1987 NHIS	1991 NHIS	1992NHIS	1992-93 CPS	1995-96 CPS
Total Male	5.9±0.7	5.3±0.4	3.5±0.3	3.3±0.5	1.6±0.1	1.9±0.1
Age						
18–24	2.8	1.6	0.8	1.0	0.6±0.1	1.2±0.2
25–34	5.6	4.9	2.3	2.3	1.1±0.2	1.6±0.2
35–44	7.4	7.1	4.6	3.9	1.7±0.2	2.1±0.2
45–64					2.2±0.2	2.3±0.2
45–54	8.8	7.6	5.7	4.7		
55–64	6.7	6.2	5.3	5.7		
65+	5.2	4.8	3.0	2.6	2.3±0.3	2.1±0.3
Hispanic Origin*						
Hispanic	7.5±3.6	3.7±1.1	1.8±1.0	2.1±2.0	0.9±0.2	1.2±0.2
Non-Hispanic White	5.8±0.7	8.3±0.8	5.5±0.5	5.5±0.9	1.8±0.1	2.1±0.1
Race						
White	6.0±0.8	8.5±0.9	5.4±0.5	5.6±0.9		
Black	5.8±2.6	5.2±0.2	4.5±1.1	4.5±2.3	1.6±0.3	1.9±0.3
Asian or PI	4.2±4.6	1.0±0.9	3.6±4.1	nr	0.5±0.3	0.5±0.3
Other**	5.7±5.7	8.9±6.3	3.2±2.4	3.8±7.2	1.7±1.1	2.9±1.4
Educational Level						
<12	6.6±1.8	8.3±1.5	7.1±1.2	4.9±1.7	1.9±0.2	1.8±0.2
12	5.2±1.2	8.2±1.0	4.8±0.7	5.3±1.4	1.6±0.2	1.9±0.2
13–15	5.9±1.5	6.6±1.2	4.9±1.1	4.7±1.9	1.4±0.2	2.0±0.2
16+	6.2±1.5	8.1±1.5	4.2±0.8	5.6±1.7	1.7±0.2	2.1±0.2

	1986 AUTS	1987 NHIS	1991 NHIS	1992 NHIS	1992-93 CPS	1995-96 CPS
Total Female	0.20±0.2	0.06±0.04	0.05±0.03	0.02±0.05	0.05±0.02	0.06±0.02
Age						
18–24	0.15	0.03	0.00	0.00	0.03±0.03	0.04±0.04
25–34	0.58	0.09	0.09	0.00	0.04±0.03	0.08±0.04
35–44	0.09	0.04	0.06	0.00	0.04±0.03	0.10±0.05
45–64					0.08±0.04	0.04±0.03
45–54	0.41	0.13	0.07	0.00		
55–64	0.13	0.06	0.06	0.22		
65+	0.00	0.00	0.02	0.00	0.03±0.03	0.04±0.03
Hispanic Origin*						
Hispanic	2.1±2.1	0.1±0.1	0.1±0.1	0.3±0.7	0.11±0.08	0.06±0.05
Non-Hispanic White	0.1±0.1	0.1±0.02	0.1±0.03	nr	0.04±0.02	0.06±0.02
Race						
White	0.3±0.2	0.1±0.03	0.1±0.03	0.03±0.06		
Black	0.1±0.3	0.1±0.1	0.1±0.1	nr	0.06±0.05	0.06±0.05
Asian or PI	nr	0.1±0.2	nr	nr	0.01±0.04	0.05±0.08
Other**	nr	0.3±0.6	nr	nr	.	0.50±0.51
Educational Level				.		
<12	0.2±0.3	0.1±0.1	0.05±0.09	0.1±0.2	0.08±0.04	0.07±0.04
12	0.4±0.3	0.02±0.02	0.02±0.03	nr	0.04±0.02	0.06±0.03
13–15	0.2±0.2	.05±0.06	0.1±0.1	nr	0.04±0.03	0.06±0.03
16+	nr	0.1±0.1	0.06±0.06	nr	0.04±0.03	0.06±0.04

*The White and Black categories in NHIS included those of Hispanic origin whereas in the CPS, all Hispanics are included in the Hispanic category.
**The 1995/96 CPS category "Other" contains only American Indians. All other respondents were assigned to existing categories.

The 1990 and 1996 California Adult Tobacco Use Surveys are perhaps the best source of data available to estimate recent trends in cigar use behavior. California adults were asked about their current cigar smoking habits in 1990 and 1996. Over this 6-year interval, cigar smoking increased among both males and females (Table 4). The rates of cigar smoking increased among males of each race, but the increase was greatest among white and black males. Current cigar smoking prevalence remained unchanged among males with less than a high school education. In contrast, males with higher educational attainment and income, and younger males, had increases in cigar smoking prevalence. Figure 4 compares current cigar smoking prevalence in 1990 and 1996 for different age groups of males and clearly demonstrates that the increase in current cigar smoking prevalence is predominantly occurring among younger age males (18-44). A similar shift in cigar smoking prevalence is also occurring among young women, but the prevalence of current cigar smoking remains low among women.

The increase in current cigar smoking prevalence with increasing educational attainment and income (Table 4) is in marked contrast to the pattern observed among cigarette smokers. Prevalence of cigarette smoking decreases with increasing educational attainment and income. Figure 5 contrasts the 1996 data for current cigarette and cigar smoking among California males by education and Figure 6 provides the same contrast for income level. Clearly the influence of these socioeconomic factors on these two tobacco-use behaviors is quite different.

Recent changes in use of cigars may be confined to current cigarette smokers, or it may also be occurring among those who are not current cigarette smokers. Table 6 presents data from the 1990 and 1996 California tobacco use surveys that classify cigar and cigarette smoking by whether only one tobacco product is currently being used or whether both products are currently being used. In 1996, 60 percent of males who reported currently smoking cigars did not smoke cigarettes at the time of the survey, and 40 percent had never smoked more than 100 cigarettes in their lifetime (the definition of a never smoker). There was an increase in male current cigar smoking prevalence between 1990 and 1996 for current and former cigarette smokers, as well as for never smokers, but the proportionate increase (278 percent) is greatest among never smokers. The increase in cigar only use between 1990 and 1996 is also greater for those groups with higher educational attainment and income.

Prevalence of Former Cigar Smoking

There is little information available on the frequency with which cigar smokers quit smoking cigars. Data from the 1991 NHIS show that, among those males who had smoked 50 or more lifetime cigars, a larger percentage of older males were former cigar smokers as compared to younger males (Table 7). Former cigarette smokers were also more likely than current or never cigarette smokers to be a former cigar smoker.

The California survey has data on the frequency with which people who reported ever using cigars responded “not at all” when asked whether they smoked some days, every day, or not at all. This group can be considered former cigar smokers and can be further divided by whether the respondent reported

Figure 4
Prevalence of current cigar smoking among California males of different ages, 1990 and 1996

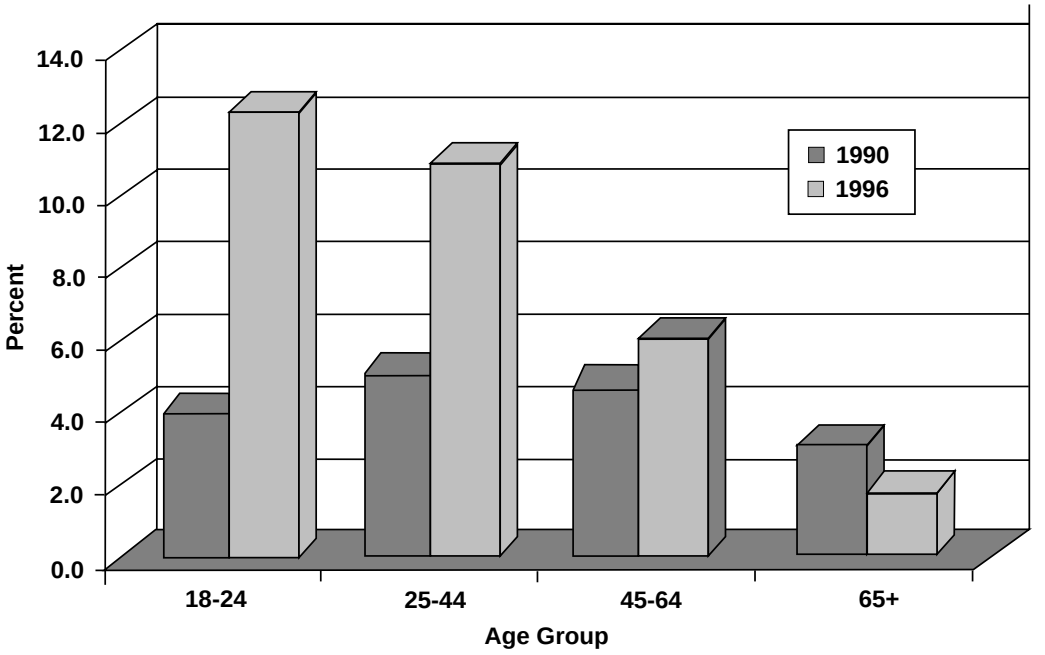


Figure 5
Prevalence of current cigarette and cigar smoking among California males of different levels of education, 1996

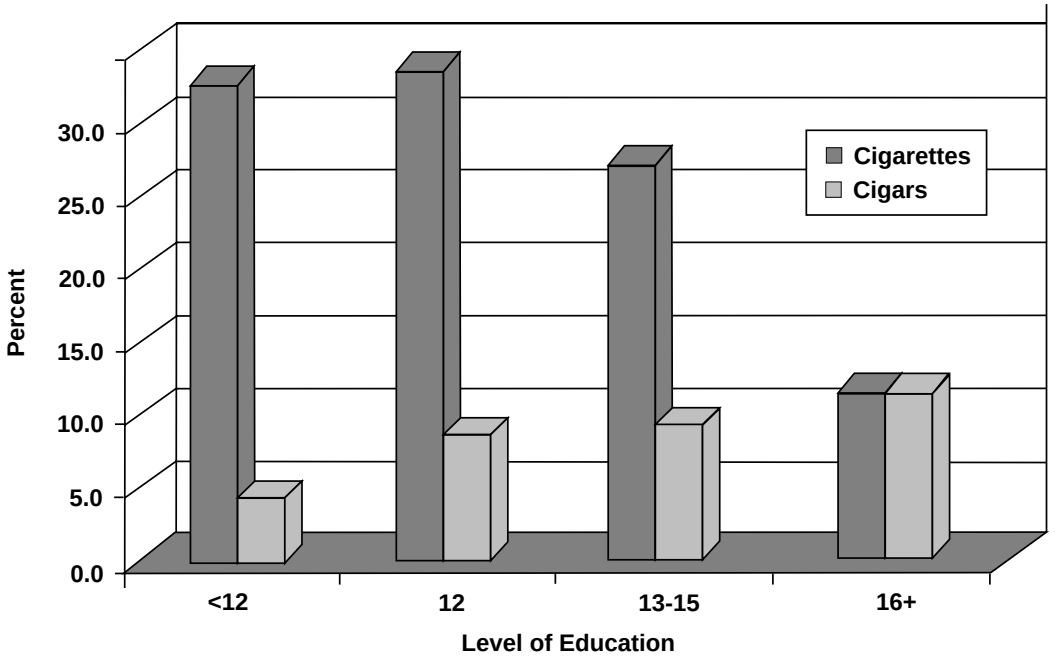


Figure 6
Prevalence of current cigarette and cigar smoking among California males of different incomes, 1996

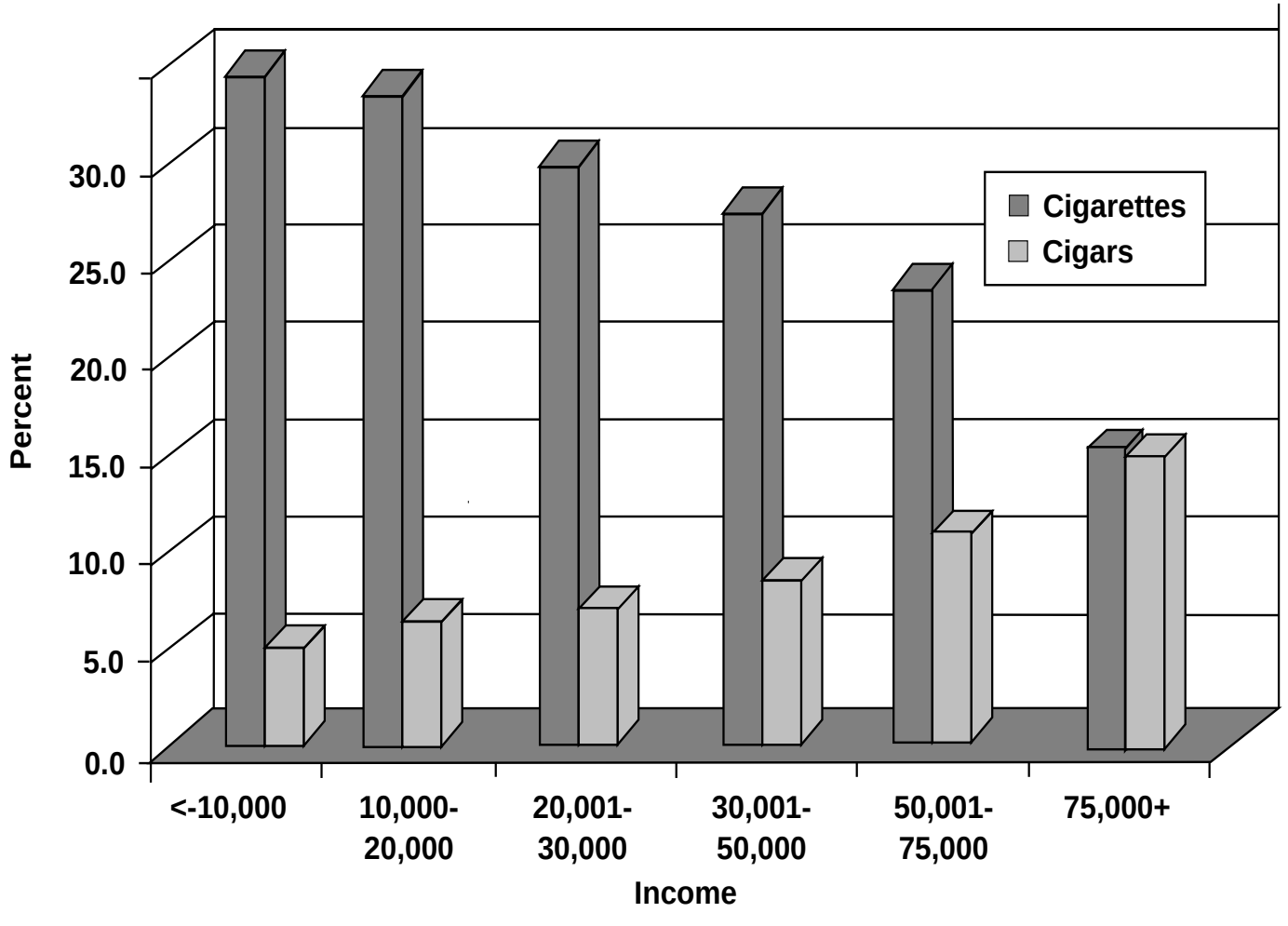


Table 6

Prevalence of cigar use in California, alone and in combination with cigarette use, 1990 and 1996

	1990					1996				
		Current Cigar Smokers					Current Cigar Smokers			
			Smoke Only Cigars					Smoke Only Cigars		
	Current Cigarettes Only (%)	Use Both Tobacco Products (%)	Never Smoked Cigarettes (%)	Former Cigarette Smoker (%)	Neither Product Used (%)	Current Cigarettes Only (%)	Use Both Tobacco Products (%)	Never Smoked Cigarettes (%)	Former Cigarette Smoker (%)	Neither Product Used (%)
Total Male	21.1±1.0	2.5±0.3	0.9±0.2	1.3±0.3	74.1±1.2	18.4±0.5	3.2±0.3	3.4±0.7	1.9±0.4	72.8±0.8
Age										
18–24	20.7±2.6	2.3±1.0	0.9±0.7	0.5±0.3	75.1±3.1	18.9±2.3	5.7±1.2	3.9±2.2	1.1±0.6	68.7±2.9
25–44	23.2±1.5	3.0±0.5	1.1±0.4	1.1±0.3	71.5±1.6	20.7±0.8	3.7±0.4	4.8±1.3	2.3±0.5	68.4±1.5
45–64	21.3±2.2	2.2±0.6	0.4±0.4	2.1±0.8	74.0±2.4	18.3±1.4	2.2±0.6	1.8±0.9	2.1±0.7	75.5±1.7
65+	12.6±2.5	1.2±0.6	0.5±0.6	1.6±0.8	84.0±3.0	9.4±1.4	0.3±0.2	0.8±0.9	0.8±0.7	88.8±1.7
Race/Ethnicity										
Non-Hispanic White	20.9±1.1	2.9±0.3	1.2±0.3	1.5±0.3	73.4±1.3	17.3±0.6	3.9±0.5	4.6±1.1	2.7±0.6	71.2±1.4
African-American	29.8±6.5	1.5±1.1	0.3±0.6	0.7±0.7	67.7±6.9	21.6±3.5	2.9±1.0	2.4±1.9	0.5±0.6	72.1±4.0
Hispanic	20.2±2.5	1.5±0.7	0.3±0.3	0.9±0.6	76.5±3.0	20.3±1.6	1.8±0.5	2.2±1.3	1.1±0.7	74.0±2.3
Asian/PI	17.5±2.4	0.9±0.5	0.2±0.2	0.8±0.6	80.5±2.4	16.2±2.0	2.1±1.1	0.6±0.9	0.3±0.2	80.9±2.3
Other	31.9±10.6	12.6±7.2	0.5±1.0	1.5±2.3	53.5±12.9	23.0±7.2	4.7±2.2	1.8±2.9	1.6±1.4	69.0±9.8
Education										
<12	26.8±2.8	3.6±1.1	0.1±0.1	1.1±0.7	68.3±3.6	25.3±2.4	2.5±0.6	1.1±1.2	0.4±0.4	70.7±2.2
12	24.2±1.6	2.5±0.5	0.7±0.5	1.0±0.3	71.3±1.9	23.8±1.2	4.4±0.7	2.6±1.4	1.7±0.7	67.0±2.1
13–15	21.0±2.0	2.5±0.4	1.0±0.4	1.5±0.6	73.9±2.1	18.1±1.4	3.8±0.6	3.1±1.2	1.9±0.7	72.7±1.9
16+	12.3±1.2	1.3±0.4	1.6±0.7	1.6±0.6	83.1±1.4	9.5±0.9	2.0±0.4	6.0±1.4	3.0±0.9	79.1±1.8
Income										
10,000	26.4±5.4	2.7±1.0	0.1±0.2	1.1±0.8	69.7±6.0	26.6±3.8	2.6±1.2	0.8±1.2	0.4±0.4	68.7±4.6
10,001–20,000	23.7±3.3	3.2±1.0	0.3±0.3	0.6±0.4	72.2±3.8	24.7±3.6	3.6±0.9	2.2±1.4	0.5±0.5	69.0±4.0
20,001–30,000	23.6±2.8	2.6±0.9	0.9±0.8	0.7±0.4	71.6±3.6	20.9±2.1	3.9±1.0	1.7±1.3	1.1±0.9	72.4±2.8
30,001–50,000	21.0±2.3	2.7±0.7	1.2±0.7	1.6±0.6	73.4±2.7	18.7±1.9	3.2±0.8	3.0±1.6	2.0±0.8	72.9±2.5
50,001–75,000	18.7±2.3	2.4±0.6	1.2±0.7	1.0±0.4	76.6±2.5	15.3±1.5	3.3±0.6	4.7±2.2	2.0±0.8	74.0±2.3
75,000+	15.1±2.0	1.7±0.6	1.4±0.7	2.7±1.3	78.9±2.6	12.1±1.4	3.1±0.7	7.1±2.1	4.2±1.1	73.1±2.4
Unknown	21.4±3.3	1.9±0.7	0.4±0.3	1.1±0.7	75.1±3.1	17.2±3.0	2.1±0.7	1.6±1.8	1.3±1.0	77.7±3.7

	1990					1996				
		Current Cigar Smokers					Current Cigar Smokers			
			Smoke Only Cigars					Smoke Only Cigars		
	Current Cigarettes Only (%)	Use Both Tobacco Products (%)	Never Smoked Cigarettes (%)	Former Cigarette Smoker (%)	Neither Product Used (%)	Current Cigarettes Only (%)	Use Both Tobacco Products (%)	Never Smoked Cigarettes (%)	Former Cigarette Smoker (%)	Neither Product Used (%)
Total Female	18.2±0.9	0.2±0.1	0.0±0.0	0.0±0.1	81.6±0.9	15.4±0.4	0.5±0.1	0.4±0.2	0.1±0.1	83.5±0.5
Age										
18–24	17.7±2.1	0.2±0.3	.	.	82.1±2.0	15.5±1.6	1.5±0.6	0.8±0.7	0.1±0.1	81.5±2.1
25--44	20.0±1.1	0.2±0.2	0.1±0.1	0.0±0.0	79.7±80.0	16.6±0.8	0.6±0.2	0.6±0.4	0.1±0.1	82.0±0.9
45--64	19.5±1.5	0.1±0.1	.	0.1±0.2	80.3±1.5	16.4±1.1	0.2±0.1	.	0.2±0.2	83.2±1.2
65+	10.9±1.07	0.1±0.1	.	.	89±1.7	9.6±1.3	.	.	.	90.4±1.3
Race/Ethnicity										
Non-Hispanic White	20.8±1.1	0.1±0.1	0.0±0.0	0.1±0.1	79.0±1.1	18.1±0.5	0.6±0.2	0.4±0.2	0.2±0.1	80.6±0.6
African-American	26.5±4.8	0.0±0.1	.	.	73.5±4.8	21.6±2.7	1.3±1.5	1.1±1.5	.	75.9±3.2
Hispanic	10.7±2.0	0.3±0.3	0.1±0.1	.	88.9±1.9	9.5±0.9	0.2±0.1	0.4±0.4	0.1±0.1	89.9±0.9
Asian/PI	8.5±2.0	0.0±0.1	0.1±0.2	0.0±0.1	91.3±2.0	8.4±2.2	0.3±0.3	0.2±0.4	.	91.1±2.2
Other	33.6±7.0	0.4±0.5	.	.	66.0±7.1	26.2±9.0	0.5±0.5	.	.	73.2±9.0
Education										
<12	18.8±2.3	0.4±0.4	.	.	80.8±2.4	15.0±1.4	0.4±0.3	.	.	84.2±1.4
12	21.7±1.3	0.1±0.1	0.0±0.1	0.0±0.0	78.1±1.3	20.1±1.3	0.5±0.2	0.3±0.3	0.1±0.1	79.0±1.4
13-15	17.7±1.5	0.1±0.1	0.1±0.8	0.0±0.0	82.1±1.5	16.7±1.2	0.6±0.3	0.5±0.5	0.1±0.1	82.0±1.3
16+	11.1±1.2	0.1±0.0	0.0±0.0	0.2±0.2	88.7±1.2	9.4±1.0	0.5±0.4	0.7±0.6	0.2±0.2	89.1±1.2
Income										
<=10,000	21.6±3.5	0.1±0.1	.	.	78.3±3.5	17.5±1.8	0.5±0.3	0.1±0.2	0.1±0.1	81.8±1.8
10,001--20,000	21.2±2.3	0.7±0.8	0.1±0.2	.	78.0±2.6	17.2±1.8	0.4±0.2	0.5±0.6	0.1±0.1	81.8±2.1
20,001--30,000	19.6±2.2	0.1±0.1	0.0±0.1	0.0±0.1	80.2±2.3	18.8±2.1	0.5±0.2	0.4±0.5	0.0±0.0	80.3±2.2
30,001--50,000	18.5±1.8	0.0±0.0	.	0.1±0.2	81.3±1.8	17.8±2.2	0.5±0.2	0.3±0.4	0.1±0.1	80.9±2.4
50,001--75,000	17.3±1.7	0.2±0.3	0.1±0.1	0.0±0.0	82.5±1.8	13.9±1.8	0.8±0.7	0.5±0.5	0.1±0.1	84.6±2.0
75,000+	14.4±2.0	0.1±0.1	.	0.0±0.0	85.5±2.0	10.0±1.3	0.4±0.2	0.8±0.9	0.3±0.4	88.3±1.5
Unknown	14.4±2.2	0.1±0.1	.	0.0±0.0	85.5±2.2	12.2±1.8	0.3±0.2	.	0.1±0.1	87.3±1.9

*Numbers may not sum to 100% because columns for missing or unknown data are omitted.

Table 7
Current occasional, current daily and former cigar smoking rates, 1991 NHIS

	Never Smoked Regularly	Former Smoker	Current Occasional Smoker	Current Daily Smoker
Gender				
Male	84.2±0.7	11.4±0.6	3.6±0.3	0.8±0.2
Female	99.7±0.1	0.2±0.1	0.07±0.04	0.005±0.007
Males Only				
Race				
White	83.1±0.7	12.5±0.6	3.7±0.3	0.7±0.1
Black	89.7±1.6	6.0±1.3	3.0±0.8	1.3±0.5
Asian/PI	94.4±3.9	2.5±2.1	1.5±2.2	1.7±2.9
Other	88.5±4.6	6.5±4.0	5.0±3.1	nr
Age				
18–24	97.2±0.8	1.3±0.6	1.4±0.6	0.07±0.1
25–34	93.6±0.8	3.0±0.5	3.3±0.6	0.06±0.06
35–44	84.7±1.4	9.5±1.1	5.1±0.9	0.7±0.3
45–54	75.3±2.0	18.4±1.8	4.6±0.9	1.7±0.8
55–64	72.7±2.2	21.1±2.0	4.5±1.1	1.7±0.5
65+	73.2±1.8	23.2±1.8	2.3±0.5	1.2±0.4
Cigarette Smoking Status				
Current	81.1±1.3	10.8±1.0	7.5±0.9	0.6±0.4
Former	72.5±1.4	23.3±1.3	2.8±0.5	1.4±0.4
Never	94.3±0.6	3.6±0.5	1.6±0.3	0.6±0.2

Current daily cigar smoker = smoked ≥ 50 cigars in life-time and smoking cigars daily at time of interview.

Current occasional = smoked ≥ 50 cigars in life-time but was not smoking cigars every day at time of interview.

Former cigar smoker = smoked ≥ 50 cigars in life-time but was not smoking at time of interview.

Never smoked regularly = never smoked ≥ 50 cigars in life-time.

smoking at least 50 lifetime cigars (Table 8). Among male Californians in 1996, 35.2 percent had ever smoked cigars, 8.8 percent currently smoked cigars and 26.4 percent were former cigar smokers. The prevalence of former cigar smoking increases with increasing age and level of education. The majority of former cigar smokers, using this definition of former smoker, had smoked fewer than 50 cigars in their lifetime.

Table 8
Detailed cigar smoking status among California adults, 1996

	Never Smoked	Former Cigar Smoker		Current Cigar Smoker	
	Cigars (%)	< 50 Lifetime (%)	≥ 50 Lifetime (%)	Occasional (%)	Daily (%)
Total Male	64.8±1.1	17.7±1.1	8.6±0.7	8.4±0.8	0.4±0.2
Age					
18–24	67.5±3.8	18.0±2.8	2.0±1.0	12.2±2.7	0.2±0.3
25–44	67.2±2.2	18.1±1.9	3.7±0.6	10.6±1.3	0.3±0.2
45–64	61.9±2.8	17.8±2.2	13.9±1.5	5.7±1.2	0.5±0.4
65+	58.8±5.2	15.2±3.2	24.1±4.4	1.0±0.8	0.8±1.0
Race/Ethnicity					
Non-Hispanic White	52.5±1.7	22.7±1.8	13.1±1.2	10.9±1.2	0.6±0.4
African-American	71.2±4.2	15.4±4.1	6.9±3.2	6.2±2.2	0.2±0.2
Hispanic	82.1±2.6	9.8±2.0	2.4±0.8	5.6±1.8	0.1±0.1
Asian/PI	83.6±3.7	11.9±3.1	1.6±0.8	2.9±1.4	0.1±0.1
Other	73.8±9.1	14.3±6.7	3.6±2.0	7.6±3.9	0.4±0.7
Education					
<12	80.9±3.0	9.1±2.1	6.0±2.0	3.7±1.4	0.2±0.2
12	64.6±2.3	17.2±2.1	9.0±1.3	8.8±1.8	0.3±0.2
13–15	60.4±2.5	20.7±2.5	9.3±1.5	8.8±1.3	0.5±0.5
16+	57.5±2.0	21.4±2.3	9.6±1.3	10.9±1.5	0.5±0.4
Income					
≤10,000	79.2±4.7	10.5±3.3	5.5±1.8	4.6±1.9	0.1±0.2
10,001–20,000	72.3±4.7	13.6±3.8	7.8±2.5	6.1±1.7	0.2±0.2
20,001–30,000	69.0±4.3	16.4±2.8	7.8±2.1	6.2±1.8	0.4±0.7
30,001–50,000	62.4±3.3	19.2±2.9	9.7±1.8	7.7±2.2	0.6±0.5
50,001–75,000	60.6±3.9	20.1±3.0	8.4±1.9	10.5±2.2	0.3±0.2
75,000+	52.4±3.3	22.6±2.7	9.9±2.0	14.2±2.1	0.6±0.5
Unknown	71.9±4.7	14.1±3.4	8.9±2.7	4.9±2.2	0.1±0.1
	Never Smoked	Former Cigar Smoker		Current Cigar Smoker	
	Cigars (%)	< 50 Lifetime (%)	≥ 50 Lifetime (%)	Occasional (%)	Daily (%)
Total Female	94.5±0.6	4.1±0.5	0.3±0.1	1.1±0.3	0.0±0.1
Age					
18–24	91.6±2.0	5.3±1.7	0.1±0.1	2.8±1.4	0.2±0.5
25–44	93.6±1.0	4.8±0.9	0.2±0.2	1.4±0.5	0.0±0.0
45–64	95.3±0.8	3.7±0.8	0.7±0.3	0.3±0.2	0.0±0.0
65+	98.1±0.9	1.5±0.8	0.3±0.4	.	.
Race/Ethnicity					
Non-Hispanic White	92.6±0.9	5.6±0.8	0.5±0.2	1.3±0.4	0.0±0.0
African-American	94.6±2.7	2.5±1.8	0.5±0.5	2.1±1.9	0.4±0.9
Hispanic	97.1±1.0	2.1±0.9	0.1±0.1	0.6±0.5	0.0±0.0
Asian/PI	97.9±1.0	1.5±0.9	0.0±0.1	0.5±0.5	.
Other	94.1±3.3	4.2±2.8	1.1±1.4	0.5±0.5	.
Education					
<12	97.3±1.2	1.7±1.0	0.2±0.2	0.7±0.7	0.0±0.1
12	95.8±0.8	3.0±0.6	0.3±0.2	0.8±0.4	0.1±0.2
13–15	93.4±1.0	5.0±1.0	0.3±0.2	1.3±0.6	0.0±0.0
16+	91.8±1.6	6.2±1.3	0.5±0.3	1.5±0.7	.
Income					
≤10,000	95.4±1.7	3.4±1.7	0.5±0.5	0.6±0.4	0.1±0.1
10,001–20,000	95.4±1.3	3.2±1.0	0.3±0.2	0.8±0.5	0.2±0.4
20,001–30,000	95.9±1.3	2.9±1.3	0.4±0.3	0.8±0.6	.
30,001–50,000	93.7±1.5	4.8±1.3	0.2±0.2	1.3±0.8	.
50,001–75,000	93.9±1.6	4.5±1.4	0.2±0.2	1.5±1.0	.
75,000+	91.4±2.2	6.6±1.8	0.4±0.4	1.6±1.0	.
Unknown	96.7±1.4	2.4±1.2	0.4±0.6	0.5±0.3	.

Smoking Patterns—Frequency

In 1986, more than half the current cigar smokers smoked less than once per week, while 28.7 percent smoked at least once per day (Table 9). The younger the smoker, the less likely he was to report smoking cigars daily. Among those who reported that they currently smoke cigars, former and never cigarette smokers were more likely than current cigarette smokers to smoke cigars on a daily basis. The predominance of occasional use among cigar smokers is not a recent phenomenon. Only one quarter of current cigar smokers reported smoking daily in 1955 (Chaenszel, Shimkin and Miller, 1956).

In the 1991 NHIS, those respondents who had smoked 50 or more lifetime cigars were asked whether they currently smoked cigars "some days," "everyday," or "not at all." Less than one percent of males were current daily cigar smokers; females were even less likely than males to be smoking cigars daily (Table 7). Black males were somewhat more likely than white males to be daily cigar smokers. Males between the ages of 45-64 were more likely than younger males to be smoking cigars daily. Some day smoking also varied with age, with males aged 35-64 having the highest rates of some day cigar smoking.

Data from California (Table 10) show that between 1990 and 1996 there was little change in male prevalence of daily cigar smoking, and the increase in cigar

Table 9
Frequency of cigar smoking among current cigar smokers, 1986 AUTS

	At Least Once/Day	At Least Once/Week	Less than Once/Week
Total	29.7±5.5	17.9±4.6	52.4±6.0
Gender			
Male	28.0±5.5	18.5±4.8	53.4±6.1
Female	67.7±32.3	3.0±11.9	29.3±31.7
Race			
White	29.3±5.8	15.9±4.7	54.7±6.3
Black	25.0±19.7	40.1±22.3	35.0±21.7
Age			
18–24	1.8±6.4	32.6±22.6	65.6±22.9
25–34	20.6±10.0	16.9±9.3	62.5±11.9
35–44	16.0±8.5	16.9±8.7	67.1±10.8
45–54	41.9±13.5	15.6±9.5	42.5±13.5
55–64	53.5±16.6	14.3±11.7	32.3±15.6
65+	44.1±18.7	17.4±14.3	38.5±18.3
Cigarette Smoking Status			
Current	10.5±5.2	16.4±6.4	73.0±7.7
Former	46.0±10.4	17.3±7.8	36.7±10.0
Never	40.0±14.1	20.0±11.5	40.0±14.1

Table 10

Current cigar smoking prevalence among adult male Californians who have and have not smoked 50 or more cigars in their lifetime, 1990 and 1996

	1990					1996				
	Never/ Former Cigar Smokers (%)	Current Cigar Smokers				Never/ Former Cigar Smokers (%)	Current Cigar Smokers			
		Occasional		Daily			Occasional		Daily	
		< 50 Lifetime (%)	≥ 50 Lifetime (%)	< 50 Lifetime (%)	≥ 50 Lifetime (%)		< 50 Lifetime (%)	≥ 50 Lifetime (%)	< 50 Lifetime (%)	≥ 50 Lifetime (%)
Total Male	95.3±0.6	1.5±0.4	2.8±0.3	0.0±0.0	0.4±0.1	91.3±0.8	4.3±0.6	4.0±0.5	0.0±0.0	0.4±0.2
Age										
18–24	95.8±1.8	2.8±1.6	1.3±0.6	0.0±0.1	0.1±0.1	87.6±2.7	9.4±2.7	2.8±0.8	.	0.2±0.3
25–44	94.7±0.7	1.8±0.4	3.1±0.5	0.1±0.1	0.3±0.2	89.1±1.3	5.7±0.9	4.8±0.9	0.0±0.0	0.3±0.2
45–64	95.3±1.0	0.6±0.5	3.5±0.8	0.0±0.0	0.5±0.3	93.9±1.2	1.2±0.5	4.5±1.0	0.0±0.0	0.5±0.4
65+	96.6±1.3	0.1±0.1	2.3±0.9	.	1.0±0.7	98.2±1.2	0.1±0.2	0.9±0.8	.	0.8±1.0
Race/Ethnicity										
Non-Hispanic White	94.3±0.6	1.5±0.3	3.7±0.5	0.0±0.0	0.4±0.1	88.6±1.1	5.2±0.8	5.5±0.9	0.0±0.0	0.6±0.4
African-American	97.5±1.4	1.3±0.9	1.0±0.9	.	0.2±0.5	93.7±2.2	3.7±1.7	2.5±1.7	0.1±0.2	0.1±0.1
Hispanic	96.7±1.3	1.7±1.1	1.2±0.5	0.2±0.2	0.2±0.2	94.4±1.8	3.9±1.5	1.7±0.7	0.0±0.0	0.1±0.1
Asian/PI	98.0±0.7	0.6±0.4	1.2±0.7	.	0.2±0.3	97.1±1.4	1.2±0.8	1.6±1.2	.	0.1±0.1
Other	85.4±7.7	1.8±2.3	10.8±6.0	.	2.0±3.7	91.9±4.0	2.7±2.9	4.9±2.5	.	0.4±0.7
Education										
<12	95.1±1.3	1.6±0.9	2.6±0.7	0.1±0.1	0.6±0.4	96.1±1.5	2.6±1.3	1.2±0.4	0.0±0.1	0.2±0.2
12	95.4±1.0	1.7±0.8	2.4±0.5	0.1±0.1	0.3±0.2	90.9±1.8	4.2±1.1	4.6±1.3	0.1±0.1	0.3±0.2
13–15	94.9±1.0	1.5±0.5	3.1±0.6	.	0.4±0.3	90.9±1.3	4.7±1.1	3.9±0.8	0.0±0.0	0.5±0.5
16+	95.5±0.8	1.1±0.5	3.2±0.8	.	0.2±0.2	88.6±1.6	5.4±1.1	5.5±1.2	0.0±0.0	0.5±0.4
Income										
≤10,000	96.0±1.4	0.9±0.5	2.2±0.9	0.1±0.1	0.7±0.7	95.3±2.0	2.6±1.7	1.9±0.9	.	0.1±0.2
10,001–20,000	95.9±1.1	1.0±0.6	2.6±0.7	0.2±0.2	0.3±0.3	93.9±1.7	2.7±1.2	3.2±1.3	.	0.2±0.2
20,001–30,000	95.2±1.7	2.1±1.5	2.2±0.8	0.1±0.1	0.5±0.4	93.4±1.9	3.7±1.5	2.5±0.8	0.0±0.0	0.4±0.7
30,001–50,000	94.5±1.3	1.3±0.5	3.7±0.9	0.0±0.0	0.5±0.3	91.7±2.2	3.8±1.4	3.9±1.3	0.0±0.1	0.6±0.5
50,001–75,000	95.3±1.0	1.9±0.7	2.6±0.7	.	0.2±0.2	89.2±2.1	6.0±1.8	4.5±1.3	0.1±0.1	0.2±0.1
75,000+	94.±1.7	1.7±1.0	4.1±1.3	.	0.1±0.2	85.2±2.1	7.0±1.7	7.2±1.5	0.0±0.0	0.6±0.5
Unknown	96.6±1.2	1.4±0.7	1.6±0.7	.	0.4±0.4	95.1±2.1	2.5±2.0	2.2±1.0	.	0.1±0.1

smoking prevalence was confined largely to the occasional cigar smoking group (those who reported smoking cigars some days). The largest increase was in those some day cigar smokers who had not yet smoked 50 cigars in their lifetime, and the biggest increase among those who had not smoked 50 cigars in their lifetime was in the youngest age group. These California data suggest that there has been a dramatic increase in occasional cigar use recently, and that much of the change that has occurred would have been missed if the evaluation were confined only to those who had smoked more than 50 cigars in their lifetime.

Smoking Patterns—Quantity Among those cigar smokers who reported that they had smoked cigars regularly in 1987, 56.4 percent (95 percent CI, 54.3-58.6 percent) reported smoking 1-2 cigars per day; 26.4 percent (95 percent CI, 24.5-28.3 percent) reported smoking between 3 and 5 cigars per day, and 12.7 percent (95 percent CI, 11.3-14.0 percent) reported smoking 6 or more cigars per day. Unfortunately, most recent surveys have not collected information on quantity of cigars smoked making it impossible to assess trends on this important exposure variable.

Age of Initiation of Cigar Smoking Among the national surveys, only the 1987 NHIS asked adults about the age at which they first smoked cigars, and this question was only asked of those who had smoked more than 50 cigars in their lifetime. The age of initiation of cigar smoking was older than that for cigarette smoking. Among cigarette smokers, 60.2 percent had begun smoking regularly prior to age 18, whereas only 24.6 percent of those who had smoked more than 50 cigars in their lifetime had started prior to age 18 (Table 11). Recent data on adolescent use suggests that the age of initiation of cigar use currently may be much younger than in the past.

Adolescent Cigar Smoking During 1996, four surveys asked teenagers about their cigar smoking. Some surveys defined current smoking as having smoked cigars in the past 30 days; other surveys used a measure of use in the past year.

A national survey conducted by the Robert Wood Johnson Foundation (RWJF) found that 26.7 percent (95 percent CI, 25.0-28.4 percent) of 14-19 year olds had smoked at least one cigar in the past year (Centers for Disease Control and Prevention (CDC), 1997). Male adolescents (37 percent) were more than twice as likely as female adolescents (16 percent) to have smoked a cigar in the last year (Table 12). Those who smoked cigarettes or used smokeless tobacco in the previous month were more likely to have smoked cigars than those who had not used other tobacco products. There was a remarkably small difference in cigar smoking by age, with 14-16-year-old adolescents reporting smoking at a 24.4 percent rate as compared to 27.5 percent of 19-year-old teens.

The adolescent respondents were asked how many cigars they had smoked in the previous year. Nearly 3.0 percent had smoked more than 50 cigars in the previous year. Cigarette smokers and smokeless tobacco users were more likely than nonusers to have smoked 50 or more cigars in the previous year. The percentage of these teenagers who had consumed 50 or more cigars in one year was larger than the percentages of young adults who had smoked 50 or more cigars in their lifetime measured by the earlier NHIS (Figure 7).

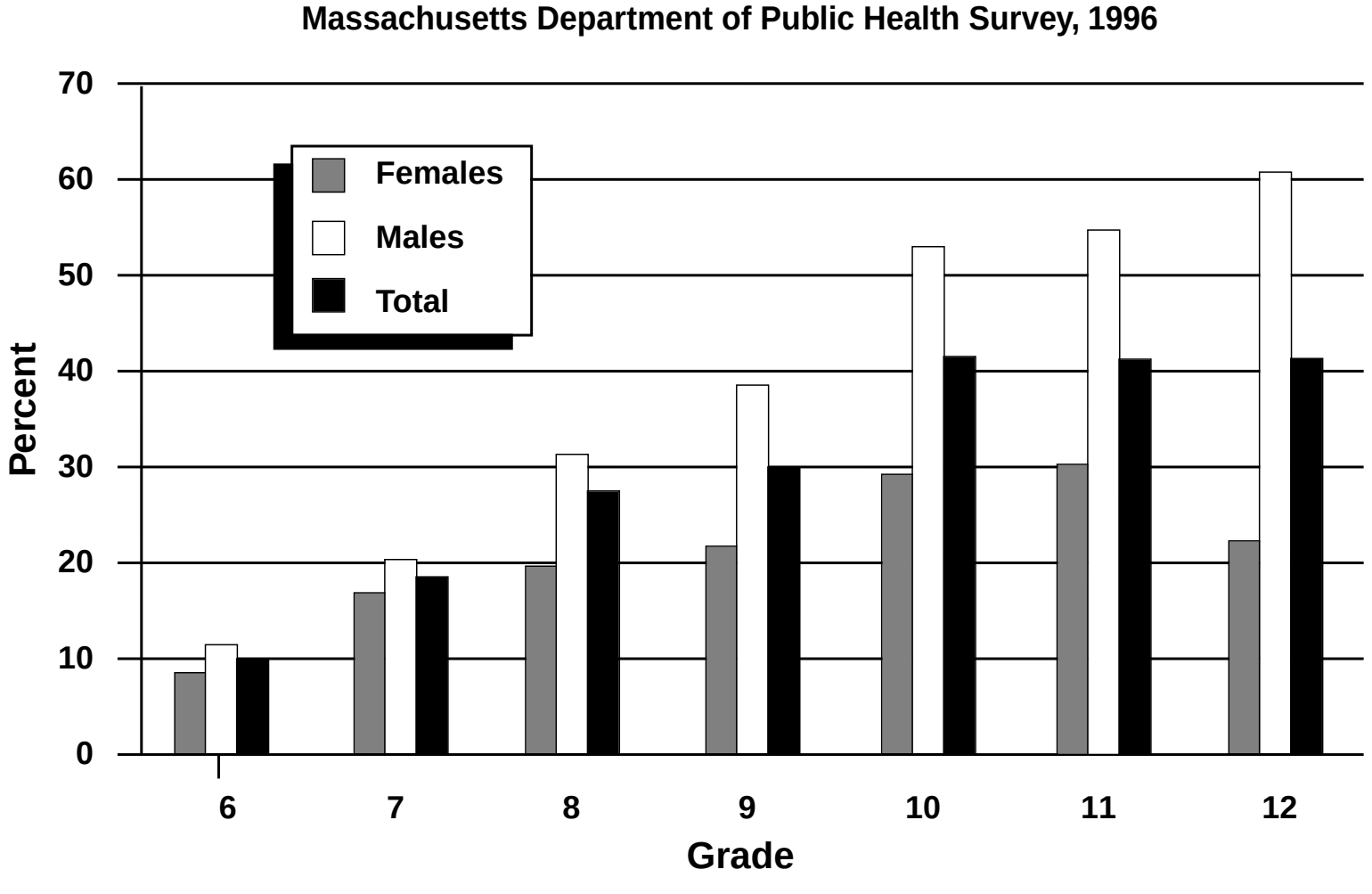
Table 11
Age of initiation of cigarette and cigar smoking for white and black males, 1987 NHIS

Age of Initiation	Cigar Smoking	Cigarette Smoking
White		
< 18	24.6±1.7	60.2±1.1
18–25	53.1±2.0	37.6±1.1
26–30	12.0±1.3	1.7±0.3
31–34	1.8±0.6	0.2±0.1
35–49	4.9±0.8	0.3±0.1
50+	3.6±0.7	0.0
Black		
< 18	19.8±6.4	52.8±3.5
18–25	52.6±7.8	43.3±3.4
26–30	14.9±5.0	3.0±1.3
31–34	2.4±2.2	0.4±0.3
35–49	5.9±2.9	0.6±0.7
50+	4.2±2.4	0.0

Table 12
Cigar use in the past year among adolescents, 1996 RWJF National Survey

	Prevalence
Gender	
Male	37.0±2.4
Female	16.0±1.3
Age	
14–16	24.4±1.7
17–18	29.8±1.7
19	27.5±5.3
Race/Ethnicity	
White, non-Hispanic	28.9±2.1
Black, non-Hispanic	19.3±2.9
Hispanic	26.2±2.1
Other	22.2±2.9
Past Month Cigarette Use	
Smoker	54.1±2.4
Nonsmoker	14.2±1.2
Past Month Smokeless Tobacco Use	
User	73.4±3.4
Nonuser	22.6±1.4

Figure 7
Lifetime use of cigars by grade and gender



The Massachusetts Department of Public Health assessed cigar use in grades 6 through 12 (CDC, 1997). The prevalence of ever having smoked a cigar increased with increasing grade and leveled off at over 40 percent for students in grades 10 through 12 (Figure 7, Table 13). Males in all grades were more likely than females to have ever smoked a cigar. Lifetime use of cigars by race (Figure 8) in Massachusetts showed that whites were more likely than other racial groups to have ever smoked a cigar.

The Massachusetts youth were also asked about past year and past month use of cigars. Past year use of cigars increased with increasing grade, with the largest increase between grades 7 and 8 (Table 13). The past year use for students in grades 9-12 (comparable in age to the students from the RWJF survey) showed that 28.1 percent had smoked a cigar in the past year, which was similar to the RWJF estimate of 26.7 percent. Past 30 day cigar use was highest in grade 11 for both male and female adolescents (Table 13). Cigar use was significantly higher

Table 13
Prevalence of cigar use in the last year, and all forms of tobacco use in the last 30 days, by school grade, Massachusetts, 1996

	Grade						
	6	7	8	9	10	11	12
Past Year Use Of Cigars	5.0 (4.2-5.8)	8.3 (6.6-10.0)	20.3 (17.7-22.9)	20.6 (18.1-23.1)	29.6 (26.9-32.3)	31.8 (28.7-34.8)	31.3 (28.2-34.4)
Past 30-Day Use							
Cigars	2.0 (1.1-2.9)	4.4 (1.3-7.5)	10.9 (8.9-12.9)	10.4 (8.5-12.3)	16.0 (13.8-18.2)	18.4 (15.9-20.9)	13.4 (11.0-15.8)
Males							
Cigarettes	10.7 (8.0-13.4)	13.7 (10.7-16.7)	24.6 (20.8-28.4)	27.2 (23.2-31.2)	32.2 (28.3-36.1)	35.5 (31.0-40.0)	45.1 (40.3-49.9)
Smokeless	2.6 (1.2-4.0)	2.5 (1.2-3.8)	5.7 (3.7-7.7)	4.4 (2.5-6.3)	10.9 (8.3-13.5)	14.3 (11.0-17.6)	13.6 (10.3-16.9)
Cigars	3.2 (1.6-4.8)	4.3 (2.6-6.0)	13.0 (10.0-16.0)	14.9 (11.7-18.1)	24.9 (21.3-28.5)	30.3 (25.9-34.7)	23.7 (19.6-27.8)
Females							
Cigarettes	5.7 (3.7-7.7)	19.0 (15.5-22.5)	27.5 (23.3-31.7)	33.0 (29.1-36.9)	35.3 (31.1-39.5)	42.0 (37.6-46.4)	36.6 (32.2-41.0)
Smokeless	0.1 (-0.8-1.0)	0.2 (-0.2-0.6)	0.8 (0.0-1.6)	1.3 (0.4-2.2)	1.2 (0.2-2.2)	0.5 (-0.1-1.1)	0.6 (-0.1-1.3)
Cigars	0.8 (-1.5-3.1)	4.6 (2.7-6.5)	8.4 (5.8-11.0)	6.6 (4.5-8.7)	6.1 (4.0-8.2)	7.7 (5.3-10.1)	4.1 (2.3-5.9)

* Numbers in the parentheses are the 95% confidence intervals of the estimates

than smokeless tobacco use for males in grades 8 through 12 and for females in grades 7 through 12. White students had the highest rate of past 30 day use, followed by blacks and Hispanics (Figure 9).

California also surveyed adolescents to estimate their rates of cigar smoking (Table 14). Males were more likely than females to have ever smoked a cigar. Older students were more likely than younger students to have ever smoked a cigar. White students were somewhat more likely than students of other races to have ever smoked a cigar. The California Tobacco Survey also asked youths between the ages of 12 and 17 about past 30-day cigar smoking. Males were more likely than females to be currently smoking cigars. The rates of current cigar smoking increased with age, and were somewhat higher among white and Hispanic adolescents.

Rates for ever smoking cigars and past 30-day cigar smoking were lower among the California teens than among the students in Massachusetts. This may be due to the different methodologies used in these surveys. The Massachusetts survey was anonymously conducted in schools; the California survey was a household survey conducted via the telephone. School based surveys of teens produce higher prevalence estimates for cigarette smoking than telephone surveys in the home (U.S. Department of Health and Human Services, 1994). It is possible that this is also true for cigar smoking behavior.

Figure 8
Ever cigar smoking by race among teenagers

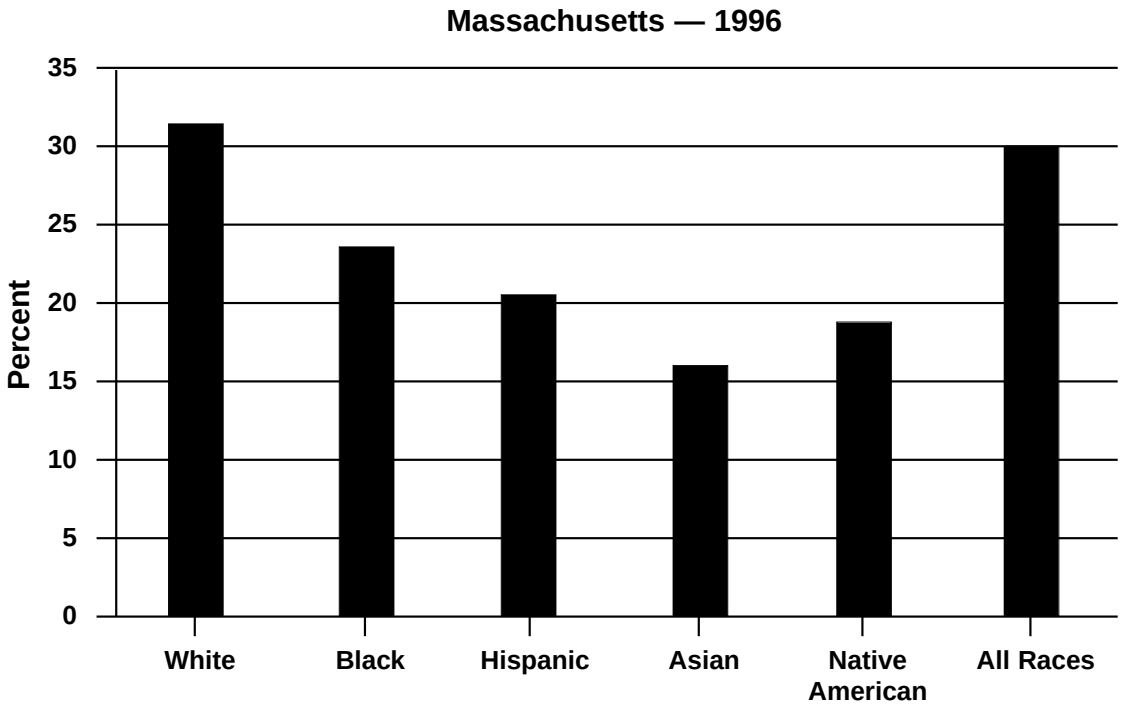


Figure 9
Past month use of cigars among teenagers by race

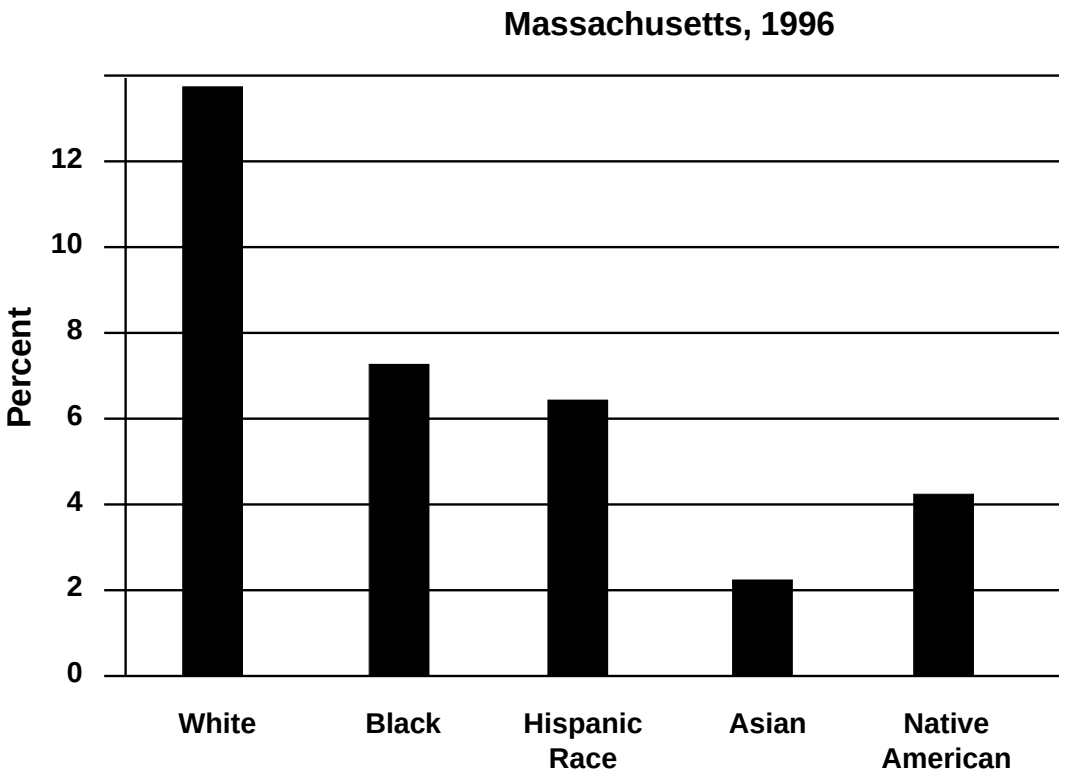


Table 14
Ever cigar smoking and current smoking in the last 30 days among California teenagers, 1996

	Ever Cigar Smoking Prevalence	Cigar Smoking in the Last 30 Days
Total:	15.0±1.2	4.0±0.6
Gender		
Male	19.7±1.9	5.7±1.1
Female	9.8±1.2	2.1±0.6
Age		
12–13	5.6±1.2	0.8±0.5
14–15	13.8±1.9	3.2±0.9
16–17	25.9±2.4	8.1±1.4
Race/Ethnicity		
Non-Hispanic White	18.1±1.4	4.9±0.9
African-American	13.2±3.7	3.2±1.6
Hispanic	13.0±2.3	3.7±0.9
Asian/PI	8.2±2.7	2.2±1.4
Other*	16.3±6.4	1.4±1.8

*Primarily Native Americans.

Table 15
Prevalence of adolescent cigar smoking in the past 30 days by various characteristics, New York, 1996

	Erie County	Chautauqua County
Gender		
Male	19.5	24.0
Female	6.1	5.3
Cigarette Smoking Status		
Never smoked	4.6	4.9
Smoked on 1–19 days in past 30	26.8	31.6
Smoked on 20–30 days in past 30	40.9	45.4
Smokeless Tobacco Use Status		
Not used in previous 30 days	10.9	11.1
Used in previous 30 days	62.4	63.0

Another school based teen survey was conducted in 1996 among ninth grade students in two New York counties (CDC, 1997). The median age of these students was 14. Males were more likely than females to have smoked a cigar in the previous 30 days (Table 15). As was seen on the RWJF national survey, cigarette smokers and smokeless tobacco users were substantially more likely than those who had not used other tobacco products to report having smoked a cigar in the previous month. As was seen in Massachusetts, smokeless tobacco use was lower than cigar use among these students (CDC, 1997).

DISCUSSION Data from the U.S. Department of Agriculture clearly demonstrate an increase in the number of cigars consumed per year since 1993. State and national surveys of smoking behavior suggest that competing trends in cigar usage are occurring. Among older males, cigar usage continues to decline. However, among young and middle-aged males, occasional use of cigars appears to be increasing dramatically. Adolescents of both genders are also using cigars, and some surveys show that their rates of use meet or exceed those of adults prior to 1993.

The only national adult data on cigar smoking collected after 1992 is from the Current Population Surveys, and these surveys show a low prevalence of cigar smoking and very little change between 1992-3 and 1995-6. Part of the explanation for the apparent difference between the consumption trends and the prevalence trends may lie in the wording of the questions used in the Current Population Surveys. The questions on this survey asked whether cigars were currently, or had ever been, "regularly used." This is in contrast to the NHIS

which asked whether the respondent had ever smoked cigars or currently smoked cigars. The difference in questions probably leads to a different subset of cigar smokers who answer positively. Occasional cigar smokers and those who have smoked fewer than 50 cigars in their lifetime may be more likely to answer no to the Current Population Survey "use regularly" question, but respond yes to the NHIS "smoke" question. Support for this explanation of the differences between survey results is provided by survey data from California, where the prevalence of male daily cigar smoking did not change between 1990 and 1996, and where much of the change in cigar use was among those who have not yet smoked 50 cigars in their lifetime.

Changes in prevalence of occasional smoking in California between 1990 and 1996 are larger among well-educated and upper-income males and females. This pattern is markedly different from that seen with cigarette smoking. Cigar smoking increased among never smokers as well as among former cigarette smokers. Initiation of tobacco use with cigars after becoming an adult is markedly different from the predominantly adolescent initiation seen with cigarette smoking.

Among California males who were never cigarette smokers 2 years prior to the 1996 survey, by 1996 4.16 percent (+/- 2.08 percent) of those who smoked cigars were currently smoking cigarettes (new initiation) in contrast to 1.70 percent (+/- 0.45 percent) of those who did not smoke cigars. It is impossible to separate the likelihood of cigar smoking leading to initiation of cigarette smoking from the possibility that those who initiated cigarette smoking were also likely to smoke cigars; but the commonality in both of these behaviors is nicotine ingestion, and it would not be surprising if use of cigars predisposed an individual to the use of cigarettes. It remains to be seen whether those who have never used tobacco products prior to using cigars as adults will be able to remain occasional tobacco users or will shift either to regular cigar use or begin smoking cigarettes.

Another concern is former cigarette smokers who are currently smoking cigars occasionally. This group presumably includes a substantial number of individuals who were nicotine-addicted while they were smoking cigarettes, and who may be at increased risk of re-initiating their nicotine addiction due to their exposure to the nicotine in cigars. Among California males who were former cigarette smokers 1 year ago, cigar smokers reported a current cigarette smoking (relapse) rate of 16.35 percent (+/- 6.50 percent) in contrast to the 7.06 percent (+/- 1.83 percent) rate of current cigarette smoking among those who did not smoke cigars. This observation does not separate the likelihood that cigar smoking leads to relapse of cigarette smoking from the possibility that relapsing cigarette smokers take up smoking cigars as well, but it raises a concern that cigar use may place former cigarette smokers at increased risk of relapse.

Non daily smoking is also the predominant mode of cigar use among adolescents, but this pattern of use is of much greater concern for this group because the use of cigarettes and smokeless tobacco, two powerfully addictive forms of tobacco, are also largely used occasionally during adolescence (U.S. Department of Health and Human Services, 1994). Data from California (Table 16) show that a small number of male adolescents may have smoked cigars

Table 16
Use of cigars by adolescents in California, 1996

		Has Not	Ever Smoked Cigars				
		Smoked	Number of Days in the Last Month Cigars Were Smoked				
	Unknown	Cigars	Unknown	0	1–9	10–29	30
	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Total Male	0.1±0.2	80.2±1.9	0.2±0.2	13.8±1.6	5.3±1.0	0.3±0.2	0.0±0.1
AGE							
12–13	0.4±0.5	92.0±2.2	.	6.5±1.8	1.1±0.9	.	.
14–15	.	82.6±3.1	0.2±0.4	12.7±2.6	4.4±1.4	0.1±0.1	0.1±0.1
16–17	.	65.6±3.8	0.3±0.5	22.5±3.4	10.6±2.2	0.9±0.7	0.1±0.1
Race/Ethnicity							
Non-Hispanic White	0.1±0.2	76.6±2.0	.	16.5±1.8	6.5±1.3	0.3±0.3	0.0±0.1
African-American	.	83.0±5.7	0.3±0.7	13.7±6.1	2.4±2.1	0.3±0.6	0.3±0.7
Hispanic	0.2±0.4	82.4±3.8	0.4±0.5	11.4±2.7	5.5±1.6	0.1±0.1	.
Asian/PI	.	88.4±4.6	0.3±0.7	7.7±3.6	2.3±1.8	1.2±1.7	.
Other	.	77.2±10.7	.	20.1±10.9	2.1±3.0	0.6±1.2	.
Family Income							
≤10,000	.	83.3±5.1	.	12.2±5.1	3.8±3.0	0.7±1.5	.
10,001–20,000	.	80.9±5.2	0.2±0.3	13.4±4.8	4.9±2.6	0.6±0.7	.
20,001–30,000	.	83.0±4.6	.	10.6±4.2	6.1±2.8	0.1±0.3	0.2±0.4
30,001–50,000	0.3±0.7	76.9±5.1	0.3±0.6	16.3±4.0	6.0±2.1	0.1±0.3	0.1±0.2
50,001–75,000	0.3±0.5	81.2±3.5	0.3±0.7	13.6±3.0	4.1±1.9	0.5±0.9	.
75,000+	.	77.2±3.2	0.2±0.4	15.6±2.5	6.7±2.0	0.2±0.5	.
Unknown	.	85.3±4.8	.	10.9±3.8	3.7±2.3	0.1±0.3	.
		Has Not	Ever Smoked Cigars				
		Smoked	Number of Days in the Last Month Cigars Were Smoked				
	Unknown	Cigars	Unknown	0	1–9	10–29	30
	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Total Female	0.2±0.2	90.0±1.3	0.1±0.1	7.6±1.2	2.1±0.6	0.0±0.1	.
Age							
12–13	0.4±0.6	96.2±1.3	0.2±0.4	2.8±1.0	0.4±0.5	.	.
14–15	0.1±0.2	90.1±2.3	.	8.0±1.9	1.8±1.0	.	.
16–17	.	83.4±2.6	.	12.3±2.3	4.2±1.7	0.1±0.2	.
Race/Ethnicity							
Non-Hispanic White	.	87.8±1.8	.	9.5±1.7	2.6±1.1	0.1±0.1	.
African-American	.	90.5±4.3	.	6.1±3.1	3.4±2.3	.	.
Hispanic	0.5±0.6	91.0±2.9	0.2±0.4	6.5±2.3	1.7±0.9	.	.
Asian/PI	.	95.6±2.6	.	3.7±2.3	0.7±1.4	.	.
Other	.	91.4±8.0	.	8.6±8.0	.	.	.
Family Income							
≤10,000	0.9±1.8	92.5±3.7	.	5.4±3.2	1.2±1.5	.	.
10,001–20,000	0.5±1.1	91.9±3.2	0.5±1.0	5.2±2.5	1.9±1.4	.	.
20,001–30,000	0.3±0.5	89.9±3.9	.	6.8±3.4	3.0±1.9	.	.
30,001–50,000	.	90.4±3.0	.	7.5±2.8	2.1±1.4	.	.
50,001–75,000	.	90.4±2.9	.	7.4±2.8	2.3±1.3	.	.
75,000+	.	87.9±3.5	.	10.1±3.0	1.8±1.2	0.2±0.4	.
Unknown	.	87.3±4.5	.	10.8±4.0	1.9±1.9	.	.

on 10 or more of the last 30 days. This frequency of use suggests that cigar smoking among adolescent males is more than simple one-time experimentation. The major concern is that this frequent use of a product that can provide nicotine in substantial doses (Henningfield et. al, 1996) will lead to addiction among those adolescents currently using cigars with some regularity (Chapter 6).

A second concern is the use of cigars by adolescents who have never used other tobacco products. Table 17 shows an increased prevalence of cigar use among male adolescents who use cigarettes or smokeless tobacco, a finding present in most other recent surveys of adolescent use (CDC, 1997). Only 0.4 percent of those who have never used either cigarettes or smokeless tobacco are currently smoking cigars, and only 3.6 percent have ever smoked cigars.

MONITORING RECOMMENDATIONS

If the emerging public health problem of cigar smoking is to be tracked successfully, tools for monitoring it must be designed to measure the variable of interest in the most efficient manner possible. Questions on cigar use should be included in surveys designed to measure tobacco use, and the questions about cigar use should be standardized so that there is uniformity of data collection. This will require researchers in the field of tobacco control to establish standard definitions similar to those developed for cigarette smoking (CDC, 1994).

It is recommended that (1) no threshold level of cigar smoking be required before a respondent is asked about current cigar smoking status; (2) duration of cigar smoking be asked of all respondents who ever smoked cigars whether or not they are current cigar smokers; (3) age of initiation be asked of all respondents who have ever smoked a cigar; and (4) some measure of frequency and type of cigar smoked and of the quantity of cigars smoked be asked of all who have ever smoked cigars.

Table 17

Prevalence of cigar smoking among adolescent males in California by the status of their use of other tobacco products

	Cigar Smoking Status			
	Never Smoked Cigars (%)	Previously Smoked Cigars (%)	Current Cigar Smoker (%)	Unknown (%)
Total	80.2±1.9	13.9±1.6	5.7±1.1	0.3±0.3
Cigarette Smoking Status				
Never	95.3±1.0	3.9±0.9	0.6±0.3	0.2±0.2
Previous	53.7±6.7	36.2±6.1	9.8±3.6	0.3±0.6
Current	27.5±6.0	42.1±5.3	29.9±5.4	0.5±1.0
Chew or Snuff Use				
Never	85.6±1.9	10.9±1.5	3.2±0.9	0.3±0.3
Previous	30.9±5.8	41.4±7.2	27.2±6.2	0.5±1.0
Current	23.7±11.9	37.7±12.8	38.7±12.8	.
Never Used Either	95.8±0.9	3.6±0.8	0.4±0.3	0.2±0.3

CONCLUSIONS

1. U.S. consumption of cigars has increased dramatically since 1993, reversing a decline in cigar consumption that had persisted for most of this century.
2. In 1996, large inexpensive cigars (<$1 retail) and cigarillos accounted for the greatest share of cigar sales (60.3 percent) followed by small cigars (33.2 percent), and large premium cigars (6.5 percent). In recent years, cigar sales have increased in all three categories, but the fastest growing segment of the cigar market has been the premium cigar category where sales have increased by 154 percent since 1993.
3. Limited national data and data from California suggest that the prevalence of cigar use among adults has increased since 1993. Much of that increase in California has been in occasional cigar smoking. There has been little change in the prevalence of daily cigar use among California adults between 1990 and 1996.
4. Among California adults in 1996, the prevalence of occasional cigar smoking increased with level of education and income, a pattern opposite that seen with cigarette smoking. This increase in prevalence with increasing level of education and income is not seen for daily cigar smoking.
5. Males are more likely to smoke cigars than females.
6. The prevalence of current cigar smoking among adults has increased between 1990 and 1996 for both current and former cigarette smokers in California, but the largest proportionate increase was among those who report never having smoked cigarettes. This suggests that many adults who have never smoked cigarettes are initiating tobacco use with cigars at ages when, prior to 1993, there had been little new initiation of tobacco use.
7. Multiple state and national surveys demonstrate a substantial rate of cigar smoking, both use in the last 30 days and ever use, among adolescents of both genders.

REFERENCES

Blackard, C.Z. Booming: In anti-tobacco America, cigars' sales growth is staggering. *Tobacco Reporter* (May): 64, 1996.

Centers for Disease Control and Prevention. Cigarette smoking among adults—United States, 1992, and changes in the definition of current cigarette smoking. *MMWR. Morbidity and Mortality Weekly Report* 43: 342-346, 1994.

Centers for Disease Control and Prevention. Cigar smoking among teenagers—United States, Massachusetts and New York, 1996. *MMWR. Morbidity and Mortality Weekly Report* 46: 433-440, 1997.

Giovino, G.A., Schooley, M.W., Zhu, B., Chrismon, J.H., Tomar, S.L., Peddicord, J.P., Merritt, R.K., Husten, C.G., Eriksen, M.P. Surveillance for selected tobacco-use behaviors—United States, 1900-1994. *MMWR. Morbidity and Mortality Weekly Report* 43: 26, 1994.

Haenzel, W., Shimkin, M.B., Miller, H.P. *Tobacco Smoking Patterns in the United States*. Public Health Monograph No. 45, 1956.

Henningfield, J.E., Hariharan, X., Kozlowski, L.T. Nicotine content and health risks of cigars. *Journal of the American Medical Association* 276: 1857-1858, 1996.

Hyland, A., Cummings, K.M., Shopland, D.R., Lynn, W.R. Prevalence of cigar use in 1989 and 1993 in 22 North American communities. Accepted for Publication, *American Journal of Public Health*, 1998.

Maxwell, J.C., Jr. *The Maxwell Consumer Report: The Cigar Industry in 1996*. Richmond, VA: Wheat First Butcher Singer, March 21, 1997.

Milmore, B.K., Conover, A.G. Tobacco Consumption in the United States, 1880-1955. In: *Tobacco Smoking Patterns in the United States*. W. Haenszel, M.B. Shimkin, H.P. Miller (Editors). Public Health Monograph No. 45, pp. 107-111, 1956.

U.S. Code of Federal Regulations. Title 26 [Internal Revenue Service] Part 270: Manufacture of cigars and cigarettes. (As adopted at 26 F.R. 8173, effective October 1, 1961). B (270) 3-B (270) 5, October 31, 1970.

U.S. Department of Agriculture. *Tobacco Situation and Outlook Report*. TBS-237. Washington, DC: U.S. Department of Agriculture, Commodity Economics Division, Economic Research Service, 1996.

U.S. Department of Agriculture. *Tobacco Situation and Outlook Report*. TBS-239. Washington, DC: U.S. Department of Agriculture, Commodity Economics Division, Economic Research Service, 1997.

U.S. Department of Health, Education, and Welfare. *The Health Consequences of Smoking*. DHEW Publication No. 73-8704. Rockville, MD: U.S. Department of Health, Education and Welfare, Public Health Service, p. 175, 1973.

U.S. Department of Health and Human Services. *Reducing the Health Consequences of Smoking: 25 years of Progress: A Report of the Surgeon General*. DHHS Publication No. (CDC) 89-8411. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, p. 511, 1989.

U.S. Department of Health and Human Services. *Preventing Tobacco Use Among Young People: A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, pp. 107-114, 1994.

U.S. Public Health Service. *Smoking and Health: Report of the Advisory Committee to the Surgeon General of the Public Health Service*. PHS Publication No. 1103. Rockville, MD: US Department of Health Education and Welfare, Public Health Service, Centers for Disease Control, 1964.

U.S. Public Health Service. *Community-based Interventions for Smokers: The COMMIT Field Experience*. NIH Publication No. 95-4028. Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, 1995.

U.S. Department of the Treasury. *Internal Revenue Cumulative Bulletin*. Revenue Ruling 69-198, p.359, 1969-1.

Chemistry and Toxicology

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HISTORICAL NOTES

Early information on the smoking of cigars originates from artifacts of the Mayas of the Yucatan region of Mexico. Smoking of tobacco was part of the religious rituals and political gatherings of the natives of the Yucatan peninsula as shown in the artwork on a pottery vessel from the 10th century (Figure 1) where a Maya smokes a string-tied cigar (Kingsborough, 1825). Five hundred years later, in 1492, when Christopher Columbus landed in America, he was presented with dried leaves of tobacco by the House of Arawaks. Columbus and his crew were thus the first Europeans who became acquainted with tobacco smoking. Early in the 16th century, Cortez confirmed that tobacco smoking was practiced by the Aztecs in Mexico. In addition, tobacco was grown in Cuba, Haiti, several of the West Indian Islands, and on the East coast of North America from Florida to Virginia (Tso, 1990).

The Mayan verb *sikar*, meaning to "smoke," became the Spanish noun *cigarro*. The form of cigar Columbus had first encountered was a long, thick bundle of twisted tobacco leaves wrapped in dried leaves of palm or maize. In 1541, the Cuban cigar appeared in Spain. The first person known to have grown tobacco in Europe was Jean Nicot, the French ambassador to Portugal. He introduced tobacco and tobacco smoke at the royal court of Paris, where Catherine de Medici and her son, King Charles IX, used it to treat migraine headaches (Jeffers and Gordon, 1996). In 1570, the botanist Jean Liebault was the first to grow tobacco in France; he gave the plant the scientific name *Herba Nicotiana*, in honor of Jean Nicot. However, the name tobacco, which is derived from the American Indians' word *tobacco*, remained in common use.

In 1828, the chemists, Posselt and Reimann of the University of Heidelberg, isolated nicotine as the major pharmacoactive ingredient in tobacco. In 1895, Pinner established the chemical structure of nicotine as that of 3-(1-methyl-2-pyrrolidinyl)pyridine.

THE CIGAR

Types and Definitions

There are many types of cigars on the market. The U.S. Department of the Treasury (1996) defines a cigar as "any roll of tobacco wrapped in leaf tobacco or in any substance containing tobacco," while a cigarette is defined as "any roll of tobacco wrapped in paper or in any substance not containing tobacco." In North America, and in many parts of Europe, there are at least four types of cigars, namely, little cigars, small cigars (also called cigarillos), regular cigars, and premium cigars (Figure 2). For taxation purposes, the U.S. Department of the Treasury (1996) differentiates only between small cigars, weighing not more than three pounds per thousand (≤ 1.36 g/cigar), and large cigars, weighing more than three pounds per thousand.

Figure 1
A man smoking a Maya's string-tied cigar depiected on a pottery vessel, dated 10th century or earlier, found in Mexico.

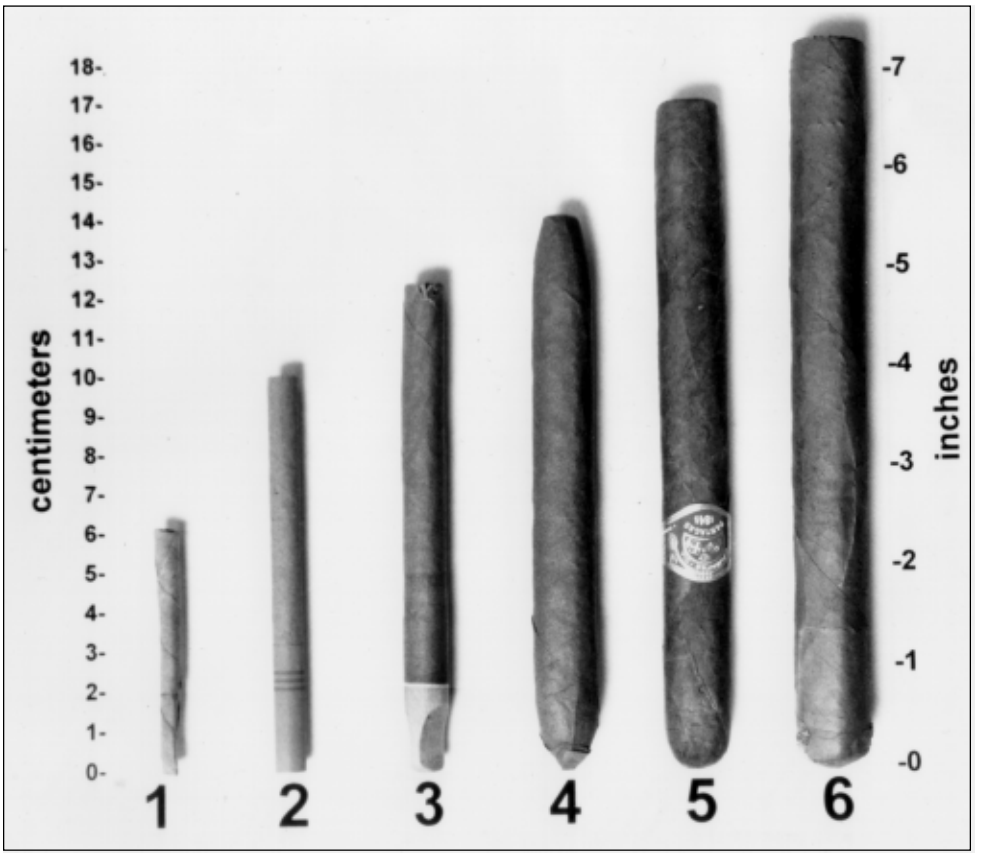
Courtesy of the General Research Division, The New York Public Library, Astor, Lenox, and Tilden Foundaitons.

In general, little cigars contain air-cured and fermented tobaccos. They are wrapped either in reconstituted tobacco or in cigarette paper that contains tobacco and/or tobacco extract. Some little cigars marketed in the U.S. have cellulose acetate filter tips and are shaped like cigarettes (length 70 - 100 mm, weight 0.9 - 1.3 g each; Hoffmann and Wynder, 1972).

The small cigars on the U.S. market have straight bodies, weigh between 1.3 and 2.5 g each, are 70 - 120 mm long, and are open on both ends. To some extent they are comparable to the *stumpen*, a form of cigar primarily smoked in Switzerland and some parts of Germany. In the Far East, small cigars, called cheroots, are made from heavy-bodied burley-type tobacco. The Indian cheroots are produced from light, air-cured tobacco (Voges, 1984). In Denmark and some other parts of Scandinavia, similar types of cigars are also called cheroots but like the small U.S. cigars, they are more akin to the Swiss *stumpen*.

Regular cigars appear on the market in various sizes and shapes. In the U.S., their dimensions are generally 110 - 150 mm in length, up to 17 mm in diameter, and they weigh between 5 and 17 g. Regular cigars are rolled to a tip, on at least one end. Some of them carry a 'banderole,' or decorative foil or paper strip, to indicate the brand's name (Wynder and Hoffmann, 1967; Brunnemann and Hoffmann, 1974a; Schmeltz et al., 1976a and 1976b; Voges, 1984). Many of the regular cigars on the U.S. market are machine-made; others are hand-rolled.

Figure 2
Types of cigars on the U.S. Market in 1996: (1) bidi (imported from India), (2) little cigar with filter tip, (3) small cigar with plastic mouth piece, (4) regular cigar, (5) and (6) premium cigar.



In recent years the popularity of premium cigars has increased in the United States. With diameters ranging from 12 to 23 mm and lengths between 12.7 and 21.4 cm, these cigars carry bands with an imprint of their brand name and/or manufacturer's name or logo. They are imported in large numbers from the Dominican Republic, Honduras, Mexico, Jamaica, and other countries (O'Hara, 1996). In 1996, the two most popular types of premium cigars on the U.S. market were the "Coronas" and the "Lonsdales." The recorded 96 brands of Coronas were between 12.7 and 15.2 cm (5 - 6 inches) long and ranged in price between $1.10 and $8.60 apiece. The 111 recorded brands of Lonsdales were between 15.2 and 17.8 cm (6 - 7 inches) long and sold for $1.50 to $11.00 per cigar (Cigar Aficionado, 1996).

Cigar Tobacco Tobacco belongs to the *Solanaceae* family. Primarily two species, *Nicotiana tabacum* and *Nicotiana rustica,* are used for the manufacture of chewing tobacco, oral and nasal snuff, cigarettes, cigars, and pipe tobacco.

Most of the tobacco products manufactured in North America, Western Europe, and Africa are made of *N. tabacum*. *N. rustica* is predominately used in South America, Russia, the former republics of the U.S.S.R., and Poland; and, to some extent, also in India and Turkey. Within the *N. tabacum* species, four types are commonly used: bright (Virginia), burley (Kentucky), Maryland, and Turkish (oriental) tobaccos. Bright tobaccos are flue-cured by drying with artificial heat; burley and Maryland tobaccos are air-cured; and Turkish tobaccos are sun-cured.

Cigars consist of a filler (the inner part of the cigar), a binder, and a wrapper. The filler, binder, and wrapper of small cigars, regular cigars, and premium cigars are all made with air-cured and fermented tobaccos (Cornell et al., 1979). Since the mid-fifties, the binders and/or wrappers of many of the regular brands (but not of premium brands) are made from reconstituted cigar tobacco (Moshy, 1967). In general, about 85 percent of the weight of a cigar is contributed by the filler, 10 percent by the binder, and 5 percent by the wrapper (Frankenburg and Gottscho, 1952).

The air-curing process of burley and Maryland tobaccos is characterized by slow, gradual drying of the leaf. Usually, the whole tobacco plant is cut off at ground level and hung in sheds or barns. However, in the case of tobaccos used for many regular cigars and premium cigars, the leaves are primed and hung individually on strings in sheds or barns for air-curing. It is important to ensure ample air flow through the barns during this process. Sometimes it is necessary to raise the temperature in the barns using charcoal fires, thereby creating a relative humidity of 65 - 75 percent. During air-curing, tobacco leaves normally reach the yellow stage 10 - 12 days after harvesting, and the brown stage after another 6 or 7 days. To complete the air-curing process requires 30 - 40 days. During this time, 80 - 85 percent of the water content of the leaves is lost. The total nitrogen content is reduced by about 30 percent and the protein-nitrogen content by about 50 percent; however, the percentage of nitrate nitrogen doubles, and the nicotine content remains practically unchanged. Following air-curing, the leaves are aged for up to two years, or even longer. During this time, the nicotine content is reduced by 30 - 50 percent, whereas protein, ammonia, and nitrate nitrogen contents generally remain unchanged (Wolf, 1967).

To become cigar tobacco, the leaves need to be fermented. After about 1 year of storage and aging, the leaves are placed in special rooms for fermentation at about 45°C and a relative humidity of 60 percent. After 3 - 5 weeks, the leaves are removed from the rooms, repacked, and returned. The repacking process is repeated several times to induce “sweating.” The baled leaves are occasionally slightly moistened. The temperature in the center of the bales may reach up to 58°C. During the fermentation, chemical and bacterial reactions lead to the formation of carbon dioxide, ammonia, water, and various volatile compounds. Carbohydrates in the leaves are reduced by 50 - 70 percent, organic acids by up to 30 percent, and a major portion of the polyphenols is degraded. The degradation of polyphenols during curing causes the browning of the leaves; whereas during fermentation, their

degradation ensures the oxygenation of several leaf components. The pH of the fermented tobacco is slightly alkaline (Wolf, 1967; Wiernik et al., 1995). During curing and fermentation of air-cured tobacco, nitrate is partially reduced to nitrite, primarily by microbal action. This contributes to the *N*-nitrosation of nicotine, converting it into the highly carcinogenic, tobacco-specific *N*-nitrosamines (TSNA), *N'*-nitrosonornicotine (NNN), and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK) (Burton et al., 1992; Hoffmann et al., 1994; Wiernik et al., 1995).

Manufacture of Cigars Cigars consist of filler, binder, and wrapper; all of which are air-cured and fermented. In recent decades, some brands of regular cigars (though not premium cigars) have used reconstituted cigar tobacco as binder, wrapper, or both (Moshy, 1967; Halter and Ito, 1980). Cigars are either hand-rolled (Jeffers and Gordon, 1996) or machine-made (Van der Boor, 1996). The flavor and aroma of cigars and their smoke are, in large measure, the results of precisely controlled fermentation of the tobacco. Most little cigars are machine-made, much like cigarettes, except that fermented cigar tobacco, not blends of cured tobaccos are used (20, 30, or 50 cuts per inch); the little cigars have wrappers which contain tobacco.

CHEMISTRY OF CIGAR TOBACCO Processed tobacco contains at least 3,050 different compounds. Table 1 lists the major groups of compounds that have been identified in tobacco (Roberts, 1988). Most of these are already present in the green tobacco leaf, others are formed during curing, aging, and fermentation. Although only a portion of the 3,050 compounds has been identified specifically in cigar tobacco, one may assume that the full spectrum of compounds is present in cigar tobacco, albeit in many cases, at different levels of concentration than are present in cigarette tobaccos. Exceptions to the qualitatively comparable constituents of cigar and cigarette tobaccos are agents such as pesticides, that are applied to tobacco during cultivation of the plant, and agents that are added during the processing of the tobaccos.

In the case of the insect control agents, the last reports on organic chlorinated hydrocarbons were published in the 1960s. DDT concentration was significantly higher in cigar tobacco (10.0 - 53.0 µg/g) than in cigarette tobacco (2.0 - 6.0 µg/g), whereas DDD and endrin concentrations in cigar tobaccos (10 - 15 µg/g and 0.0 - 0.5 ppm) and cigarette tobaccos (12 - 23 µg/g and < 0.5 - 2 ppm) were comparable (Lawson et al., 1964). However, in the seventies, chlorinated pesticides were banned for use on tobacco; thus, their concentrations in U.S. tobacco declined by > 98 percent by 1994 (Djordjevic et al., 1995b). An overview of the pesticides currently applied to U.S. tobacco plants and a discussion of their residues on tobacco was presented by Sheets (1991).

In general, flavor additives are not applied to cigar tobacco which is quite different from the treatment of tobacco formulated for cigarettes, especially in the case of filter cigarettes designed to yield low nicotine emission (Doull et al., 1994; Hoffmann and Hoffmann, 1997). It is also different from pipe tobacco formulation (LaVoie et al., 1985) and possibly from the formulation of tobacco for small cigars. Furthermore, it is unlikely that plasticizers are

Table 1
Compounds identified in tobacco and smoke

Functional Groups	No. in Tobacco	No. in Smoke	No. in Tobacco and Smoke
Caboxylic Acids	450	69	140
Amino Acids	95	18	16
Lactones	129	135	39
Esters	529	456	314
Amines & Imines	205	227	32
Anhydrides	10	10	4
Aldehydes	111	106	48
Carbohydrates	138	30	12
Nitriles	4	101	4
Ketones	348	461	122
Alcohols	334	157	69
Phenols	58	188	40
Amines	65	150	37
Sulfur Compounds	3	37	2
N-Heterocycles:			
Pyridines	63	324	46
Pyrroles & Indoles	9	88	3
Pyrazines	21	55	18
Non-aromatics	13	43	7
Polycyclic Aromatics	1	36	0
Others	4	50	2
Ethers	53	88	15
Hydrocarbons:			
Saturated Aliphatics	58	113	44
Unsaturated Aliphatics	338	178	10
Monocyclic Aliphatics	33	138	25
Polycyclic Aliphatics	55	317	35
Miscellaneous	112	110	19
Inorganics & Metals	105	111	69

Source: D.L. Roberts, 1988

used for manufacturing small, regular and premium cigars which do not contain reconstituted tobacco, whereas plasticizers (e.g., glyceryl triacetate, triethylene glycol diacetate) are applied to filter tips in the production of little cigars. When reconstituted tobacco is chosen as a binder and/or wrapper for regular cigars, such cigars will contain plasticizers and other tobacco treatment products in addition to humectants, adhesives, and/or inorganic additives (Moshy, 1967).

Distinct quantitative differences between cigar and cigarette tobaccos are primarily related to the long aging and fermentation process of cigar tobacco. Table 2 shows some of the distinct differences for a select number of compounds as they occur in cigar tobacco and in the four major types of cigarette tobaccos. Cigar tobacco contains only traces of polyphenols

Table 2
Comparison of some selected components in the tobacco of cigars and of four cigarette Tobacco Types (% of dry weight of tobacco)

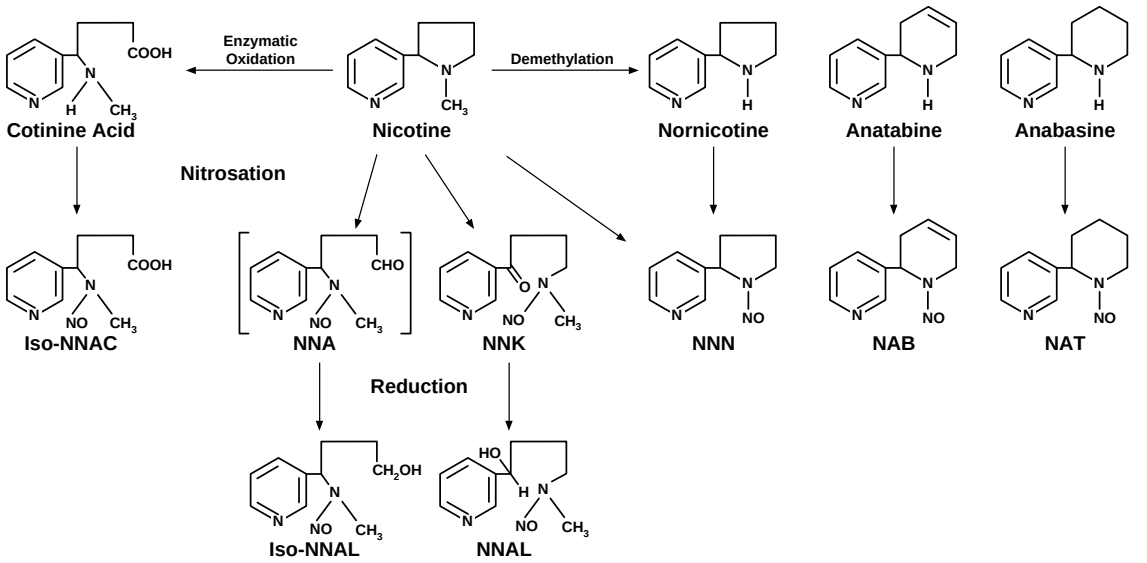
	Type of Tobacco				
Component	Cigar	Burley	Maryland	Bright	Oriental
Nitrate	1.4 - 2.1	1.4 - 1.7	0.9	< 0.15	< 0.1
pH	6.9 - 7.8	5.2 - 7.5	5.3 - 7.0	4.4 - 5.7	4.9 - 5.3
Reducing Sugars	0.9 - 2.7	1.5 - 3.0	1.2	7.0 - 25.0	5.5
Total Polyphenols	< 0.1	2.0	1.6	5.1	4.5
Nicotine	0.6 - 1.7	2.0 - 2.9	1.1 - 1.4	1.2 - 1.9	1.1
Paraffins	0.3 - 0.32	0.34 - 0.39	0.34 - 0.41	0.24 - 0.28	0.37
Neophytadiene	0.4 - 0.8	0.4	0.40	0.3	0.2
Phytosterols	0.14 - 0.16	0.3 - 0.39	0.38	0.3 - 0.45	0.26
Citric Acid	5.5 - 6.0	8.22	2.98	0.78	1.03
Oxalic Acid	3.3 - 3.6	3.04	2.79	0.81	3.16
Maleic Acid	1.5 - 1.8	6.75	2.43	2.83	3.87

References: Wolf, 1967; Hoffmann and Wynder, 1972; Schmeltz et al., 1976a and 1976b; Tso, 1990.

(< 0.1 percent; Table 2) compared to cigarette tobaccos (1.6 - 5.1 percent). The nitrate content of cigar tobacco is relatively high (1.4 - 2.1 percent versus. < 0.1 - 1.7 percent in U.S. cigarette tobacco blends) and the amounts of phytosterols are lower in cigar tobacco (0.14 - 0.16 percent versus. 0.26 - 0.45 percent). In respect to the nitrate content,
the pH of a suspension of tobacco in water, and the percentage of reducing sugars, cigar tobacco is comparable to the two types of air-cured cigarette tobaccos, namely, burley and Maryland (Wolf, 1967; Hoffmann and Wynder, 1972; Tso, 1990; Schmeltz et al., 1976a and 1976b).

During the processing of tobacco, especially during air-curing and aging, nitrate is partially reduced to nitrite (Burton et al., 1992; Hoffmann et al., 1994; Wiernik et al., 1995). Nitrite is a strong *N*-nitrosating agent of secondary and tertiary amines. Consequently, during these stages of tobacco processing, *N*-nitrosamines are formed (Hoffmann et al., 1994). In tobacco, we distinguish between volatile nitrosamines (VA), nonvolatile nitrosamines (NVA), nitrosamino acids (NA), and tobacco-specific *N*-nitrosamines (TSNA). The latter group is of significance for several reasons. TSNA are formed by *N*-nitrosation of nicotine and of the minor *Nicotiana* alkaloids, nornicotine, anatabine, and anabasine (Figure 3). Among the seven TSNA, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), *N*′-nitrosonornicotine (NNN), and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL) are strong carcinogens in mice, rats, hamsters, and mink. *N*′-Nitrosoanabasine (NAB) is weakly carcinogenic, while *N*′-nitrosoanatabine (NAT), 4-(methylnitrosamino)-4-(3-pyridyl)-1-butanol (iso-NNAL), and 4-(methylnitrosamino)-4-(3-pyridyl)butyric acid (iso-NNAC) are inactive in carcinogenesis assays (Hoffmann et al., 1994). Furthermore, in the

Figure 3
Formation of tobacco-specific N-nitrosamines. Iso-NNAC, 4-(methylnitrosamino)-4-(3-pyridyl)-butyric acid; NNA, 4-(methylnitrosamino)-4-(3-pyridyl) butyric aldehyde; NNK, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone; NNN, N′-nitrosonornicotine; NAT, N′-nitrosoamatabine; NAB, N′-nitrosoanabasine; iso-NNAL, 4-(methylnitrosamino)-4-(3-pyridyl)-1-butanol; NNA, 4-(methylnitrosamino)-4-(3-pyridyl)-1-(3-pyridyl)-1-(3-pyridyl)-1-butanol



Source: Hoffmann et al., 1994.

smoke of a nonfilter cigarette, about 45 percent of NNN originates by transfer from the tobacco, whereas the remainder is pyrosynthesized during smoking (Hoffmann et al., 1977). Between 23 percent and 35 percent of the NNK in smoke originates from the tobacco by transfer (Adams et al., 1983). NNN in cigar tobacco is present at levels of 3.0 - 10.7 μg/g, in the tobacco of little cigars at 11.1 - 13.0 μg/g, in tobacco of nonfilter cigarettes at 1.5 - 2.2 μg/g, and in tobacco of filter cigarettes at 5.0 - 6.6 μg/g. NNK levels in the four tobacco types are 1.2 - 1.3 μg/g, 3.5 - 4.5 μg/g, 0.5 - 0.8 μg/g, and 0.4 - 1.0 μg/g, respectively (Brunnemann et al., 1983). During fermentation of cigar tobacco, a small portion of nicotine is converted into 2,3-dihydronicotine, which easily forms 4-methylamino-1-(3-pyridyl)-1-butanone (Frankenburg et al., 1958). The latter, a secondary amine, is rapidly *N*-nitrosated to NNK. This compound and the higher nitrate levels in cigars may explain why more NNK is formed in little and regular cigars than during the processing of cigarette tobacco.

Table 3 presents data obtained in a comparative study of the concentrations of nicotine, nitrate, volatile nitrosamines (VNA), nonvolatile nitrosamines (NVNA), and TSNA in cigar and cigarette tobacco (Brunnemann et al., 1983). All seven of the VNA identified are carcinogenic in mice, rats, and/or hamsters. The nonvolatile nitrosoproline is neither carcinogenic in rats nor in hamsters, while *N*-nitrosodiethanolamine (NDELA) does cause cancer in

Table 3
Nicotine nitrate and N-nitrosamines in the tobacco of U.S. cigars little cigars, and nonfilter and filter cigarettes (ng/g)

Compound	Little Cigars	Nonfilter Cigars	Filter Cigarettes	Cigarettes
Nicotine, %	1.10	1.66 - 1.72	1.81 - 2.05	1.45 - 2.04
Nitrate, %	1.98	0.74 - 0.89	0.7 - 1.08	0.81 - 1.23
Volatile Nitrosamines				
Nitrosodimethylamine	n.dt.	43	250 - 280	n. dt. - 6.7
Nitrosodiethylamine	3.2	11	n. dt. - 47	n. dt. - 2.0
Nitrosodi-n-propylamine	11.8	nd	n. dt.	n. dt. - 2.3
Nitrosodi-n-butylamine	0.9	nd	n. dt. - 65	n. dt.
Nitrosopiperidine	22	nd	5.5 - 13.3	n. dt. - 7.0
Nitrosopyrrolidine	20	19	n. dt. - 4.9	n. dt. - 9.9
Nitrosomorpholine	44	nd	3.7 - 4.1	n. dt. - 10.0
Non-Volatile Nitrosamines				
Nitrosodiethanolamine	108	420	115	194
Nitrosoproline	1130	nd	880 - 1200	1450 - 2300
Tobacco-Specific Nitrosamines				
N^1-Nitrosonornicotine	2940	4500	1830 - 1960	1940 - 3200
Total TSNA	4780	9300	3610 - 4090	3730 - 8900

Abbreviations: nd, not determined; n. dt., not detected.
Source: Brunnemann and Hoffmann, 1981; Brunnemann et al., 1983.

mice, rats, and hamsters. The concentrations of the VNA and TSNA are somewhat higher in cigar tobaccos than in cigarette tobaccos. Since the nitrate content of the tobaccos of the little cigars tested was not exceptionally high (0.74 - 0.89 percent), other factors must be correlated with these high NDELA and TSNA values.

As already mentioned, tobacco also contains nitrosamino acids. The noncarcinogenic *N*-nitrosoproline and *N*-nitrosopipecolic acid belong to this group. In addition, cigarette tobaccos were found to contain the carcinogenic *N*-nitrososarcosine, 3-(methylnitrosamino)propionic acid, and 4-(methylnitrosamino)butyric acid (Djordjevic et al., 1989). Cigar tobacco has not yet been analyzed for these nitrosamino acids.

Cigar tobaccos, like other types of processed tobaccos, contain at least 28 metals and more than ten metalloids (Wynder and Hoffmann, 1967; Iskander et al., 1986). Their concentrations range from 5,300 to 97,000 µg calcium/g tobacco to trace amounts, as in the case of mercury (0.05 µg/g tobacco) (Wynder and Hoffmann, 1967; Andren and Harriss, 1971). Most of the metals and metalloids are essential elements for the tobacco plant. Others, such as lead, arsenic, and mercury, are trace contaminants. Small

portions, at most a few percent of the metals and metalloids, transfer from the tobacco into the smoke. Among those that transfer into the smoke and are thus inhaled, the International Agency for Research on Cancer (1987) considers arsenic, beryllium, chromium, nickel, and cadmium as human carcinogens (IARC, 1993a, 1993b).

Like all types of tobacco, cigar tobacco contains, or may contain, radioactive elements such as radium-226 and polonium-210 at concentrations ranging from 0.1 - 0.47 and 0.18 - 0.46 pCi/g cigar tobacco respectively) (Tso et al., 1966a). Phosphate fertilizers are the major source of these radioelements (Tso et al., 1966b); minor contributions come from airborne particles carrying lead-210 and polonium-210. These particles are trapped by the trichomes on the undersides of the tobacco leaves (Martell, 1974). A minor amount of polonium-210 transfers into the mainstream smoke and is thus inhaled by the smokers. The U.S. National Council on Radiation Protection and Measurement (1987) ascribes about 1 percent of the risk for lung cancer after 50 years of cigarette smoking to the role of polonium-210 inhaled as a tobacco smoke constituent.

CHEMISTRY AND ANALYSIS OF MAINSTREAM CIGAR SMOKE

It is one of the objectives of tobacco-related research to design smoking devices that can simulate human smoking patterns under reproducible conditions. Smoking instruments that are widely accepted today are piston-type machines which generate puff profiles that simulate the puff profiles of smokers (Wynder and Hoffmann, 1967).

Smoking Conditions

For the smoking of cigarettes by machines, the U.S. Federal Trade Commission (FTC) (Pillsbury et al., 1969) adopted and modified a method that was initially devised by Bradford et al. in 1936. This method employs, as standard smoking conditions, one puff per minute, of two-seconds duration with a volume of 35 ml; the butt length is 23 mm for nonfilter cigarettes and filter length plus overwrap, plus 3 mm, for filter cigarettes (Table 4). The U.K., Germany, and the Cooperative Center for Scientific Research Relative to Tobacco (Centre De Cooperation Pour Les Recherches Scientifiques Relatives Au Tabac, CORESTA) in Paris, France, developed similar standard smoking parameters (Brunnemann et al., 1976a). The FTC smoking schedule has also been employed for the determination of "tar," nicotine, carbon monoxide, and other smoke constituents in the mainstream smoke of little cigars (Hoffmann and Wynder, 1972; Schmeltz et al., 1976a).

In the course of smoke-uptake analyses, it soon became clear that the employed machine-smoking conditions do not simulate the smoking habits of consumers of filter cigarettes; most certainly they are not even close to the average smoking parameters observed for smokers of filter cigarettes delivering low levels ≤(1.2 mg/cigarette, according to the FTC method) of nicotine (Russell, 1980a; Herning et al., 1981; Fagerström, 1982; Haley et al., 1985). With a recently developed "tobacco smoke inhalation testing system," it has been shown that smokers of cigarettes with low nicotine yields ≤(1.2 mg/cigarette according to FTC method) titrate nicotine uptake by taking, on average, 12 ± 2.7 puffs per cigarette (FTC 10) with average puff

[1]The scientific definition of "tar" is the total particulate matter collected by a Cambridge filter after subtacting moisture and nicotine. (SG Report 1972, Chapter 9)

Table 4
Standard conditions for machine smoking of cigars, cigarettes, and pipe

Parameters	Cigars (CORESTA)[2]	Cigarettes (FTC)[1,4]	Pipes (CORESTA)[3]
Weight	2.5 - 8.0 g	0.9 - 1.1 g	1.2 g (filling)
Puff:			
Frequency	1/40 seconds	1/60 seconds	1/20 seconds
Duration (sec.)	1.5	2	2
Volume (ml)	40	35	50
Butt length (mm)	33	23 nonfilter	1.0 g burned

[1]Pillsbury et al., 1969; [2]International Committee for Cigar Smoking, 1974; [3]Miller, 1963; [4]Little cigars are smoked as cigarettes.

volumes of 52 ± 5.7 ml (FTC 35 ml), puff durations of 1.7 ± 0.24 seconds (FTC 2.0 seconds), every 28.5 ± 10.3 seconds (FTC 58 seconds). When operated with the same parameters that were determined for individual smokers, a smoking machine produced smoke yields per cigarette of 28 - 40 mg "tar" (FTC 11 - 14 mg) and 2.1 - 2.5 mg nicotine (FTC 0.9 - 1.0 mg). Smoke emissions of the carcinogenic B*a*P were 23.2 - 25.5 ng (FTC 11.9 - 21.9 ng) and those of NNK were 30.1 - 33.9 ng (FTC 14.4 - 14.9 ng) per cigarette (Djordjevic et al., 1995a).

Today, more than 97 percent of all cigarettes in the U.S. have filter tips (Creek et al., 1994) and about 75 percent of these give FTC-measured nicotine yields of ≤ 1.2 mg/cigarette. The FTC data for "tar," nicotine, and carbon monoxide are, therefore, of limited usefulness and can, at most, compare relative smoke yields of commercial cigarettes generated under the FTC standardized smoking conditions.

Rickert et al. (1985) examined the delivery of "tar," nicotine and CO per liter of smoke for different tobacco products. They found that the mean yields per liter of smoke were highest for small cigars followed by hand-rolled and manufactured cigarettes and were lowest for large cigars. Total delivery was greatest for large cigars because of their larger amount of tobacco.

So far, only a study by Miller (1963) has been concerned with a standardized method for pipe smoking. The pipe is filled with 1.2 g tobacco and is smoked by taking five puffs per minute, of two-seconds duration and a 50-ml volume per puff. Miller also determined nicotine in the tobacco and the smoke yields of the tobaccos from a filter cigarette (1.58 percent nicotine) and two pipe tobaccos (1.52 percent and 1.30 percent nicotine), all smoked in a pipe bowl. Then, smoking 1.0 g of the tobacco from a filter cigarette under the pipe smoking conditions, he found 59.5 mg "tar," 7.15 mg nicotine, and 1.36 vol. % CO, whereas the pipe tobaccos gave 53.3 and 56.4 mg "tar", 5.18 and 6.12 mg nicotine, and 1.04 and 1.10 vol% CO. When the filter cigarette tobacco was smoked in a cigarette with such standard cigarette-smoking conditions, the yields for the 1 g of tobacco smoked were: 24.1 mg "tar,"

*Mainstream smoke (MS) is the smoke a smoker draws into his mouth from the butt end or mouth piece of a cigar, cigarette, or pipe. Sidestream smoke (SS) is the smoke emitted form the burning cone of a cigar or cigarette, or pipe during the interval between puffs. (SG Report 1979 Chapter 14)

1.63 mg nicotine, and 4.89 vol% CO. Clearly, pipe smoking produces much higher yields of "tar" and nicotine per gram of tobacco than cigarette smoking.

It has been reported that with increasing number of puffs per given cigar, and also with increasing puff volume per given unit of time (puff velocity), the amount of tobacco burned rises linearly (Rice and Scherbak, 1976). CORESTA developed a standard smoking method for cigars with the following parameters: one puff of 20 ml volume is taken during 1.5 seconds every 40 seconds. The cigars are smoked to a butt length of 33 mm. In 1974, the International Committee for Cigar Smoke Study of CORESTA chose these smoking parameters as an average of the observations made on cigar smokers in France, Germany, the U.S., and the U.K. The smoke yields for cigars reported in the literature since 1974 are based on the CORESTA method (Table 4). However, for smoke analyses of little cigars, the cigarette-smoking parameters of the FTC are applied. To date, the testing of the actual smoking parameters of cigar smokers by a computer-assisted instrument has not been reported. Table 4a presents the dimensions and yield characteristics of cigarettes, little cigars, large cigars, and premium cigars smoked under these standardized machine smoking conditions.

Physicochemical Nature of Cigar Smoke

Tobacco smoking, like the burning of all organic matter, is a process of incomplete combustion governed by several in air factors relating to the combustibility of certain leaf components (such as laminae, ribs, and stems), insufficient supply of oxygen, and the existence of a temperature gradient in the burning cone.

At least three types of reactions occur simultaneously during smoking: pyrolysis, pyrosynthesis, and distillation. The process of tobacco burning leads to thermal degradation, in which organic matter is broken down into smaller molecules (pyrolysis). The newly formed fragments, or radicals, are often unstable and may recombine with identical and/or other radicals to form components that were not originally present in tobacco. This process is called pyrosynthesis. Distillation of certain compounds from the tobacco into the smoke is the third process occurring during smoking. Compounds such as nicotine and some low-molecular-weight terpenes participate in this third process. They decompose only partially (Osdene, 1976). Some of the metals transfer into the smoke stream while entrained in microfragments of ash (Wynder and Hoffmann, 1967). It has been suggested that the presence of high-molecular-weight pigments and other high-molecular-weight components in tobacco smoke is due to the sharp thermal gradient behind the burning cone which leads to cellular rupture, thereby expelling these compounds into the smoke stream where they form the nuclei of the smoke particles (Stedman et al., 1966).

The smoke from a burning tobacco product is divided into the mainstream smoke and the sidestream smoke. The heat produced during the burning of one gram of tobacco is estimated to be 4.5 - 5.0 kcal. The temperature in the burning cone of a cigar reaches 930°C, in that of a cigarette up to 910°C; it

Table 4a
Smoke yields of leading U.S. cigarettes[a] without and with filter tips, little cigars with filter tips, cigars[b], and premium cigars[b] 1997

Parameters	Pall Mall Non-filter Cigarettes	Marlboro Filter Cigarettes	Swisher Sweets Little Cigars	King Edward Cigars	Macanudo Premium Cigars
Length (mm)	85	85	100	138	176
Weight (g)	1.1	1.0	1.24	8.06	8.01
Puff (No)	11	10	18.5	89.7	119.4
Total Smoke (L)	0.385	0.35	0.4	1.8	2.4
"Tar" (mg)	26	16	24	37	44
CO (mg)	18	14	38	96	97
Nicotine (mg)	1.7	1.1	3.8	9.8	13.3
BaP (ng)	20	16	26.2	96.0	97.4
NNN (ng)	280	200	595	1225	1225
NNK (ng)	160	130	310	1200	1145

[a]The cigarettes were smoked under FTC conditions: 1 puff/min, 35 ml, 2-second puff duration butt length NF, 23 mm; F., 29 mm. (FTC) Pillsbury et al., 1969
[b]Little cigars, cigars; and premium cigars were smoked under the conditions of the International Committee for Cigar Smoke Study (ICCSS): 1 puff/40 seconds, 20 ml, 1.5-second puff duration, butt length 33 mm. Values are averages of 3 runs. (ICCSS) International Committee for Cigar Smoke Study, 1974.
Abbreviations: BaP, Benzo (*a*) pyrene; NNN, N^1-nitrosonornicotine; NNK, 4-(methylnitrosamino) -1-(3-pyridyl)-1-butanone.

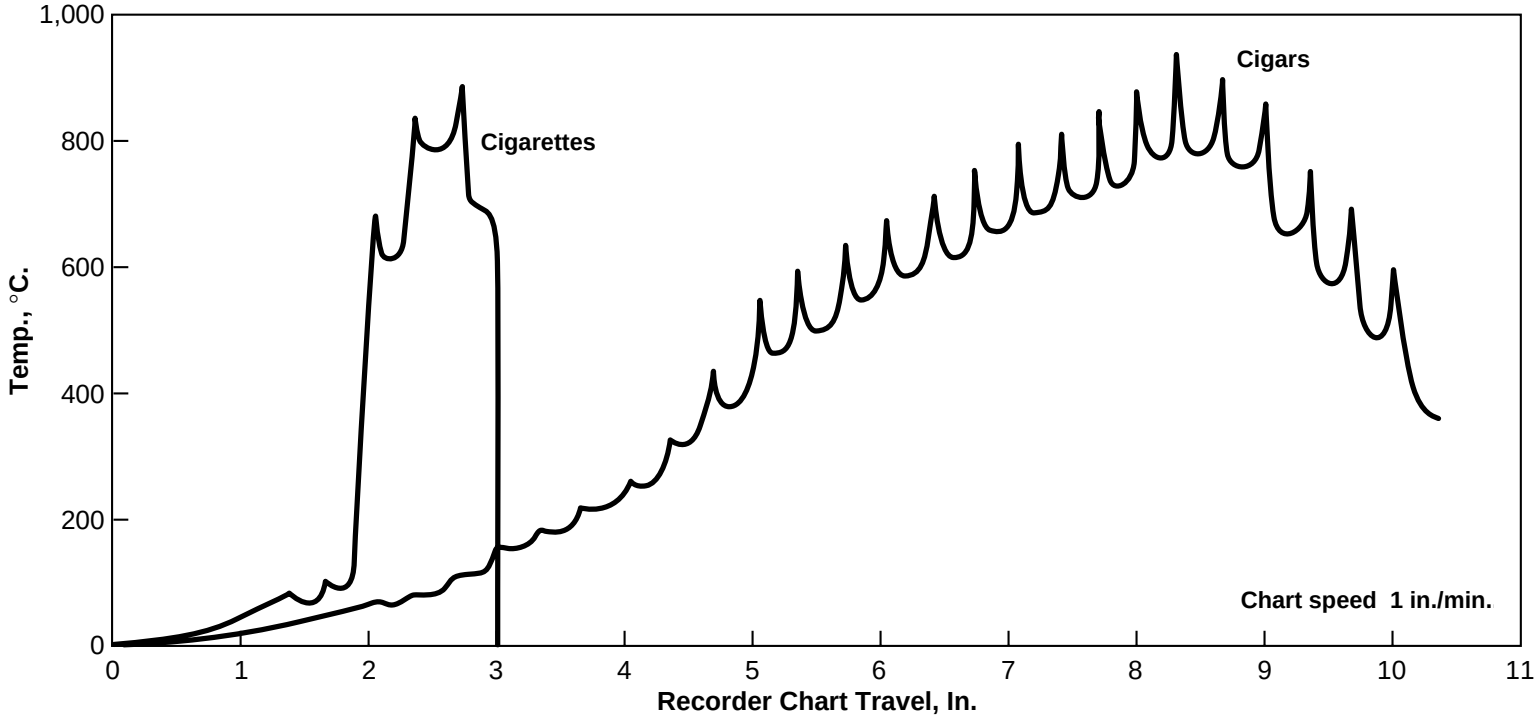
Source: Unpublished data Hoffmann, D. American Health Foundation

decreases to 820°C between puffs (Figure 4) (Touey and Mumpower, 1957a; 1957b). Taking four puffs per minute with volumes of 10, 15, or 20 ml, Adams (1968) reported that peak temperatures of 1,117°C and 1,290°C occur during smoking of small cigars and 1,139°C and 1,160°C have been measured for large cigars. Using cigar tobacco in a cigarette, peak temperatures of 944°C and 970°C were recorded (Table 5).

The temperature of the mainstream smoke emitting from the mouthpiece with early puffs from cigars and cigarettes lies only a few degrees above room temperature (25° - 30°C). The temperature of subsequent puffs rises gradually above 50°C and can even reach 75°C with the last puff of a cigar that is smoked down to 10 mm (Borowski and Seehofer, 1962).

In general, the pH of the whole smoke of cigars increases from the early puffs when it is ~ 6.5, to ~ 8.0 for the last (35th) puff. The pH of the puffs of small cigars increases from 6.5 to 7.4 (14th puff), that of little cigars from pH 6.5 to 7.5 (9th puff), and that of cigarettes decreases from pH 6.0 to 5.7 (11th puff) (Table 5). This phenomenon is of major significance, since above pH 6.0 the smoke contains unprotonated (free) nicotine. Thus, the last puff of a cigar with a pH of 8.0 contains about 50 percent unprotonated

Figure 4
Temperature profiles in the burning cones of cigarettes and cigars



Source: Touey and Mumpower, 1951a.

Table 5
Comparison of some physicochemical parameters of the mainstream smoke of cigars and cigarettes

Parameters		Cigars	Little Cigars	Cigarettes
pH[1]	3rd Puff	6.5	6.5	6.0
	Last Puff	8.0	7.4	5.7
Temperature[2]				
	During puffing, range, °C	1139° - 1160°	n. a.	944 - 970
	Between puffs, °C	820	n. a.	800
Reducing Activity[3] (units of DCIP)				
	Particulate Phase	45.0	n. a.	108.3
	Gas Phase	10.1	n. a.	4.9

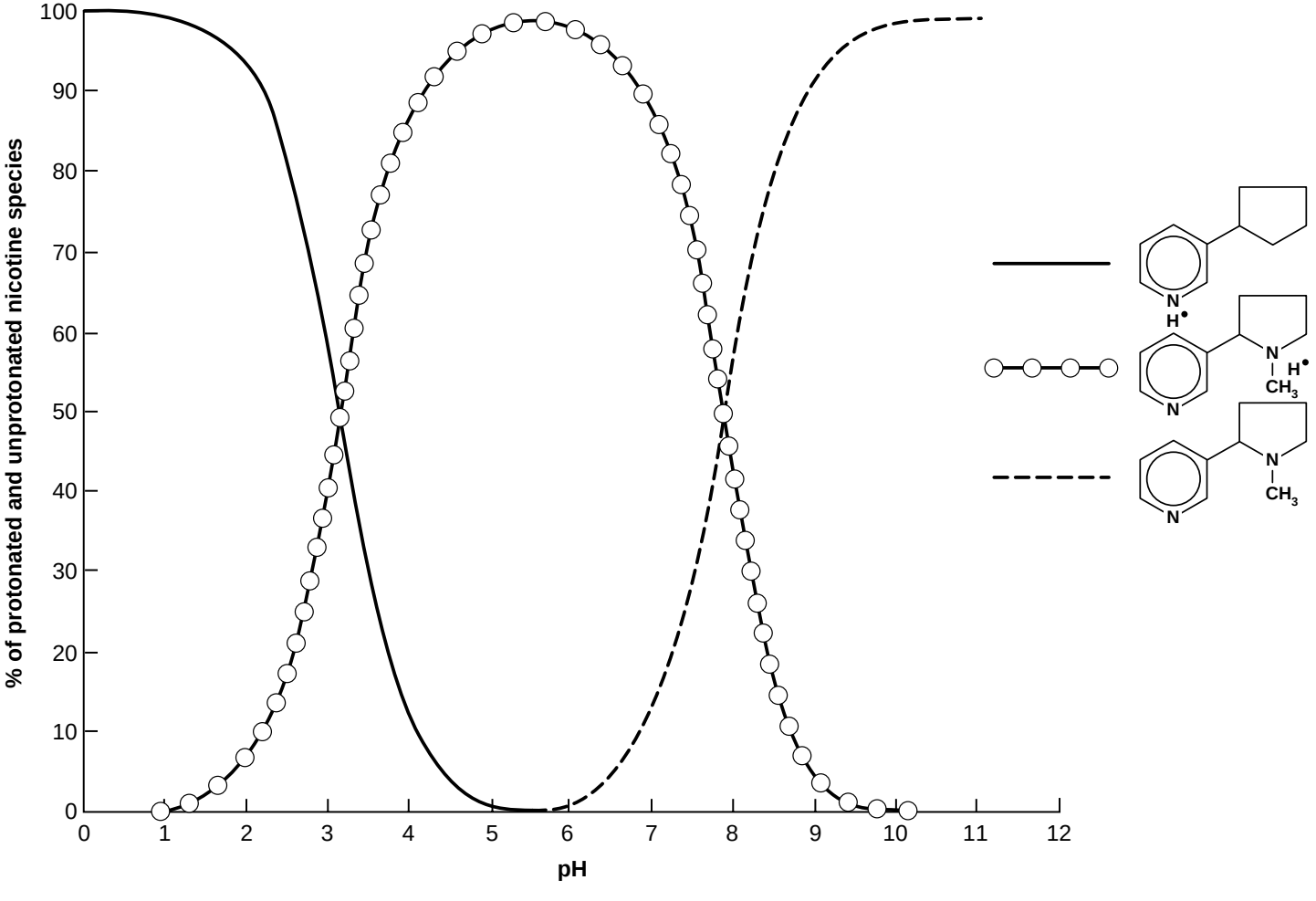
n. a., not available.
[1]Brunnemann and Hoffmann, 1974a; [2]Adams, 1968; [3]Bilimoria and Nisbet, 1972.

nicotine in the vapor phase; that of a small cigar, at pH 7.4, about 30 percent unprotonated nicotine; and the last puff of a little cigar, at pH 7.5, has about 32 percent unprotonated nicotine. On the other hand, the smoke of the U.S. blended cigarette does not contain unprotonated nicotine when tested under current FTC smoking conditions (Figures 5 and 6) (Brunnemann and Hoffmann, 1974a). Unprotonated nicotine is present in the vapor phase of the inhaled smoke; protonated nicotine resides in the particulate phase. Unprotonated nicotine is absorbed through the mucous membrane of the oral cavity and delivers a dose of the pharmacoactive agent, that "satisfies" the primary cigar smoker without his inhaling the smoke (Armitage and Turner, 1970).

The smoke of fresh (unaged) mainstream smoke of a U.S. blended, nonfilter cigarette contains about 5×10^9 spherical droplets with a particle-size distribution of 0.1 - 1.0 micron (maximum around 0.2 micron) (Keith and Derrick, 1961). Slightly less than half of the particles are neutral, whereas most of the particles carry only one electrical charge and these are evenly divided between those with negative and those with positive charges (Norman and Keith, 1975). There is a lack of published data on particle concentration and particle size distribution in cigar smoke and also on the electrical charges of cigar smoke particles.

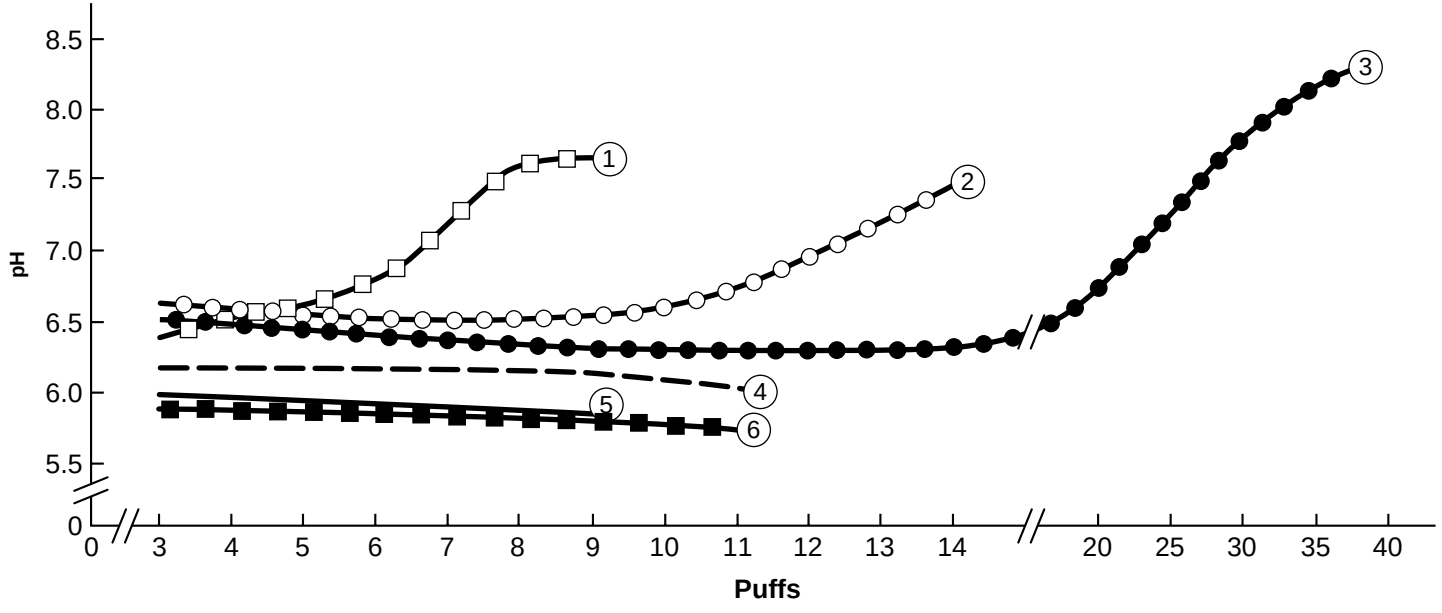
All tobacco smoke products exhibit significant reducing activity. Studies using the reduction of 2,4-dichloroindophenol as a marker of the reducing potential of tobacco smoke have shown that cigarette smoke has a significantly higher reducing potential than cigar or pipe smoke. In cigarette smoke, about 96 percent of the reducing activity of the total smoke

Figure 5
Degree of protonation of nicotine in relation to pH.



Source: Brunnemann and Hoffmann, 1974.

Figure 6
pH of total mainstream smoke of various tobacco-products



(1) little cigar I
(2) little cigar II
(3) cigar
(4) Kentucky reference cigarette
(5) blended filter-tipped cigarette (85 mm)
(6) blended cigarette without filter (85 mm)

Source: Brunnemann and Hoffmann, 1974a and 1974b.

resides in the particulate phase, while in cigar smoke, 82 percent is found in the particulate phase (Table 5) (Bilimoria and Nisbet, 1972).

Chemical Composition of Cigar Smoke

Gas Phase*

Tobacco smoke contains more than 4,000 individual components; about 500 of these occur in the gas phase. The major gas-phase constituents in cigar smoke are 51.8 - 54.6 volume% nitrogen (for cigarettes, 55 - 72 vol%), 4.1 - 4.2 vol% oxygen (9.2 - 14.3 vol%), 15.5 - 16.7 vol% carbon dioxide (6.9 - 13.4 vol%), and 9.7 - 12.7 vol% carbon monoxide (1.9 - 6.3 vol%) (Boyd et al., 1972). These comparisons strongly indicate that the combustion during puff drawing from cigars is even less complete (oxygen 4.1 - 4.2 vol%; CO, 1.9 - 6.3 vol%) than that during cigarette smoking. A primary reason for the low concentration of O_2 and the high concentration of CO in cigar smoke is the lack of porosity of the cigar binder and wrapper compared to that of cigarette paper. The porosity of cigarette paper accelerates the delivery of oxygen into the tobacco column and the diffusion of certain gaseous components (e.g., CO, CO_2, NO) through the paper into the environment.

Table 6 presents select volatile components in the smoke of cigars, little cigars, and cigarettes. Remarkably, the concentrations of nitrogen oxides (NO_x) and ammonia are significantly higher in cigar smoke than in cigarette smoke. Formation of nitrogen oxides and ammonia is primarily linked to the nitrate content of the cigar tobacco, the incomplete combustion, and the lack of porosity of cigar binders and wrappers. The amounts of ammonia reported in the smoke of cigars and cigarettes may not only originate from the ammonia produced in the reducing atmosphere of the burning cone but can also, to a minor extent, come from amides which partially decompose in the sulfuric acid that is used for trapping the ammonia from the smoke (Brunnemann and Hoffmann, 1975). In the smoke of cigars, up to 0.8 percent is present as free ammonia at pH levels between 6.8 and 7.2; whereas cigarette smoke contains only up to 0.01 percent of free ammonia at a pH between 5.3 and 5.6 (Figure 7) (Sloan and Morie, 1976). The higher quantities of free ammonia contribute to the pungency of cigar smoke.

Cigar smoke also contains a large number of volatile amines (Pailer et al., 1969). However, there is a lack of quantitative data. The levels of volatile *N*-nitrosamines are also higher in cigar smoke than in cigarette smoke, again primarily because of the higher nitrate content of the cigar tobacco compared to that of cigarette tobacco. Furthermore, cigar smoke contains a large spectrum of volatile agents, such as volatile olefins, dienes (1,3-butadiene, isoprene, etc.), volatile nitriles, and halogenated hydrocarbons.

* The classification of the tobacco smoke aerosol into gas phase and particulate phase is based on the separation of the smoke that occurs when it is drawn through a Cambridge glass fiber filter CM-113. Fifty percent of the components are from the gas phase and pass through the filter. That portion of the smoke which is trapped on the filter consists of particulate phase components. These are arbitrary definitions, they do not fully reflect the conditions prevailing in undiluted, unaged smoke; however, they serve as guidelines.

Table 6
Components in mainstream smoke of cigars and cigarettes: gas phase (values are given for 1.0 g tobacco smoked)

Component	Cigars	Non-filter Cigarettes	Little Cigars	Filter Cigarettes	Ref.
Carbon monoxide, mg	39.1 - 64.5	16.3	22.5 - 44.9	19.1	1-3
Carbon dioxide, mg	121 - 144	61.9	47.9 - 97.9	67.8	1-3
Nitrogen oxides (NO_x), µg	159, 300	160	45, 150	90 - 145	1
Ammonia, µg	30.5	95.3	200, 322	98	4
Hydrogen cyanide, µg	1,035	595	510, 780	448	2
Vinyl chloride, ng	n.a.	17.3, 23.5	19.7, 37.4	7.7 - 19.3	5
Isoprene, ng	2,750 - 3,950	420, 460	210 , 510	132 - 990	1.6
Benzene, µg	92 - 246	45, 60	n.a.	8.4 - 97	1,6-8
Toluene, µg	n.a.	56, 73	n.a.	7.5 - 112	1,7
Pyridine, µg	49 - 153	40.5	61.3	27.6, 37.0	9
2-Picoline, µg	7.9 - 44.6	15.4	17.0	14.8, 15.6	9
3-+4-Picoline, µg	17.9 - 100	36.1	32.9	12.6, 20.2	9
3-Vinylpyridine, µg	7.0 - 42.5	29.1	21.2	102, 192	9
Acetaldehyde, µg	1,020	960	850, 1,390	94.6	2
Acrolein, µg	57	130	55, 60	87.6	2
N-Nitrosodimethylamine, ng	n.a.	16.3 - 96.1	555	7.4	10
N-Nitrosopyrrolidine, µg	n.a.	13.8 - 50.7	24.5	6.6	10

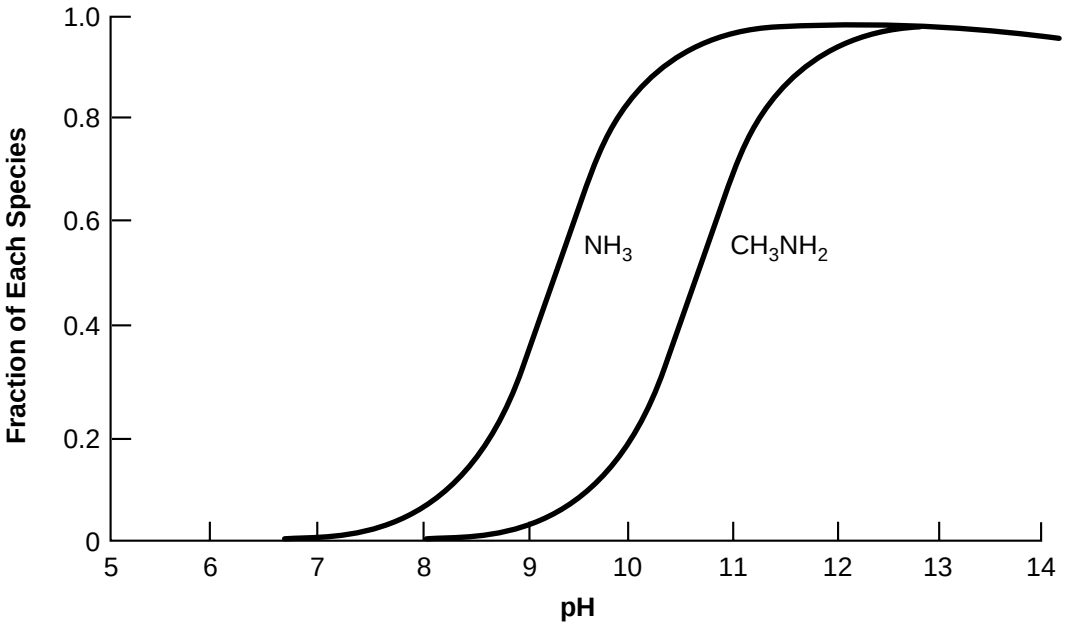
n.a., data not available.
References: (1) Wynder and Hoffmann, 1967; (2) Hoffmann et al., 1973; (3) Brunnemann and Hoffmann, 1974b; (4) Brunnemann and Hoffmann, 1975; (5) Hoffmann et al., 1976; (6) Brunnemann et al., 1990; (7) Osman and Barson, 1964; (8) Appel et al., 1990; (9) Brunnemann et al., 1978; (10) Brunnemann et al., 1977b.

However, the available literature offers few quantitative data for cigar smoke, except for a report on the presence of vinyl chloride (Hoffmann et al., 1976).

Particulate Phase The particulate phase of tobacco smoke contains at least 3,500 individual components (Roberts, 1988). Most of our knowledge about the physicochemical nature and composition of tobacco smoke derives from studies on cigarette smoke.

Only limited research has been done on the chemical composition of cigar smoke. One would expect cigar smoke chemistry to be qualitatively similar to that of cigarette smoke, except for differences caused by the use of additives, by the pH effects, and by the lower concentrations of oxygen available to support combustion. Cigar smoke may contain components that derive from additives incorporated into reconstituted tobacco sheets, and these may be different from additives used in reconstituted tobacco formulations for cigarettes (Moshy, 1967; Halter and Ito, 1980). The tobacco of low-yielding cigarettes is often treated with flavor additives (Doull et al., 1994). Such flavor additives are generally not used for cigars except for some little cigars with filter tips.

Figure 7
Fraction of free ammonia and methylamine vs. pH.



Source: Sloan and Morie, 1976.

Quantitative similarities are seen when one compares the smoke yields of cigars and cigarettes per gram tobacco smoked (Table 7). This is the case for the smoke yields of volatile phenols and polynuclear aromatic hydrocarbons (PAH), compounds primarily pyrosynthesized during smoking. However, "tar" yields per gram of cigar tobacco burned are somewhat higher because the nonporous cigar binder and wrapper make the combustion less complete than that of cigarette tobacco combustion of which is facilitated by highly porous cigarette paper (Rickert et al., 1985). Also, cigars have larger diameters than cigarettes which further hinders more complete combustion. The nicotine yields in the mainstream smoke of cigars are also generally higher than in the mainstream smoke of cigarettes because the latter contain a tobacco blend, while most cigars are made solely from burley tobacco that delivers a weakly alkaline smoke with a high proportion of unprotonated nicotine.

The significantly lower yields of long-chain paraffin hydrocarbons in cigar smoke compared to cigarette smoke can, in part, be explained by the loss of such hydrocarbons during fermentation of the cigar tobacco (Wolf, 1967). The low yields of the long-chain hydrocarbons in cigar smoke are likely also attributable to the very intense "cracking" of these compounds during smoking. The high yield of *N*-nitrosodiethanolamine seen in the smoke of little cigars was probably related to the treatment of the tobacco of these little cigars with the sucker growth inhibitor MH-30, maleic hydrazide

Table 7

Components in the mainstream smoke of cigars and cigarettes: particulate phase (values are given for /g tobacco smoked)

Smoke Component	Cigars	Non-filter Cigarettes	Little Cigars with Filter	Filter Cigarettes	Ref.
"Tar" (FTC), mg	38.0 - 40.6	16.0 - 36.1	17.4 - 31.8	8.0 - 20.3	1,2,3
Nicotine, mg	2.9 - 3.1	1.7 - 2.65	0.6 - 1.8	0.6 - 1.4	1,2,3
Tridecane, µg	1.2	14.3			4,5
Pentadecane, µg	0.8	14.3			4,5
Eicosane, µg	0.8	27.4			4,5
Docosane, µg	0.6	26.2			4,5
Cholesterol, µg		27.5	49.0[a]		6
Camposterol, µg		53.4	57.4[a]		6
Stigmasterol, µg		97.5	152[a]		6
β-Sitosterol, µg		74.1	82.5[a]		6
Phenol, µg	24 - 107	96 - 117	37.0	19.0 - 33.2	2,7
o-Cresol, µg	19 - 21	22 - 26	4.3	4.2 - 6.8	2,7
m- and *p*-Cresol, µg	19 - 62	50 - 58	18.0	17 - 23.3	2,7
Catechol, µg		318	129 - 169	178	8
Formic acid, µg	109 - 121	400			9
Acetic acid, µg	286 - 320	900			9
Quinoline, µg	2.0 - 4.1	1.67	0.66	0.62	10
Naphthalene, ng		3,900 - 5,000	1,780		11
1-Methylnaphthalene, ng		1,390 - 1,760	1,110		11
2-Methylnaphthalene, ng		1,720 - 2,130	1,470		11
Acenaphthene, ng	16	50			12,13
Anthracene, ng	119	109			12,13
Pyrene, ng	176	125			12
Fluoranthene, ng	201	125			12
Benz(*a*)anthracene, ng	39 -92.5	92	44.3	40.6	12
Benzo(*a*)pyrene, ng	30 - 51	47 - 58.8	25.7	26.2	12
N-Nitrosodiethanolamine, ng	5.7	4.6	700	38	13
N^1-Nitrosonornicotine, ng	820	300	7,100	390	14
NNK, ng	4.90	140	5,400	190	14
N^1-Nitrosoamabasine	4.90	410	2,200	460	14
Copper, ng	40 - 160	< 10 - 100			15
Lead, ng	160 - 280	100 - 510			15
Cadmium, ng	2.0 - 38	16 - 82			15
Zinc, ng	360 - 2,500	120 - 920			15
Nickel, ng	2,500 - 7,000	300 - 600			16,17

[a] Small cigar without filter.

[b] N^1-Nitrosoanatabine contains 10 - 15% N^1-nitrosoanabasine.

References: (1) Hoffmann et al., 1963; (2) Wynder and Hoffmann, 1967; (3) Hoffmann and Wynder, 1972; (4) Spears et al., 1963; (5) Osman et al., 1965; (6) Schmeltz et al., 1975a; (7) Osman et al., 1963; (8) Brunnemann et al., 1976; (9) Schmeltz and Schlotzhauer, 1961; (10) Dong et al., 1978; (11) Schmeltz et al., 1976a; (12) Campbell and Lindsey, 1957; (13) Brunnemann and Hoffmann, 1981; (14) Hoffmann et al., 1979a; (15) Franzke et al., 1977; (16) Sunderman and Sunderman, 1961; (17) Stahly and Lard, 1977.

diethanolamine. Since 1980-1981, due to an official ban, the use of MH-30 on tobacco has been greatly reduced (Brunnemann and Hoffmann., 1991a).

As to be expected, the smoke of cigars contains significantly higher amounts of the carcinogenic, tobacco-specific *N*-nitrosamines (TSNA) than cigarette smoke (Table 7). A major reason for the elevated levels of TSNA in cigar smoke is the relatively high concentration of nitrate in cigar tobacco. During curing and fermentation, nitrate is partially reduced to nitrite, an important precursor for the *N*-nitrosation of amines, including alkaloids like nicotine; nitrate constitutes up to 2.0 percent of the cigar tobacco (Table 3). The nitrosamines formed from nicotine are NNK and NNN (Figure 3). The latter is also formed in high yields from nornicotine (Hoffmann et al., 1994). In laboratory animals, NNK and NNN are metabolically activated by α-hydroxylation which results in the formation of unstable α-hydroxy nitrosamines. These decompose to yield alkylating agents that react with the nuclear DNA *in vitro* and also *in vivo* (Hecht and Hoffmann, 1989; Hecht, 1996). Lesions formed by this reaction give rise to tumors in the target organs. NNN elicits carcinoma of the esophagus in rats. In explants of human esophageal tissue, NNN is also (-hydroxylated, although to varying extents. The degree of α-hydroxylation of NNN varies between individuals and is likely related to phenotypic differences (Castonguay et al., 1983). In this regard, it is of interest to recall that the risk for cancer of the esophagus among cigar smokers is comparable to that of cigarette smokers (Kahn, 1966; Schottenfeld, 1984; U.S. Department of Health and Human Services, 1989) (Chapter 4).

Like most plants, tobacco contains a number of metal ions; a small percentage of these transfers into the mainstream smoke of tobacco products. The reported transfer rates into cigar smoke were for lead 2.0 - 6.6 percent (cigarette smoke 3.4 - 19.7 percent), for zinc 1.0 - 8.5 percent (cigarette smoke 0.6 - 4.6 percent), for cadmium 0.3 - 2.3 percent (cigarette smoke 1.1 - 7.3 percent), and for copper 0.1 - 0.8 percent (cigarette smoke 0.3 - 1.1 percent) (Franzke et al., 1977). The high transfer rate of nickel into tobacco smoke ((20 percent) has been explained by the formation of the volatile nickel carbonyl (bp 43°C) (Sunderman and Sunderman, 1961; Stahly and Lard, 1977). Cigar tobacco was reported to contain between 1.1 and 4.9 (g nickel per gram tobacco. In inhalation studies, nickel carbonyl ($Ni[CO]_4$) induced a few pulmonary tumors in rats; upon intravenous injection of this compound, 19 out of 20 rats developed lung tumors (International Agency for Research on Cancer, 1990).

SIDESTREAM SMOKE AND ENVIRONMENTAL TOBACCO SMOKE

Environmental tobacco smoke (ETS) is the term used to describe indoor air pollutants derived from burning tobacco products. The major contributor to ETS is the sidestream smoke (SS) that originates between puffs from smoldering cigars, cigarettes, or pipes. Lesser contributions to ETS come from the smoke emitted at the butt end of a burning cigar or cigarette and/or from the mouthpiece of a pipe stem, and also from gases diffusing through cigarette paper. Exhaled smoke also contributes to ETS.

Sources of Environmental Tobacco Smoke

It has been known for a long time that the alkaline cigar SS is irritating to eyes, ears, and throats of people, especially in enclosed environments with limited ventilation, such as offices and other workplaces and conveyances.

The ph levels of cigar Tobacco and of its smoke are slightly alkaline (Wolf, 1967; Brunnemann and Hoffmann, 1974a). This contributes to the unpleasant odor of cigar butts, which contain partially unprotonated, readily volatilizing ammonia, pyridine, methyl- and ethylpyridines, 3-vinylpyridine, 2,4-, 2,6-, and 3,s-dimethylpyridines as well as allylalcohol, ethylmercaptan, volatile phenols, aliphatic nitriles, and benzonitrile (Peck et al., 1969; Adler et al., 1971).

The Physicochemical Nature of Sidestream Smoke

SS is primarily formed in the burning cones and hot zones of cigars, cigarettes, and pipes between the drawing of puffs. The smoldering tobacco releases more of many compounds into the SS than into mainstream smoke (MS).

This applies especially to those agents that are preferably formed in reducing atmospheres, namely ammonia, aliphatic and aromatic amines, and volatile *N*-nitrosamines (Table 8). When SS is generated, several compounds result from the degradation of tobacco constituents of low volatility. These include benzene, toluene, 3-vinylpyridine (from the *Nicotiana* alkaloids), and polynuclear aromatic hydrocarbons (PAH). Smoke components that are formed by oxidation, such as catechol and hydroquinone, are released into SS in significantly lower amounts than into MS (Schmeltz et al., 1975a,b; Schmeltz et al., 1979; Klus, 1990; Guerin et al., 1992).

Because of the release of relatively large quantities of ammonia, the pH of the SS of cigarettes is neutral (MS slightly acidic) and that of cigars is alkaline (Figure 8; see Figure 6 to compare with the pH of MS). Therefore, the SS of both cigarettes and cigars contains a greater proportion of unprotonated nicotine and ammonia than the MS (Figures 5 and 7; Brunnemann and Hoffmann, 1974a; Morie, 1972).

Few physicochemical parameters of cigar SS are available in the accessible literature (Table 9). It is likely that they are generally similar to those of cigarette SS. Under standardized machine-smoking conditions (FTC method) (Pillsbury et al., 1969), the generation of MS from cigarettes requires, on average, 10 puffs of 35 ml each and a total of 20 seconds, while the formation of SS occurs over 550 seconds. During these periods, 347 mg tobacco are burned to generate MS and 411 mg tobacco are burned to produce SS. In the MS of a nonfilter cigarette one finds 10.5×10^{12} particles; in the SS, 35×10^{12} particles (Scassellati-Sforzolini and Savino, 1968); the particle sizes range from 0.1 to 1.0 µm in MS and from 0.01 to 0.8 µm in SS, with means of 0.4 µm and 0.32 µm, respectively (Carter and Hasegawa, 1975; Hiller et al., 1982). Ingebrethsen and Sears (1985) reported that particle size declines in line with the degree of dilution of SS by air. Diluting SS from 226 $\mu g/m^3$ to 26 $\mu g/m^3$ and down to 1.4 $\mu g/m^3$ reduces the median diameter from 0.210 to 0.196 and to 0.185 µm, while the percentage of particles with diameters <0.10 µm increases from about 39 to 54, and to 73 percent of the

Table 8
Distribution of select constituents in fresh, undiluted mainstream smoke and diluted sidestream smoke from nonfilter cigarettes

Constituent	Amount in MS	Range in SS/MS
Vapor phase		
Carbon monoxide	10-23 mg	2.5-4.7
Carbon dioxide	20-40 mg	8-11
Carbonyl sulfide	18-42 μg	0.03-0.13
Benzene	12-48 μg	5-10
Toluene	100-200 μg	5.6-8.3
Formaldehyde	70-100 μg	0.1-≦50
Acrolein	60-100 μg	8-15
Acetone	100-250 μg	2-5
Pyridine	16-40 μg	6.5-20
3-Methylpyridine	12-36 μg	3-13
3-Vinylpyridine	11-30 μg	20-40
Hydrogen cyanide	400-500 μg	0.1-0.25
Hydrazine	32 ng	3
Ammonia	50-130 μg	40-170
Methylamine	11.5-28.7 μg	4.2-6.4
Dimethylamine	7.8-10 μg	3.7-5.1
Nitrogen oxides	100-600 μg	4-10
N-Nitrosodimethylamine	10-40 ng	20-100
N-Nitrosodiethylamine	ND-25 ng	<40
N-Nitrosopyrrolidine	6-30 ng	6-30
Formic acid	210-490 μg	1.4-1.6
Acetic acid	330-810 μg	1.9-3.6
Methyl chloride	150-600 μg	1.7-3.3
Particulate phase		
Particulate matter	15-40 mg	1.3-1.9
Nicotine	1-2.5 mg	2.6-3.3
Anatabine	2-20 μg	<0.1-0.5
Phenol	60-140 μg	1.6-3.0
Catechol	100-360 μg	0.6-0.9
Hydroquinone	110-300 μg	0.7-0.9
Aniline	360 ng	30
2-Toluidine	160 ng	19
2-Naphthylamine	1.7 ng	30
4-Aminobiphenyl	4.6 ng	31
Benz[*a*]anthracene	20-70 ng	2-4
Benzo[*a*]pyrene	20-40 ng	2.5-3.5
Cholesterol	22 μg	0.9
γ-Butyrolactone	10-22 μg	3.6-5.0
Quinoline	0.5-2 μg	8-11
Harman	1.7-3.1μg	0.7-1.7
N'-Nitrosonornicotine	200-3,000 ng	0.5-3
NNK	100-1,000 ng	1-4
N-Nitrosodiethanolamine	20-70 ng	1.2

(continues)

Table 8 *(continued)*

Cadmium	100 ng	7.2
Nickel	20-80 ng	13-30
Zinc	60 ng	6.7
Polonium-210	0.04-0.1 pCi	1.0-4.0
Benzoic acid	14-28 µg	0.67-0.95
Lactic acid	63-174 µg	0.5-0.7
Glycolic acid	37-126 µg	0.6-0.95
Succinic acid	110-140 µg	0.43-0.62

National Research Council, 1986.

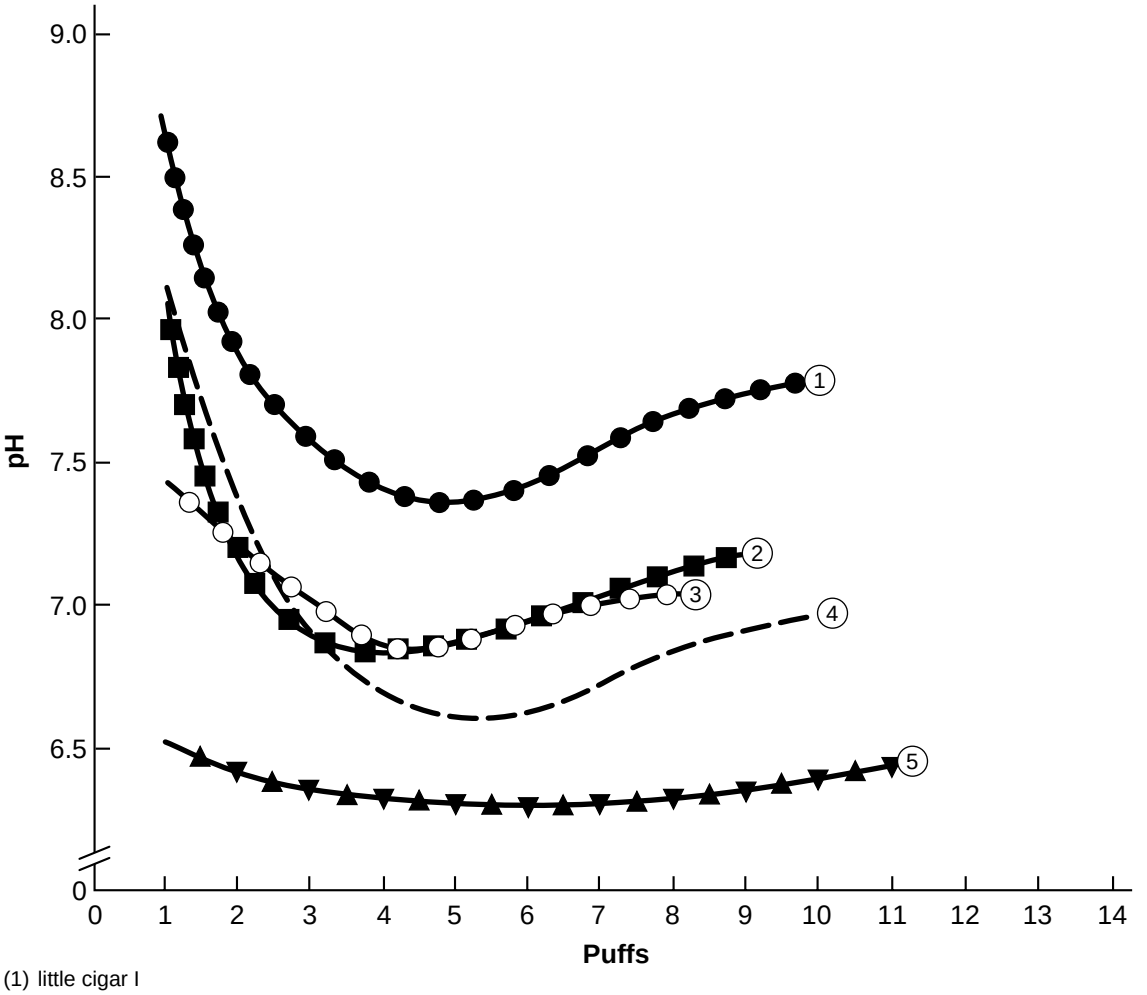
total ETS particles. In respect to particle sizes in the MS and SS of cigars, it is likely that similar parameters prevail; however, precise data are currently not available.

Environmental Tobacco Smoke

The tobacco smoke released into the environment from a burning cigarette, cigar, or pipe, and the exhaled smoke (that portion not retained by the smoker) is usually diluted by air several hundred-fold and often a thousand-fold before the ETS-polluted aerosol is inhaled (International Agency for Research on Cancer, 1986; U.S. Department of Health and Human Services, 1986; National Research Council, 1986; Guerin et al., 1992). However, to date only one model study with cigar smoke as a source for ETS has been reported (Nelson et al., 1997). It involved the concurrent smoking of three cigars of one brand by three men over a 10-minute period in a 45 m^3 chamber. The environmental conditions were static, i.e., there was neither air supply nor recirculation of the air in the chamber. Table 10 compares ETS data from this model study with the data from a model study with six cigarette smokers located for 10 minutes in the same chamber under identical (static) chamber conditions (Nelson et al., 1996 and 1997). Clearly, the smoking of three cigars by three smokers during 10 minutes polluted the air significantly more with CO (16.9 to 25.3 ppm), nitrogen oxides (412 to 520 ppb), nicotine (168 to 450 $\mu g/m^3$), and respirable suspended particulate matter (RSP; 1,520 to 5,770 $\mu g/m^3$) than the smoking by six cigarette smokers which generated 0.629 to 0.782 ppm CO, 226 to 461 ppb nitrogen oxides, 49 to 61 $\mu g/m^3$ nicotine, and 1,170 to 1,960 $\mu g/m^3$ RSP (Table 10). The greater degree of ETS pollution generated by the three cigar smokers can be explained, at least in part, by the fact that these cigar smokers burned cumulatively between 21.4 g and 33.9 g of tobacco while the six cigarette smokers burned only between 3.77 g and 4.69 g tobacco during the same time. This model study documents clearly what has been assumed, namely that cigar smokers pollute enclosed environments to a significantly higher degree than cigarette smokers. Studies of the levels of CO produced under actual cigar smoking conditions are described in Chapter 5 (Repace et al., 1998).

ETS differs from freshly generated mainstream smoke in a number of ways. The conditions under which MS is formed are very different from

Figure 8
pH of total sidestream smoke of various tobacco-products



(1) little cigar I
(2) little cigar II
(3) French (black tobacco) cigarette
(4) Kentucky reference cigarette
(5) blank (air)

Source: Brunnemann and Hoffmann, 1974a and 1974b.

those prevailing during SS formation, and the latter is the main contributor to ETS. The pH of SS is different from that in the MS of cigars and cigarettes (Figures 6 and 8), reflecting the presence of free ammonia and creating major differences in the degree of unprotonated nicotine (Figures 5 and 7). In addition, with the higher degree of air dilution of SS, more nicotine evaporates from the particulate phase into the vapor phase. Eudy et al. (1986) reported that 90 - 95 percent of the nicotine is present in the vapor phase of

Table 9
Some selected compounds in the sidestream smoke of cigars, little cigars, nonfilter cigarettes and filter cigarettes (values are given for 1 g tobacco burned)

Compound	Cigars	Nonfilter Cigarette	Little Cigar with Filter Tips	Filter Cigarette	Ref.
Ammonia, mg		7.18 (44) 6.11 (64)	9.34 (47) 12.9 (40)	7.14 (13)	1
Hydrogen cyanide, µg		134 (0.85)	114 (0.17)	167 (0.37) 141 (0.30)	2
Pyridine, µg	665 - 800 (5013)	420 (10)			3
2-Picoline, µg	170 - 255 (6-20)	160 (10)			3
3- and 4-Picoline, µg	600 - 930 (–51)	380 (13)			3
3-Vinylpyridine, µg	595 - 900 (14-80)	800 (28)			3
NDMA, ng	473 (6.4)	930 (50)	2,280 (412)	950 (129)	4,5
NEMA, ng	15 (1.4)	74 (30)	97 (15)	129 (95)	4,5
NDEA, µg		72.6 (35.3)	29 (26)	56 (89)	4,5
NPYR, µg	128 (10.5)	410 (27.3)	922 (32)	758 (89)	4,5
Cholesterol, µg		23.6 (0.9)	9.5 (0.6)[a]		
Campesterol, µg		32.5 (0.)	12.5 (0.8)[a]		6
Stigmasterol, µg		67.0 (0.7)	11.8 (0.8)[a]		6
β-Sitosterol, µg		35.0 (0.5)	9.8 (0.8)[a]		6
NNN, µg	4.27 (5.2)	2.13 (7.1)	1.14 (0.16)	0.19 (0.48)	7
NNK, µg	4.03 (8.3)	0.63 (3.7)	1.05 (0.15)	0.24 (1.3)	7
NAB, µg		0.34 (0.82)	0.71 (0.34)	0.19 (0.41)	7

Numbers in parentheses SS/MS.
[a]Little cigar without filter.

References: (1) Brunnemann and Hoffmann, 1974; (2) Brunnemann et al., 1977a; (3) Brunnemann et al., 1978; (4) Brunnemann et al., 1977b; (5) Brunnemann and Hoffmann, 1991; (6) Schmeltz et al., 1975a and 1975b; (7) Hoffmann et al., 1979.

ETS. The particle mass median diameter in ETS is significantly smaller than the particle diameter of inhaled MS (Carter and Hasegawa, 1975; Ingebrethsen and Sears, 1985). Furthermore, even compounds with relatively high molecular weight, such as the paraffin hydrocarbons $C_{25}H_{52}$ to $C_{34}H_{70}$, have been found to be present in the vapor phase of ETS to a significant degree (Ramsey et al., 1990).

Exhaled smoke may also contribute more to the particulate than to the vapor phase of ETS (Baker and Procter, 1990).

The time elapsing between generating and inhaling mainstream smoke is only fractions of seconds or, at most, seconds; thus, chemical reactions between constituents of freshly generated MS are limited compared to reactions during the aging of ETS, which may go on for periods up to a few hours and may be influenced by various atmospheric conditions. Certain ETS constituents may react with other materials in an enclosed environment, or components may be absorbed by textiles or by the surfaces of furniture.

Table 10

Contribution of cigar and cigarette smoke to environmental tobacco smoke model studies in a 45 m^3 room operated in the static mode[a]

	Cigars [b]						Cigarettes [c]			
ETS - component	C	F	D	B	E	A	FF	FFLT	ULT	100
Tobacco burned, g	7.11	7.33	10.5	7.77	10.3	6.53	0.7	0.661	0.629	0.782
CO, ppm	20.0	16.8	22.8	18.3	24.7	25.3	6.3	6.0	6.4	7.7
NO_x, ppb	572	412	445	526	472	520	234	226	242	261
3-Ethenylpyridine, $\mu g/m^3$	114	125	136	149	128	185	25	27	34	27
Nicotine, $\mu g/m^3$	168	202	283	290	169	450	51	61	49	56
RSP, $\mu g/m^3$	1810	1520	2920	2280	1280	5770	1440	1330	1170	1960
Solanesol, $\mu g/m^3$	43	26	16	74	21	102	45	44	35	53

[a] No air supply, no air recirculation.

[b] Three cigar smokers smoked the same cigar brands concurrently for 10 minutes.

[c] Six cigarette smokers smoked the same cigarette brands concurrently.

Abbreviations: ETS, environmental tobacco smoke; Nox, nitrogen oxide plus nitrogen dioxide; RST, respirable suspended particulate matter; FF, full flavor cigarette; FFLT, full flavor-low “tar”; ULT, ultra low “tar” cigarette; 100, full flavor-low “tar” 100 mm cigarette.

References: Nelson et al., 1997; Nelson et al., 1996.

This is the case with nicotine. The ratio between smoke components in ETS thus undergoes changes over time.

Tables 11 and 12 list some data for specific constituents of the vapor phase and of the particulate phase of ETS. These tables present only a fraction of the data that are known about ETS composition. (More detailed information is in the following sources: U.S. Department of Health and Human Services, 1986; National Research Council, 1986; Guerin et al., 1992.) The tables do indicate some elevation in the concentration of toxic agents in enclosed environments polluted with ETS compared to outdoor air. Moreover, there are concerns about an apparent ongoing TSNA formation during aging of ETS, yet there are no data in the literature to verify this phenomenon.

Tables 11 and 12 also list trace amounts of those agents in ETS that IARC (1987) regards as either "carcinogenic to humans," or as "probably or possibly carcinogenic to humans." These include the human carcinogens benzene and the aromatic amines 2-naphthylamine and 4-aminobiphenyl, as well as the animal carcinogens 1,3-butadiene, isoprene, acrylonitrile, formaldehyde, acetaldehyde, volatile *N*-nitrosamines, tobacco-specific *N*-nitrosamines, and various polynuclear aromatic hydrocarbons.

TOXICITY AND CARCINOGENICITY OF CIGAR SMOKE

As stated earlier, tobacco smoke contains at least 4,000 compounds (Roberts, 1988). At first glance, it appears to be an insurmountable task to identify all of the individual chemicals and groups of chemicals that are involved in the toxicity or carcinogenicity of the smoke of cigars, cigarettes, or pipes. However, intensive research in the tobacco sciences and advances in our understanding of toxicology and carcinogenesis during the past five decades have enabled scientists to define which agents, or groups of agents, are major contributors to the biologic activities of tobacco smoke (U.S. Department of Health and Human Services, 1989; Hoffmann et al., 1997).

Toxicity

Tables 6 and 7 list several smoke constituents that contribute to the overall toxicity and carcinogenicity of cigar smoke. Carbon monoxide and nicotine are major contributors to the acute toxicity of cigar smoke. Among agents which also add to the acute toxicity of cigar smoke are nitrogen oxides, hydrogen cyanide, ammonia, and volatile aldehydes.

Human hemoglobin has 210 times greater affinity for carbon monoxide than for oxygen. Inhaling tobacco smoke with up to 6 volume percent of CO diminishes the oxygen carrying capacity of the blood. Carboxyhemoglobin (COHb) concentration in the blood of nonsmokers amounts to about 0.5 percent, whereas in smokers it may reach 8 - 9 percent. The relationship between smoking and CO intoxication has received little attention. In 1969, Hamill and O'Neill reported two cases of CO intoxication of cigar smokers. Both were secondary cigar smokers, practicing inhalation of the smoke just as they did with cigarettes. One smoked 40 - 50 cigars, the other up to 15 cigars per day. Both had CO intoxication with polycythemia and decreased arterial oxygen saturation. Their COHb concentrations were 13 - 15 percent and 12 - 13 percent, respectively. In primary cigar smokers, COHb amounts to about

Table 11
Concentrations of ETS-compounds in indoor air - vapor phase*

Compound	Concentration Mean	Range	Reference
Carbon Monoxide, ppm			
25 offices	2.8		Szadkowski et al., 1976
Nonsmoking offices	2.6		Szadkowski et al., 1976
Office: 72m^3-40 cigs/day		< 2.5 - 4.6	Harke, 1974
Office: 78m^3-70 cigs/day		< 2.5 - 9.0	Harke, 1974
Offices - 66, urban area	2.3 ± 2.0	0.1 - 10.5	Guerin et al., 1992
Offices - 57, control-outdoor	2.5 ± 2.3	NR - 10.4	Guerin et al., 1992
Working areas - 221 situations	2.2	0.0 - 31.9	
controls - 450 situations	2.1	0.0 - 21.9	Guerin et al., 1992
Restaurants, 49	3.4 ± 1.2	2.0 - 7.9	Guerin et al., 1992
13 controls	3.0 ± 0.6	2.0 - 4.1	Guerin et al., 1992
Restaurants, 99	4.2 ± 2.7	1.5 - 42.3	Guerin et al., 1992
99 outdoor controls	2.5 ± 2.1	0.3 - 13.7	Guerin et al., 1992
Nitrogen Oxides, ppb			
10 Office Buildings, NO_2	24 ± 7	11 - 32	Guerin et al., 1992
outdoor controls, NO_2	27 ± 11		Guerin et al., 1992
5 Office Buildings, NO_2	16 ± 5	7 - 20	Guerin et al., 1992
outdoor controls	14 ± 6		Guerin et al., 1992
44 workrooms[a], 227 determ., NO	82		Weber and Fischer, 1986
44 workrooms[a], 227 determ., NO_2	64		Weber and Fischer, 1986
44 workrooms[b], 102 determ., NO	66		Weber and Fischer, 1986
44 workrooms[b], 102 determ., NO_2	49		Weber and Fischer, 1986
Aliphatic Hydrocarbons μg/m^3			
Ethane		56 - 100	Löfroth et al., 1989
outdoor air, control		8 - 9	
Propane		30 - 70	Löfroth et al., 1989
outdoor air, control		6 - 7	
1,3-Butadiene[c]		11 - 19	Löfroth et al., 1989
outdoor air, control		< 1 - 1	
(Bar at 3 different days)	3.5	27 - 4.5	Brunnemann et al., 1990
Isoprene[c], 6 taverns		85 - 150	Löfroth et al., 1989
outdoor air, control		< 1 - 1	
4 restaurants	42.6	16.6 - 90	Higgins et al., 1991
1 bar, 3 samplings	97	60 - 106	Brunnemann et al., 1990
Aromatic Hydrocarbons, μg/m^3			
Benzene[a], 6 coffee houses	100	50 - 150	Badré et al., 1978
3 train spaces	68	20 - 100	Badré et al., 1978
cars, ventilation	30	20 - 40	Badré et al., 1978
cars, no ventilation		150	Badré et al., 1978
trains			Löfroth et al., 1989
outdoor air, control		6 -	
bar, 3 samplings	31	31 - 36	Brunnemann et al., 1990

Table 11 *(continued)*

Compound	Concentration Mean	Range	Reference
Toluene, coffee house	448	40 - 1,040	Badré et al., 1978
4 train compartments	1128	180 - 1,870	Badré et al., 1978
car, ventilation		500	Badré et al., 1978
car, no ventilation	30	50 - 70	Badré et al., 1978
bar, 3 days	55	41 - 80	Brunnemann et al., 1990
Formaldehyde[b], (tavern) μg/m^3		89 - 109	Löfroth et al., 1989
Acetaldehyde[c] (tavern) μg/m^3		183 - 204	Löfroth et al., 1989
coffees	460	170 - 630	Badré et al, 1978
trains	546	65 - 1,040	Badré et al, 1978
automobile - ventilation	370	260 - 480	Badré et al, 1978
automobile - no ventilation		1080	Badré et al, 1978
Acetonitrile bowling alley, μg/m^3		75.9	Higgins et al., 1991
residence, smoke		17.3	Higgins et al., 1991
residence, no smoke		3.4	Higgins et al., 1991
4 restaurants	17.5	2.4 - 48.9	Higgins et al., 1991
Acrylonitrile[b] bowling alley, μg/m^3		1.8	Higgins et al., 1991
residence, smoker		0.8	Higgins et al., 1991
residence, nonsmoker		0.6	Higgins et al., 1991
4 restaurants	0.6	0.1 - 1.9	Higgins et al., 1991
Pyridine bowling alley, μg/m^3		38	Higgins et al., 1991
residence, smoker		6.5	Higgins et al., 1991
residence, nonsmoker		0.6	Higgins et al., 1991
4 restaurants	5.0	0.8 - 15.7	Higgins et al., 1991
3-Vinylpyridine bowling alley, μg/m^3		3.6	Higgins et al., 1991
residence, smoker		6.4	
residence, nonsmoker	3.2	ND	
4 restaurants	3.2	0.2 - 6.4	
415 nonsmokers, smoker's home			Jenkins et al., 1996
16 h breathing some samples	14.0		Jenkins et al., 1996
520 nonsmokers, workplace			
8 h breathing some samples	5.52		
Volatile N-Nitrosamines μg/m^3			
N-Nitrosodimethylamine[b]			
train, beverage car		0.11 - 0.13	Brunnemann and Hoffmann, 1978
bar		0.24	Brunnemann and Hoffmann, 1978
discotheque		0.09	Brunnemann and Hoffmann, 1978

The concentrations of individual components in ETS reported before 1985-1988 are, in general, significantly higher than those reported today. This is a consequence of measures to limit indoor smoking or to ban smoking entirely, as in the case of US airlines.

[a,b,c] These compounds are all carcinogenic to animals. According to the International Agency for Research on Cancer (1987), compounds are: [a]carcinogenic to humans; [b]probably carcinogenic to humans; and [c] possibly carcinogenic to humans.

Table 12
Concentrations of ETS-compounds in indoor air - particulate phase*

Compound	Concentration Mean	Range	Reference
Nicotine**, μg/m^3			
(residences, 47 houses)	2.2	0.1 - 9.4	Lederer & Hammond, 1991
(residences, 3 houses)	11.1	7.6 - 14.6	Muramatsu et al., 1984
(offices, 44)	1.1	0.0 - 16.0	Weber & Fischer, 1986
(offices, 10)	2.3	0.3 - 6.7	Thompson et al., 1989
(restaurants, 6 coffees)		25 - 52	Badré et al., 1978
(restaurants, 5 coffees)	14.8	7.1 - 27.8	Muramatsu et al., 1984
(cafeterias, 3)	26.4	11.6 - 42.2	Muramatsu et al., 1984
		2.3 - 4.4	Thompson et al., 1989
(bars, 2)	8.4	4.7 - 13.0	Kirk et al., 1968
(bars, 5)	7.4	2.0 - 13.1	Miesner et al., 1989
(pubs, 3)	31		Muramatsu et al., 1987
Automobile (natural ventilation)	65		Badre et al., 1978
(ventilation)	1,010		Badre et al., 1978
Trains (8)	16.4	8.6 - 26.1	Muramatsu et al., 1984
Airplanes, (48 smoking seats)			Oldaker & Conrad, 1987
(20 nonsmoking seats)	5.5	≤0.08 - 40.2	Oldaker & Conrad, 1987
Aromatic Amines, μg/m^3			
2-Naphthylamine[a] (offices)		0.27 - 0.34	
4-Aminobiphenyl[a]		0.1	
Carcinogenic PAH, μg/m^3			
Benzo(*b*)fluoranthene[c] (rooms)		0.132 - 0.578	Gundel et al., 1990
(outdoor air)		0.007 - 0.098	Gundel et al., 1990
Benzo(*a*)pyrene[b] (common smoking conditions)		0.2 - 10	Guerin et al., 1988
(heavy smoking conditions)		10 - 20	Guerin et al., 1988
Benzo(*a*)pyrene (room air)		3.25	Adlkofer et al., 1989
Tobacco-Specific *N*-Nitrosamines, μg/m^3			
N[1]-Nitrosonornicotine[c] (3 bars)	11.8	4.3 - 22.8	Brunnemann et al., 1992
(2 restaurants)		nd. - 1.8	Brunnemann et al., 1992
(2 train comparts.)		n.d.	Brunnemann et al., 1992
(smoker's home)		n.d.	Brunnemann et al., 1992
4-(Methylnitrosamino)-1-(3-pyridyl)-1-butanone[c]			
(3 bars)	14.9	9.6 - 23.8	Brunnemann et al., 1992
(2 restaurants)		1.4, 3.3	Brunnemann et al., 1992
(2 train comparts.)		4.9 - 5.2	Brunnemann et al., 1992
(smoker's home)		1.9	Brunnemann et al., 1992

*See footnote of Table 9.

**Although in ETS, generally, 90-95% of the nicotine is in the vapor phase for didactic reasons, nicotine in ETS is listed under "Particulate Phase".

n = not detected.

[a,b,c] The compounds are all carcinogenic to animals. According to the International Agency for Research on Cancer (1987), compounds are: [a]carcinogenic to humans; [b]probably carcinogenic to humans; and [c]possibly carcinogenic to humans.

2 percent; in secondary cigar smokers, the values are usually higher, up to 11 percent (Castleden and Cole, 1973).

Ciliatoxic Agents Development of squamous epithelium metaplasia is likely to be accentuated by the presence of ciliatoxic compounds that cause mucus stagnation. This knowledge motivated several investigators to identify the ciliatoxic agents in tobacco smoke in *in vitro* and *in vivo* assays (Kensler and Battista, 1963; Wynder et al., 1963; Bernfeld et al., 1964; Dalhamn and Rylander, 1966). Battista (1976) tabulated the existing knowledge about the chemical nature of ciliatoxic agents in tobacco smoke (Table 13). Although the concentrations of ciliatoxic agents per volume of cigar smoke are somewhat higher than those in cigarette smoke, the lungs of primary cigar smokers will only be exposed to a fraction of these toxic agents because these smokers tend to inhale far less of the smoke than cigarette smokers do. However, secondary cigar smokers who are inhaling this smoke into their lungs will have significant exposure to ciliatoxins.

Genotoxicity During the past two decades, *in vitro* and *in vivo* short-term assays have been employed to establish the genotoxicity of xenobiotic agents in order to gain an indication of their carcinogenic potential. Genotoxic agents have the ability to form DNA adducts and DNA-oxidation products in cellular nuclei, or otherwise change the configuration of DNA. So far, only one short-term test for the genotoxicity of cigar "tar" has been reported. Sato et al. (1977) tested five cigar "tars" for their mutagenic activities on the *Salmonella typhimurium* tester strains TA98 and TA100 and compared these activities with those of eight cigarette "tars." The genotoxic agents in these "tars" were metabolically activated with an S9 liver fraction of untreated rats. The number of revertants induced by 1 mg of cigar "tar" in TA100 was 922 ± 63; those in TA98 were 2,320 ± 305. One mg of cigarette "tar" caused, on average 735 ± 101 revertants in TA 100 and 1,460 ± 317 revertants in TA98. The mutagenicity of cigar "tars" was significantly higher (in TA100, $p = 0.01$; in TA98, $p = 0.004$) when compared to cigarette "tars."

Carcinogenicity and Carcinogenic Agents The first report on the carcinogenicity of the "tar" from cigars was conducted with denicotinized "tar" by Croninger et al., 1958 (Table 14). Subsequently, three additional bioassays with cigar "tar" were reported in the literature (Table 14). Several of these studies, especially the study by Davies and Day (1969) reported a significantly higher tumorigenic activity with cigar "tar" in mouse skin than with cigarette "tar," as reflected in the induction of both papilloma and carcinoma in the skin. This result was expected since cigar "tar" contains higher concentrations of carcinogenic PAH.

Table 15 lists those agents in cigarette and cigar smoke that, according to the International Agency for Research on Cancer (1987, 1990, 1991, 1993a, 1993b, 1994, 1996), are animal carcinogens; ten of these are also carcinogenic in humans. Because data for cigar smoke are lacking, the yields of carcinogens in the smoke of cigarettes made exclusively from bright and blended tobacco are compared with those in the smoke of cigarettes made exclusively from burley tobacco (Table 16). Because cigars are primarily

Table 13
Vapor phase constituents with high ciliatoxic potency - *in vitro*

Compound	Potency	Amount in Smoke (μg/puff) Typical (Range)
Hydrogen Cyanide	+++	38 (16-63)
Formaldehyde	+++	5 (2.5-11)
Acrolein	+++	10 (5.6-10.4)
Sulfur Dioxide	+++	<1
Crotonaldehyde	++	1.6
2,3-Butanedione	++	12
Ammonia	++	1
Nitrogen Dioxide	++	<10
Methacrolein	+	1
Vinyl Acetate	+	0.5
Nitric Oxide	+	60 (12-75)

Score	ED_{50} (8 puffs) (μg/puff)
+++	High = ≤50
++	Moderate = 50-100
+	Low = 100-500

Vapor phase constituents with low ciliatoxic potency - in vitro

Aliphatic Hydorcarbons
- Cyclopentane
- Cyclopentene
- *Cis*-1,3-Pentadiene
- *Trans*-1,3-Pentadiene
- 2-Methyl-1,3-Butadiene
- Limonene

Aromatic Hydrocarbons
- Benzene
- Toluene

Aldehydes
- Acetaldehyde
- Propionaldehyde
- Butyraldehyde
- Valeraldehyde
- Isovaleraldehyde
- Pivaldehyde
- 2-Methylvaleraldehyde

Ketones
- Acetone
- 2-Butanone
- 2-Pentanone
- 3-Pentanone

Ethers
- Furan
- 2-Methylfuran
- 2,5-Dimethylfuran

Esters
- Methyl Formate
- Methyl Acetate
- Ethyl Acetate

Nitriles
- Acetonitrile
- Propionitrile
- Acrylonitrile
- Isobutyronitrile
- Methacrylonitrile

Sulfur Compounds
- Hydrogen Sulfide

Other Nitrogenous Compounds
- Nitrous Oxide

Miscellaneous
- Carbon Dioxide
- Carbon Monoxide
- Phenol Vapor

+≥ 500 μg/puff needed to achieve activity comparable to cigarette smoke. None of the above are present in cigarette smoke at levels ≥ 20 % of the amount needed for biological activity.

Source: Battista, 1976

Table 14
Comparison of the induction of papilloma and carcinoma in the skin of mice with "tars" from cigars and cigarettes

Mouse Strain	Sex	% "Tar" Suspension	"Tar" dose per application, mg	Applications each week	# mice	Cigar "Tar" % papilloma	% cancer	"Tar" from # mice	Control % papilloma	Cigarettes % cancer	Reference
Swiss	F	33	25	3	100	33	18				Croninger et al., 1958
CAF_1	F	33	25	3	100	50	10				Croninger et al., 1958
Swiss	F	50 - NF	40	3	100	65*	41	100	47	37	Croninger et al., 1958
Swiss	M,F	50		3		42	40		40	24	Kensler, 1962
Swiss	M,F	50		3		42	40		34	34	Kensler, 1962
CAF_1	M	50	21	3	87	27.5	15	86	27	15	Homburger et al., 1963
CAF_1	F	50	21	3	82	37.5*	19	96	15	23	Homburger et al., 1963
ICI - Albino	F	25	75	2	144	44.4**	27.1**	144	27.8	13.2	Davies & Day, 1969
ICI - Albino	F	12.5	37.5	2	144	20.8*	11.1**	144	7.6	0.7	Davies & Day, 1969
ICI - Albino	F	6.25	18.7	2	144	6.3	2.1				Davies & Day, 1969

Abbreviations: NF, nicotine free "tar."
Cigar "tar" induces significantly more papilloma or carcinoma than the cigarette control "tar."
*$p \leq 0.05$; ** $p \leq 0.01$.

Table 15
Carcinogens in tobacco and tobacco smoke

Compound	In processed tobacco[b] (per gram)	In mainstream smoke[b] (per cigarette)	IARC evaluation evidence of carcinogenicity[a] In laboratory animals	IARC evaluation evidence of carcinogenicity[a] In humans
PAHs[c]				
Benz(a)anthracene		20-70 ng	Sufficient	
Benzo(b)fluoranthene		4-22 ng	Sufficient	
Benzo(j)fluoranthene		6-21 ng	Sufficient	
Benzo(k)fluoranthene		6-12 ng	Sufficient	
Benzo(a)pyrene	0.1-90 ng	20-40 ng	Sufficient	Probable
Dibenz(a,h)anthracene		4 ng	Sufficient	
Dibenzo(a,l)pyrene		1.7-3.2 ng	Sufficient	
Dibenzo(a,l)pyrene		present	Sufficient	
Indeno(1,2,3-cd)pyrene		4-20 ng	Sufficient	
5-Methylchrysene		0.6 ng	Sufficient	
Aza-arenes				
Quinoline		1-2 µg	Sufficient	
Dibenz(a,h)acridine		0.1 ng	Sufficient	
Dibenz(a,j)acridine		3-10 ng	Sufficient	
7-H-Dibenzo(c,g)-carbazole		0.7 ng	Sufficient	
N-Nitrosamines				
N-Nitrosodimethylamine	ND-215 ng	0.1-180 ng	Sufficient	
N-Nitrosoethylmethylamine		3-13 ng	Sufficient	
N-Nitrosodiethylamine		ND-2.8 ng	Sufficient	
N-Nitrosopyrrolidine	5-50 ng	3-60 ng	Sufficient	
N-Nitrosodiethanolamine	50-3000 ng	ND-68 ng	Sufficient	
N-Nitrososarcosine	20-120 ng		Sufficient	
N-Nitrosonornicotine	0.3-89 µg	0.12-3.7 µg	Sufficient	
4-(Methylnitrosamino)-3-(pyridyl)-1-butanone	0.2-7 µg	0.08-0.77 µg	Sufficient	
N'-Nitrosoanabasine	0.01-1.9 µg	0.14-4.6 µg	Limited	
N-Nitrosomorpholine	ND-690 ng		Sufficient	
Aromatic amines				
2-Toluidine		30-200 ng	Sufficient	Inadequate
2-Napththylamine		1-22 ng	Sufficient	Sufficient
4-Aminobiphenyl		2-5 ng	Sufficient	Sufficient
N-Heterocyclic amines				
AaC		25-260 ng	Sufficient	
MeAaC		2-37 ng	Sufficient	
IQ		0.26 ng	Sufficient	Probable
Trp-P-1		0.29-0.48 ng	Sufficient	
Trp-P-2		0.82-1.1 ng	Sufficient	
Glu-P-1		0.37-0.89 ng	Sufficient	
Glu-P-2		0.25-0.88 ng	Sufficient	
PhIP		11-23 ng	Sufficient	Possible
Aldehydes				

Table 15 *(continued)*

Compound	In processed tobacco[b] (per gram)	In mainstream smoke[b] (per cigarette)	IARC evaluation evidence of carcinogenicity[a] In laboratory animals	In humans
Formaldehyde	1.64-7.4 µg	70-100 µg[d]	Sufficient	Limited
Acetaldehyde	1.4-7.4 µg	18-1400 µg[d]	Sufficient	Inadequate
Miscellaneous organic compounds				
1,3-Butadiene		20-75 µg	Sufficient	Probable
Isoprene		450-1000 µg	Sufficient	Possible
Benzene		12-70 µg	Sufficient	Sufficient
Styrene		10 µg	Limited	Possible
Vinyl chloride		1-16 µg	Sufficient	Sufficient
DDT[e]	20-13,400 ng	800-1200 ng	Sufficient	Possible
DDE[e]	7-960 ng	200-370 ng	Sufficient	
Acrylonitrile		3.2-15 µg	Sufficient	Limited
Acrylamide		Present	Sufficient	Probable
1,1-Dimethylhydrazine	60-147 µg		Sufficient	
2-Nitropropane		0.73-1.21 µg	Sufficient	
Nitrobenzene		25.3 ng	Sufficient	Possible
Ethyl carbamate	310-375 ng	20-38 ng	Sufficient	
Ethylene oxide		7 µg	Sufficient	Sufficient
Di(2-ethylhexyl)phthalate	Present	20 µg	Sufficient	
Furan		18-30 µg	Sufficient	Inadequate
Benzo(b)furan		Present	Sufficient	Inadequate
Inorganic compounds				
Hydrazine	14-51 ng	24-43 ng	Sufficient	Inadequate
Arsenic	500-900 ng	40-120 ng	Inadequate	Sufficient
Beryllium	15-75 mg	0.5 mg	Sufficient	Sufficient
Cobalt	90-1,400 mg	0.13-0.2 mg	Sufficient	Inadequate
Nickel	2000-6000 ng	0-600 ng	Sufficient	Limited
Chromium	1000-2000 ng	4-70 ng	Sufficient	Sufficient
Cadmium	1300-1600 ng	41-62 ng	Sufficient	Sufficient
Lead	8-10 µg	35-85 ng	Sufficient	Inadequate
Polonium-210	0.2-1.2 pCi	0.03-1.0 pCi	Sufficient	Sufficient

[a] No designation indicates that IARC has not evaluated the compound.

[b] ND, not detected.

[c] PAH, polynuclear aromatic hydrocarbons: AaC, 2-amino-9H-pyrido[2,3-b]indole; MeAaC, 2-amino-3-methyl-9H-pyrido[2,3-b]indole; IQ, 2-amino-3-methylimidazo[4,5-b]quinoline; Trp-P-1, 3-amino-1,4-dimethyl-5H-pyrido[4,3-b]indole; Trp-2, 3-amino-1-methyl-5H-pyrido[4,3-b]indole; Glu-P-1, 2-amino-6-methyl[1,2-a:3',2"-d]imidazole; Glu-P-2, 2-aminodipyrido[1,2-a:3',2'-d]imidazole; PhlP, 2-amino-1-methyl-6-phenylimidazo[4,5-b]pyridine.

[d] The 4th report of the Independent Scientific Committee on Smoking and Health (1988) published values for the 14 leading British cigarettes in 1986 (51.4% of the market) of 20-1050 µg/cigarette (mean 910 µg) for acetaldehyde.

[e] During the last decade, DDT and DDE levels have been drastically reduced in U.S. cigarette tobacco ((60 ng and (13 ng).

Source: Hoffmann and Hoffmann, 1997

Table 16
Known carcinogens (ng/cigarette) in the smoke of bright or blond and burley and black tobacco

Carcinogens		Bright or blended tobacco	Burley or black tobacco
I. Volatile nitrosamines			
NDMA	NF	6.8-13.8	29
	F	1.8-5.7	4.3
NEMA	NF	(0.1-1.8	2.7
	F	0.4-1.0	0.5
NPYR	NF	11.0-30.3	25
	F	3.1-8.7	10.5
NDMA	NF	9.4-48.4	38.8-76.4
NEMA	NF	(0.1-7.1	2.1-6.3
NPYR	NF	6.9-41.2	22.7-36.1
II. NDELA	NF (Exp. Cigarettes)	30-51	290
III. TSNA			
NNN	NF (Exp. Cigarettes)	620	3700
NNK	NF (Exp. Cigarettes)	420	320
NAT[b]	NF (Exp. Cigarettes)	410	4600
NNN	NF	85-255	512-625
NNK	NF	70-156	108-432
NAT[b]	NF	81-225	266-353
NNN	NF	29	203
NNK	NF	40-136	
NAT[b]	NF	45	108
NNN	NF	79-885	550-800
NNK	NF	62-185	84-470
NAT[b]	NF	75-380	225-520
NNN	F	213	117-389
NNK	F	32	13-55
NAT[b]	F	92	74-196
IV. Aromatic amines			
2-Toluidine	NF	32.2	162
	F	41.0	66.8
2-Naphthylamine	NF	1.0	1.7
	F	2.1	1.8
4-Aminobiphenyl	NF	2.4	4.6
	F	0.3-0.2	23
V. 2-Nitropropane	NF	220-1190	1430-2180

Table 16 *(continued)*

Carcinogens		Bright or blended tobacco	Burley or black tobacco
VI. PAH			
BaA	NF (Exp. Cigarettes)	21.0-25.9	10.7-16.7
BaP	NF (Exp. Cigarettes)	38-53	24
	NF (Exp. Cigarettes)	7.5-9.6	25
	NF (Exp. Cigarettes)	35.4	19.7
VII. Volatile Aldehydes			
Formaldehyde	NF (Exp. Cigarettes)	26,800-36,300	16,100-25,100
Acetaldehyde	NF (Exp. Cigarettes)	797,000-906,000	726,000-966,000
IX. Benzene		27,000	12,000
X. Quinoline	F	620	1200

Note. Abbreviations: NDMA, nitrosodimethylamine; NEMA, nitrosoethylamine; NPYR, nitrosopyrrolidine; NDELA, nitrosodiethanolamine; TSNA, tobacco-specific *N*-nitrosamines; NNN, *N'*-nitrosonornicotine; NNK, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone; NAT, *N'*-nitrosoanatabine; BaA, benz[a]anthracene; BaP, benzo[a]pyrene; NF, nonfilter; F, filter. The pH of the smoke of blond type cigarettes varies between 6.15 (1st puff) and 5.7 (last puff); the pH of the French black cigarette with filter tip measures from 6.8 to 7.4 and without filter tip from 6.6 to 6.95 cm. With pH above 6, the toxicity of the smoke increases.

[a] Black cigarettes = French type black cigarettes made exclusively from Burley tobacco; Blond cigarettes = Virginia type cigarettes and U.S. Blended cigarettes.

[b] NAT contains some N'-nitrosoanabasine (NAB).

Hoffmann and Hoffmann, 1997

made with burley tobacco, this table also indicates those carcinogens that would be expected to be more prevalent in cigar smoke than in cigarette smoke (Hoffmann and Hoffmann, 1997).

BIOMARKERS FOR THE UPTAKE OF TOBACCO SMOKE

Estimates of the smoker's exposure to toxic and carcinogenic smoke constituents are based on the measurements of certain biomarkers. In general, these are determined in saliva, blood, urine, and/or exhaled air.

Nicotine

Upon inhaling alkaline cigar smoke, nicotine is absobed through the mucous membranes in the oral cavity as well as across the alveolar surface of the lung. The nicotine concentration in the blood of a cigar smoker rises gradually (Russell et al., 1980). In blood with a pH of 7.4, about 31 percent of the nicotine is present in unprotonated form. Nicotine transfers from the bloodstream across cell membranes, including those of the central nervous system. In the case of those secondary cigar smokers and of cigarette smokers who inhale tobacco smoke, the aerosol reaches the small airways and alveoli of the lung from which nicotine is quickly absorbed. Within minutes, the blood concentration of nicotine rises to a maximum (U.S. Department of Health

and Human Services, 1988). Using nicotine-^{14}C and measuring the radioisotope in exhaled air, Armitage et al., (1975) found that cigarette smokers absorb 82 - 92 percent of the inhaled nicotine; those who do not inhale the smoke absorbed about 29 percent of inhaled nicotine.

After smoking one piece of the respective product, the nicotine level in the plasma of cigarette smokers rose from 25 to between 35 and 40 ng/ml; that of secondary cigar smokers rose from 12.8 to 45.6 ng; and that of primary cigar smokers changed from 3.4 to 5.2 ng/ml as average measurements in five smokers per group (Turner et al., 1977). These data show clearly that the primary cigar smokers takes up far less nicotine because he does not inhale the smoke deep into the lungs as in the case with cigarette smokers and secondary cigar smokers.

Carbon Monoxide The determination of carboxyhemoglobin (COHb) is regarded as the most reliable assay for the uptake of carbon monoxide by smokers. In nonsmokers who have no significant exposure to CO in their occupational or home environment, the COHb level is below 1.7 percent; even levels as low as 0.2 percent COHb have been reported in nonsmokers. Turner et al. (1977) reported the mean concentration of COHb in 1,933 cigarette smokers to be 4.78 percent, with 94.7 percent of the measurements indicating COHb to be (1.7 percent. The mean COHb concentration for 39 primary cigar smokers was 1.36 percent and none showed COHb levels above 1.7 percent. One hundred and fifty-four secondary cigar smokers had a mean COHb concentration of 6.8 percent; 97.4 percent of these had concentrations above 1.7 percent. These data were confirmed by several additional reports, all of which clearly show that the primary cigar smoker tends to inhale not at all or only very shallowly, while the secondary cigar smoker inhales the smoke at least as deeply as the cigarette smoker does.

The determination of CO in exhaled breath is not as reproducible as the COHb determination that measures uptake of CO. However, the method can be readily executed in an office or at any site by just asking the subject to exhale into a CO meter. Ockene et al. (1987) conducted a large-scale study and measured 1.8 - 2.1 CO in the exhaled breath of primary cigar smokers and 3.3 - 11.0 in the breath of secondary cigar smokers. Similar findings were reported by others (Cowie et al., 1973; Goldman, 1976, Wald et al., 1981).

Hydrogen Cyanide The smoke of 1 g tobacco from a cigar contains 1,000 µg of hydrogen cyanide (HCN), and that from a little cigar contains up to 780 µg. The smoke of 1 g cigarette tobacco contains up to 600 µg of HCN (Table 6). The release of HCN into the sidestream smoke per gram of tobacco burned in a little cigar amounts to 114 µg and that in cigarettes reaches 134 - 167 µg (Table 9). Although HCN is liberated from certain food items (cyanogens; *e.g.* cabbage, broccoli, conifers, vegetables, and certain nuts), the quantities produced in this manner are significantly lower than the amounts of HCN inhaled as a tobacco smoke constituent (Galanti, 1997). Therefore, they usually do not interfere with the assay of thiocyanate, the most important metabolite of HCN, in physiological fluids of smokers. Thiocyanate

concentration is determined by a colorimetric method in an autoanalyzer (Butts et al., 1974). In one study, the mean concentration of thiocyanate in the saliva of 30 nonsmokers on a cyanogen-containing diet was 101 ± 51 µg/ml; in 15 nonsmokers on a diet free of cyanogens, thiocyanate levels were 92 ± 90µg/ml, and in the saliva of 20 smokers it was 413 ± 172 µg/ml ($p < 0.01$ *vs.* both nonsmokers' groups) (Galanti, 1977).

Pechacek et al. (1985) reported serum thiocyanate levels in never smokers at 2.52 ± 1.60 µg/ml, in primary cigar and pipe smokers at 4.22 ± 2.56 µg/ml, in secondary cigar and pipe smokers at 5.63 ± 3.55 µg/ml, and in cigarette smokers at 8.34 ± 3.03 µg/ml.

Benzene

Benzene, a leukomogenic agent, is a ubiquitous contaminant of the respiratory environment. The American Conference of Governmental Industrial Hygienists has set the upper permissible limit of a time-weighted concentration of benzene for an 8-hour work day and a 40-hour work week (TWA) at 10 ppm (32 µg/L) (American Conference of Governmental Industrial Hygienists, 1996). Benzene in the smoke of 1 g tobacco burned as a cigar, amounts to between 90 and 250 µg per gram tobacco (est. 80-200 µg/L); from 1 g tobacco smoked as a cigarette, one obtains between 8 and 60 µg benzene (est. 25-180 µg/L).

Polynuclear Aromatic Hydrocarbons (PAH)

Tobacco smoke contains at least ten carcinogenic PAH (Hoffmann and Hoffmann, 1997). Benzo(*a*)pyrene (B*a*P) concentration in environmental samples and food items serves as a surrogate measure of PAH-related carcinogenic potential. Per gram tobacco B*a*P yields in the mainstream smoke (MS) of cigars range from 30 to 51 ng; in MS of little cigars, 26 ng; and in MS of a cigarette without a filter tip, 26 - 59 ng (Table 7). Up to 90 percent of the PAH in cigarette smoke is retained upon inhalation in the respiratory tract of a long-term smoker; however, only a small percentage of the PAH is absorbed from food as found in the digestive tract (Bresnick et al., 1983; Grimmer, 1983; Rahman et al., 1986).

Carcinogenic PAH are primarily contact carcinogens. They are metabolically activated by P450 isozymes to their ultimate carcinogenic forms, the dihydrodihydroxy epoxides (Dipple et al., 1984). They form intracellular adducts with macromolecules, including DNA (Dipple et al., 1984). The prevailing DNA adduct formed through B*a*P metabolism is (+)*trans-anti*-7,8-dihydro-9-hydroxy-10-N^2-guanosine (Geacintov et al., 1997).

Among biomakers of uptake and metabolic activation of smoke constituents in cigarette smokers, hemoglobin adducts of 4-aminobiphenyl, BaP, and other PAH have been measured, and urinary metabolites and/or detoxification products of NNK and/or benzene have been quantified. As an indicator of endogenous N-nitrosation, leading to N-nitrosamine formation, N-nitrosoproline has been determined in the urine of cigarette smokers. Similar biomarker studies for cigar smokers are lacking.

SUMMARY AND RESEARCH NEEDS

Today, several types of cigars are marketed in the United States: little cigars, (each weighing less than 1.36 g), regular cigars, small cigars, cigarillos, and premium cigars.

Primary cigar smokers tend not to inhale the cigar smoke, whereas primary cigarette smokers do tend to inhale the cigarette smoke. The principal reason for this difference is the pH of cigar smoke which is initially 6.2 for early puffs and rises to 8.0 for later puffs. At alkaline pH conditions, part of the nicotine is present in unprotonated form in the vapor phase. Unprotonated, volatile nicotine is absorbed through the mucous membrane of the oral cavity and is quickly transported via the bloodstream to the various sites, including the central nervous system, where it exerts the pharmacological effects that seem to "satisfy" the smoker. The elevated pH of the smoke of cigars is caused by the relatively high nitrate content of the air-cured and fermented cigar tobacco (1.4 - 2.1 percent) compared to the nitrate content of the U.S. blended cigarette tobacco (0.5 - 1.7 percent).

In the burning cigar, part of the nitrate is reduced to ammonia and part of it yields NO_x. Nitrogen dioxide in the smoke contributes to the *N*-nitrosation of secondary and tertiary amines. The most abundant amines in tobacco smoke, nicotine and the minor *Nicotiana* alkaloids, are thereby nitrosated and become TSNA. Some TSNA are formed by pyrosynthesis and some TSNA transfer from the tobacco into the smoke. TSNA are present in significantly higher amounts in cigar smoke than in cigarette smoke.

Tobacco smoke contains more than 4,000 individual compounds with about 500 of these in the gas phase. One gram of tobacco burned in a cigar delivers between 39 and 65 mg carbon monoxide and 160 - 300 μg nitrogen oxides compared to maxima of 19 mg carbon monoxide and up to 160 μg of nitrogen oxides for the same amount of tobacco burned in a cigarette. These high concentrations of CO and NO_x in cigar smoke are due to the very low porosity of the cigar binder and wrapper which contrasts with the high porosity of cigarette paper.

Many toxic agents and 62 known carcinogens have been identified among the 4000 compounds in cigarette smoke. Fewer of these have been identified in cigar smoke. However, it is highly likely that most of the toxic and carcinogenic constituents found in cigarette smoke are also present in cigar smoke, albeit at different concentrations. Disregarding studies on the effects of additives to cigar tobacco, there is only a limited need to specifically identify toxic and carcinogenic compounds in cigar smoke.

There exists a need to investigate two particular areas with regard to health effects of cigar smoking. One is the study of the smoking patterns of primary and secondary cigar smokers and of the uptake of toxic and carcinogenic smoke constituents by both types of cigar smokers, as well as the study of metabolism of critical constituents by the cigar smoker. It is especially important to verify the possibility of endogenous formation of carcinogenic *N*-nitrosamines in cigar smokers. Except for a few isolated investigations on nicotine uptake by cigar smokers, these aspects remain unexplored.

The second area of needed investigation relates to the reduction of toxic and carcinogenic agents in cigar smoke, including nicotine. Can the porosity of the cigar wrapper be changed? Is it possible, by addressing this aspect and others, to reduce the high yields of carbon monoxide and "tar" in cigar smoke? Are there ways to reduce the high nitrate content of cigar tobacco? In view of the increasing consumption of cigars in the United States, our knowledge regarding the uptake and metabolic fate of the toxic and carcinogenic agents in cigar smoke, and means for their reduction in the smoke should be intensified. Such efforts need to parallel public health measures toward informing the consumers about the ill effects of cigar smoke on human health.

CONCLUSIONS

1. Cigar smoke contains the same toxic and carcinogenic compounds identified in cigarette smoke.
2. When examined in animal studies, cigar smoke tar appears to be at least as carcinogenic as cigarette smoke tar.
3. The differences in risk between cigarette smoking and cigar smoking appear to be related to the differences in patterns of use of those two tobacco products, principally non-daily use and less inhalation among cigar smokers, rather than a difference in the composition of the smoke.
4. The amount of nicotine available as free, unprotonated nicotine is generally higher in cigars than in cigarettes due to the higher pH of cigar smoke. This free nicotine is readily absorbed across the oral mucosa, and may explain why cigar smokers are less likely to inhale than cigarette smokers.

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REFERENCES

Adams, J.D., Lee, S.J., Vinchkoski, N., Castonguay, A., Hoffmann, D. On the formation of the tobacco-specific carcinogen 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone during smoking, *Carcinogenesis* 17:339-346, 1983.

Adams, P.I. Combustion temperatures in cigars and cigarettes. A comparative study *Tobacco Science* 12:144-150, 1968.

Adler, R., Peck, R.L., Thompson, L. Chemistry of cigar butt odor. II. Further investigations on the distillable portion. *Tobacco Science* 15:121-123, 1971.

Adlkofer, F.X., Scherer, G., Von Meyernick, L.,Von Malzan, C.H., Jarcyk, L. Exposure to ETS and its biological effects: A review. In: Present and Future Indoor Air Quality C. J. Bieve, Y. Courteous and M. Govaerts (eds.), Elsevier Science Publishers, pp. 183-196, 1989.

American Conference of Governmental Industry Hygienists. 1996-1997 Threshold Limit Values for Chemical Substances and Physical Agents, and Biological Exposure Indices. American Conference of Governmental Industry Hygienists, Cincinnati, Ohio, 1996.

Ames, B.N., Shigenaga, M.K., Hagen, T.M. Oxidants, antioxidants, and the degenerative disease of aging. Proc. Natl. Acad. Sci. USA 90: 7915/7922, 1993.

Andren, A.W., Harriss, R.C. Mercury content of tobacco. *Environmental Letters* 1(4):231-234, 1971.

Appel, B.R., Guirguis, G., Kim, I.S., Garbin, O., Fracchia, M., Flessel, C.P., Kizer, K.W., Book, S.A., Warriner, T.E. Benzene, benzo(a) pyrene, and lead in smoke of tobacco products other than cigarettes. *American Journal of Public Health* 80 (5):560-564, 1990.

Armitage, A.K., Turner, D.M. Absorption of nicotine in cigarette and cigar smoke through the oral mucosa. *Nature (London)* 226:1231-1232, 1970.

Armitage, A.K., Dollery, C.T., George, C.F., Houseman, T.H., Lewis, P.J., Turner, D.M. Absorption and metabolism of nicotine from cigarettes. *British Medical Journal* 4(5992):313-316, 1975.

Badré, R., Guillerm, R., Abran, N., Bourdin, M., Dumas, C. Atmospheric pollution by smoking. *Annales Pharmaceutiques Francaises* 36 (9-10):443-452, 1978.

Baker, R.R., Proctor, C.J. The origin and properties of environmental tobacco smoke. *Environment International* 16:231-245, 1990.

Battista, S.P. Ciliatoxic components in cigarette smoke. In: *Smoking and Health*. Volume 1. The Risk for the Smoker. Proceedings of the Third World Conference on Smoking and Health DHEW Publication No. (NIH) 76-1221: 517-534, Washington, D.C., 1976.

Benowitz, N.L., Jacob, P.,III., Fong, I., Gupta, S. Nicotine metabolic profile in man and comparison of cigarette smoking and transdermal nicotine. *Journal of Pharmacology and Experimental Therapeutics* 268 (1):296-303, 1994.

Bernfeld, P., Nixon, C.W., Homburger, F. Studies on the effect of irritant vapors on ciliary mucus transport. I. Phenol and cigarette smoke. *Toxicology and Applied Pharmacology* 6:103-111, 1964.

Bilimoria, M.H., Nisbet, M.A. Differentiation of tobacco smoke condensates on the basis of reducing properties. *Beiträge zur Tabakforschung* 6:27-31, 1972.

Borowski, H., Seehofer, F. Temperaturverlauf des Hauptstromrauches im Cigaretten stummel während des Rauchens. *Beiträge zur Tabakforschung* 1:329-333, 1962.

Boyd, D.F., Briggs, C.D., Darby, P.W. Dependence of the gas phase composition of smoke on the combustion temperature of tobacco products. *Tobacco Science* 16:160-165, 1972.

Bradford, J.A., Harlan, W. R., Hanmer, H.R. Nature of cigarette smoke. Technic of experimental smoking. *Industrial and Engineering Chemistry* 28:836-839, 1936.

Bresnick, E., Anderson, M.W., Gorse, F.A., Jr., Grosjean, D., Hites, R.A., Kappas, A., Kouri, R.E., Pike, M.C., Selkirk, J.K., White, L.J., Frazier, J.A., Grossblatt, N., Perrin, J.E. Polycyclic Aromatic Hydrocarbons: Evaluation of Sources and Effects, Chapters 1, 2, 4, and 6. Washington, D.C: National Academy Press, 1983.

Brunnemann, K.D., Cox, J.E., Hoffmann, D. Analysis of tobacco-specific *N*-nitrosamines in indoor air. *Carcinogenesis* 13:2415-2418, 1992.

Brunnemann, K.D., Hoffmann, D. The pH of tobacco smoke. *Food Cosmetics and Toxicology* 12:115-124, 1974(a).

Brunnemann, K.D., Hoffmann, D. Analytical studies on *N*-nitrosamines in tobacco and tobacco smoke. *Recent Advances in Tobacco Science* 17:71-112, 1991(b).

Brunnemann, K.D., Hoffmann, D. Assessment of the carcinogenic *N*-nitrosodiethanolamine in tobacco products and tobacco smoke. *Carcinogenesis* 2:1123-1127, 1981.

Brunnemann, K.D., Hoffmann, D. Chemical studies on tobacco smoke. XXIV. A quantitative method for carbon monoxide and carbon dioxide in cigarette and cigar smoke. *Journal of Chromatographic Science* 12 (2):70-75, 1974 (b).

Brunnemann, K.D., Hoffmann, D. Chemical studies on tobacco smoke XXXIV. Gas chromatographic determination of ammonia in cigarette and cigar smoke. *Journal of Chromatographic Science* 13: 1237-1244, 1975.

Brunnemann, K.D., Hoffmann, D. Decreased concentrations of *N*-nitrosodiethanolamine and -N-nitrosomorpholine in commercial tobacco products. *Journal of Agricultural and Food Chemistry* 39:207-208, 1991 (a).

Brunnemann, K.D., Hoffmann, D., Wyder, E.L., Gori, G.B. Determination of tar, nicotine and carbon monoxide in cigarette smoke. A comparison of international smoking conditions. Proc. 3rd World Conference on "Smoking and Health", Volume 1. *Modifying the Risk for the Smoker.* DHEW Publ. No. (NIH) 76-1221, pp. 441-449; 1976a.

Brunnemann, K.D., Kagan, M.R., Cox, J.E., Hoffmann, D. Analysis of 1,3-butadiene and other selected gas phase components in cigarette mainstream and sidestream smoke by gas chromatography-mass selected detection. *Carcinogenesis* 11:1863-1868, 1990.

Brunnemann, K.D., Lee, H.C., Hoffmann, D. Chemical studies on tobacco smoke. XLVII. On quantitative analysis of catechols and their reduction. *Analytical Letters* 9:939-955, 1976.

Brunnemann, K.D., Scott, J.C., Hoffmann, D. *N*-nitrosoproline, an indicator for *N*-nitrosation of amines in processed tobacco. *Journal of Agricultural and Food Chemistry* 31:905-909, 1983.

Brunnemann, K. D., Stahnke, G., Hoffmann, D. Chemical studies on tobacco smoke. LXI. Volatile Pyridines: Quantitative analysis in mainstream and sidestream smoke of cigarettes and cigars. *Analytical Letters* A 11:545-560, 1978.

Brunnemann, K.D., Yu, L., Hoffmann, D. Assessment of carcinogenic volatile *N*-nitrosamines in tobacco and in mainstream and sidestream smoke from cigarettes. *Cancer Research* 37: 3218-3222, 1977b.

Brunnemann, K.D., Yu, L., Hoffmann, D. Chemical Studies on tobacco smoke. XLIX. Gas chromatographic determination of hydrogen cyanide and cyanogen in tobacco smoke. *Journal of Analytical Toxicology* 1:38-42, 1977a.

Burton, H.R., Dye, N.K., Bush, L. Distribution of tobacco constituents in tobacco leaf tissue. 1. Tobacco-specific nitrosamines, nitrate, nitrite and alkaloids. *Journal of Agricultural and Food Chemistry* 40 (6):1050-1055, 1992.

Butts, W.C., Kuehneman, J., Widdowson, G.M. Automated method for determining serum thiocyanate to distinguish smokers from nonsmokers. *Clinical Chemistry* 20(10) 1344-1348, 1974.

Byrd, G.D., Chang, K.M., Greene, J.M., deBethizy, J.D, Reynolds, J.H. Evidence for urinary excretion of glucuronide conjugates of nicotine, cotinine, and trans-3'-hydroxycotinine in smokers. *Drug Metabolism and Disposition* 20 (2):192-197, 1992.

Campbell, J.M., Lindsey, A.J. Polycyclic hydrocarbons in cigar smoke. *British Journal of Cancer* 11: 192-195, 1957.

Carter, W.L., Hasagawa, I. Fixation of tobacco smoke aerosols for size distribution studies. *Journal of Colloid Interface Science* 63:134-141, 1975.

Castleden, C.M., Cole, P.V. Inhalation of tobacco smoke by pipe and cigar smokers. *Lancet* II (819):21-22, 1973.

Castonguay, A., Stoner, G.D., Schut, H.A.J., Hecht, S.S. Metabolism of tobacco-specific *N*-nitrosamines by cultured human tissues. *Proceedings of the National Academy of Sciences* 80: 6694-6697, 1983.

Chakraborty, M.K., Ghelani, L.M., Patel, B.K. Agricultural and technological experiments to reduce toxic chemicals in bidi smoke. In: *Tobacco and Health: The Indian Scene.* L. D. Sanghvi and P. Natami, eds. Tata Memorial Centre, Bombay, India, 1989, pp. 89-100.

Cigar Aficionado. Coronas and Lonsdales, Fall 1996.

1991.

Cornell, A., Cartwright, W.F., Bertinuson, T.A. Influence of microorganisms (fermentation) on the chemistry of tobacco. *Recent Advances in Tobacco Scienc*e 5:27-61, 1979.

Cowie, J., Sillett, R.W., Boll. K.P. Carbon monoxide absorption by cigarette smokers who change to smoking cigars. *Lancet* I: 1033-1035, 1973.

Creek, L. Capehart, T., Grise, V. U.S. Tobacco Statistics 1935-1992, U.S. Department of Agriculture. *Statistical Bulletin* 869:14, 1994.

Croninger, A.B., Graham, E.A., Wynder, E.L. Experimental production of carcinoma with tobacco products. V. Carcinoma induction in mice with cigar, pipe and all-tobacco cigarette tar. *Cancer Research* 18:1263-1271, 1958.

Dalhamn, T., Rylander, R. Cigarette smoke and ciliastasis. Effect of varying composition of smoke. *Archives of Environmental Health* 13:47-50, 1966.

Davies, R.F., Day. T.D. A study of the comparative carcinogenicity of cigarette and cigar smoke condensate on mouse skin. *British Journal of Cancer* 23:363-368, 1969.

Dipple, A., Moschel, R.C., Bigger, A.H. Polynuclear aromatic hydrocarbons. In: *Chemical Carcinogenesis*, Second Edition, C.E. Searle (ed.). Washington, D.C., *American Chemical Society Monograph* 182:41-163, 1984.

Djordjevic, M.V., Brunnemann, K.D., Hoffmann, D. Identification and analysis of a nicotine- derived N-nitrosamino acid and other nitroamino acids in tobacco. *Carcinogenesis* 10:725-731, 1989.

Djordjevic, M.V., Fan, J., Ferguson, S, Hoffmann, D. Self-regulation of smoking intensity, smoke yields of low-nicotine, low-"tar" cigarettes. *Carcinogenesis* 16:2015-2021, 1995(a).

Djordjevic, M.V., Fan, J., Hoffmann, D. Assessment of chlorinated pesticide residues in cigarette tobacco based on supercritical fluid extraction and GC-ECD. *Carcinogenesis* 16:2627-2632, 1995b.

Djordjevic, M.V., Hoffmann, D. Analysis of the mainstream smoke of cigarettes, little cigars, cigars, and premium cigars. 1998 unpublished data.

Dong, M., Schmeltz, I., Jacobs, E., Hoffmann, D. Chemical studies on tobacco smoke. LV. Aza-arenes in cigarette smoke. *Journal of Analytical Toxicology* 2:21-25, 1978.

Doull, J., Frawley, J.P., George, W. List of ingredients added to tobacco in the manufacture of cigarettes by six major American cigarette companies. Washington D.C: Covington and Burling, April 12, 1994.

Eudy, L.W., Thome, F.W., Heavner, D.K., Green, C.R., Ingebrethsen, B.J. Studies on the vapor-particulate phase distribution of environmental nicotine by selective trapping and detection methods. *Proceedings of the 70th Annual Meeting of the Air Pollution Control Association,* Minneapolis, MN: paper 38.7, 1986.

Fagerström, K.O. Effects of a nicotine-enriched cigarette on nicotine titration, daily cigarette consumption and levels of carbon monoxide, cotinine and nicotine. *Psychopharmacology* 77 (2):164-167, 1982.

Frankenburg, W.G., Gottscho, A.M. Nitrogen compounds in fermented cigar leaves. *Industrial and Engineering Chemistry* 44:301-305, 1952.

Frankenburg, W.G., Gottscho, A.M., Vaitekinnos, A.A. Biochemical conversion of some tobacco alkaloids. *Tobacco Science* 2:9-13, 1958.

Franzke, Ch., Ruick, G., Schmidt, M. Untersuchungen zum Schwermetallgehalt von Tabakwaren und Tabakrauch. *Nahrung* 21(5):417-428, 1977.

Galanti, L.M. Specificity of salivary thiocyanate as a marker of cigarette smoking is not effected by alimentary sources. *Clinical Chemistry* 43:184-185, 1997.

Geacintov, N.E., Cosman, M., Hingerty, B.E., Amin, S., Broyde, S., Patel, D.J. NMR solution structures of stereoisomeric covalent polycyclic aromatic carcinogen - DNA adducts: Principles, patterns and diversity. *Chemical Research in Toxicology* 10:111-146, 1997.

Goldman, A.L. Cigar smoking. *American Review of Respiratory Diseases* 113:87-89, 1976.

Grimmer, G. (ed.) *Environmental Carcinogenesis: Polycyclic aromatic hydrocarbons. Chemistry, Occurrence, Biochemistry, Carcinogenicity*. C.R.C. Press, Inc., Boca Raton, Florida, 1983.

Guerin, M.R. Formation and general characteristics of environmental tobacco smoke. *Air Pollution Control Association Speciality Conference on Combustion Process and the Quality of Indoor Environments*, Niagara Falls, NY, 1988.

Guerin, M.R., Jenkins, R.A., Tomkins, B.A. The Chemical Nature of Environmental Tobacco Smoke: Composition and Measurement. Chelsea, MI: Lewis Publishers, Inc., 1992.

Gundel, L.A., Daisey, J.M., Offermann, F.J. Development of an indoor sampling and analysis method for particulate polycyclic aromatic hydrocarbons. *Proceedings of the 5th International Conference on Indoor Air Quality and Climate*. Toronto, Canada. Volume 2:299-304, 1990.

Haley, N.J., Sepkovic, D.W., Hoffmann, D., Wynder, E.L. Cigarette smoking as a risk factor for cardiovascular diseases. Part VI. Compensation with nicotine availability as a single variable. *Clinical Pharmacology and Therapeutics* 38:164-170, 1985.

Halter, H.M., Ito, T.I. Effect of tobacco reconstitution and expansion process on smoke composition. *Recent Advances in Tobacco Science* 4:113-137, 1980.

Hamill, W., O'Neill, R.P. Carbon monoxide intoxication in cigar smokers. *Irish Journal of Medical Science* 8 (6):273-277, 1969.

Harke, H.P. The problem of passive smoking. I. The influence of smoking on the CO concentration of office rooms. *Internationales Archiv für Arbeitsmedizin* 33:199-206, 1974.

Hecht, S.S. Recent studies on mechanisms of bioactivation and detoxification of 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), a tobacco-specific lung carcinogen. *Critical Reviews in Toxicology* 26:163-181, 1996.

Hecht, S.S., Hoffmann, D. The relevance of tobacco-specific *N*-nitrosamines to human cancer. *Cancer Surveys* 8:273-294, 1989.

Herning, R.I., Jones, R.T., Bachman, J., Mines, A.H. Puff volume increases when low-nicotine cigarettes are smoked. *British Medical Journal Clinical Research* Edition 287:187-189, 1981.

Higgins, C.E., Thompson, C.V., Ilgner, R.H., Jenkins, R.A., Guerin, M.R. Determination by vapor phase hydrocarbons and nitrogen constituents in environmental tobacco smoke. *Analytical Chemistry Division,* Oak Ridge National Laboratory, Oak Ridge, TN 37831; 6120, 1991.

Hiller, F.C., McCusker, K.T., Mazumder, M.K.,Wilson, J.D., Bone, R.C. Deposition of sidestream cigarette smoke in the human respiratory tract. *American Review of Respiratory Diseases* 125:406-408, 1982.

Hoffmann, D., Adams, J.D., Brunnemann K.D., Hecht, S.S. Assessment of tobacco specific *N*-nitrosamines in tobacco products. *Cancer Research* 39:2505-2509, 1979 (a).

Hoffmann, D., Brunnemann, K.D. Endogenous formation of *N*-nitrosoproline in cigarette smokers. *Cancer Research* 43:5570-5574, 1983.

Hoffmann, D., Brunnemann, K.D., Prokopczyk, B., Djordjevic, M.V. Tobacco-specific *N*-nitrosamines and areca-derived N-nitrosamines: chemistry, biochemistry, carcinogenicity and relevance to humans. *Journal of Toxicology and Environmental Health* 41:1-5, 1994.

Hoffmann, D., Djordjevic, M.V., Hoffmann, I. The changing cigarette. *Preventive Medicine,* 26: 427-434, 1997.

Hoffmann, D., Dong, M., Hecht, S.S. Origin in tobacco smoke of *N'*-nitrosonornicotine, a tobacco-specific carcinogen. Brief Communication. *Journal of the National Cancer Institute* 58: 1841-1844, 1977

Hoffmann, D., Hoffmann, I. Chemical studies on tobacco smoke. The changing cigarette, 1950-1995. *Journal of Toxicology and Environmental Health* 50:307-364, 1997.

Hoffmann, D., Patrianakos, C.P., Brunnemann K.D., Gori, G.B. Chemical studies on tobacco smoke XXXVI. Chromatographic determination of vinyl chloride in tobacco smoke. *Analytical Chemistry* 48:47-50, 1976.

Hoffmann, D., Rathkamp, G., Brunnemann, K.D., Wynder, E.L. Chemical studies on tobacco smoke XXII. On the profile analysis of tobacco smoke. *Science of the Total Environment* 2:151-171, 1973.

Hoffmann, D., Rathkamp, G., Wynder, E.L. Comparison of the yields of several selected components in the smoke from different tobacco products. *Journal of the National Cancer Institute* 31:627-637, 1963.

Hoffmann, D., Rivenson, A., Hecht, S.S., Hilfrich, J., Kobayashi, N. Wynder, E.L. Model studies in tobacco carcinogenesis with the Syrian golden hamster. [Review]. *Progress in Experimental Tumor Research* 24:370-390, 1979(b).

Hoffmann, D., Sanghvi, L.D., Wynder, E.L. Comparative analysis of Indian bidi and American cigarette smoke. *International Journal of Cancer* 14:49-53, 1974.

Hoffmann, D., Wynder, E.L. Chemical studies on tobacco smoke XVIII. Smoke of cigarettes and little cigars. An analytical comparison. *Science* 178:1197-1199, 1972.

Homburger, F., Treger, A., Baker, J.R. Mouse skin painting with smoke condensates from cigarettes made of pipe, cigar and cigarette tobaccos. *Journal of the National Cancer Institute* 31:1445-1459, 1963.

Ingebrethsen, B.J., Sears, S.B. Particle size distribution measurements of sidestream smoke. *Abstract's 39th Tobacco Chemists Research Conference,* Montreal, Quebec, 1985.

International Agency for Research on Cancer. Beryllium and Beryllium compounds. *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans* 58: 41-117, 1993a.

International Agency for Research on Cancer. Tobacco Smoking. *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans* 38, 1986, p. 421.

International Agency for Research on Cancer. Overall evaluations of carcinogenic risk to humans: An updating of *IARC Monographs* Volumes 1-42, p. 440, Lyons, France, 1987.

International Agency for Research on Cancer. Nickel and Nickel Compounds. *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans* 49:257-445, 1990.

International Agency for Research on Cancer. DDT and associated compounds. *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*. 53:179-249, 1991.

International Agency for Research on Cancer. Cadnium and cadnium compounds. *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*. 58:119-237, 1993b.

International Agency for Research on Cancer. Ethyleneoxide. *ARC Monographs on the Evaluation of Carcinogenic Risks to Humans*. 60:73-159, 1994.

International Agency for Research on Cancer. Nitrobenzene. *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans.* 65:381-408, 1996.

International Committee for Cigar Smoke Study. Machine smoking of cigars. *Bulletin du Information CORESTA* 1:31-34, 1974.

Iskander, F.Y., Bauer, T.L., Klein, D.E. Determination of 28 elements in American cigarette tobacco by neutron-activation analysis. *Analyst* 111:107-109, 1986.

Jeffers, H.P., Gordon, K. *The Good Cigar*. New York: Lyons and Burford Publishers, 1996.

Jenkins, R.A., Palansky, A., Counts, R.W., Bayne, C.K., Dindall, A.B., Guerin, M.R. Exposure to environmental tobacco smoke in sixteen cities in the United States as determined by personal breathing zone air sampling. *Journal of Exposure, Analytical and Environmental Epidemiology* 6:473-502, 1996.

Kahn, H.A. The Dorn study on smoking and mortality among U.S. Veterans: Report on eight and one half years of observation. *National Cancer Institute Monographs* 19:1-125, 1966.

Keith, C.H., Derrick, J.C. Measurement of the particle size distribution and concentration of cigarette smoke by the conifuge. *Tobacco Science* 5:84-91, 1961.

Kensler, C.J. The pharmacology of tobacco smoke. Effects of chronic exposure. In: *Tobacco and Health*. G. James and T. Rosenthal (eds.) Springfield, IL: Charles G. Thomas Publishers, 1962, pp. 5-20.

Kensler, C.J., Battista, S.P. Components in cigarette smoke with ciliary depressant activity and their selective removal by filters containing activated charcoal granules. *New England Journal of Medicine* 269:1161-1169, 1963.

Kingsborough, E.K. *Antiquities of Mexico. Comparing facsimilies of ancient Mexican paintings*. London, 1831-1849.

Kirk, P.W.W., Hunter, M., Back, S.O., Lester, J.N., Perry, R. Environmental Tobacco and Indoor Air. In: *Indoor and Ambient Air Quality*. R. Perry and P.W.W. Kirk (eds.), London: Selper Ltd., 1988, pp. 99-112.

Klus, H. Distribution of mainstream and sidestream smoke components. *Recent Advances in Tobacco Science* 16:189-222, 1990.

LaVoie, E.J., Shigematsu, P.L., Adams, J.D., Hoffmann, D. Comparison of the steam-volatile components in cigarette, pipe and chewing tobaccos. *Journal of Agricultural and Food Chemistry* 33:876-879, 1985.

Lawson, F.R., Corley,C., Schechter, M.S. Insectide residues on tobacco during 1962. *Tobacco Science* 8:110-112, 1964.

Lederer, B.P., Hammond, S.K. Evaluation of vapor phase nicotine and respirable suspended particle mass as markers for environmental tobacco smoke. *Environmental Science and Technology* 25:770-777, 1991.

Löfroth, G., Burton, R.M., Forehand, I., Hammond, K.S., Seila, R.I., Zweidinger, R.B., Lewtas, J. Characterization of environmental tobacco smoke. *Environmental Science and Technology* 23:610-14, 1989.

Lopt, S., Vistisen, K., Ewertz, M., Tjonneland, A., Overvad, K., Poulsen, H.E. Oxidative DNA damage estimated by 8-hydroxydeoxyguanosine excretion in humans: influence of smoking, gender, and body mass. *Carcinogenesis* 13:2241-2247, 1992.

Martell, E.A. Radioactivity of tobacco trichomes and insoluble cigarette smoke particles. *Nature* 249 (5):215-217, 1974.

Miesner, E.A., Rudnick, S.N., Hu, P.-C., Spengler, J.D., Preller, I., Özkaynak, H., Nelson, W. Particulate and nicotine sampling in public facilities and offices. *Journal of the Air Pollution Control Association* 39:1577-1582, 1989.

Miller, J.E. Determination of the components of pipe tobacco smoke by means of a new pipe-smoking machine. Proceedings of the 3rd World Tobacco Scientific Congress. Salisbury, Rhodesia, CORESTA. February 1963, 11.

Morie, G.P. Fractions of protonate and unprotonated nicotine in tobacco smoke at various pH. *Tobacco Science* 16: p. 76, 1972.

Moshy, R.J. Reconstituted tobacco sheet. In: *Tobacco and Tobacco Smoke. Studies in Experimental Carcinogenesis*, E.L. Wynder and D. Hoffmann, (eds.) New York: Academic Press, 1967, pp. 47-83.

Muramatsu, M., Umemura, S., Okada, T., Tomita, H. Estimation of exposure to tobacco smoke with a newly developed nicotine personal monitor. *Environmental Research* 35:218-227, 1984.

Muramatsu, M., Umemura, S., Fukui, J., Arai, T., Kira, S. Estimation of personal exposure to ambient nicotine in daily environment. *International Archives of Occupational and Environmental Health* 59 (6): 545-550, 1987.

National Research Council. Environmental Tobacco Smoke. Measuring Exposures and Assessing Health Effects. National Academy Press: Washington, D.C., 1986.

Nelson, P.R., Kelly, S.P., Conrad, F.W. Environmental chamber test method for the quantitative comparison of environmental tobacco smoke generated by different cigarettes. Presented at a Conference on "Eclipse and the Reduction Strategy for Smoking". Duke University, Winston-Salem, North Carolina, August 29, 1996, p. 31.

Nelson, P.R., Kelly, S.P., Conrad, F.W. Generation of environmental tobacco smoke by cigars. Presented at the 51st Tobacco Chemists' Research Conference. Winston-Salem, North Carolina, September 14-17, 1997, p. 15.

Norman, V., Keith, C.H. Charged particles in cigarette smoke. *Tobacco Science* 9:75-79, 1975.

O'Hara, C.B. Cohabitation. How the cigar resurgence is affecting the cigarette industry. *Tobacco International* 198(4):39-41, 1996.

Ockene, J.K., Pechacek, T.F., Vogt,T., Svendsen, K. Does switching from cigarettes to pipes or cigars reduce tobacco smoke exposure? *American Journal of Public Health* 77(11):1412-1416, 1987.

Oldaker, G.B., III, Conrad, F.W., Jr. Estimation of the effect of environmental tobacco smoke on air quality within passenger cabins of commercial aircraft. *Environmental Science and Technology* 21:994-999, 1987.

Osdene, T.S. Reaction mechanisms in the burning cigarette. In *The Recent Chemistry of Natural Products Including Tobacco*. N. J. Fina, ed. Philip Morris Second Science Symposium; New York, Philip Morris, 42-59, 1976.

Osman, S., Barson, J. Hydrocarbons in cigar smoke. *Tobacco Science* 8:158-160, 1964.

Osman, S., Barson, J., Dooley, C.J. Paraffins of tobacco smoke. *Journal of the Association of Official Agricultural Chemists* 48:1059-1062, 1965.

Osman, S., Schmeltz, I., Higman, H.C., Stedman, R.L. Volatile phenols in cigar smoke *Tobacco Science* 7:141-143, 1963.

Pailer, M., Vollmin, J, Karninen, Ch., Kuhn, H. Über das Vorkommen von primären und sekundären Aminen im Zigarrenrauch. *Fachliche Mitteilungen der Österreichischen Tabakregie* 10:1-4, 1969.

Pechacek, T.F., Folsom, A.R., deGaudermaris, R., Jacobs, D.R., Jr., Luepker, R.V., Gillum R.F., Blackburn, H. Smoke exposure in pipe and cigar smokers: Serum thiocyanate measures. *Journal of the American Medical Association* 254 (23):3330-3332, 1985.

Peck, R.L., Osman, S.F., Barson, J.L. Cigar butt aroma. I. Preliminary study of cigar butt headspace vapors. *Tobacco Science* 13:38-39, 1969.

Pillsbury, H.C., Bright, C.C., O'Connor, J., Irish, F.W. Tar and nicotine in cigarette smoke. *Journal of the Association of Official Analytic Chemists* 52:458-462, 1969.

Posselt, W., Reimann, L. Chemische Untersuchungen des Tabaks und Darstellung des eigenthümlichen wirksamen Princips dieser Pflanze. *Geigers Magazin der Pharmazie* 24:138-161, 1828.

Rahman, A., Barrowman, J.A. and Rahimtula, A. The influence of bile on bioavailability of polycyclic aromatic hydrocarbons from rat intestine. *Canadian Journal of Physiology and Pharmacology* 64:1214-1218, 1996.

Ramsey, R.S., Moneghan, J.H., Jenkins, R.A. Generation, sampling, and chromatographic analysis of particulate matter in dilute sidestream tobacco smoke. *Analytica Chimica Acta* 236: 213-220, 1990.

Repace, J.L., Ott, W.R., Klepeis, N.E. indoor air pollution from cigar smoke. (Chapter 5) in: *Cigars: health effects and trends,* Monograph 9, D. Burns, K.M. Cummings, D. Hoffmann (eds.). USDHHS NIH NCI, Bethesda, MD. U.S. Department of Health and Humans Services, National Institutes of Health, 1998.

Rice, R.L., Scherbak, M. A method for measuring the burning characteristics of cigars. *Beiträge zur Tabakforschung* 8:326-329, 1976.

Rickert, W.S., Robinson, J.C., Bray, D.F., Roberts, B., Collishaw, N.E., Characterization of tobacco products: a comparative study of the tar, nicotine and carbon monoxide yield of cigars manufactured cigarettes and cigarettes made from fine cut tobacco. *Preventative Medicine* 14:226-233, 1985.

Roberts, D.L. Natural tobacco flavor. *Recent Advances in Tobacco Science* 14:49-113, 1988.

Russell, M.A.H. The case of the medium-nicotine, low-tar, low-carbon monoxide cigarette *Banbury Reports* 3:297-310, 1980.

Sato, S., Seino, Y., Ohka, T., Yahagi, T., Nagao, M., Matsushima, T., Sugimura, T. Mutagenicity of smoke condensates from cigarettes, cigars and pipe tobacco. *Cancer Letters* 3 (1-2):1-8, 1977.

Scassellati-Sforzolini, G., Savino, A. Evaluation of a rapid index of ambient contamination by cigarette smoke in relation to the composition of gas phases of the smoke. *Rivista Italiana di Igiene* 28:43-55, 1968.

Schmeltz, I., Brunnemann, K.D., Hoffmann, D., Cornell, A. On the chemistry of cigar smoke: Comparisons between experimental little and large cigars. *Beiträge zur Tabakforschung* 8:367-377, 1976a.

Schmeltz, I., dePaolis, A., Hoffmann, D. Phytosterols in tobacco: Quantitative analysis and fate in tobacco combustion. *Beiträge zur Tabakforschung* 8:211-218, 1975a.

Schmeltz, I. Hoffmann, D., Wynder, E.L. The influence of tobacco smoke on indoor atmospheres. I. An overview. *Preventive Medicine* 44:66-82, 1975b.

Schmeltz, I., Schlotzhauer, W.S. Volatile acids in cigar smoke. *Tobacco Science* 5:92-94, 1961.

Schmeltz, I., Tosk, J., Hoffmann, D. Formation and determination of naphthalenes in cigarette smoke. *Analytical Chemistry* 48:645-650, 1976 (b).

Schmeltz, I., Wenger, A., Hoffmann, D., Tso, T.C. Chemical studies on tobacco smoke. LXIII. On the fate of nicotine during pyrolysis and in a burning cigarette. *Journal of Agricultural and Food Chemistry* 27:602-608, 1979.

Schottenfeld, D. Epidemiology of cancer of the esophagus. *Seminars in Oncology* 11 (2):92-100, 1984.

Sheets, T.J. Pesticide residues on tobacco: Perceptions and realities. *Recent Advances in Tobacco Science* 17:33-69, 1991.

Sloan, C.H., Morie, G.P. Determination of unprotonated ammonia in whole cigarette smoke. *Beiträge zur Tabakforschung* 8:362-365, 1976.

Spears, A.W., Laser, C.W., Bell, J. Quantitative determination of alkalis in cigarette smoke. *Journal of Gas Chromatography* 1:34-37, 1963.

Stahly, EE, Lard, E.W. Further considerations of metal carbonyls in tobacco smoke. *Chemistry and Industry, London* pp. 85-86, 1977.

Stedman, R.L., Chamberlain, W.J., Miller, R.L. High molecular weight pigment in cigarette smoke. *Chemistry and Industry, London* pp. 1560-1562, 1966.

Sunderman, F.W. Sr., Sunderman, F.W. Jr. Nickel poisoning. XI. Implication of nickel as a pulmonary carcinogen in tobacco smoke. *American Journal of Clinical Pathology* 35:203-209, 1961.

Szadkowski, D., Harke, H.P., Angener, J. Burden of carbon monoxide from passive smoking in offices. *Innere Medizin* 3:310-313, 1976.

Thompson, C.V., Jenkins, R.A., Higgins, C.A. A thermal desorption method for the determination of nicotine in indoor environments. *Environmental Science and Technology* 23:429-435, 1989.

Touey, G.P., Mumpower, R.C.II. Combustion-zone temperatures in cigars and cigarettes. Meeting of the Cigar Manufacturers' Association of America Inc. Atlantic City, NJ, Dec 4-5, 1957.

Touey, G.P., Mumpower, R.C.II. Measurement of the combustion-zone temperatures of cigarettes. *Tobacco Sci*ence 1:33-37, 1957b.

Tso T.C. Production, Physiology and Biochemistry of the Tobacco Plant. Beltsville, MD: IDEALS Inc., 1990.

Tso, T.C., Harley, N., Alexander, L.T. Radium-226 and polonium-210 in burley and cigar wrapper tobacco. *Tobacco Science* 10:105-106, 1966 (a).

Tso, T.C., Harley, N., Alexander, L.T. Source of lead-210 and polonium-210 in tobacco, *Science* 153:880-882, 1966 (b).

Turner, J.A., McM, Sillett, R.W., McNicol, M.W. Effect of cigar smoking on carboxyhemoglobin and plasma nicotine concentrations in primary pipe and cigar smokers and in cigarette smokers. *British Medical Journal* 2:1387-1389, 1977.

U.S. Department of Health, Education, and Welfare. *The Health Consequences of Smoking. A Report of the Surgeon General: 1972.* U.S. Department of Health, Education, and Welfare, Public Health Services and Mental Health Administration. DHEW Publication No. (HSM) 72-7516, 1972.

U.S. Department of Health, Education, and Welfare. *Smoking and Health. A Report of the Surgeon General.* U.S. Department of Health, Education, and Welfare, Public Health Service, Office of the Assistant Secretary for Health, Office on Smoking and Health. DHEW Publication No. (PHS) 79-50066, 1979.

U. S. Department of Health and Human Services. *The Health Consequences of Involuntary Smoking. A Report of the Surgeon General*. DHHS (CDC) 87-8398, Washington D.C., 1986.

U. S. Department of Health and Human Services. *The Health Consequences of Smoking. Nicotine Addiction. A Report of the Surgeon General*. DHHS Publication No. (CDC) , 88-8406. Rockville, MD. U.S. Dept of Health and Human Services. Office on Smoking and Health, 1988.

U. S. Department of Health and Human Services. *Reducing the Health Consequences of Smoking: 25 Years of Progress. A Report of the Surgeon General*. DHHS Public No. (CDC) 89-8411, Washington D.C., 1989.

U. S. Department of the Treasury, Bureau of Alcohol, Tobacco & Firearms. *Tobacco-Subpart B. Definitions of cigars. Federal Register*, pp. 141-143, April 1, 1996.

U. S. Environmental Protection Agency. *Maleic hydrazide. Notification of issuing of intent to suspend pesticide registrations, Federal Register* 46 (179):45999-46000, 1981.

U. S. National Council on Radiation Protection and Measurement. *Ionizing radiation exposure of the population of the United States*. National Council on Radiation Protection Rept. 93, Bethesda, MD, 1987.

Van der Boor, P. Consistent high quality , a telling mark of the machine-made cigar *Tobacco Journal International* 35186, 32-35, 1996.

Voges, E. Tobacco Encyclopedia. *Tobacco Journal International*, Mainz, Germany, 1984.

Wald, N.J., Idle, M., Boreham, J., Bailey, A. Carbon monoxide in breath in relation to smoking and carboxyhemoglobin levels. *Thorax* 36:366-369, 1981.

Weber, A., Fischer, T. Passive smoking at work. *International Archives of Occupational and Environmental Health* 47 (31):209-221, 1980.

Wiernik, A., Christakopoulos A., Johansson, L., Wahlberg, I. Effect of air-curing on chemical composition of tobacco. *Recent Advances in Tobacco Science* 21:39-80, 1995.

Wolf, F. A. Tobacco production and processing. In: *Tobacco and Tobacco Smoke: Studies in Experimental Carcinogenesis*. E.L. Wynder and D. Hoffmann, (eds.) New York: Academic Press, 5-41, 1967.

Wynder, E.L., Hoffmann, D., eds. Tobacco and Tobacco Smoke: Studies in Experimental *Carcinogenesis*, New York, Academic Press, 1967.

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

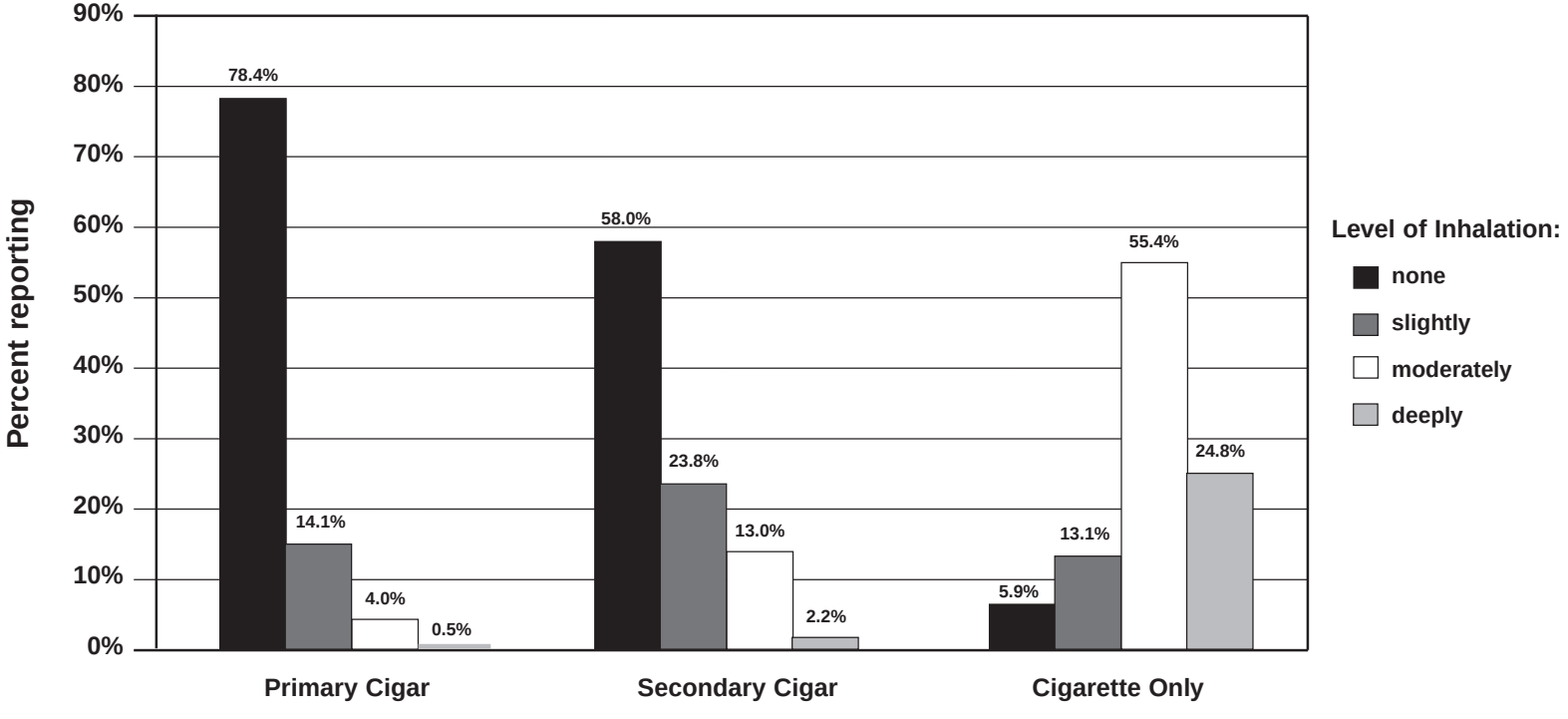


Table 2

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

Prospective Studies	Sample Size*	Never-Smoker	Rate Ratio (RR)		
			Cigar	Mixed, Cigar & Cigarette	Cigarette
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 MORTALITY There is a consistent pattern of elevated overall mortality for all groups 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) 35-49	50-64	65-79	80+	Combined (95% CI)	Deaths*
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) 35-49	50-64	65-79	80+	Combined (95% CI)	Deaths*
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.*

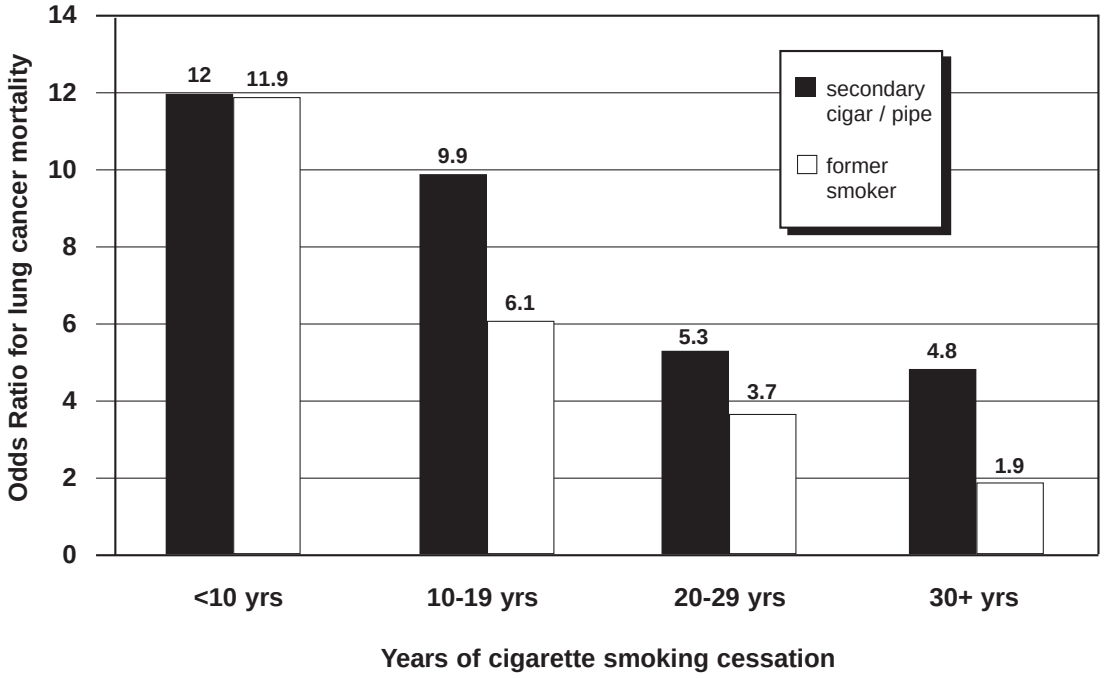
***Cigar and pipe combined.*

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) 35-49	50-64	65-79	80+	Combined (95% CI)		Deaths*
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) 35-49	50-64	65-79	80+	Combined (95% CI)		Deaths*
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.

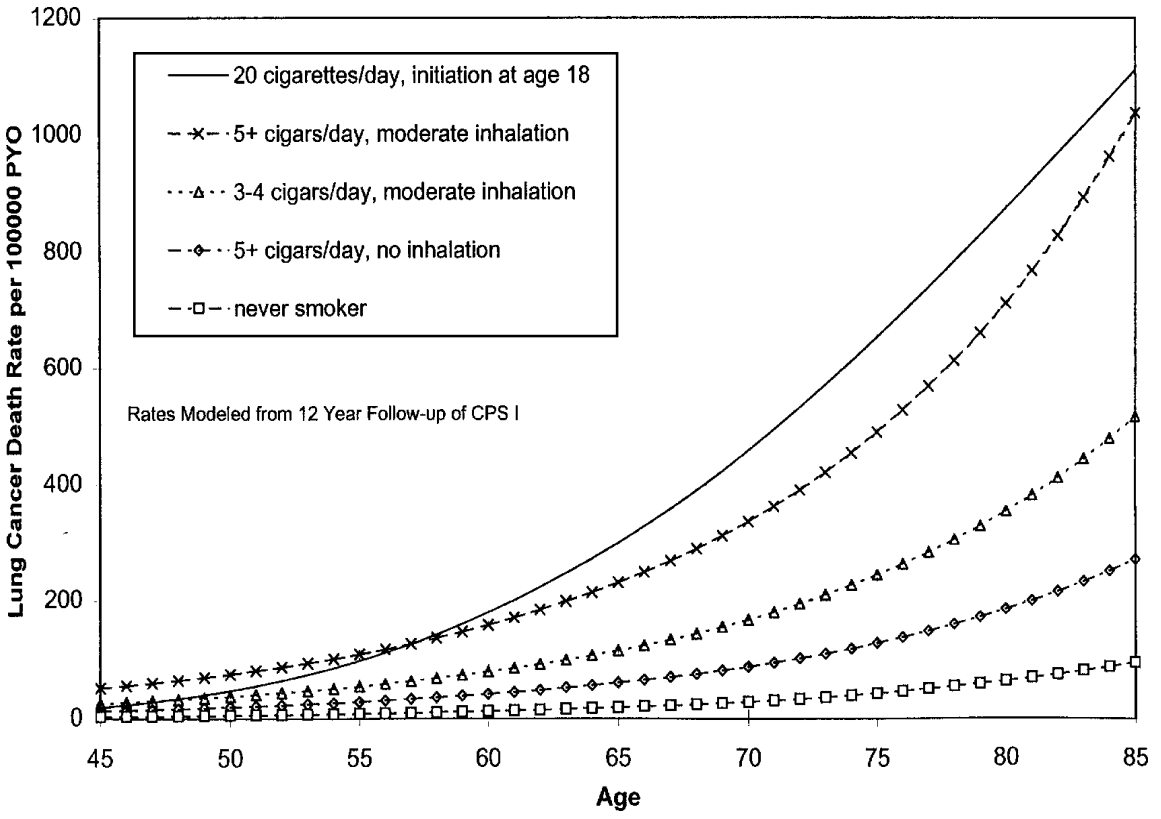
Blot et al. (1988) report a case-control study of 1,114 oral and pharyngeal cancer cases, excluding salivary and nasopharyngeal carcinoma, with 1,268

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			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) 35-49	50-64	65-79	80+	Combined (95% CI)	Deaths**
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) 35-49	50-64	65-79	80+	Combined (95% CI)	Deaths**
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)					
	35-49	50-64	65-79	80+	Combined (95% CI)	Deaths**
			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)					
	35-49	50-64	65-79	80+	Combined (95% CI)	Deaths**
			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 The esophagus is exposed to the carcinogens from tobacco smoke 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 URINARY SYSTEM CANCERS In a case-control study of 75 bladder cancer cases of both sexes in northern New Jersey primarily focused on industrial chemical 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)						
Daily Use	35-49	50-64	65-79	80+	Combined (95% CI)		Deaths**
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)						
Level of Inhalation	35-49	50-64	65-79	80+	Combined (95% CI)		Deaths*
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)

			Odds Ratio (OR)		
	Sample Size*	Never-Smoker	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*

	Age (years)						
Daily Use	35-49	50-64	65-79	80+	Combined (95% CI)		Deaths**
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)

			Odds Ratio (OR)		
	Sample Size*	Never-Smoker	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*

	Age (years)						
Daily Use	35-49	50-64	65-79	80+	Combined (95% CI)		Deaths**
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	Odds Ratio (OR) Cigar	Mixed, Cigar & Cigarettes	Cigarette
Case-Control Studies					
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*

Smoking group	RR of First Acute MI	
	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
≥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) 35-49	50-64	65-79	80+	Combined (95% CI)		Deaths**
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) 35-49	50-64	65-79	80+	Combined (95% CI)		Deaths*
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*

	Age (years)					
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)	

**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) 35-49	50-64	65-79	80+	Combined (95% CI)	Deaths**
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*	Never-Smoker	Rate Ratio (RR) 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)		1.74 (1.64-1.83)
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) 35-49	50-64	65-79	80+	Combined (95% CI)		Deaths**
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) 35-49	50-64	65-79	80+	Combined (95% CI)		Deaths*
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	Rate Ratio (RR) Cigar	Mixed, Cigar & Cigarette	Cigarette
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*

	Age (years)						
Daily Use	35-49	50-64	65-79	80+	Combined (95% CI)		Deaths**
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

	Age (years)						
Level of Inhalation	35-49	50-64	65-79	80+	Combined (95% CI)		Deaths*
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.

REFERENCES

Abelin, T., Gsell, O.R. Relative risk of pulmonary cancer in cigar and pipe smokers. *Cancer* 20:(8)1288-1296, 1967.

Ben-Shlomo, Y., Smith, G.D., Shipley, M.J., Marmot, M.G. What determines mortality risk in male former cigarette smokers? *American Journal of Public Health* 84:1235-1242, 1994.

Benhamou, S., Benhamou, E., Flamant, R. Lung cancer risk associated with cigar and pipe smoking. *Cancer* 37:825-829, 1986.

Best, E.W.R., McGregor, J.T. *A Canadian study of smoking and health*. Ottawa, Department of National Health and Welfare, 1966.

Blot, W.J., McLaughlin, J.K., Winn, D.M., Austin, D.F., Greenberg, R.S., Preston-Martin, S., Bernstein, L., Schoenberg, J.B., Stemhagen, A., Fraumeni, J.F., Jr. Smoking and drinking in relation to oral and pharyngeal cancer. *Cancer Research* 48:3282-3287, 1988.

Breslow, N.B., Day, N.E. *Statistical Methods in Cancer Research. The Analysis of Cohort Studies*. Volume 1. IARC Scientific Publication No. 32. International Agency for Research on Cancer, 1980.

Breslow, N.B., Day, N.E. *Statistical Methods in Cancer Research. The Design and Analysis of Cohort Studies*. Volume 2. IARC Scientific Publication No. 82. International Agency for Research on Cancer, 1987.

Broders, A.C. Squamous-cell epithelioma of the lip. A study of five hundred and thirty-seven cases. *Journal of the American Medical Association* 74:(10)656-664, 1920.

Bueno de Mesquita, H.B., Maisonneuve, P., Moerman, C.J., Runia, S., Boyle, P. Life-time history of smoking and exocrine carcinoma of the pancreas: A Population-based Case-Control Study in the Netherlands. *International Journal of Cancer* 49: 816-822, 1991.

Burch, J.D., Howe, G.R., Miller, A.B., Semenciw, R. Tobacco, alcohol, asbestos, and nickel in the etiology of cancer of the larynx: A Case-Control Study. *Journal of the National Cancer Institute* 67:(6)1219-1224, 1981.

Burch, J.D., Rohan, T.E., Howe, G.R., Risch, H.A., Hill, G.B., Steele, R., Miller, A.B. Risk of bladder cancer by source and type of tobacco exposure: A Case-Control Study. *International Journal of Cancer* 44:622-628, 1989.

Carstensen, J.M., Pershagen, G., Eklund, G. Mortality in relation to cigarette and pipe smoking: 16 years' observation of 25000 Swedish men. *Journal of Epidemiology and Community Health* 41:166-172, 1987.

Chow, W.H., McLaughlin, J.K., Hrubec, Z., Nam, J.M., Blot, W.J. Tobacco use and nasopharyngeal carcinoma in a cohort of US veterans. *International Journal of Cancer* 55:538-540, 1993.

Doll, R., Peto, R. Mortality in relation to smoking: 20 years' observations on male British doctors. *British Medical Journal* 2:(6051)1525-1536, 1976.

Ebenius, B. Cancer of the lip. A clinical study of 778 cases with particular regard to predisposing factors and radium therapy. *Acta Radiologica* 24:(Supplement 48)1-232, 1943.

Farrow, D.C., Davis, S. Risk of pancreatic cancer in relation to medical history and the use of tobacco, alcohol and coffee. *International Journal of Cancer* 45:816-820, 1990.

Franceschi, S., Talamini, R., Barra, S., Baron, A.E., Negri, E., Bidoli, E., Serraino, D., La Vecchia, C. Smoking and drinking in relation to cancers of the oral cavity, pharynx, larynx, and esophagus in northern Italy. *Cancer Research* 50:6502-6507, 1990.

Franceshci, S., Barra, S., La Vecchia, C., Bidoli, E., Negri, E., Talamini, R. Risk factors for cancer of the tongue and the mouth: a case-control study from northern Italy. *Cancer* 70:(9)2227-2233, 1992.

Freudenheim, J.L., Grahman, S., Byers, T.E., Marshall, J.R., Haughey, B.P., Swanson, M.K., Wilkinson, G. Diet, smoking, and alcohol in cancer of the larynx: a case-control study. *Nutrition and Cancer* 17:33-45, 1992.

Garfinkel, L. Selection, follow-up, and analysis in the American Cancer Society prospective studies. *National Cancer Institute Monograph 67* 49-52, 1985.

Gyntelberg, F., Pedersen, P.B., Lauridsen, L., Schubell, K. Smoking and risk of myocardial infarction in Copenhagen men aged 40-59 with special reference to cheroot smoking. *Lancet* 1:(8226)987-989, 1981.

Haheim, L.L., Holme, I., Hjermann, I., Leren, P. Smoking habits and risk of fatal stroke: 18 years follow up of the Oslo study. *Journal of Epidemiology and Community Health* 50:621-624, 1996.

Hammond, E.C. Smoking in relation to the death rates of one million men and women. In: *Epidemiological Approaches to the Study of Cancer and Other Chronic Diseases*, Haenszel, W. (Editor). National Cancer Institute Monograph 19. National Institutes of Health pp. 127-204, 1966.

Hammond, E.C., Horn, D. Smoking and death rates—report on forty-four months of follow-up of 187,783 men. I. Total mortality. *Journal of the American Medical Association* 166:(10) 1159-1172, 1958.

Hartge, P., Hoover, R., Kantor, A. Bladder cancer risk and pipes, cigars and smokeless tobacco. *Cancer* 55:901-906, 1985.

Herling, S., Kozlowski, L.T. The importance of direct questions about inhalation and daily intake in the evaluation of pipe and cigar smokers. *Preventive Medicine* 17:73-78, 1988.

Higgins, I.T.T., Mahan, C.M., Wynder, E.L. Lung cancer among cigar and pipe smokers. *Preventive Medicine* 17:116-128, 1988.

International Agency for Research on Cancer. *Tobacco Smoking. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans*. Volume 38. IARC Scientific Publication No. 32., 1986.

Jajich, C.L., Ostfeld, A.M., Freeman, D.H., Jr. Smoking and coronary heart disease mortality in the elderly. *Journal of the American Medical Association* 252:(20)2831-2834, 1984.

Jensen, O.M., Wahrendorf, J., Blettner, M., Knudsen, J.B., Sorensen, B.L. The Copenhagen case-control study of bladder cancer: role of smoking in invasive and non-invasive bladder tumours. *Journal of Epidemiology and Community Health* 41:30-36, 1987.

Joly, O.G., Lubin, J.H., Caraballoso, M. Dark tobacco and lung cancer in Cuba. *Journal of the National Cancer Institute* 70:(6)1033-1039, 1983.

Kahn, J.A. The Dorn study of smoking and mortality among U.S. veterans: report on eight and one-half years of observation. In: Haenszel, W. (Editor). Epidemiological Approaches to the Study of Cancer and Other Chronic Diseases. *National Cancer Institute Monograph* 19:1-125, 1966.

Kaufman, D.W., Palmer, J.R., Rosenberg, L., Shapiro, S. Cigar and pipe smoking and myocardial infarction in young men. *British Medical Journal* 294:1315-1316, 1987.

Keller, A.Z. Cellular types, survival, race, nativity, occupations, habits and associated diseases in the pathogenesis of lip cancers. *American Journal of Epidemiology* 91:(5)486-499, 1970.

Kunze, E., Chang-Claude, J., Frentzel-Beyme, R. Life style and occupational risk factors for bladder cancer in Germany. *Cancer* 69:(7)1776-1790, 1992.

Lange, P., Nyboe, J., Appleyard, M., Jensen, G., Schnohr, P. Relationship of the type of tobacco and inhalation pattern to pulmonary and total mortality. *European Respiratory Journal* 5:(9) 1111-1117, 1992.

Levin, M.L., Goldstein, H., Gerhardt, P.R. Cancer and tobacco smoking. A preliminary report. *Journal of the American Medical Association* 143:(4)336-338, 1950.

Lombard, H.L., Snegireff, L.S. An epidemiological study of lung cancer. *Cancer* 12:(2)406-413, 1959.

Lubin, J.H., Richter, B.S., Blot, W.J. Lung cancer risk with cigar and pipe use. *Journal of the National Cancer Institute* 73:(2)377-381, 1984.

Martinez, I. Factors associated with cancer of the esophagus, mouth and pharynx in Puerto Rico. *Journal of the National Cancer Institute* 42:(6)1069-1094, 1969.

Martinez, I. Retrospective and prospective study of carcinoma of the esophagus, mouth, and pharynx in Puerto Rico. *Boletin de la Asociacion Medica de Puerto Rico* 62:(6)170-178, 1970.

Matroos, A., Magnus, K., Strackee, J. Fatal and nonfatal coronary attacks in relation to smoking in some Dutch communities. *American Journal of Epidemiology* 109:(2)145-151, 1979.

Merletti, F., Boffetta, P., Ciccone, G., Mashberg, A., Terracini, B. Role of tobacco and alcoholic beverages in the etiology of cancer of the oral cavity/ oropharynx in Torino, Italy. *Cancer Research* 49:4919-4924, 1989.

Mills, C.A., Porter, M.M. Tobacco smoking habits and cancer of the mouth and respiratory system. *Cancer Research* 10:539-542, 1950.

Mills, C.A., Porter, M.M. Tobacco smoking, motor exhaust fumes, and general air pollution in relation to lung cancer incidence. *Cancer Research* 17:(6)981-990, 1957.

Mommsen, S., Aagaard, J. Tobacco as a risk factor in bladder cancer. *Carcinogenesis* 4:(3)335-338, 1983.

Morrison, A.S., Buring, J.E., Verhoek, W.G., Aoki, K., Leck, I., Ohno, Y., Obata, K. An international study of smoking and bladder cancer. *Journal of Urology* 131:(4)650-654, 1984.

Muscat, J.E., Stellman, S.D., Hoffmann, D., Wynder, E.L. Smoking and pancreatic cancer in men and women. *Cancer Epidemiology, Biomarkers and Prevention* 6:15-19, 1997.

Muscat, J.E., Wynder, E.L. Tobacco, alcohol, asbestos, and occupational risk factors for laryngeal cancer. *Cancer* 69:(9)2244-2251, 1992.

Najem, G.R., Louria, D.B., Seebode, J.J., Thind, I.S., Prusakowski, J.M., Ambrose, R.B., Fernicola, A.R. Life time occupation, smoking, caffeine, saccharine, hair dyes and bladder carcinogenesis. *International Journal of Epidemiology* 11:(3)212-217, 1982.

National Cancer Institute. *Changes in Cigarette-Related Disease Risks and Their Implication for Prevention and Control*. Smoking and Tobacco Control Monograph 8. NIH Publication No. 97-4213. National Institutes of Health, 1997.

Nyboe, J., Jensen, G., Appleyard, M., Schnohr, P. Smoking and the risk of first acute myocardial infarction. *American Heart Journal* 122:(2)438-447, 1991.

Pernu, J. An Epidemiological study on cancer of the digestive organs and respiratory system. A study based on 7,078 cases. *Annales Medicinae Internae Fenniae* 49:(Supplement 33) 1-117, 1960.

Randig, K. Untersuchungen zur aetiologie des bronchialkarzinoms (Investigations on the aetiology of bronchial carcinoma). *Oeffentliche Gesundheitsdienst* 16:(9)305-313, 1954.

Rothman, K.J. *Modern Epidemiology*. Boston/Toronto: Little, Brown and Company, 1986.

Sadowsky, D.A., Gilliam, A.G., Cornfield, J. The statistical association between smoking and carcinoma of the lung. *Journal of the National Cancer Institute* 13:(5)1237-1258, 1953.

Sandler, D.P., Comstock, G.W., Helsing, K.J., Shore, D.L. Deaths from all causes in non-smokers who lived with smokers. *American Journal of Public Health* 79:(2)163-167, 1989.

Schrek, R., Baker, L.A., Ballard, G.P., Dolgoff, S. Tobacco smoking as an etiologic factor in disease. I. Cancer. *Cancer Research* 10:(1)49-58, 1950.

Schwartz, D., Flamant, R., Lellouch, J., Denoix, P.-F. Results of a French survey on the role of tobacco, particularly inhalation, in different cancer sites. *Journal of the National Cancer Institute* 26:(5)1085-1108, 1961.

Slattery, M.L., Schumacher, M.C., West, D.W., Robinson, L.M. Smoking and bladder cancer. *Cancer* 61:402-408, 1988.

Spitz, M.R., Fueger, J.J., Goepfert, H., Hong, W.K., Newell, G.R. Squamous cell carcinoma of the upper aerodigestive tract: a case comparison analysis. *Cancer* 61:203-208, 1988.

Staszewski, J. Palenie a rak wargi, jamy ustnej, migdalkow i krtani (Tobacco smoking and its relation to cancer of the mouth, tonsils and larynx). *Nowotwory* 10:(2)121-132, 1960.

U.S. Department of Health and Human Services. *The Health Consequences of Smoking. Report of the Surgeon General*. DHEW Publication No.(HSM) 73-8704, 1973.

U.S. Department of Health and Human Services. *Smoking and Health. Other Forms of Tobacco Use. Chapter 13. Report of the Surgeon General*. DHEW Publication No.(PHS) 79-50066, 1979.

Wald, N.J., Watt, H.C. Prosepective study of effect of switching from cigarettes to pipes or cigars on mortality from three smoking related diseases. *British Medical Journal* 314:1860-1863, 1997.

Wannamethe, S.G., Shaper, A.G., Whincup, P.H., Walker, M. Smoking cessation and the risk of stroke in middle-aged men. *Journal of the American Medical Association* 274:(2)155-160, 1995.

Wicken, A.J. Environmental and personal factors in lung cancer and bronchitis mortality in
Northern Ireland, 1960-62. Research Paper 9. London. *Tobacco Research Council* 84, 1966.

Wynder, E.L., Bross, I.J. A study of etiological factors in cancer of the esophagus. *Cancer* 14:(2)389-413,1961.

Wynder, E.L., Cornfield, J. Cancer of the lung in physicians. *New England Journal of Medicine* 248:(11)441-444, 1953.

Wynder, E.L., Graham, E.A. Tobacco smoking as a possible etiologic factor in bronchiogenic carcinoma: A Study of Six Hundred and Eighty-four Proved Cases. *Journal of the American Medical Association* 143:(4)329-336, 1950.

Wynder, E.L., Hultberg, S., Jacobsson, F., Bross, I.J. Environmental factors in cancer of the upper alimentary tract. A Swedish study with special reference to Plummer-Vinson (Paterson-Kelly) syndrome. *Cancer* 10:(3)470-487, 1957.

Wynder, E.L., Mabuchi, K., Beattie, E.J., Jr. The epidemiology of lung cancer. Recent trends. *Journal of the American Medical Association* 213:(13)2221-2228, 1970.

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.

Indoor Air Pollution From Cigar Smoke

James L. Repace, Wayne R. Ott, and Neil E. Klepeis

INTRODUCTION Smoking in enclosed spaces exposes occupants to indoor air pollution from the by-products of tobacco combustion in confined spaces where airborne contaminant removal is slow and uneven. This chapter investigates the factors determining the indoor environmental tobacco smoke exposure from cigar smoking. Mathematical models allow the prediction of the levels of indoor pollutants, such as environmental tobacco smoke (ETS).

The physical design of the cigar, leaf type and composition, and wrapper type may all affect the cigar emissions (Schmeltz et al., 1976) (Chapter 3). For a given composition, the mass of a cigar consumed during smoking is the primary determinant of the quantity of its emissions. The greater mass of tobacco in cigars relative to cigarettes leads to a prolonged smoking time and greater total emissions when a single cigar is smoked compared to a single cigarette. An alternate means of comparing emissions from cigars with those of cigarettes is to compare the emission per minute or per gram of tobacco burned. Both the emission rates and the number of minutes a tobacco product is smoked need to be considered when comparing the contribution of cigars and cigarettes to ETS. The emissions of cigars differ from those of cigarettes due to differences in construction and engineering and differences in tobacco leaf (Chapter 3). The number of puffs taken to smoke a large cigar is dependent on the size of the cigar and may be as high as 100, whereas for a cigarette, it is approximately 10 (Rickert et al., 1985).

MATHEMATICAL MODELS FOR CIGAR ETS CONCENTRATIONS ETS concentrations of indoors can be predicted with reasonable accuracy by application of a mass balance model (Leaderer, 1990). This model shows that the average concentration, Z_{ave}, of ETS pollutants in indoor air is directly proportional to the pollutant mass emission rate and inversely proportional to the rate at which a unit volume of indoor air is cleared of ETS (Ott et al., 1992; Leaderer, 1990; Repace, 1987a,b).

Ott et al.(1992) have shown that the time-averaged ETS concentration Z_{ave} (in units of $\mu g/m^3$), is given by:

$$Z_{ave} = g_c n_{ave} / \phi v \qquad (1)$$

where g_c is the cigar emission rate in units of $\mu g/min$, n_{ave} is the average number of cigars being smoked during the averaging time ΔT, where the generation rate need not be uniform, i.e., the number of cigars being smoked at any instant may vary. We define $n_{ave} = t_s/\Delta T$ where t_s is the total duration of smoking (Repace et al., 1996). The quantity $\phi = q\phi_v$ is the effective air exchange rate in units of hr^{-1}, ϕ_v is the air exchange rate due to ventilation alone, and v is the space volume in units of m^3. The term q is an empirically-derived factor ($q \geq 1$) expressing the

increase in removal over ventilation alone due to such processes as surface sorption of particulate matter (Repace, 1987). The estimation accuracy of this equation improves as the correction term $\Delta Z/\phi\Delta T$ becomes small compared to Z_{ave}, where ΔZ is the difference between the initial and final observed concentrations (Ott et al., 1996).

For each individual cigar (Repace, 1987), the change over time of the ETS pollutant concentration during smoking, assuming a uniform generation rate, is given by Z(t), the concentration at time t where e is the base of natural logarithms:

$$Z(t) = Z_{eq}(1 - e^{-\phi t}) \qquad (2)$$

After a long time period, the pollutant concentration approaches an equilibrium value Z_{eq}, but most cigars typically are extinguished before reaching their equilibrium value. The equilibrium value is a function of the emissions space volume and ventilation rate and is defined by the equation.

$$Z_{eq} = g_c / \phi\nu \qquad (3)$$

Once smoking has ended, at a time t_s, the concentration will decay as:

$$Z(t) = Z(t_s)\, e^{-\phi(t - t_s)} \qquad (4)$$

where $Z(t_s)$ is given by Equation 2 with $t = t_s$. Equations 2 through 4 are illustrated in Figure 1.

Equations 1 through 4 allow the results from field surveys and chamber experiments to be generalized, estimating concentrations for pollutants from ETS in a variety of indoor settings. These predictions require determination of the values of n_{ave}, g_c, ν, and ϕ. It is possible to determine ϕ by experiment and to measure or estimate ν, and to determine ϕ_v from either measurement or estimation from tables of ventilation rates (Repace, 1987). The emission factor, g_c, must be measured for the ETS constituent of interest.

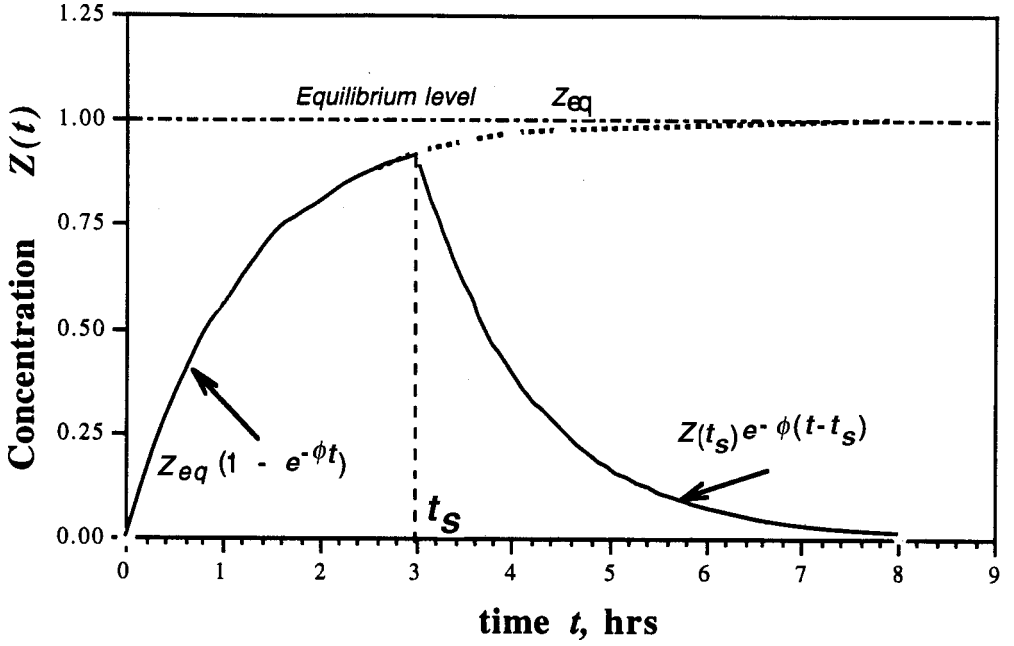
CIGAR EMISSIONS: MACHINE SMOKING

The chemical composition of cigar smoke is described elsewhere in this monograph (Chapter 3).

Sidestream smoke is the major contributor to ETS for cigarettes (Adams et al., 1987; Surgeon General (SG), 1986); there is little available data on the relative amounts of sidestream and exhaled mainstream smoke for cigars. On a per-cigar basis, large cigars deliver substantially higher amounts of carbon monoxide (CO) and other sidestream gas-phase constituents than little cigars or cigarettes, and substantially higher amounts of sidestream ammonia (Schmeltz, et al., 1976). Armitage et al. (1978) collected the exhaled mainstream and sidestream smoke of seven male habitual smokers of both little cigars and cigarettes and reported that the sidestream nicotine emissions averaged 30.9 percent $\pm$ 5.4 percent of total cigar nicotine, while exhaled mainstream smoke averaged 12.7 percent $\pm$ 9.0 percent. The cigar butt retained 20.1 percent $\pm$ 8.8 percent, while the smoker retained the remainder, in an amount similar to cigarette smoking.

Figure 1.

Growth and decay of the concentration (in normalized units) of an ETS pollutant as a function of time (in hours) as predicted by the mass balance model (solid line), respectively given by Equations 2 and 4 in the text. In this example, the air exchange rateϕ = 0.84 hour^{-1}, is equivalent to the ASHRAE Standard for an office, and is slightly higher than the average closed window air exchange rate for a home. Smoking begins at time t = 0, and ends at time t_s = 3 hours. The figure represents the concentration from three cigars of 1 hour duration each smoked over a 3-hour period; the average number of cigars smoked during the 3-hour period, is thus 1, from Equation 1. The concentration at the end of the three hour smoking period is calculated by Equation 2 as $Z(3) = 0.93\ Z_{eq}$. The dashed curve shows the concentration which would occur if smoking continued; after a long time, the equilibrium concentration Z_{eq}, described by Equation 3 in the text, is approached. The actual decay of concentration after smoking ceases is given by Equation 4.



CIGAR EMISSIONS: HUMAN SMOKING

Machine smoking in chambers under standard conditions can provide a comparison of the relative emissions of various tobacco products. However, in order to understand how differences among tobacco products affect ETS concentrations, we must also measure emissions and concentrations when cigars are smoked by human smokers who, unlike machines, smoke idiosyncratically.

Emissions of RSP, CO, and Nicotine from Cigars

Repace and Lowrey (1982) measured Respirable Suspended Particles RSP (particles less than 3.5 microns in aerodynamic diameter) and CO emissions of a popular-priced, mass-market cigar (Marsh-Wheeling Stogie, length ≈5-1/2", ring size ≈38, mass ≈7 g) smoked in a well-mixed volume $\nu = 51$ m^3 in a mechanically ventilated office building. The logarithms of the RSP and CO concentrations plotted versus time show a straight-line decay pattern from which the air exchange rate can be calculated (Figure 2).

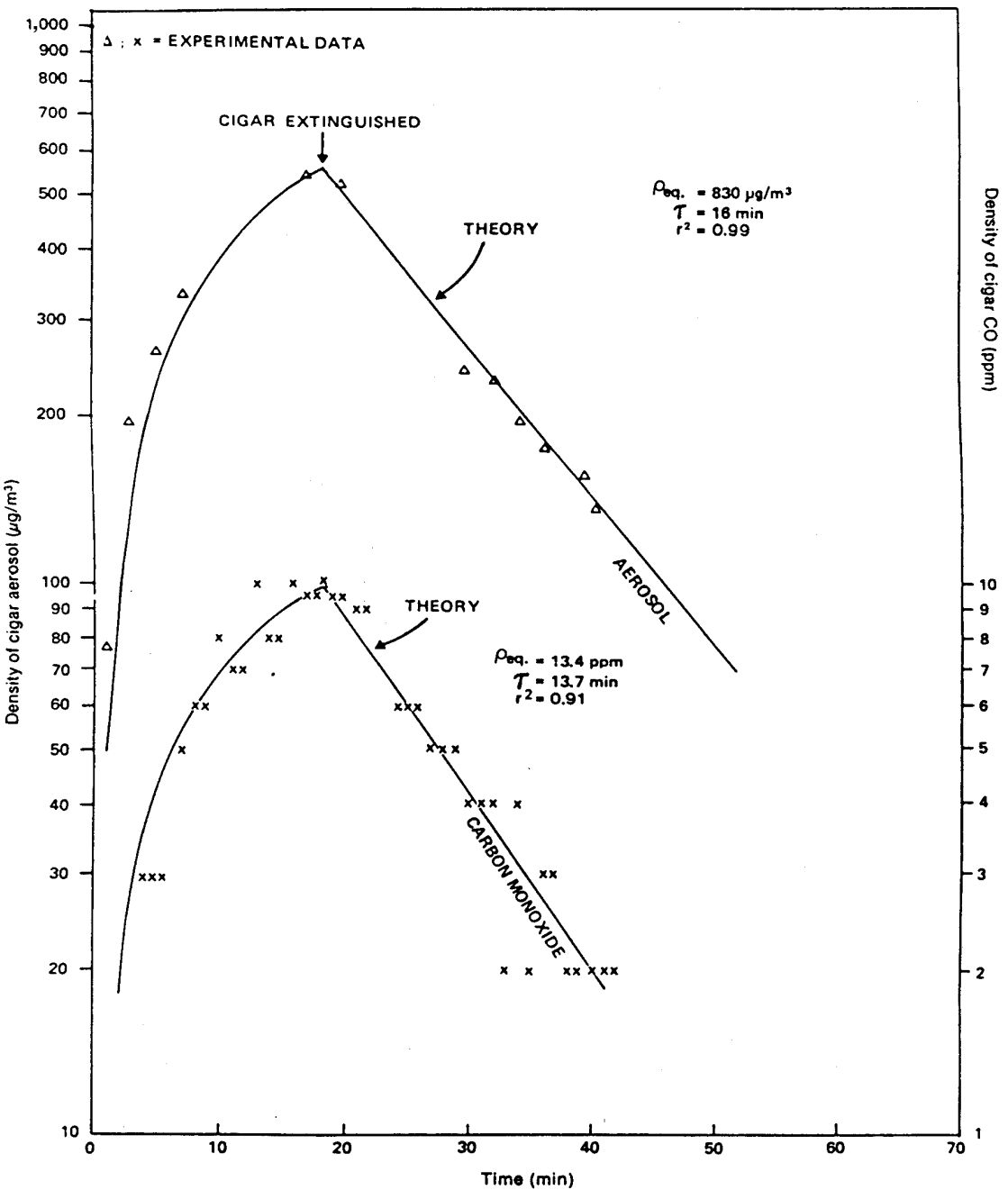
The cigar was smoked by a regular cigar smoker for 20 minutes, yielding a predicted equilibrium of $Z_{eq} = 830$ μg/m^3 for RSP and 13.4 ppm (15,340 μg/m^3) for CO, calculated using Equation 3. The total calculated RSP emissions were $G_{RSP} = 51\text{m}^3 \times 830\ \mu\text{g/m}^3 \times 20\ \text{min} / 16\ \text{min} = 52.9$ mg, and the RSP emission rate was $g_{RSP} = G_{RSP}/t_s = 52.9\ \text{mg}/20\ \text{min} = 2.65$ mg/min. For CO, the total emissions were $G_{CO} = (51\ \text{m}^3 \times 15{,}340\ \mu\text{g/m}^3 \times 20\ \text{min}) / 13.7\ \text{min} = 1142$ mg, using $\tau = 1/\phi = 13.7$ min ($\phi = 4.38\ \text{hr}^{-1}$) yielding a CO emission rate of $g_{CO} = G_{CO}/t_s = 57.12$ mg/min. Neither the fraction of the cigar smoked nor the after-smoking weight was recorded.

In 1978, by comparison, a single king-sized Marlboro was smoked by a smoker for $t_s = 5.33$ mins in a $\nu = 29$ m^3 unventilated but well-mixed bedroom with the windows and door closed (Repace and Lowrey, 1980). The value of $Z_{eq} = 1773$ μg/m^3 for ETS-RSP was calculated using Equations 2 and 4, and the mean residence time for the RSP was $\tau = 16.39$ mins ($R^2 = 0.80$). Using Equation 3 (with $\phi = 1/\tau$), the total RSP emissions were calculated to be $G_{RSP} = 29\ \text{m}^3 \times 1773\ \mu\text{g/m}^3 \times 5.33\ \text{min} / 16.39\ \text{min} = 16.72$ mg per cigarette, and the RSP emission rate was $g_{RSP} = G_{RSP}/t_s = 3.14$ mg/min. The cigarette RSP emission rate is actually higher than the cigar, although the total RSP emissions of the cigar are much greater due to the four-fold greater smoking duration and larger mass of tobacco in the cigar.

Leaderer and Hammond (1991) measured the emissions of 10 U.S. brands of cigarettes and 1 cigar (a cigarillo -- B. Leaderer, personal communication, 1997) as smoked by human smokers. From data presented in the paper, an estimated total of 440 U.S. cigarettes and 40 cigars were smoked in this study. The average smoking duration for the cigarettes was 7.5 mins; the average duration for the cigars was not specified, but appears to be the same as for the cigarettes. The RSP emissions of the 10 brands of cigarettes representing 48 percent of the sales-weighted U.S. market in 1987, averaged $G_{RSP}/M_{cig} = 27 \pm 3.4$ mg/g, where an average of $M_{cig} = 0.63 \pm 0.023$ g of tobacco was smoked per cigarette. This results in an emission rate of 2.27 mg of RSP per minute. The total average cigar emissions were $G_{cigar} = 48 \pm 9.1$ mg/g. The physical characteristics of the cigar were not specified; however, a cigarillo typically contains less than 1.3 g of tobacco. The

Figure 2.

Growth and decay of RSP and CO from a cigar smoked by a smoker in a mechanically ventilated 51 m³ office at the U.S. Naval Research Laboratory's main computer building in Washington D.C. in 1978. The effective air exchange rates of RSP and CO are similar (about 4 ach) due to the effect of three mixing fans. By contrast, when the ventilation and mixing fans were not used, the effective air exchange rate for RSP was 1 ach, and for CO, 0.43 ach (Repace and Lowrey, 1982).



steady-state chamber nicotine concentration for the cigars was essentially the same as for the cigarettes, whereas the RSP emissions were 28 percent higher for the cigar.

Klepeis et al. (in press) report cigar smoking in two locations: a residence and an office. These experiments consisted of the smoking of a cigar by a person in both locations, and by a smoking machine in the latter. The effects on real-time pollutant concentrations of various cigar durations, smoking styles, and ventilation rates were measured.

In some of the experiments, two-minute average RSP concentrations were measured with a TSI Model 8510 piezobalance. For one experiment, particle-bound polycyclic aromatic hydrocarbon (PAH) concentrations were measured with an EcoChem PAS 1002i Realtime PAH monitor (West Hills, CA).

The ventilatory air exchange rate was determined using Equation 4 by observing the exponential decay of CO concentration after smoking had stopped, thus including only the removal from air flow in and out of the room. In contrast, the effective air exchange rate for RSP or PAH, which includes mechanisms of RSP or PAH removal such as deposition and ventilation, was measured by observing the exponential decay of RSP and PAH concentrations. Together with the room volume and the observed pollutant time series, these decay rates provided a means to calculate CO and RSP emission factors for each cigar.

In the residence, Klepeis et al. (in press) report results for a single cigar smoked by a human smoker on two separate days in a 97 m^3 parlor. Measurements of the particle size distribution showed that the bulk of the cigar aerosol mass was in the particle-size range 0.1 to 2.5 μm. A regular cigar smoker smoked the cigar for 1 to 2 hours. Once the levels had declined to near background, a different smoker smoked a cigarette for 9 minutes providing a comparison of the cigar and cigarette emissions under the similar conditions (Figure 3).

The upper curves of Figure 3 show the real-time PAH concentrations of the cigar and cigarette and the lower curves show the real-time RSP concentrations. The mass balance model predicts the pollutant concentration time series with reasonable accuracy (Figure 3, bottom) (Klepeis, et al., in press).

The ratio of CO to RSP concentrations is 1 ppm of CO per 165 $\mu g/m^3$ of RSP for a Santona cigar smoked on day 1 (Table 1). The ratio of particulate PAH to RSP concentrations is 1 $\mu g/m^3$ of particulate PAH per 238 $\mu g/m^3$ of RSP for a Paul Garmirian cigar smoked on day 2. By contrast, for a Marlboro cigarette, the ratio is 1 $\mu g/m^3$ of particulate PAH per 137 $\mu g/m^3$ of RSP. However, the total PAH emissions for the cigar are twice that of the cigarette due to the much longer smoking duration and mass of the cigar.

In a field study of a 521 m^3 sports tavern, investigators machine-smoked four Dutch Masters Corona Deluxe cigars in 11 minutes, two at a time. Figure 7 shows the results for CO (Mage and Ott 1996, Ott et al. 1996). This experiment used the decay of cigar CO to determine the ventilatory air exchange rate of the tavern, ϕ_v = 7.5 ach. Similarly, the decay rate of RSP (less background) yielded the effective air exchange rate for cigar RSP, ϕ = 7.63 ach. They used three CO monitors and two

Figure 3.

The time series, i.e., growth and decay of PAH and RSP concentration with time, measured in a naturally ventilated San Francisco residence while a Paul Garmarian cigar and a Marlboro cigarette were smoked sequentially by two different persons on March 9, 1997. The upper plot shows the source activity pattern (rectangles) and the PAH data, while the bottom plot shows the simultaneously measured RSP data and the RSP time series predicted by the mass balance model (Klepeis et al., in press).

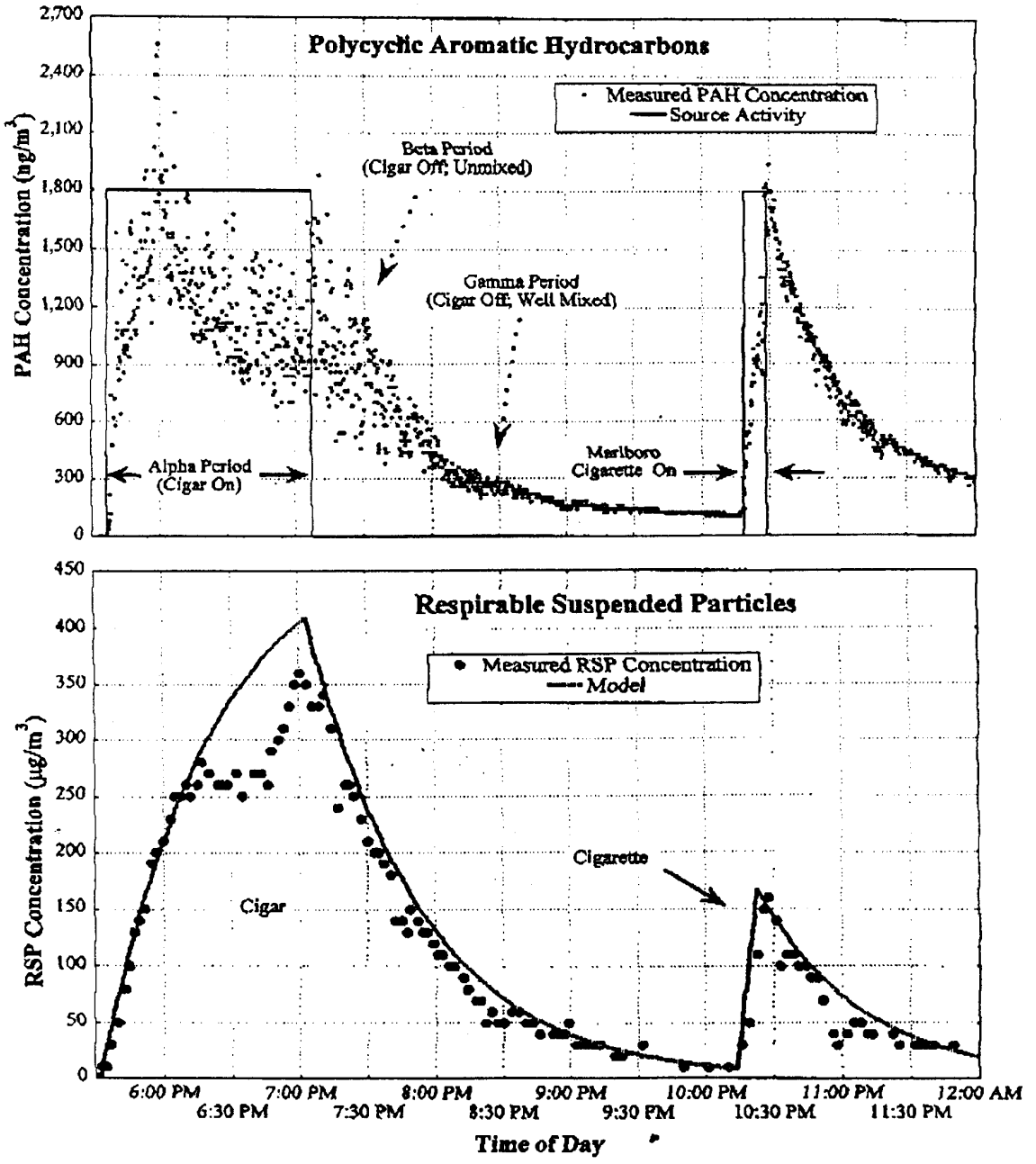


Figure 4.
Relative Emissions, Cigars versus Cigarettes: For each of the measured compounds, large cigars produce greater total emissions than cigarettes. For CO, RSP, PAH, and Cadmium, the emissions ratios are for ETS. For all others except benzene, they are for sidestream smoke. For benzene, they are for mainstream smoke. (Brunnemann et al. 1977; Appel et al. 1990; Brunnemann, Stahnke, and Hoffmann 1978; Brunnemann, Yu, and Hoffmann 1979; Brunnemann Adams and Hoffmann 1979; Brunnemann and Hoffmann 1978; Klepeis et al. in press; Brunnemann and Hoffmann, 1975.)

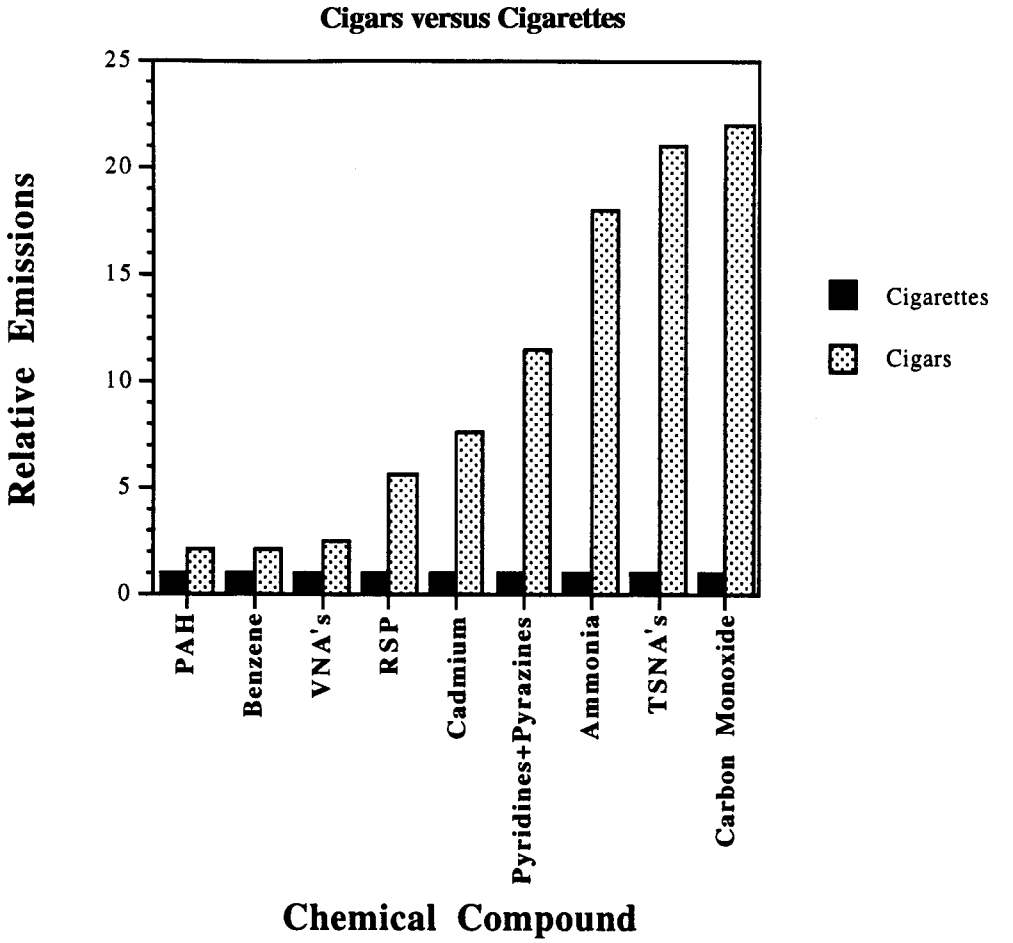


Table 1
CO, RSP, and Nicotine Emission Factors[1] Measured in Various Cigar and Cigarette Studies

[2]Experiment Description	Source Duration	[3]Ave Source Emission Rate	[4]Total ETS Source Emissions	[5]Mass Smoked	ETS emissions per Mass Smoked
Klepeis et al. (in press) 1 Sante Fe Fairmont cigar smoked by a machine in 49.6 m^3 office (4/6/96); 4.5 ach	7.8 min	140 mg CO/min	1.1 g CO	6 g	190 mg CO/g
1 Sante Fe Fairmont cigar smoked by a machine in a 49.6 m^3 office (4/7/96); 0.12 ach	24 min	50 mg CO/min	1.2 g CO	6.1 g	200 mg CO/g
1 AyC Grenadiers cigar smoked by a machine in a 49.6 m^3 office (4/27/96); 0.12 ach	10 min	87 mg CO/min	890 mg CO	4.9 g	180 mg CO/g
1 AyC Grenadiers cigar smoked by a machine in a 49.6 m^3 office (4/29/96); 4.5 ach	11.5 min	67 mg CO/min	780 mg CO	4.9 g	160 mg CO/g
1 Santona cigar smoked by a person in a 97 m^3 parlor of a (1.3 hrs) residence (3/1/97); 2.0 ach; 2.5 eff ach for RSP	76 min	14 mg CO/min 1.0 mg RSP/min	1.1 g CO 78 mg RSP	8.8 g	130 mg CO/g 8.9 mg RSP/g
1 Paul Garmirian cigar smoked by a person in a 97 m^3 parlor of a residence (3/9/97); 0.9 ach; 1.2 eff ach for RSP and 1.5 for PAH	90 min (1.5 hrs)	0.95 mg RSP/min 0.0042 mg PAH/min	86 mg RSP 0.38 mg PAH	10.8 g	8.0 mg RSP/g 0.035 mg PAH/g
1 Marlboro cigarette smoked by a person in a 97 m^3 parlor of a residence (3/9/97); 1.3 eff ach for RSP and 2.0 for PAH	7 min	1.9 mg RSP/min 0.022 mg PAH/min	16 mg RSP 0.18 mg PAH	0.4 g	40 mg RSP/g 0.45 mg PAH/g
Repace and Lowrey (1982) 1 Marsh Wheeling Stogie smoked by a person in a 51 m^3 office; 3.8 ach for RSP; 4.4 ach for CO (mechanical ventilation).	20 min	57 mg CO/min 2.7 mg RSP/min	1.14g CO 53 mg RSP	not recorded	
Nelson (1994) 50 top brands of cigarettes smoked by a person in an unventilated room (analyzed by Repace et al., in press)			13.8 ± 3.1 mg ETS RSP per cigarette 1.8 ± 0.28 mg ETS nicotine per cigarette		
Klepeis et al. (1996) Cigarette smoking in two airport lounges		11.9 mg CO/min 1.43 mg RSP/min			
CPRT (1990) 13 brands of cigars sold in Canada	not reported	not reported	not reported	not reported	10.3 ± 2.4 mg RSP/g 0.13 ± 0.08 mg nicotine/g
Mage and Ott (1996) 4 cigars smoked two at a time by separate machines in a 521 m^3 tavern (8/24/94); 7.2 ach; results are from two monitors, one in SW booth and one in NW booth	11 min (all sources)	SW, 240 mg CO/min NW, 250 mg CO/min	SW, 1.2 g CO per cigar NW, 1.3 g CO per cigar	not recorded	

Notes: [1]Calculations of emission factors are based on a single-compartment mass balance model, which assumes uniform mixing. [2]Experiment descriptions include the type of cigar or cigarette source, the location where smoking took place, the room volume, and the air exchange rate and/or effective air exchange rate, which includes all removal mechanisms (both are in units of air changes per hour). [3]Ave Source Emission Rate is the average emission rate over the time the source(s) was(were) on and over all the individual sources that were ever active. [4]Total Source Emissions is the total mass emitted over all sources. [5]Mass Smoked is the measured difference between the mass of the unsmoked cigar(s) or cigarette(s) source and the mass after smoking. [6]Emissions per Mass Smoked is Total Source Emissions divided by Mass Smoked. 1 ppm = 1.145 mg/m^3 at 25°C and 1 ATM.

Source: Because of the exceptional and multi-source nature of this composite table, the general reference for the "Experiment description" column is: Klepeis et al. (in press). Specific references for horizontal data fields are noted in bold in the table.

RSP monitors, in three locations: a central table, a Southwest corner booth and a Northwest corner booth. The 30 minute average RSP concentration for the two monitors was 194 μg/m^3. The 30 minute average CO concentration for the three locations was 1.7 ppm (Mage and Ott, 1996).

Emissions of particulate phase Polycyclic Aromatic Hydrocarbons (PAH's) from Cigars

Available evidence suggests that cigar smoke contains many of the same carcinogenic PAH's that are found in cigarette smoke (SG,1979; IARC, 1986).

Real-time measurements of particle-bound PAH's (4 or more ringed compounds) are possible using a newly-developed photo-ionization monitor (EcoChem, West Hills, CA). Investigators have applied this new monitor to make real-time measurements of PAH aerosols from tobacco smoking and other sources in homes, automobiles, and outdoor ambient conditions (Buckley and Ott, 1996; Wilson et al., 1993; 1994; Ott et al., 1994).

Klepeis et al. (in press) used the EcoChem 1002i monitor in a 97 m^3 San Francisco parlor with a human smoking a Paul Garmirian cigar. The cigar caused the particle-bound PAH level to increase by as much as 2500 ng/m^3 above a near-zero background concentration, while a Marlboro cigarette increased the levels by 1700 ng/m^3 above background. Using a calibration factor of 1000 ng/m^3 per pA, they report that the total PAH emission for the cigar was 380 μg, while the cigarette emitted 180 μg. The emission rate and the total emissions per gram (22 μg/min, and 450 μg/g respectively) were higher for the cigarette than for the cigar (4.2 μg/min, and 35 μg/g respectively), but the cigar emitted twice as much total PAH as the cigarette because of its longer smoking time. The PAH concentrations of both the cigar and the cigarette shown in the upper part of Figure 3 generally track the RSP emissions shown in the lower part of the figure.

Figure 4 presents the total emission of various smoke constituents for cigars contrasted with that from cigarettes. For CO, RSP, PAH, and Cd, the emissions ratios are for ETS. For all others except benzene, they are for sidestream smoke.

MEASUREMENTS AT CIGAR SMOKING SOCIALS

Klepeis et al. (in press) report results from two field experiments in which an investigator wearing a concealed CO personal monitor attended public social events that featured cigar smoking. The hidden miniaturized monitoring instrument was a Langan L15 Personal Exposure Measurer™ equipped with a battery-powered data logger (Langan, 1992). The monitor was carried in the inside pocket of a jacket. Measurements were logged every minute in the first field study, and every 15 seconds in the second study.

The first cigar smoking social event, a "Cigar Smoker," was held in a private club in suburban San Francisco. Four different types of cigars were available at the entrance. The private club was a large house with two adjoining rooms (a large reception hall with a mezzanine and a food preparation area) measuring 1560 ft^2 (155 m^2) in total area, with a volume of 570 m^3. The event's sponsors opened all doors and windows to allow maximum flow of outdoor air.

The investigator wearing the monitor smoked the first cigar only partially and then mingled with the other guests. Because the monitor was carried for several hours while traveling to and from the party, it is possible to compare the

in-vehicle and outdoor CO concentrations with those measured during the cigar smoker (Figure 5). As many as 89 persons were present (when 50 persons were present, there were 12 women and 38 men). Indoor CO concentrations during the smoker ranged between 5 and 11 ppm, yielding an indoor average of about 6 ppm. The highest CO concentrations occurred on the upstairs mezzanine of the main hall. If we adjust the observed CO concentrations by subtracting the ambient CO levels of 1.5 ppm measured outside the building on the sidewalks, the cigar smokers contributed about 4.5 ppm. The CO levels were similar to those measured during the rush-hour freeway drive to the event on Route 280, which is a major arterial roadway between San Francisco and San Jose, California. The high air exchange rate caused by the wide-open doors and windows probably reduced the interior CO concentrations considerably.

The second concealed monitoring field study (Klepeis et al., in press) took place at a cigar banquet held in a downtown San Francisco restaurant. This cigar banquet featured three premium cigars per person: [a Hoyo De Monterrey Epicure *#2,* (5", ring gauge 50) (Curtis, 1995) a Romeo Y Julieta Gold Label Churchill (7", ring gauge 47) (Curtis, 1995) and a Partagas Series "D" #4, (Robusto, 4-7/8", ring gauge 50) (Curtis, 1995, Resnick, 1996). Figure 6 shows the CO concentration time series from the point when the investigator departs from home in Redwood City, driving North on California Highway 101 to San Francisco. The CO averages about 4 ppm on this leg of the trip.

The CO concentration spikes to about 18 ppm in the confines of the parking garage, whereas it is only 1 ppm on the street. The guests received the first cigar when they entered the door, which was kept open during the entire social, and they gathered around the bar to socialize for about an hour prior to being seated for dinner. The indoor levels in the restaurant-bar during the first hour, due to about 24 smokers at the bar (including the investigator) were 13 to 17 ppm (Figure 6). At 7:45 PM the patrons were all seated for dinner at individual tables of 4 to 6 persons. After everyone was seated, waiters distributed the second imported cigar to all and began serving the three-course dinner. The investigator was seated with five other persons; all six smoked cigars during dinner; the investigator's cigar was only partially smoked. The third cigar was distributed just before dessert; the investigator did not smoke his. Overall, more than 100 cigars were smoked during this banquet; "laser lighters" rather than matches were used to ignite the cigars.

The indoor CO concentration averaged over the 3-hour-and-20-minute event was 10 ppm, and about 75 percent of the 40 persons present were smoking cigars at any instant of time. Based on measurements outdoors on downtown sidewalks before and after the event, ambient CO concentrations were found to be about 1 ppm, so the indoor CO concentration caused by cigar smoking was about 9 ppm. If the cigar dinner had lasted more than 8 hours, then indoor CO concentrations would have violated the National Ambient Air Quality Standard (NAAQS) adopted by the Environmental Protection Agency (EPA) to protect public health (9 ppm CO for 8 hours).

Figure 5.

The carbon monoxide (CO) personal concentration time series measured before, during and after attendance at a "cigar party" in the San Francisco Bay Area on January 1, 1997. The total volume of the establishment was about 570 m . At one point in the evening 89 persons were present of whom about two thirds were estimated to be smoking cigars. Notice that the background CO levels outdoors are between 1 and 2 ppm, and that the average CO concentration while driving from San Jose to the party (5.5 ppm; 5:00 PM - 6:20 PM) is similar to the average concentration while present at the party (5.8 ppm; 6:26 PM - 8:09 PM) (Klepeis et al. In press).

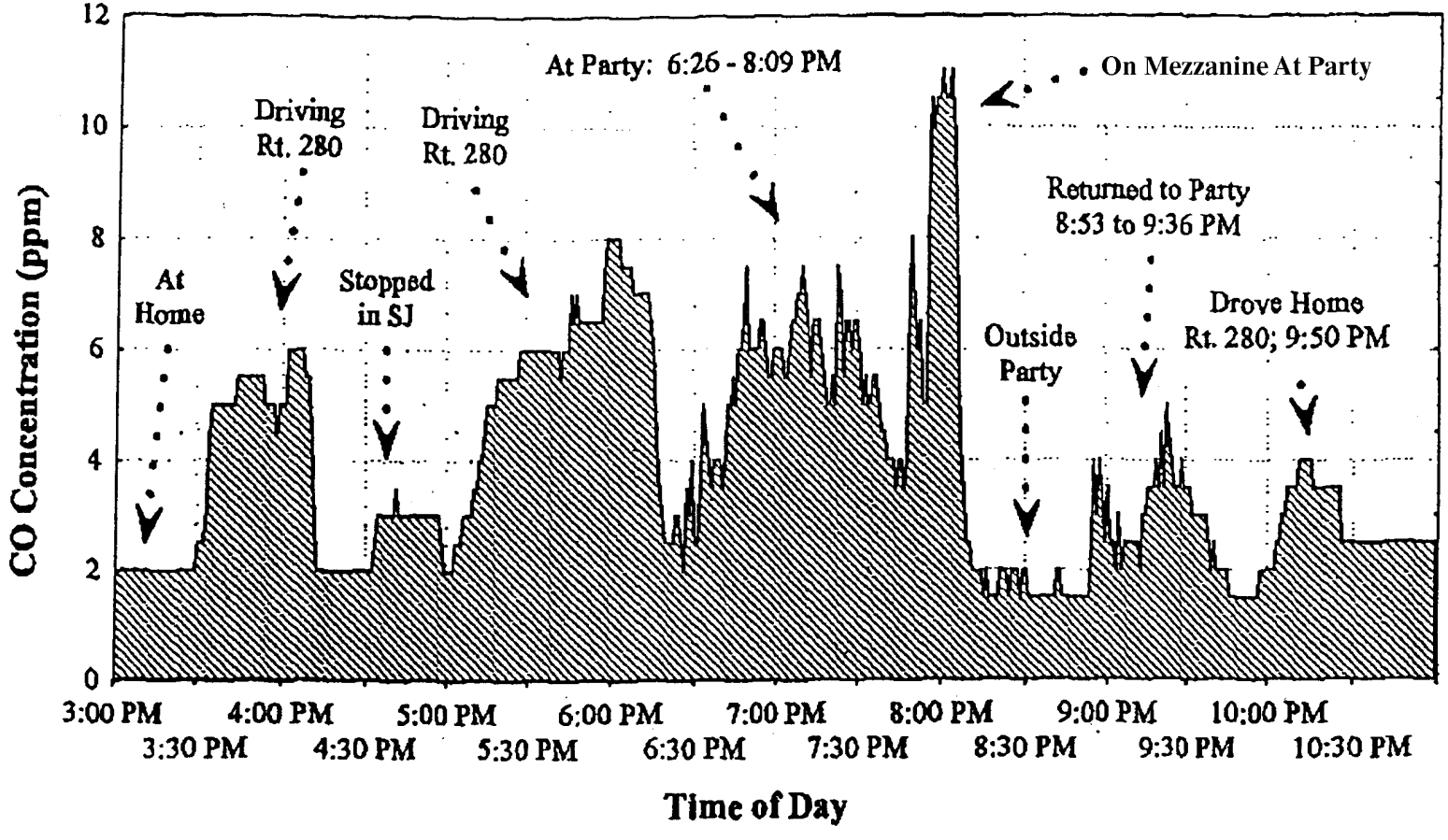


Figure 6.

CO concentrations measured using a concealed personal exposure monitor at a cigar dinner party in downtown San Francisco. The investigator carried the Langan L15 CO Personal Exposure Measurer concealed beneath his dinner jacket. Concentrations were logged every 15 seconds, and the background value (concentration that would occur in the absence of indoor sources) was estimated as 1 ppm (Klepeis et al. In press).

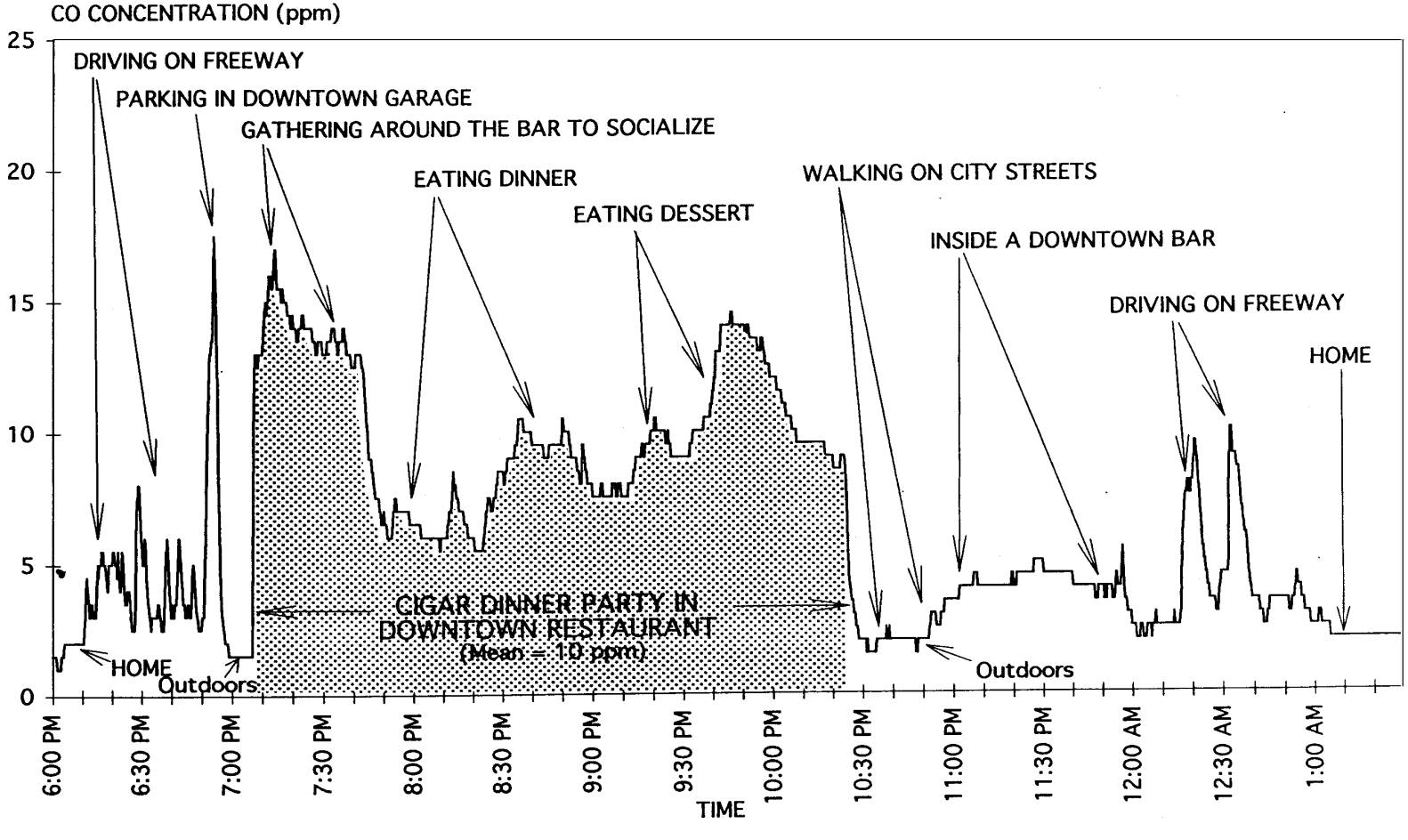


Figure 7(a).
CO concentration time series measured in a 548 m3 tavern at three locations after investigators machine-smoked four cigars in the central area. The air exchange rate was 7.5 air changes per hour. Despite the wide separation of the three monitors (approx. 6 - 7 m) the simultaneous CO exposures at all three locations are nearly within ± 10 percent of the overall average concentration (1.84 ppm), which is used by ASTM (ASTM E 741) as a criterion for uniformity of mixing (Mage and Ott, 1996).

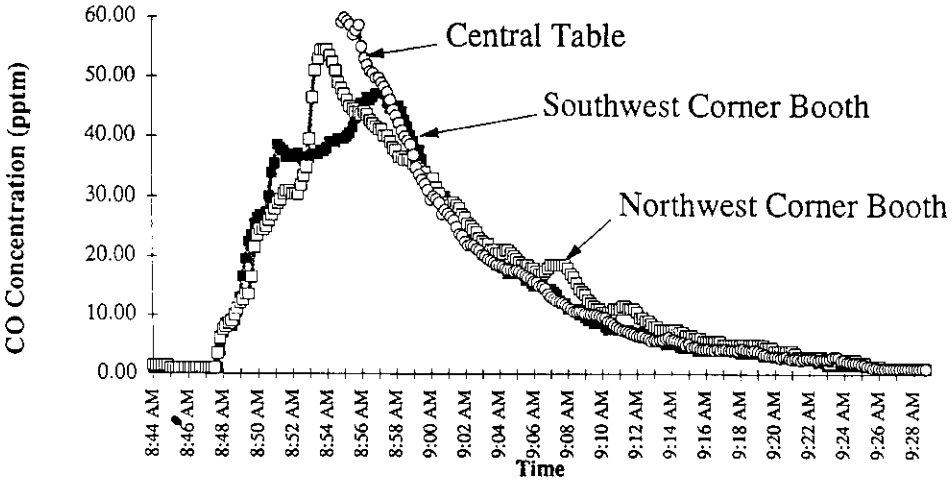
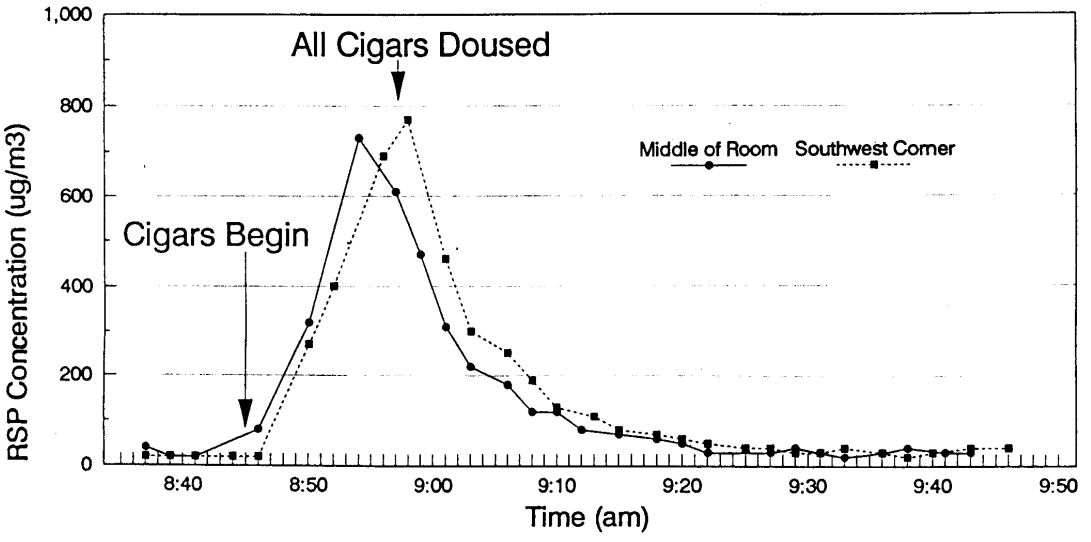


Figure 7(b).
RSP concentration time series measured in a 548 m3 tavern at three locations after investigators machine-smoked four cigars in the central area (Ott, Switzer, and Robinson, 1996). The RSP concentration ($PM_{3.5}$) was measured with two piezobalances in the middle of the room and at the southwest corner booth. Figures 7 (a) and 7(b) suggest that when averaged over a length of time long compared to the source duration, it doesn't matter where you are in the tavern, illustrating both the validity of the well-mixed assumption for the mass-balance model and the futility of spatial separation of smokers and nonsmokers as a putative public health measure.



CO concentrations recorded on the freeway while driving to and from this cigar banquet averaged 4.5 ppm, similar to values observed on the freeway while driving to the earlier cigar smoker social. This observation is the same as the average in-traffic CO concentration measured on 96 trips on a year-long study of an urban arterial highway in the San Francisco Bay Area (Ott et al., 1996). After leaving the restaurant, the investigator walked to a San Francisco bar where several cigarettes were being smoked but no cigars; indoor CO levels were about 4.5 ppm, much lower than at the cigar dinner.

These studies show that cigar smoking can considerably elevate indoor CO concentrations in a restaurant, even when the doors are wide open, and the ventilation system is operating.

DISCUSSION Klepeis et al. (in press) report that the average emission rate and total emissions per source are not good emission factors for use in comparisons between different cigars and/or other tobacco sources, because they depend on smoking style, smoking duration, or the mass of the cigar smoked. Emission per mass smoked is a better basis for use in comparisons of cigar potencies, since it provides a normalized measure of the ability of a tobacco source to produce ETS-pollutant concentrations. Klepeis et al. (in press) report that CO emissions per mass smoked (Table 1) ranged from 130 mg CO/g to 200 mg CO/g for three different brands of cigars and two different smoking styles (i.e., by a machine and by a person) in five settings. Two different Santa Fe Fairmont cigars smoked by a machine gave CO emissions per mass smoked that were very similar (190 and 200 mg/g). The AyC Grenadiers cigars emitted CO in amounts of 160 and 180 mg/g when smoked by a machine. A Santona cigar smoked in a residential parlor generated CO mass emissions that were somewhat smaller (130 mg/g), which might be due to either the different smoking style or the different cigar brand (Table 1).

RSP emissions per mass smoked for two cigar experiments in a residential parlor were 8.0 and 8.9 mg RSP/g (Klepeis et al., in press). These RSP emission factors are comparable to the results found for the 13 brands of medium and large cigars smoked in a Canadian Report (CPRT, 1990) described above, which averaged 10.3 ± 2.39 mg RSP/g. By contrast, the RSP emissions per mass smoked for a cigarette in the same residence was 40 mg/g, which is five times larger than the emissions per mass smoked for the cigar.

Emissions of PAH per mass smoked were calculated for both the cigar and the cigarette in the second residential experiment of Klepeis et al.(in press) from Figure 3. Although the errors in estimation of the PAH background levels introduce additional uncertainty (about 20 to 30 percent error), cigarettes appear to generate more PAH than cigars (PAH emissions of 0.45 versus 0.035 mg/g).

Cigars appear to emit less RSP and PAH per mass burned than cigarettes, but cigars contain more tobacco than cigarettes and also tend to be smoked for much longer time periods (10 minutes or less for a cigarette versus an hour or more for cigars).

The Effects of Cigar Smoking On Indoor Air Pollution

Using the mathematical models presented earlier, the concentration of ETS in an enclosed space will be directly proportional to the smoker density ($g_c n_{ave}/v$) and inversely proportional to the effective air exchange rate ϕ. The effective air exchange rate for nonreactive gases is the same as the air exchange rate due to building ventilation plus infiltration, and for particles may be somewhat higher due to surface sorption or air cleaning (Repace, 1987).

Ventilation rates for mechanically ventilated buildings are recommended by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE, 1990) and are typically incorporated into local building codes. In buildings without ventilation systems, closed-window air exchange rates are determined by the tightness of the building structure, and open-window ventilation rates may be comparable to or higher than in mechanically ventilated buildings. Typical closed-window residential air exchange rates are of the order of 0.75 ach. Typical mechanical air exchange rates designed for commercial buildings are a function of the density of human occupancy, and range from 0.84 air changes per hour (ach) for office buildings to 7 ach for restaurants.

If the ventilation rate ϕ_v is determined by the building structure and condition and the building volume is fixed, the concentration of ETS in a building will be determined by the number of smokers, their smoking rate, and the emission rate of the tobacco product.

The concentrations of certain ETS constituents can be compared to the National Ambient Air Quality Standards (NAAQS) for regulated outdoor air pollutants. The NAAQS for particulate matter $\leq$10 µm (PM_{10}) is 50 µg/m^3 on an annual basis, and on a 24-hour basis, 150 µg/m^3, with one exceedance allowed per year. Recently the U.S. EPA adopted a new fine particle standard. This proposed EPA NAAQS for $PM_{2.5}$, (particle size $\leq$ 2.5 µm) is 15 µg/m^3 averaged on an annual basis, or 65 µg/m^3 on a 24-hr average basis with one allowed violation (i.e., no more than one day at each monitor in a location may exceed the specified daily standard concentration).

The RSP level from a single Paul Garmirian cigar smoked in a San Francisco residence (Klepeis et al., in press) averaged 160 µg/m^3 over a 4.7- hour period (Table 1), or 31 µg/m^3 averaged over a 24-hour period. By comparison, the Marlboro cigarette smoked in the same San Francisco residence averaged 65 µg/m^3 over a period of 2.75 hours, or 7 µg/m^3 averaged over 24- hour period.

The current NAAQS for carbon monoxide is 9 ppm, an 8 hour time-weighted average (TWA)(USEPA, 1996). The average CO concentration measured during the cigar party (5.8 ppm) (Figure 3) is slightly greater than encountered on a California freeway (5.5 ppm), despite the fact that all the doors and windows were open.

On a per-cigarette basis, Ott et al. 1992, Rosanno and Owens 1969, and Rickert et al. 1984 report total CO emissions ranging from 40 to 70 mg per cigarette for sidestream smoke. On a rate basis, Ott et al. (1992) report an average CO emission rate of 9.4 mg CO/min for cigarettes, which is much lower than the 14 to 140 mg /min emission rates that Klepeis et al. (in press) found for cigars.

On a mass basis, Klepeis et al. (in press) report that CO emissions for cigars are between 100 and 200 mg/g (Table 1). If the mass of a cigarette smoked is about 0.4 g, as it was for one of the experiments of Klepeis et al. (in press), then the cigarette CO emissions per mass smoked would also be in the range of 100 to 175 mg /g. However, the larger total mass of a cigar results in the total CO emissions of cigars studied by Repace and Lowrey (1982) and Klepeis et al. (in press) (Table 1) averaging more than 1000 mg/cigar, placing the total cigar CO emissions about 1000/50 = 20 times that of a cigarette.

The cigar RSP emissions reported by Klepeis et al. (in press) and Repace and Lowrey (1982) for 3 cigars averaged about 77 mg per cigar. By contrast, (Table 1) data from Nelson (1994) as analyzed by Repace et al. (in press) show ETS-RSP emissions of about 14 $\pm$ 3 mg/cig for the top 50 brands of cigarettes; an RSP datum, 16 mg/cig reported by Klepeis et al.(in press) for a single Marlboro is consistent with these results. This suggests that total RSP emissions of large cigars are 5 to 6 times greater than cigarettes.

From the limited data available (Table 1) it appears that the total PAH emissions of a large Paul Garmirian cigar (380 μg) is only twice that of a Marlboro cigarette (180 μg) because the PAH emission rate for the Marlboro was 5 times as large as for the cigar. The total PAH emissions for the cigar, however, were twice as great as the cigarette because of the more than ten-fold larger smoking time for the cigar. (Table 1 and Figure 2).

Cigar size and the extended smoking time compensate for the cigar's lower emission rate for RSP and PAH and enhance the delivery of CO to the indoor environment. Smoking a single cigar can result in a much higher exposure of nonsmokers to CO, RSP, and PAH than smoking a single cigarette.

CONCLUSIONS

1. ETS from cigar smoke is a major and increasing source of exposure to indoor air pollution.
2. When smoked in confined indoor spaces at typical smoking and ventilation rates, cigars may produce concentrations of certain regulated ambient air pollutants, including CO and RSP, which can violate federal air quality standards and add to the level of these compounds already in the ambient air from other combustion sources.
3. Measurements of the CO concentrations at a cigar party in a hall and at a cigar banquet in a restaurant showed carbon monoxide levels comparable to those observed on a crowded California freeway.
4. The smoking of one cigar generates more Respirable Suspended Particles (RSP) and Polycyclic Aromatic Hydrocarbons (PAH) than the smoking of one cigarette due to the larger mass of tobacco contained in a cigar, but the amount of PAH and RSP generated per gram of tobacco burned appears to be somewhat lower for cigars compared to cigarettes.

REFERENCES

Adams, J.D., O'Mara-Adams, K.J., Hoffmann, D. Toxic and carcinogenic agents in undiluted mainstream and sidestream smoke of different types of cigarettes. *Carcinogenisis* 8: 729-731, 1987.

Armitage, A., Dollery C., Houseman T., Kohner E., Lewis P.J., Turner, D. Absorption of nicotine from small cigars. *Clinical Pharmacol Ther* 23: 143-151, 1978.

Brunnemann, K.D., Hoffmann, D. *Chemical Studies on Tobacco Smoke LIX Analysis of volatile nitrosamines in tobacco smoke and polluted indoor environments: environmental aspects of n-nitroso compounds*. Walker EA, Castegnaro M., Giciute L., and Lyle R.E., eds. Lyon, France: IARC Scientific Publications No. 19. 343-356, 1978.

Brunnemann, K.D., and Hoffmann, D. *Chemical Studies on Tobacco Smoke XXIV*. Gas chromatographic determination of ammonia in cigarette and cigar smoke. *J Chromatogr Sci 13*: 159-163, 1975.

Brunnemann, K.D., Stahnke, G., Hoffmann, D. *Chemical Studies on Tobacco Smoke. LXI. Volatile pyridines: quantitative analysis in mainstream and sidestream smoke of cigarettes and cigars*. Analytical Letters A11: 545-560, 1978.

Brunnemann, K.D., Yu, L., Hoffmann, D. Assessment of carcinogenic volatile n-nitrosamines in tobacco and in mainstream and sidestream smoke from cigarettes. *Cancer Res 37*: 3218-3222, 1977.

Buckley, T.J., Ott, W.R. Demonstration of real-time measurements of PAH and CO to estimate in-vehicle exposure and identify sources. *Proc International Symposium* Measurements of Toxic and Related Air Pollutants, U.S. EPA/AWMA, Research Triangle Park, NC, May 1996.

Cigar Aficionado Bi-Monthly Magazine. M. Shanken Communications, 387 Park Ave. South, N.Y., N.Y. 10016 May/June Issue, 1997.

CPRT Laboratories Inc. Final Report - Development of methods for the characterization of toxic constituents in cigars, pipe tobacco and smokeless tobacco. SSC Contract No. H4078-1-C230/01-SS. Submitted to The Tobacco Branch, Health Canada. (M. Kaiserman, personal communication, 1997)

Curtis, B. Bob Curtis's Cigar Database (8/21/95). http://www.netins.net/showcase/fujicig/bcdb.hmtl. (21 August 1995)

Daley, P.S., Lundren, D.A. The performance of piezoelectric crystal sensors used to determine aerosol mass concentrations, Am. Ind. Hyg. Assoc. J. 26: 518-532, 1975.

Hoffmann, D, Adams J.D., Brunnemann, K.D., Hecht, S.S. Assessment of tobacco-specific N-nitrosamines in tobacco products. *Cancer Research* 39: 2505-2509, 1979.

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Tobacco Smoking, Vol 38, IARC, Lyon, 1986.

Klepeis, N.E., Ott, W.R., Repace, J.L. The effect of cigars on indoor air quality. *Journal of Exposure Analysis and Environmental Epidemiology*, In press.

Klepeis, N.E., Ott, W.R., Switzer, P. A Multiple-smoker model for predicting air quality in public lounges," *Environ. Sci. Technol*. 30 (9), 2813 - 2820, 1996.

Langan, L. Portability in measuring exposure to carbon monoxide, J Exposure Analysis and Environmental Epidemiology, Suppl. 1, 223-289, 1992.

Leaderer, B. Assessing exposure to environmental tobacco smoke. *Risk Analysis* 10: 19-26, 1990.

Mage, D.T., Ott, W.R. Accounting for nonuniform mixing and human exposure in indoor microenvironments. In characterizing sources of Indoor AF pollution and related sink effects, TIchenor, B.A., ed., West Conshohocken, Pa, ASTM STP 1287, PCN 04-12870-17, 263-269, 1996.

Nelson, P. Testimony of R.J. Reynolds Tobacco Company, OSHA Docket No. H-122, comment 8-266, Indoor Air Quality, Proposed Rule, U.S. Occupational Safety & Health Administration, Washington, D.C., 1994.

Ott, W.R., Switzer, P., Willits, N. Trends of in-vehicle CO exposures on a California arterial highway over one decade, Paper No. 93-RP-116B.04 presented at the 86th Meeting of the Air and Waste Management Association, Denver, Co, 1996.

Ott, W.R., Wilson, N.K., Klepeis, N., Switzer, P. Real-time monitoring of polycyclic aromatic hydrocarbons and respirable suspended particles from environmental tobacco smoke in a home. *Proc 1994 EPA/A&WMA Int Symposium on Meas of Toxic and Related Air Pollutants VIP-39*, Air & Waste Mgt Assoc Pittsburgh, 887-892, 1994.

Ott, W., Langan, L., Switzer, P. A time series model for cigarette smoking activity patterns: model validation for carbon monoxide and respirable particles in a chamber and an automobile, *J. Exposure Anal*. Environ. Epidemiol. (2), 175-200, 1992.

Ott, W.R., Switzer, P., Robinson, J. Particle concentrations inside a tavern before and after prohibition of smoking: evaluating the performance of an indoor air quality model, *J Air Waste Manag Assoc 46*: 1120-1134, 1996.

Ott, W.R., Vreman, H.J., Switzer, P., Stevenson, D.K. evaluation of electrochemical monitors for measuring carbon monoxide concentrations in indoor, in-transit, and outdoor microenvironments, presented at the International Symposium on the Measurement of Toxic and Related Air Pollutants of the Air and Waste Management Association, Research Triangle Park, N.C., 1995.

Repace, J.L., Lowrey, A.H. Indoor air pollution, tobacco smoke, and public health. *Science* 208: 464, l980.

Repace, J.L., Lowrey, A.H. tobacco smoke, ventilation, and indoor air quality, *ASHRAE Transactions* 88: Part I, 895, l982.

Repace, J.L. Indoor concentrations of environmental tobacco smoke: models dealing with effects of ventilation and room size. In: Environmental *Carcinogens Methods of Analysis and Exposure Measurement*, Vol. 9: Passive Smoking. (I.K. O'Neill, K.D. Brunnemann, B. Dodet, and D. Hoffmann, eds.) International Agency for Research on Cancer, Lyon France. 25-41, 1987.

Resnick J. *International Connoisseur's Guide to Cigars*. New York: Black Dog and Leventhal Publishers, 1996.

Rickert, W.S., Robinson, J.C., Bray, D.F., Rogers, B., and Collishaw, N.E. Characterization of tobacco products: A Comparitive Study of the Tar, Nicotine, and Carbon Monoxide Yields of Cigars, Manufactured Cigarettes, and Cigarettes Made from Fine-cut Tobacco. *Preventive Medicine* 14: 226-233, 1985.

Rickert, W.S., Robinson, J.C., Collishaw, N. Yields of tar, nicotine, and carbon monoxide in the sidestream smoke from 15 brands of Canadian cigarettes," *Am J Pub Health*, 74 (3), 228-231, 1984.

Rosanno, A.J., Owens, D.F. Design procedures to control cigarette smoke and other air pollutants, *ASHRAE Trans*., 75, 93-102, 1969.

Schmeltz, .I, Brunnemann, K.D., Hoffmann, D., Cornell, A. On the chemistry of cigar smoke: Comparison Between Experimental Little and Large Cigars. *Beitrage zur Tabakforschung*: 8: 367-377, 1976.

Sem, G.J., Tsurubayashi, K. A New mass sensor for respirable dust measurement, *Am. Ind. Hyg. Assoc. J*., 36, 791-800, 1975.

Sem, G.J., Tsurubayashi, K., Homma, G.J. performance of the piezoelectric microbalance respirable aerosol sensor, *Am. Ind. Hyg. Assoc. J.* 38, 580-588, 1977.

Switzer, P., Ott, W. R. Derivation of an indoor air averaging time model from the mass balance equation for the case of independent source inputs and fixed air exchange rates," *J. Exposure Anal. Environ. Epidemiol*., 2 (2), 113-135, 1977.

U.S. Department of Health, Education, and Welfare. *Smoking and Health. A Report of the Surgeon General*. U.S. Department of Health Education, and Welfare, Public Health Service, Office of the Assistant Secretary for Health, Office on Smoking and Health. DHEW Publication No. (PHS) 79-50066, 1979.

U.S. Department of Health and Human Services. *The Health Consequences of Involuntary Smoking. A Report of the Surgeon General*. DHHS (CDC) 87-8398, Washington, D.C., 1986.

USEPA National Ambient Air Quality Standards for PM10, PM2.5, and CO. *Federal Register*:

Wallace LA. Indoor particles: a review. *J Air Waste Manage Assoc* 46:98-126, 1996.

Wilson, N.K., Barbour, R.K., Chuang, J.C., and Mukund, R. Evaluation of a real-time monitor for fine particle-bound PAH in air. Polycyclic Aromatic Compounds 5: 167-174, 1994.

Wilson, N.K., Barbour, R.K., Burton, R.M., Chuang, J.C. Mukund, R. Evaluation of a Real-Time monitor for particle-bound PAH in air. Proc. *1993 U.S. EPA/ A&WMA Int. Symp. on Meas. of Toxic & Related Air Pollutants*. Air &Waste Mg Assoc, Pittsburgh, Pa, 451-456, 1993.

Pharmacology and Abuse Potential of Cigars

Reginald V. Fant and Jack E. Henningfield

INTRODUCTION Cigar tobacco contains the highly addictive drug nicotine in concentrations similar to those observed in cigarettes; however, since most cigars contain more tobacco, they also contain more nicotine than cigarettes. Most cigar smokers do not inhale cigar smoke, and those who do inhale far less than typical cigarette smokers (Chapter 4). The pH of the smoke from most cigars is sufficiently alkaline to enable efficient absorption of nicotine through the oral and nasal mucosa. These basic observations, along with the behavioral observation that some cigar smokers report symptoms of dependence and withdrawal similar to those of cigarette smokers, have led the American Psychiatric Association to include cigars along with cigarettes in their manual listing drug dependence and other disease states (American Psychiatric Association, 1987). This chapter will review the scientific evidence supporting the categorization of cigars as dependence-producing nicotine delivery devices.

EARLY OBSERVATIONS OF ADDICTIVE EFFECTS The history of tobacco use includes accounts of cigar smoking by native Americans dating back more than 1000 years. In fact, when the term addiction was applied to describe the enslavement of some people to their tobacco in the late 1700's, the main forms of tobacco smoking were cigar and pipe smoking (Murray et al., 1991). The cigarette, which is now the most commonly used nicotine delivery device, did not make its appearance in common use until the 1840's (McKim, 1986).

It has long been recognized that cigars contain and deliver psychoactive doses of nicotine. The concept that tobacco strain, growing conditions, and manipulation of the pH of nicotine preparations could greatly affect the amount of nicotine available from cigars was reported by Graham and Carr in 1924. In 1925, Mendenhall noted that the experiments in which a pipe or cigar was smoked were more likely to have subjects report feelings of being dizzy or sick than experiments in which subjects smoked cigarettes, presumably because the cigars and pipes delivered more nicotine than cigarettes. In 1931, Lewin reported on the psychoactive effects of cigars, noting the ceremonial use of cigars to produce a strong psychosis during which a young man can "see spirits which prophesy his future and endow him with strength, knowledge and happiness" (from Phantastica: Narcotic and Stimulating Drugs, Their Use and Abuse reprinted in English by E. P. Dutton and Company, 1964). Lewin concluded that the pharmacological effects of tobacco, smoked or unsmoked, were primarily due to the nicotine released from the tobacco and absorbed by the person. Other pharmacologic effects of cigar smoking, including tolerance, pleasure, and tranquilization were described by Gies et al. in 1921, who concluded that these effects contributed to the habitual use of cigars. Interestingly, Gies and colleagues (1921) listed cigars before cigarettes in the order of greatest to least degree of psychoactive and toxic potency.

Other psychological and physiological effects of cigar smoking have also been referenced in classic early psychopharmacology research. Bates reported on the cardiovascular (Bates, 1922a), as well as the cognitive and psychomotor (Bates, 1922b) effects of cigar smoking. Bates showed that smoking increased systolic and diastolic blood pressure, as well as heart rate. Mixed results of cigar smoking and cigar smoke deprivation were seen on psychomotor and cognitive performance tasks which included arithmetic and dart throwing. Dixon (1928) also reported on the cardiovascular effects of cigar smoking as well as the on the cognitive-enhancing effects of cigar smoking and the lowered cognitive performance produced by deprivation from cigars. In 1927, Dixon reported on the psychoactive and performance effects of cigar smoking and stated that "acquired tolerance to nicotine is probably the same as that of morphine" (p. 20). Thus the concept that many of the effects of cigar smoking are due to nicotine has been understood for well over 70 years.

NICOTINE DOSING CAPABILITY OF CIGARS

Cigars contain and deliver a wide range of biologically-active chemicals, several of these such as nicotine, acetaldehyde, and carbon monoxide can serve to modify behavior. However, of all the chemicals known to be common across most cigar brands, nicotine is the only known dependence-producing drug present in substantial quantities. This section examines the nicotine dosing capabilities of cigars in greater detail to determine how cigars compare to products known to readily cause nicotine addiction, namely cigarettes and smokeless tobacco.

The nicotine delivery of cigars is a complex issue due to the variability in size, nicotine content, and pH of various cigar brands. Henningfield et al. (1996) examined characteristics of ten cigar brands selected from a cigar retailer in Baltimore. Table 1 summarizes the results of this study. The weight of the cigars examined ranged from 0.77 to 22 g, and the nicotine content of these products ranged from 10 to 444 mg. The pH of the tobacco in solution also varied greatly, with values ranging from 6.2 to 8.2. By contrast, cigarettes typically weigh less than 1 g and contain an average of 8.4 mg nicotine (Benowitz et al., 1983), and cigarette tobacco is generally mildly acidic with pH values ranging from 5.5 to 6 (Brunneman and Hoffmann, 1974). Additionally, in 1996, 98.2 percent of cigarettes produced in the United States had filters which prevent the direct contact of the cigarette tobacco with the lips and the buccal mucosa (United States Department of Agriculture, 1997).

The data in Table 1 indicate that cigars contain amounts of nicotine ranging (on the low end) from that equivalent to a single cigarette to (on the high end) that equivalent to an entire pack of cigarettes. With the exception of cigars that are similar in size to cigarettes, most cigars contain nicotine in quantities equivalent to several cigarettes. In addition, the higher pH of cigar tobacco and cigar smoke may result in a higher proportion of the nicotine contained in a cigar being in free unprotonated form and more available for absorption via the mouth, nose, and throat than is the case with cigarettes.

Table 1
Physical characteristics of ten cigars selected at random from a cigar retailer in Baltimore, MD, November 1995* (Reprinted from Henningfield et al., 1996)

Code	Length (mm)	Diameter (mm)	Weight (g)	Nicotine Concentration (mg/g)	Total Nicotine Content (mg)	Tobacco pH
A	68	8	0.77	14.95	16.59	6.2
B	79	8	1.12	9.00	10.08	6.6
C	124	17	9.56	17.40	166.30	6.8
D	125	12	4.20	4.70	19.74	7.6
E	138	17	12.60	8.43	106.22	7.3
F	148	12	5.78	10.74	62.07	7.2
G	149	16	10.06	7.75	77.79	8.0
H	170	17	15.37	16.35	251.30	6.7
I	198	21	22.00	22.00	444.00	7.1
J	214	20	21.29	8.90	189.50	8.2

** Nicotine content was determined by the HPLC method. Smoke pH was not assessed; however, the pH of the tobacco was determined by suspending 2 g of tobacco in 10 ml of water, mixing, then testing at fixed intervals up to 60 min.*

INHALATION OF CIGAR SMOKE The manner in which a person smokes a cigar also affects nicotine delivery. Some cigar smokers regularly inhale smoke, whereas others inhale very little (Turner et al., 1977). The pKa of nicotine is 8.02, which means that 50 percent of nicotine is in an unionized state, and this free unprotonated nicotine is present in the vapor phase of cigar smoke which contributes to the nicotine's rapid absorption through the oral mucosa (Lide, 1991). Therefore, nicotine from cigars which generate smoke with a high pH could readily be absorbed across the buccal mucosa, and smokers would not need to inhale the smoke deeply into the lung to absorb substantial amounts of nicotine. Absorption of nicotine through the buccal mucosa is highly pH dependent; absorption in the lung is less influenced by pH due to the much larger absorptive surface area of the lung. The smoke from cigarettes and those cigars which produce low–pH smoke must therefore be inhaled in order to absorb substantial amounts of nicotine. In contrast, cigar smokers with a high–pH smoke can absorb nicotine by holding the smoke in their mouth, or they can increase their absorption by inhaling. These differences in the absorption of nicotine from cigar and cigarette smoke are likely to contribute to the lower rates of inhalation among cigar smokers.

A cigar can also function much like a smokeless tobacco product such as chewing tobacco or oral snuff (i.e., "spit tobacco") and permit extraction of nicotine from the unburned tobacco so that it can be absorbed directly through the buccal mucosa and lips. This is possible for two reasons which

distinguish most cigars from most cigarettes: (1) most cigars have neither filters nor tips and are designed and used in a manner such that tobacco leaf material is in direct contact with the lips and to a lesser extent, with the tongue and gums; this contact serves to moisten the leaf and enable extraction of its nicotine; (2) most cigars are manufactured with tobacco leaf material which has been cured and/or buffered so as to produce a mildly alkaline tobacco which facilitates nicotine transfer.

Several studies have examined the absorption of nicotine from cigar smoke in human cigar smokers as well as in animals exposed to cigar smoke. Armitage and Turner (1970) examined delivery of nicotine by cigars and cigarettes through the oral mucosa in cats. The authors found that pharmacologic responses to the smoke were greater following cigar smoke exposer than following cigarette smoke exposer despite the fact that more nicotine was present in the cigarette smoke (4.4 mg versus 4.0 mg after 30 puffs of cigarette and cigar smoke, respectively). The authors interpreted these results to mean that more nicotine was absorbed from the cigar smoke due to the higher pH values in the cigar smoke (pH = 5.4 for cigarette and 8.5 for cigar smoke). Armitage and Turner (1970) also describe a separate experiment in which carotid blood levels of nicotine were measured after placing solutions of nicotine with pH values of 6, 7, and 8 in the mouths of cats. The authors found that absorption of nicotine in the first 2.5 min was 8 times higher following the pH 8 solution compared to the pH 6 solution.

Pechacek et al. (1985) examined serum thiocyanate levels, a chemical marker for inhaled tobacco smoke, in cigarette smokers, ex-cigarette-smoking cigar and pipe smokers, and never-cigarette-smoking cigar and pipe smokers. The authors found that cigarette smokers inhaled the greatest amount of tobacco smoke, followed by ex-cigarette smokers, then never-cigarette-smoking smokers of cigars and pipes. The authors suggest that most cigarette smokers inhale, whereas only some cigar smokers inhale, and that inhalation among cigar smokers is influenced by former cigarette smoking status. Serum thiocyanate levels were also related to the number of cigars smoked per day; subjects who smoked four or more cigars per day had serum thiocyanate levels comparable to cigarette smokers who smoked ten cigarettes per day. However, most of these heavy (> 4 per day) cigar smokers also tended to be ex-cigarette-smokers.

Similar results were found in a study by Turner et al. (1986) in which carboxyhemoglobin was used as the biological marker of inhaled tobacco smoke. Turner et al. found that the mean concentration of carboxyhemoglobin was 4.8 percent of the total hemoglobin among cigarette smokers, compared to 0.9 percent among never-cigarette- smoking cigar smokers and 6.8 percent former-cigarette smoking cigar smokers.

Combined data from more than 8,000 tobacco smokers, of whom more than 1,000 smoked cigars or pipes, from the Multiple Risk Factor Intervention Trial (MRFIT) confirmed significant levels of tobacco exposure (based on serum thiocyanate) and smoke inhalation (based on expired air carbon monoxide) among cigar smokers as compared to non tobacco users (Ruth and Neaton,

1991). Not surprisingly, overall levels of nicotine and smoke exposure were lower and more variable among cigar smokers than among cigarette smokers. Another analysis of data from MRFIT indicated that switching from cigarette smoking to cigar or pipe smoking resulted in decreased smoke exposure, but that levels remained significantly higher than those observed during tobacco abstinence (Ockene et al., 1987). The former cigarette smokers were also more likely to report inhaling cigar or pipe smoke into the lung than were cigar smokers who had never smoked cigarettes. The MRFIT data on cigar smoke inhalation patterns by former cigarette smokers are consistent with those reported in Chapter 2 and show that less than 15 percent of cigar smokers who never smoked cigarettes reported inhaling smoke into the lung, more than 20 percent of former cigarette smokers and approximately two-thirds of concurrent cigar and cigarette smokers reported inhaling. These data confirm that some cigar smokers who formerly or currently smoke cigarettes are likely to obtain regular doses of nicotine by inhalation of smoke directly into the lung.

RATE OF NICOTINE ABSORPTION

Armitage et al. (1978) examined the absorption of nicotine from small cigars labeled with 14C-nicotine. The authors found that the amount of nicotine delivered to the smoker's mouth during cigar smoking was greater that that during cigarette smoking, but the proportion retained by the subject was similar for cigars and cigarettes. Arterial nicotine concentrations were comparable for the two products, but the rise in arterial plasma nicotine levels was faster for cigarettes than for the small cigars. This difference in rates of delivery is probably due to the route of absorption since cigarette smoke is delivered largely through the lung, whereas cigar smoke is delivered through both the oral and lung routes, mostly buccal in subjects where there is little inhalation. Nicotine delivery to the brain is slower when nicotine is absorbed across the oral mucosa compared to absorption across the alveolar surfaces of the lung (Benowitz et al., 1988). In addition, absorption through the pulmonary route is more complete than through the oral route, which accounts for the fact that, whereas more nicotine was actually delivered to the mouth by the small cigars than by the cigarettes, similar amounts were actually retained.

Inhalation parameters have a dramatic affect on nicotine delivery. A study which examined the absorption of nicotine from non-inhaled cigar smoke found nicotine delivery to be slower than that observed following cigarette smoke inhalation (Russell et al., 1980). The authors studied the nicotine absorption from a single small cigar (6.2 g) and found an increase in plasma nicotine of 16.5 ng/ml after 1 hour of smoking the single cigar (Medallion Petit Corona).

Despite the acidic pH of cigarette smoke, inhalation into the lung can produce arterial nicotine concentrations as much as ten times greater than those concurrently observed in venous blood. Arterial levels achieving values of nearly 100 ng/ml have been reported with smokers smoking a single cigarette (Henningfield et al., 1993).

In summary, cigars have the capability to provide high levels of nicotine exposure, whether or not their smoke is inhaled. Furthermore, measures of physiologic response (e.g., Gies, 1921; Bates, 1922a, 1922b), as well as the toxicological consequences of cigar smoking (Chapter 3 and 4), demonstrate that humans can be exposed to high levels of nicotine through their consumption of cigars. On the other hand, the extraordinary variability in cigar nicotine content, the pH of tobacco and tobacco smoke , and inhalation patterns of cigar smokers imply that a wide range of levels of absorption, and potentially of dependence, would be expected to occur.

Drug Addiction: Basic Concepts and Definitions

"Drug addiction" is the common term for the various medical and social disorders related to the compulsive ingestion of psychoactive chemicals. The term "drug addiction" is often used interchangeably with the term "drug dependence" even though the term "drug dependence" is the preferred technical term in the scientific and medical literature. In this report, the terms "addiction" and "dependence" will be used interchangeably to refer to the syndrome of drug seeking behavior that meets criteria described in Table 2.

The occurrence of an abstinence-induced withdrawal syndrome may also play a role in the development of drug dependence. A drug withdrawal syndrome reflects an adaptation of behavioral and physiologic processes such that physiologic, cognitive and behavioral functioning are impaired when the drug is no longer present. This effect of drug exposure can complicate the process of achieving and maintaining drug abstinence, and the symptoms

Table 2
1988 Surgeon General's report criteria for drug dependence (US DHHS, 1988)

Primary Criteria:
Highly controlled or compulsive use
Psychoactive effects
Drug-reinforced behavior
Additional Criteria:
Addictive behavior often involves:
stereotypic patterns of use
use despite harmful effects
relapse following abstinence
recurrent drug cravings
Dependence-producing drugs often produce:
tolerance
physical dependence
pleasant (euphoriant) effects

can be so unpleasant as to precipitate relapse in those who do achieve abstinence (Jaffe, 1985; US DHHS, 1988). Drug addiction can be powerful even in the absence of a withdrawal syndrome, however. In fact, the majority of people monitored in surveys by the National Institute on Drug Abuse who regularly use addictive drugs (including cocaine and marijuana) report that they have not experienced withdrawal, even though many of these people feel dependent and have been unable to maintain abstinence (US DHHS, 1988).

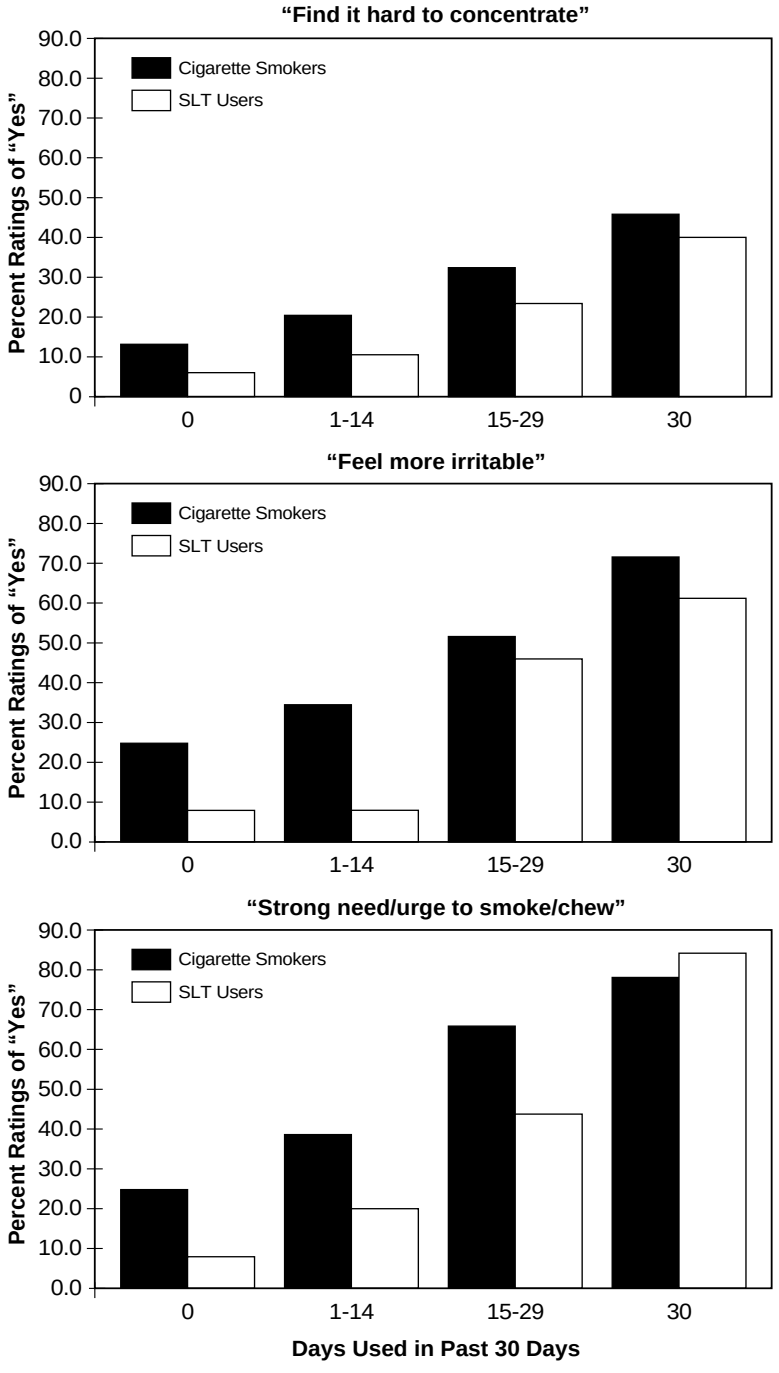
NICOTINE DEPENDENCE

Tolerance to the effects of nicotine is demonstrated by the fact that most cigarette smokers increase their consumption of cigarettes over time. Daily use increases over several years and then stabilizes. Only 10 to 15 percent of cigarette smokers smoke fewer than five cigarettes per day (Shiffman, 1989; Giovino, 1991). Between 1/3 and 1/2 of people that try even one cigarette develop an escalating pattern of use. This rate is much higher than that seen with other addictive drugs (US DHHS, 1994). Current epidemiological data suggest that the majority of adult cigar smokers maintain patterns of intermittent use and smoke fewer cigars per day than is seen in cigarette smokers (Chapter 2).

The extensive studies of time course and symptomology of withdrawal symptoms that have been conducted in cigarette smokers have not been duplicated in cigar smokers; however, several lines of evidence suggest that it may be possible for cigar smokers to develop a similar syndrome of withdrawal. Withdrawal symptoms from cigarettes, which primarily involve lung-delivered nicotine, are generally similar in nature, but higher in magnitude when compared to withdrawal symptoms associated with smokeless tobacco use, which primarily involve bucally-absorbed nicotine (Figure 1) (Centers for Disease Control and Prevention, 1994). A pattern of increasing severity of symptom development with increasing frequency of use is present for use of both cigarettes and smokeless tobacco. Other research on withdrawal from cigars and smokeless tobacco confirms the similarities in withdrawal symptoms across nicotine delivery formulations. However, it appears that formulations which deliver nicotine very slowly (e.g., nicotine patch and smokeless tobacco), or in generally low daily doses (e.g., nicotine gum as typically used), result in weaker syndromes of abstinence-associated withdrawal. Discontinuation of smokeless tobacco results in less reliable and/or weaker syndromes of withdrawal than discontinuation of cigarette smoking (e.g., Hatsukami et al., 1987; Henningfield, et al., 1997). These observations raise the possibility that withdrawal syndromes may be associated with regular heavy cigar smoking (which typically involves less lung exposure to nicotine than cigarette smoking). However, comparisons are complicated by the extraordinarily wide variation in nicotine delivery characteristics across cigars and smoke inhalation patterns of cigar smokers along with the absence of specific data for cigar smokers.

Figure 1

Symptoms of nicotine withdrawal among adolescents and young adults by the number of days of reported use of cigarettes or smokeless tobacco within the past month. Reported withdrawal symptoms significantly increased as a function of days used (Centers for Disease Control and Prevention, 1994).



FACTORS INFLUENCING NICOTINE DEPENDENCE

The level of dependence of nicotine in adults has been found to be inversely related to the age of initiation of smoking when measured by diagnostic criteria of the American Psychiatric Association (Breslau et al., 1992) or by Fagerstrom Tolerance Questionnaire Score (Henningfield, 1987). Because cigars vary so widely in their nicotine dosing characteristics, it is possible for an individual to obtain as much nicotine from one or two cigars with substantial nicotine dosing capacity as from a much larger number of smaller cigars or cigarettes. Because nicotine may be extracted directly from lip contact with the cigar tip itself, the common practice of keeping an unlit cigar in the mouth may also contribute to the total daily nicotine intake of some cigar smokers.

For many people, the process of graduation from first use to addiction is not immediate and can take months or even years (US DHHS, 1988). Initial experiences with tobacco, as with other addictive substances, are often negative, requiring social pressures and other factors to maintain exposure until the addiction develops (Haertzen et al., 1983). Over the course of many months, tolerance develops such that dysphoric subjective effects become minimal and much higher doses are needed to obtain the desired euphoric effects. At that point, mood, behavior, physiologic function, and cognition require the continued presence of nicotine to enable the person to feel normal — the person has become dependent.

With respect to cigarette smoking, 80 to 90 percent of all current cigarette smokers smoke more than five cigarettes and the vast majority of these individuals display symptoms of nicotine dependence. Some individuals who smoke fewer than six cigarettes per day appear able to smoke with a much greater degree of volition and display few symptoms of nicotine withdrawal upon cessation (Shiffman, 1989; US DHHS, 1988).

The proportion of cigar smokers showing clear signs of dependence remains unknown. Lower rates of inhalation in cigar smokers and slower absorption of nicotine through the buccal mucosa suggest that cigar smoking may have a lower potential to induce addiction to nicotine than cigarette smoking . In addition, it is plausible that persons who never had been nicotine dependent and who began smoking cigars in adulthood would be at a lower risk for developing dependence than children and adolescents who take up tobacco use. It does appear that a much higher proportion of adult cigar users compared to adult cigarette smokers are non daily users (Chapter 2).

It has long been observed that drug use that is restricted to occurring only in conjunction with social rituals may be less likely to escalate to patterns of abuse and severe dependence (e.g., Falk, 1983). These observations suggest that cigar smokers who do not begin smoking until adulthood, and who were not formerly nicotine-dependent, and who smoke only in certain settings (e.g., New Year's Eve) might be less likely to escalate their use and become dependent than someone who began smoking at a younger age.

Nicotine polacrilex gum and transdermal patch systems have low abuse liability, in part because rapid absorption is not possible from either nicotine delivery system. (Henningfield and Keenan, 1993; Henningfield and Stitzer, 1991; US DHHS, 1988). Cigar smoke may be inhaled, producing the same virtually instantaneous effects of nicotine delivery produced by cigarette smoking, or cigar smoke may be held in the nose and mouth providing a somewhat slower rate of nicotine absorption as occurs with smokeless tobacco products. Both routes of nicotine delivery are well-documented to lead to dependence and withdrawal with other forms of tobacco use (cigarettes and smokeless tobacco (US DHHS, 1986, 1988).

Henningfield and Keenan (1993) examined the pharmacokinetics of nicotine delivered by different routes of administration as well as the changes in subjective "liking" for the drugs. They found that nicotine delivered intravenously and through cigarette smoke was very rapidly absorbed and produced high scores on a question of subjective "liking" which may be indicative of the abuse liability of the drug (Jasinski et al., 1984). Nicotine delivered transdermally, however, was absorbed slowly and produced very low scores of drug liking, despite the achievement of comparable venous plasma levels. Because nicotine delivery through cigar smoke is primarily through the oral mucosa with delivery through the pulmonary route as well for those who inhale the smoke, it is likely that the delivery kinetics of nicotine may be more comparable to smokeless tobacco which had scores of subjective liking falling somewhere between those of transdermal and cigarette delivery. These observations suggest that the risk of becoming nicotine dependent might be somewhat lower in the cigar smokers as opposed to cigarette smokers.

It is likely that nicotine tolerance and physical dependence to cigars may develop among heavy regular users. However, there would be little basis to expect that substantial levels of physical dependence would be observed in people who rarely smoked on two or more consecutive days. Nicotine has a half-life of approximately 2.5 hours and therefore, smoking a single cigar or smoking with a non-daily frequency would not create a chronic exposure to nicotine. Exposure of at least a few weeks is felt to be necessary to create the degree of physical dependence that would enable substantial withdrawal symptoms to develop upon cessation of use (American Psychiatric Association, 1994). Table 3 gives DSM-IV criteria for nicotine withdrawal. The novice cigar smoker would certainly feel a number of adverse effects during smoking the first cigar, much as a first-time cigarette smoker would. These effects would include the nausea and lightheadedness associated with nicotine administration. After several cigars, however, these effects should dissipate, allowing the cigar smoker to use more of the product.

Table 3
DSM-IV criteria for nicotine withdrawal (American Psychiatric Association, 1994)

A. Daily use of nicotine for at least several weeks.

B. Abrupt cessation of nicotine use, or reduction in the amount of nicotine used, followed within 24 hours by four (or more) of the following signs:

   (1) dysphoric or depressed mood

   (2) insomnia

   (3) irritability, frustration, or anger

   (4) anxiety

   (5) difficulty concentrating

   (6) restlessness

   (7) decreased heart rate

   (8) increased appetite or weight gain

C. The symptoms in Criterion B cause significant distress or impairment in social, occupational, or other important areas of functioning.

D. The symptoms are not due to a general medical condition and are not better accounted for by another mental disorder.

CONCLUSIONS

1. Cigars contain amounts of nicotine that vary from the amounts contained in a single cigarette to the amount contained in a pack or more of cigarettes. The amount of nicotine is usually proportional to the amount of tobacco contained in the cigar.

2. There is substantial variability in the pH of the tobacco smoke produced by cigars, but most cigars produce smoke that is more alkaline than cigarette smoke. This alkaline pH facilitates nicotine absorption across the oral mucosa and may explain why cigar smokers are less likely to inhale than cigarette smokers.

3. There is sufficient nicotine absorption among regular heavy cigar smokers to expect that nicotine dependence might develop, but studies to document the frequency or intensity of nicotine dependence have not been published.

4. The pattern of cigar use in the population (infrequent use, low number of cigars smoked per day, and lower rates of inhalation compared to cigarette smokers) suggest that cigar use which begins in adulthood may be less likely to produce dependence than cigarette smoking. However, most of the cigar smokers studied began smoking cigars as adults. The current trend of adolescent cigar use generates a concern that prior low adult rates of developing dependence may not apply to cigar use begun during adolescence.

REFERENCES

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*, 3rd Edition (revised). Washington, DC: American Psychiatric Press, 1987.

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*, 4th Edition. Washington, DC: American Psychiatric Press, 1994.

Armitage, A., Dollery, C., Houseman, T., Kohner, E., Lewis, P. J., Turner, D. Absorption of nicotine from small cigars. *Clinical Pharmacology and Therapeutics*, 23: 143-151, 1978.

Armitage, A.K., Turner, D.M. Absorption of nicotine in cigarette and cigar smoke through the oral mucosa. *Nature*, 226: 1231-1232, 1970.

Bates, R.L. The effects of cigar and cigarette smoking on certain psychological and physiological functions: II. Blood pressure and heart rate. *Journal of Comparative Psychology*, 2: 431-505, 1922a.

Bates, R.L. The effects of cigar and cigarette smoking on certain psychological and physiological functions: I. Dart throwing. *Journal of Comparative Psychology*, 2: 371-423, 1922b.

Benowitz, N.L., Hall, S. M., Herning, R. I., Jacob, P., Jones, R. T., Osman A. L. Smokers of low yield cigarettes do not consume less nicotine. *New England Journal of Medicine*, 309: 139-142, 1983.

Benowitz, N.L., Porchet, H., Sheiner, L., Jacob, P. Nicotine absorption and cardiovascular effects with smokeless tobacco use: Comparison with Cigarettes and Nicotine Gum. *Clinical Pharmacology and Therapeutics*, 44: 23-28, 1988.

Breslau, N., Fenn. N., Peterson, E.L. Early smoking initiation and nicotine dependence in a cohort of young adults. *Drug and Alcohol Dependence*, 33: 129-137, 1992.

Brunneman, K.D., Hoffmann, D. The pH of tobacco smoke. *Food and Cosmetics Toxicology*, 12: 115-124, 1974.

Centers for Disease Control and Prevention. *Reasons for tobacco use and symptoms of nicotine withdrawal among adolescent and young adult tobacco users-United States*, 1993. Morbidity and Mortality Weekly Report 43(41): 745-750, 1994.

Dixon, W.E. The physiological effects of smoking. *Practitioner*, 118: 20-28, 1927.

Dixon, W.E. The tobacco habit. *British Journal of Inebriety* (Alcoholism and Drug Addiction), 25: 99-121, 1928.

Falk, J.L. Drug dependence: Myth or motive? *Pharmacology, Biochemistry and Behavior*, 19: 385-391, 1983.

Gies, W.J., Kahn, M., Limerick, O. V. The effect of tobacco on man. *New York Medical Journal*, June 1: 809-811, 1921.

Giovino, G.A. Public-health perspectives. Henningfield, J.E., and Stitzer, M. L. (eds.). In: *New Developments in Nicotine-Delivery Systems*. New York: Cortland Communications, pp. 3-10, 1991.

Graham, V., Carr, R. H. Chemical factors determining the quality of tobacco. *Journal of the American Chemical Society*, 46: 695-702, 1924.

Haertzen, C.A., Kocher, T.R., Miyasato, K. Reinforcement from the first drug experience can predict later drug habit and/or addiction: Results with coffee, cigarettes, alcohol, barbiturates, minor and major tranquilizers, stimulants, marijuana, hallucinogens, heroin, opiates and cocaine. *Drug and Alcohol Dependence*, 11: 147-165, 1983.

Hatsukami, D.K., Gust, S.W., Keenan R.M. Physiologic and subjective changes from smokeless tobacco withdrawal. *Clinical Pharmacology and Therapeutics* 41: 103-107, 1987.

Henningfield, J.E. Acquisition of dependence to cigarettes and smokeless tobacco. In: *Annual Report of the Addiction Research Center*. Rockville, MD: US DHHS, p. 36, 1987.

Henningfield, J.E., Fant, R.V., Tomar, S. L. Smokeless tobacco: An addicting drug. Advances in Dental Research, 11: 330-335, 1997.

Henningfield, J.E., Hariharan, M., Kozlowski, L.T. Nicotine content and health risk of cigars. *JAMA*, 276: 1857-1858, 1996.

Henningfield, J.E., Keenan, R.M. Nicotine delivery kinetics and abuse liability. *Journal of Consulting and Clinical Psychology*, 61: 743-750, 1993.

Henningfield, J. E., Stapelton, J. M., Benowitz, N. L., Grayson, R. F., and London, E.D. Higher levels of nicotine in arterial than in venous blood after cigarette smoking. *Drug and Alcohol Dependence*, 33: 23-29, 1993.

Henningfield, J.E., Stitzer, M. L. (eds.) *New Developments in Nicotine-Delivery Systems*. New York: Cortland Communications, 1991.

Jaffe, J.H. Drug addiction and drug abuse. Gilman, A. G., Goodman, L. S., Rall, T. W. and Murad, F. (eds.) Goodman and Gilman's *The Pharmacologic Basis of Therapeutics*, Seventh Edition. New York: MacMillan Publishing Company, pp. 532-581, 1985.

Jasinski, D.R., Johnson, R.E., and Henningfield, J.E. Abuse liability assessment in human subjects. *Trends in Pharmacological Science*, 5: 196-200, 1984.

Lewin, L. *Phantastica: Narcotic and Stimulating Drugs, Their Use and Abuse*. Reprinted in English 1964. New York: E.P. Dutton and Company, 1931.

Lide, D.R. (ed.) *CRC Handbook of Chemistry and Physics*, 72nd ed. 1991-1992. Boca Raton: CRC Press, 1991.

McKim, W.A. Drugs and Behavior: An Introduction to Behavioral Pharmacology. Englewood Cliffs, NJ: Prentice-Hall, pp. 130, 1986.

Mendenhall, W.L. A study of tobacco smoking. *American Journal of Physiology*, 72: 549-557, 1925.

Murray, J., et al. *New English Dictionary on Historical Principles*. Oxford: Clarendon Press, 1991.

Ockene J.K., Pechacek, T.F., Vogt, T., Svendsen, K. Does switching from cigarettes to pipes or cigars reduce tobacco smoke exposure? *American Journal of Public Health* 77: 1412-1416, 1987.

Pechacek, T.F., Folsom, A.R., de Gaudermaris, R., Jacobs, D. R., Luepker, R. V., Gillum, R. F., Blackburn, H. Smoke exposure in pipe and cigar smokers: serum thiocyanate measures. *JAMA*, 254: 3330-3332, 1985.

Russell, M.A.H., Jarvis, M.J., Feyerabend, C. A new age for snuff? *Lancet*, 1: 474-475, 1980.

Ruth, K. J., Neaton, J. D. Evaluation of two biological markers of tobacco exposure. *Preventive Medicine* 20: 574-589, 1991.

Shiffman, S. Tobacco 'chippers'. Individual differences in tobacco dependence. *Psychopharmacology*, 97: 539-547, 1989.

Turner, J.A. McM, McNicol, M.W., and Sillett, R.W. Distribution of carboxyhaemoglobin concentrations in smokers and non-smokers. *Thorax*, 41: 25-27, 1986.

Turner, J.A. McM, Sillett, R.W., McNicol, M.W. The effect of cigar smoking on carboxyhaemoglobin and plasma nicotine concentrations in primary pipe and cigar smokers and ex-cigarette smokers. *British Medical Journal*, 2: 1387-1389, 1977.

U.S. Department of Agriculture. *Tobacco Situation and Outlook Report*. Commercial Agriculture Division, Economic Research Department, U.S. Department of Agriculture, TBS-238, p. 5, 1997.

U.S. Department of Health and Human Services. *The Health Consequences of Involuntary Smoking*. A report of the Surgeon General. DHHS (CDC) 87-8398, Washington, D.C. 1986

U.S. Department of Health and Human Services. The Health Consequences of Smoking: *Nicotine Addiction: A Report of the Surgeon General*, DHHS publication No. (CDC) 88-8406. Washington DC: U.S. Government Printing Office, 1988.

U.S. Department of Health and Human Services. *Preventing tobacco use among young people. A report of the Surgeon General*, 1994. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, Office on Smoking and Health (U.S. Government Printing Office Publication No. S/N 017-001-00491-0). Atlanta, GA: U.S. Government Printing Office, 1994.

Marketing and Promotion of Cigars

John Slade

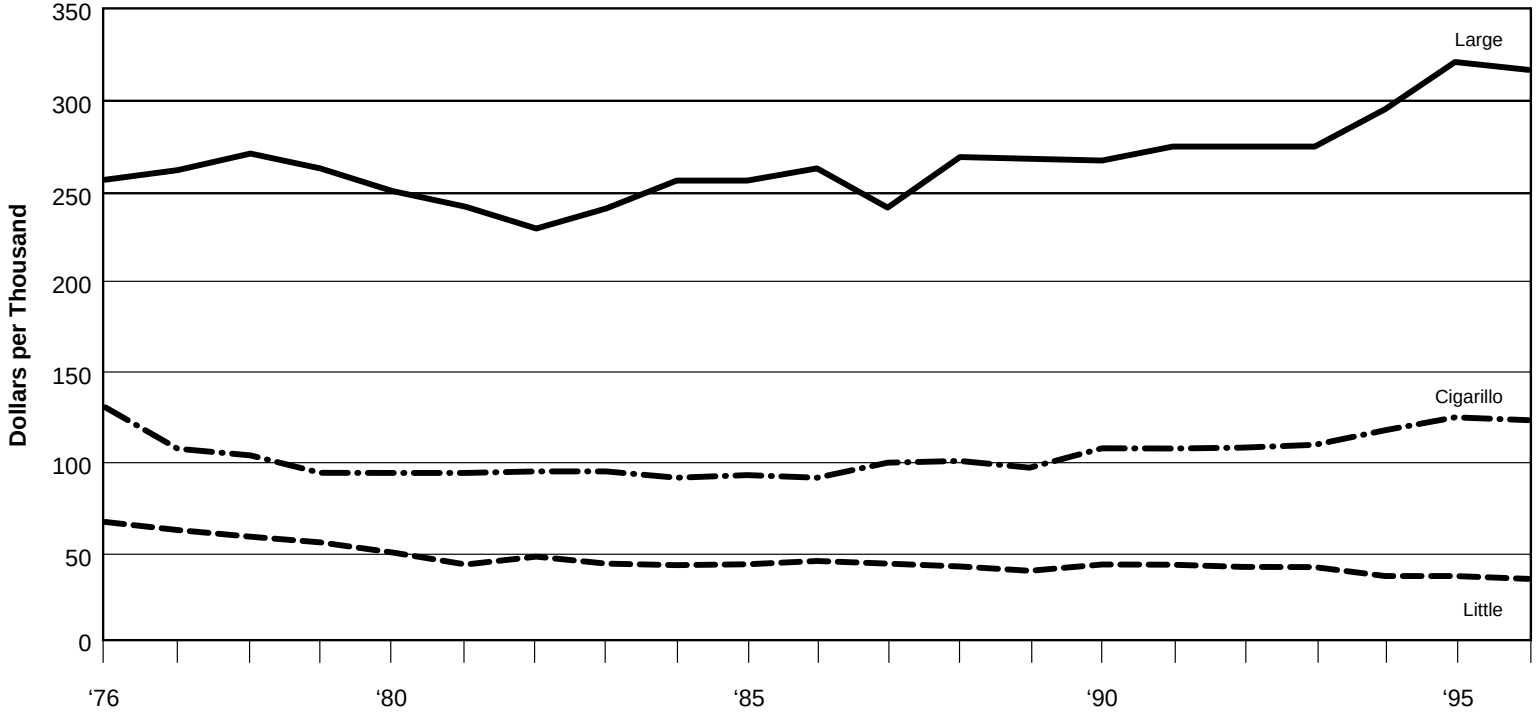
INTRODUCTION This chapter examines the recent commercial history of cigars in the United States. Sales patterns, advertising, and apparent promotional activities are explored. Most of the discussion of marketing activities is descriptive, since few quantitative data are available. There is almost no publicly available information on how the increased visibility that cigars have achieved since about 1992 has been financed. Accordingly, what are described in this chapter as promotional activities are not necessarily the result of activities by commercial interests. They are, though, activities that have probably contributed to the promotion of cigar consumption.

SALES PATTERNS Figure 1 charts the mean retail price of cigars from 1976 through 1996, adjusted for inflation. The inflation adjusted price of small cigars fell steadily over the period, losing 52 percent of their initial average price by 1996. Inflation adjusted prices for cigarillos ended the period about where they had begun despite a prolonged dip during the 1980's. Large cigars showed generally steady overall prices with some year to year fluctuations in the 70's and 80's, but 1994 and 1995 were two consecutive years of substantial increases in mean price, probably reflecting the relative growth of the premium segment.

In a prospectus for the initial public offering of 5.4 million shares of company stock, Consolidated Cigar Holdings Inc. pointed to several factors which it believes have contributed to the increase in cigar sales in recent years.

> The Company believes that the growing cigar market and increased demand for cigars continue to offer the Company substantial growth opportunities. Recently, cigar smoking has gained popularity in the United States, resulting in a significant increase in consumption and retail sales of cigars, particularly for premium cigars. Management believes that this increase in cigar consumption and retail sales is the result of a number of factors, including: (i) the increase in the number of adults over the age of 50 (a demographic group believed to smoke more cigars than any other demographic segment) and (ii) the emergence of an expanding base of younger affluent adults who have recently started smoking cigars and who tend to smoke premium cigars. The Company believes the increase in cigar smoking is in large part attributable to a positive and improving image of cigar smoking resulting from increased publicity, including the success of *Cigar Aficionado* magazine, the increased visibility of use by celebrities and the proliferation of "Cigar Smokers" dinners and other special events for cigar smokers. (Consolidated Cigar Holdings Inc., 1996, p. 3)

Figure 1
Mean retail price of various size cigars, U.S. 1976-1996, corrected for CPI (1982-1984 = 100)



Source: Maxwell, 1997

Similarly, the CEO and the President of Culbro have stated,

> The emergence and rise in popularity of cigar dinners, cigar clubs, cigar bars and successful magazines such as Cigar Aficionado lend additional credence to the link that now exists between premium cigars and affluent consumers. (Culbro Corporation, 1996, p. 2)

The marketing of cigars has emphasized premium cigars; however, when market shares of different brands are examined, inexpensive brands of machine-made cigars actually dominate the cigar market (Table 1). The leading brand is a machine-made variety of little cigars, Swisher Sweets, which had a 19 percent market share in 1996. In contrast, the heavily advertised premium brand Macanudo has only a 0.8 percent share. (General Cigar is building Macanudo into a major name brand with a coordinated campaign of advertising, sportswear, and ventures such as Club Macanudo (Smoke Signals, 1997; Culbro Corporation, 1996).) Table 2 lists premium brands of the largest U.S. cigar companies.

While there is a plethora of brands, styles, and sizes of cigars, only a few companies sell most of them (Table 3). Just five companies, Swisher International, Havatampa, Consolidated Cigar, Middleton, and Culbro (General Cigar), control 95 percent of the market in the United States. Except for Havatampa, which only sells machine-made cigars, each of the major companies sells both premium and non-premium brands. In addition to the major companies, a welter of small companies manufacture and import premium cigars.

The market for little cigars is even more concentrated, with just three companies, Swisher International, Consolidated Cigar, and Tobacco Exporters International, controlling 86 percent of the market (Table 4). Swisher alone, with its Swisher Sweets little cigars, has a 42 percent share. Table 4 also lists the major brands of little cigar now on the market.

Many companies which manufacture or import cigars are involved in other aspects of the tobacco business. Table 5 lists cigar companies which also sell other tobacco products.

The recent rise in cigar sales has led to increased value of cigar companies as investments. Several have made public share offerings and both popular and trade magazines have offered information about these potential investments (Wall Street Report, 1997; Luz, 1997; Finora, 1997).

There has been a marked increase in the number of smoke shops since 1992 (Flying High, 1997). The number of retail specialty tobacco outlets has increased from 2,358 in 1992 to 4,948 in 1996. A sign that this increase has drawn in many small businessmen who have not previously been involved in the trade is the publication of an extensive article in a trade magazine about the function of sales representatives (Scott, 1997).

Table 1
Market share large cigars and cigarillos, United States, 1996, millions and percent

Brand	Company	Units	Percent
Swisher Sweets	Swisher Int'l	601	19.4
Phillies	Havatampa Inc	462	15.0
Havatampa	Havatampa Inc	258	8.3
White Owl	General Cigar	184	6.0
Dutch Masters	Consolidated	138	4.5
Garcia y Vega	General Cigar	138	4.5
Antonio y Cleopatra	Consolidated	124	4.0
King Edward	Swisher Int'l	105	3.4
Muriel	Consolidated	100	3.2
Backwoods	Consolidated	98	3.2
Robert Burns	General Cigar	87	2.8
El Producto	Consolidated	53	1.7
William Penn	General Cigar	44	1.4
Tijuana Smalls	General Cigar	34	1.1
Macanudo	**General Cigar**	**26**	**0.8**
Universal	Swisher Int'l	24	0.8
La Corona	Consolidated	13	0.4
Bering	**Swisher Int'l**	**10**	**0.3**
Partagas	**General Cigar**	**9**	**0.3**
Roi-Tan	Consolidated	7	0.2
Canaria d'Oro	**General Cigar**	**2**	**0.1**
Other, non-premium		340	11.0
Other, premium		**233**	**7.5**
Total		3,090	99.9

Premium brands in bold face.
Note: A premium cigar is hand-made, is comprised entirely of natural, long filler tobacco, and has a retail price of more than $1.00.
Sources: Data on premium cigars and market share, Maxwell, 1997. Data on total U.S. consumption, USDA, 1997.

ADVERTISING Only a small amount of conventional advertising appears for cigars. Measured media spending increased from $1.1 million in 1994 to $4.0 million in the first nine months of 1996 (Table 6). Most advertising for cigars appears in magazines; 39 magazines carried cigar advertising in this 3-year period. As of December 1996, the price for a one time insertion of a full-page, four-color advertisement in *Cigar Aficionado* was $18,360 while a similar ad in *Smoke* cost $7,950.

Cigar advertising employs a variety of themes. Cigars are presented as lavish, even outrageous, yet affordable luxuries and indulgences. Other ads depict a rich history and tradition of cigar making or appeal to nostalgia in

Table 2
Premium brands of the major cigar companies

Company	Premium brands
Consolidated Cigar	H. Upmann
	Montecristo
	Don Diego
	Te-Amo
	Santa Damiana
	Royal Jamacia
	Primo Del Rey
	Montecruz
General Cigar	Macanudo
	Partagas
	Punch
	Hoyo de Monterrey
	Cohiba
	Excalibur
	Ramon Allones
	Temple Hall
	El Rey Del Mundo
	Canaria D'Oro
	Cifuentes
	Bolivar
	Belinda
	Bances
Swisher Int'l	Bering
	Pléiades

Table 3
Large cigars and cigarillos, United States, 1996. Market share, company by company, millions and percent

Company	Units	Percent
Swisher Int'l, Inc.	758	24.5
Havatampa	720	23.3
Consolidated Cigar	634	20.5
Culbro (General Cigar)	527	17.1
Middleton	310	10.0
M & N Standard Cigar	47	1.5
House of Windsor	30	1.0
Others	64	2.1
Total	3,090	100.0

Sources: Data on market share, Maxwell, 1997. Data on total U.S. consumption, USDA, 1997.

Table 4
Little cigars, United States, 1996. Market share and leading brands, company by company, millions and percent

Company	Units	Percent
Swisher Int'l Inc.	632	42.4
Swisher Sweets Little		
Consolidated	340	22.8
Dutch Treats		
Tobacco Exporters Int'l	316	21.2
Winchester		
Havatampa, Inc.	139	9.3
Omega		
Between the Acts		
Madison		
Hav-a-tampa		
Lane Limited	76	5.1
Captain Black		
House of Windsor	1	0.1
Little Nippers		
Change in Inventory	(14)	(0.9)
Total	1,490	100.0

Source: Maxwell, 1997.

Table 5
Cigar companies that also manufacture tobacco products that are regulated by the Food and Drug Administration

Company	Regulated Products
Commonwealth Brands	Cigarettes Cigarette tobacco
Consolidated Cigar	Cigarette tobacco
Finck Cigar	Smokeless tobacco
Lane Limited	Cigarette tobacco
Red Lion International	Cigarette tobacco Smokeless tobacco
Nat Sherman	Cigarettes
Pinkerton Group	Smokeless tobacco
Swisher International, Inc.	Smokeless tobacco
UST	Smokeless tobacco

Sources: Smoke 2(1):40-41, Winter 96/97; Tobacco Reporter, 1996; UST Annual Report.
Smokeless tobacco includes oral snuff.

Table 6
Measured media spending for cigars, United States 1994, 1995, 1996 (first 9 months for '96), $000's

Company	1994	1995	1996 (9 months)
CULBRO CORP. (General Cigar)			
General Cigar	60	42	n/a
Garcia Y Vega	n/a	n/a	24
Macanudo	234	1,503	1,597
Partagas	375	689	134
DAVIDOFF OF GENEVA, INC.			
Davidoff Cigars	128	249	230
MACANDREWS & FORBES HOLDINGS (Consolidated Cigar)			
Don Diego	n/s	83	406
H Upmann	96	187	366
Te-Amo	193	104	303
RICHEMONT AG			
Dunhill	n/a	30	173
Winchester Little Cigars	107	54	150
SWISHER INTERNATIONAL INC.			
Swisher Sweets Little Cigars	n/a	121	296
THOMPSON CIGAR CO.			
Thompson Cigars	n/a	277	n/a
TRIPLE C ACQUISITION CORP.			
Consolidated Cigars	n/a	111	287
Total	1,193	3,450	3,966

Source: Leading National Brands, 1997.

other ways; for instance, by evoking a romantic vision of pre-revolutionary Cuba. Many ads create a personal link with the company owners, founders, or the artisans and the farmers who create the product and its raw material.

Some advertising seeks to expand the market for cigars by legitimizing new users and new settings for use. The former is illustrated by the ads which invite women to smoke cigars. An example of the latter is an ad for a brand sold by U.S. Tobacco International, Don Tomás (U.S. Tobacco International, 1997). The ad shows a man dressed in a terry cloth robe, holding a coffee cup, smoking a cigar. The ad copy reads,

> What time of day should you light up a cigar? We know people who wouldn't think of having their first cup of caffe latte without firing up a good cigar. Then there are the traditionalists who wait until the after dinner single malt is served to light up their handmade Don Tomás Presidentes. When you really get down to it, as long as the label says Don Tomás you're in for a treat, day or night.(p.253)

Just by asking the question, U.S. Tobacco International legitimizes an expansion of when cigars are smoked, especially by people who think of themselves as not being bound by tradition. Smoking cigars with morning coffee is not in exchange for consumption later in the day. Like promoting soft drinks as a breakfast beverage, it is a marketing tactic which is aimed at expanding the market.

Sexuality permeates many of the ads (Figure 2), and it can be especially blatant in ads from some of the smaller companies. An ad for a 3.5 inch-long cigarillo shows an attractive couple having a good time, each holding the product. The copy reads, "For the women who say size doesn't matter, and the men who actually believe them" (*Caribbean Cigar*, 1997, p. 33).

Some ads work at a more sophisticated level. An ad for Macanudo, which is part of a "campaign aimed at younger adult smokers" (Culbro Corporation, 1996, p. 5), shows an attractive woman and a handsome older man, both holding cigars and looking directly at the camera. The headline reads, "And they thought you'd have nothing in common." The copy creates suggestions of professional tension and competition between the two, but their cigars create an affirming bond that is "to be shared like wit. To be savored like wisdom" (*Cigar Aficionado*, May/June 1997a, p. 9).

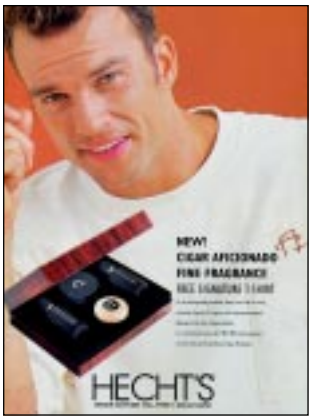
Figure 2
Sexuality in cigar advertisements

PROMOTION By far the most important ways cigars have been presented to the public have been through various promotional activities.

Lifestyle magazines The resurgence of cigar use in the United States has been closely associated with the glossy lifestyle magazine, *Cigar Aficionado*, published by Marvin R. Shanken. Launched in the Fall of 1992, the magazine was targeted for what Shanken asserted was an increasing number of men who enjoy smoking expensive cigars (Shriver, 1992). The publication has grown from 130 pages per issue to more than 400 and has increased its publication frequency from four to six times annually. Its circulation has grown from 40,000 (Conrad, 1996) to 400,119 (*New York Times*, 1997. Each issue promotes cigar use as part of successful, indulgent living through interviews with celebrities, sports stars, and others. Reviews of expensive cigars are offered as well as lavish descriptions of cigar accessories such as lighters and humidors. The editorial context is how to live life to the fullest in a style reminiscent of Esquire, GQ or Playboy. While advertising for cigars and their perquisites are prominent, sellers of upscale clothing, luxury cars, expensive watches, jewelry, premium liquor, casinos, other resorts, and perfume also feature their goods and services in this publication. Each issue has an article about gambling.

Cigar Aficionado has launched a line of clothing and accessories named for the magazine. A *Cigar Aficionado* branded fragrance for men was promoted in time for holiday shopping (*Washington Post Magazine*, 1998) (Figure 3)

Figure 3
***Cigar Aficionado* fine fragrance**



Source: Washington Post Magazine, 1998

Most cover stories feature profiles of prominent people whose cigar use is illustrated on the cover and described in the accompanying article (Table 7) (Figure 4).

Articles romanticize cigar smoking Actor James Woods (Figure 5) told his interviewer, "When you smoke a cigar, time stops. And you can sort out your thoughts. Contemplate. You can just kind of hold it and puff it and just drift down the stream of your thoughts for an hour or so. Thank God for cigars. At least there is one place where I can be quiet for a moment and actually be alone with my thoughts" (*Cigar Aficionado*, 1997b, p.147, 149). There are also frequent defiant comments about cigars in reaction to what are depicted as puritanical or radical emblems in the culture. Woods remarked, "Cigar smoking is the kind of thing a feminist would whine about. . . .And that's a good thing" (*Cigar Aficionado*, 1997, p.144).

A feature story on Claudia Schiffer (Figure 6) opens with an indignant blast at dissipation and drug use in the modeling profession:

Table 7
Persons featured on covers of *Cigar Aficionado* and *Smoke*, 1993 - Winter 1998

	Year	Persons
Cigar Aficionado	1993	Groucho Marx Winston Churchill
	1994	Rush Limbaugh Fidel Castro Bill Cosby George Burns
	1995	Ron Perelman Jack Nicholson Linda Evangelista Tom Selleck
	1996	Matt Dillon Arnold Schwartzenegger Demi Moore Danny Devito
	1997	Wayne Gretzky Janet Jones James Woods Claudia Schiffer Michael Richards
	1998	Denzel Washington
Smoke	1996	Pierce Brosnan Tom Arnold Red Hot Chili Peppers Mel Gibson
	1997	Elle Macpherson Jeff Goldblum Carmen Electra

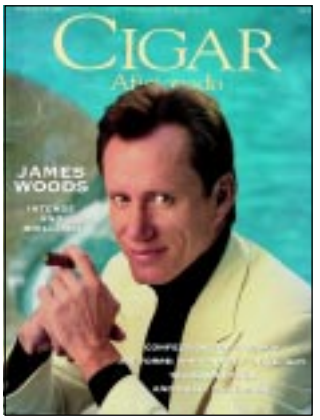
> Claudia Schiffer is talking tough. There's a problem in the world of fashion these days, she says — the fact that too often models have to look like junkies just to be cool. "I think fashion should be promoting beauty and health," she says. "That doesn't happen if the model looks anorexic, unhealthy, tired, if the photography makes her look as if she's on drugs or been out partying all night. That kind of thing can end up hurting young women or girls who feel they have to imitate the models they see in the magazines. That's not what fashion is about. For me, fashion is about beauty." (Rothstein, 1997, p. 170)

The article and magazine cover include seven large photos of the supermodel cum cigar in alluring poses (Rothstein, 1997). The contrast being drawn between drug use and dissipation on the one hand and cigar use on the other could not be more clear.

Figure 4
Jack Nicholson, Matt Dillon, and Bill Cosby

Source: Cigar Aficionado, Summer 1995, Spring 1996, and Autumn 1994.

Figure 5
James Woods

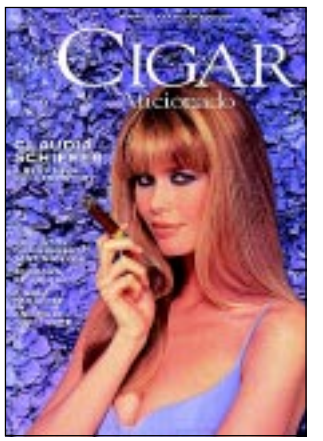


Source: Cigar Aficionado, May/June 1997

The magazine has created a following. Readers send in photographs of themselves and their cigar-related activities. Several pages have been devoted to photos of readers showing off cigar-related vanity license plates (*Photo Gallery*, 1997a; *Photo Gallery*, 1997b).

From time to time, the publisher takes on criticisms of cigar use in the editorial he writes for each issue, taking the Environmental Protection Agency (EPA) report on environmental tobacco smoke and the proposed Occupational Safety and Health Administration (OSHA) rule on tobacco smoke in the work place to task (Shanken, 1993; Shanken, 1997c), issuing a call to action against the "new Prohibition" in another (Shanken, 1994), and expressing sharp disagreement with critics of cigar use as indulging in "scare tactics" in another (Shanken, 1997a). Within days of the announcement from the Centers for Disease Control that surveys show that kids now frequently use cigars (Kaufman et al.,

Figure 6
Claudia Schiffer



Source: Cigar Aficionado, August 1997

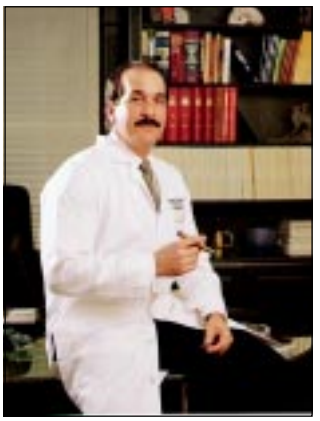
1997), posted a column on the magazine's web page proclaiming that cigars are for adults only and not for teenagers (Shanken, 1997b). He has blasted the American Cancer Society for publishing public service ads about cigars and Brooks Brothers for stopping the use of cigars as props for models in its advertising (Shanken, 1997d).

Figure 7
Ear, nose, and throat surgeon

Source: Cigar Aficionado, Spring 1993

The posture taken is that the occasional, non-inhaled, moderate use of cigars is OK even though potentially serious problems can sometimes arise when cigar use is outside of these parameters. The studied reassurance the magazine offers has been reinforced by a column written by a cigar-loving Ear, Nose, and Throat (ENT) surgeon, who was photographed in surgical scrubs holding a cigar (Pearlman, 1993) (Figure 7). A similar image was evoked in a photograph which illustrated an article on cosmetics and cosmetic surgery for men. A plastic surgeon posed in a white lab coat, holding a cigar (Wolfson, 1997) (Figure 8).

Figure 8
Cosmetic surgeon



Source: Cigar Aficionado, March/April 1997

The periodical has not only been sanctioned by physicians, it has been blessed by a person of the cloth. In its second issue, the magazine published a letter from an anonymous member of the clergy, who praised the new publication and reflected on the importance of a cigar in composing sermons. "In moderation, ten a week or so, cigar smoking, I declare, is not a sin. Gentlemen, you have my blessings. Those who do like the art and transcendental experience of smoking a fine cigar need not worry of divine retribution. I think God understands" (An inspired preacher, 1992).

By 1996, the success of *Cigar Aficionado* spawned imitation from a tobacco trade publisher, Lockwood, in the form of *Smoke*, whose subtitle is "Cigars, pipes and life's other burning desires." It, too, has seen an increase in pages, from 182 in the premier issue to 464 in the Summer 1997 issue. S*moke*, which seems targeted at a somewhat younger, more hip audience, has a similar mix of cigar features and general lifestyle articles. Its covers also feature celebrities smoking cigars (Table 7) (Figure 9). Another similar magzine, *Cigar Monthly*, has featured various cover stories (Figure 10).

These three publications have been imitated in France (French Toast, 1996). In keeping with the style of its American cousins, the cover of the March 1997 issue of L'Amateur de Cigare features General Charles de Gaulle with a cigar.

Figure 9
Mel Gibson, Carmen Electra, Jeff Goldblum, and Elle Macpherson

Source: Smoke, Anniversary Issue Winter 1996-1997, 2nd Anniversary Issue Winter 1997, Summer 1997, and Spring 1997

Figure 10
***Cigar Monthly* cover stories**

Source: Cigar Monthly, April 1995, November 1995, March 1996, July 1996, 1997

The hedonistic themes these magazines explore are captured in the concluding exchange from an interview published in *Smoke* with actress Kim Cattrall (Cattrall, 1996).

Q. What do you think all the buzz is about cigars?

A. It's a very large phallic symbol that men like to play with — and women like to watch them. I understand the attraction. Just holding one, there's sort of a power related there.

Cigar-centered Dining and Entertainment

The current era of fancy cigar dinners and other entertainments focused on cigars seems to have begun around 1988 (Luz, 1997).

From its own beginnings four years later, *Cigar Aficionado* sponsored gala affairs and dinner parties at expensive restaurants featuring cigars, wines, and celebrity guests. Similar events, which build word of mouth advertising, have become widespread, and the magazine publicizes restaurants that offer "smoker nights." In a 1992 issue, there was a list of 32 domestic and 4 foreign restaurants and cigar clubs that offered such events (Smoker Nights, 1992); by Spring 1997, the number of listings had grown to 591 entries in the United States and 70 listings from outside the country (Smoker Nights, 1997). Magazine subscribers receive formal invitations to events sponsored by the magazine, and the magazine regularly features photographs from these events in its pages. The popularity and acceptability of these events is illustrated by the fact that a restaurant at Walt Disney World has hosted cigar dinners (Scott, 1996a).

Sometimes, these events are linked to charitable causes. In New Jersey, cigar nights have provided fund-raising settings for the Women's Center of Monmouth County, the Make-A-Wish Foundation of New Jersey, the Easter Seal Society of New Jersey, and the Cerebral Palsy Association of Middlesex County (Henderson, 1996; Henderson, 1997a; Henderson, 1997b; Robert Kucharski, personal communication, June 5, 1997). An event called "Celebrity Smoke '97," sponsored by Smoke, was produced by Celebrity Fund-raisers, Inc. and benefitted a charity called The Miami Project (Celebrity Smoke '97, 1997). A $1,000-per-ticket cigar dinner and viewing of the film "Napoleon" (accompanied by a 65 piece orchestra) is to benefit the Culinary Institute of America at Greystone and the North Beach Homeless Project of San Francisco (Coppola and Shanken, 1997).

In October 1994, *Cigar Aficionado* sponsored a dinner in Paris called the "Dinner of the Century" (Nights to Remember, 1994). Formal invitations for the event indicated that a portion of the ticket price would be donated to the United Nations Children's Fund (UNICEF). When the director of UNICEF was informed of this unsolicited and unwanted association, an attorney for UNICEF put the organizers on notice that they were to stop using the name of the children's fund in association with the dinner. Instead, a donation was made to CaP Cure, a charity for prostate cancer research (Ron Davis, personal communication, October 1994).

Adding a charitable dimension to these events may add a sense of mainstream mission, purpose, and respectability to what may simultaneously be regarded as daring, flaunting of convention, and even somewhat underground. Not only is a cigar dinner fun for itself and more so for being a bit of a slap at puritanical attitudes, it can also be for a good cause.

Scott, writing in a trade magazine for retail tobacco shops, has described how to organize a cigar dinner.

> Cigar dinners, if planned and executed well, are an excellent way to build your business. They work best as a promotional tool, just like advertising. The nice thing about them, as a business builder, is they can be operated at a break-even level. What other advertising medium do you use that costs you nothing? The dealer who thinks he can make a profit on cigar dinners, however, will probably find his dinners, non-competitively priced, won't yield the results he wants. (Scott, 1996a, p.44)

> Ed Kotoch, owner of the Tobacco Road stores in Las Vegas, says, "Instead, think of a cigar event as a way to get to know your customers better, especially the ones who just breeze in and out of your store; or to meet your customers' cigar-smoking friends whom they bring to the dinner; or to say 'thank you' to a few selected and valued customers." (Scott, 1996a, p. 44)

The article offers detailed advice on planning, organizing, and conducting these events. A balanced blend of entertainment, food, wine and cigars is to be sought. Cautioning against seeking venues in restaurants owned by non-smokers, Scott advises making sure that ventilation is adequate and even providing additional air filters because, he notes, "cigars put out a lot of smoke" (Scott, 1996a, p. 46). In selecting cigars for the evening, he suggests a mix of full-bodied and mild cigars. He especially suggests providing a selection of smaller, mild cigars for women so that they can more easily participate in the revelry. For a ticket price of $75-$90, Scott suggests a budget of $20-$25 for food, $5 for tips, $15 for cigars, $10 for a gift, $15-$20 for drinks, $5 for invitations, and complimentary tickets for the dinner speaker and the people who represent the cigar and beverage distributors.

Figure 11
Augusta

Source: Augusta, September 1997

Entertainments such as these serve to further embed cigar use in the culture, socialize people to the use of cigars, and teach novices how to use them. The luxurious settings foster the high-class image with which the cigar industry seeks to associate itself. In *Augusta*, Georgia, Mike Smith, proprietor of Cigar Affairs, hosts cigar dinners, such as the Spring Big Smoke (Barshafsky, 1997) (Figure 11).

Sanctioned social clubs organized around cigars have appeared on a number of major college campuses (Barry, 1997).

Smoking clubs appeared in many communities in the mid-1990s. Among the most elaborate are cigar bars identified with Macanudo brand cigars, the Club Macanudo in Chicago and in New York (Club Macanudo, 1997). At the New York club, which offers patrons a cigar school for initiates, a large painting of the bar hangs in the dining room. The painting features Culbro executives Edgar M. Cullman, Sr. and his son, Edgar M. Cullman, Jr., as well as Marvin Shanken surrounded by famous people who smoked cigars. Winston Churchill and John F. Kennedy are joined by Madonna, Whoopi Goldberg, Michael Jordan, Julie Andrews, Linda Evangelista, Richard Pryor, Jack Nicholson, Robert deNiro, Orson Wells, and Bruce Willis. Patrons are offered menus for both food and cigars. Culbro products are featured in great variety with prices ranging up to $40, but there are also a few offerings of lesser quality from other major purveyors. Among the holders of humidors at the Club are a number of New York-based magazines, including *Esquire, Vanity Fair, Business Week, Sports Illustrated, U.S. News and World Report,* and *Golf Digest*.

Retail establishments devoted to smoking seem in part a reaction to the elimination of smoking from more and more indoor spaces. The fashion brings to mind the early history of smoking in 17th century England where customers would leave their pipes at the local tobacco shop. They would come to the shop not just to purchase tobacco but to smoke as well.

Newspaper stories about cigars

The resurgence in popularity of cigars has been covered, and in part fueled by, articles in newspapers. Among the twenty daily newspapers indexed by the Dialog data base, there were 325 articles over the seven-year period 1990 - 1996 that dealt with news about cigars or feature stories about their increasing popularity in the culture. Coverage of cigars was fairly constant for the first 5 years of the period, and then showed an abrupt upswing (Table 8). Uncritical stories describing this as a social or as a fashion phenomenon have been common in newspapers as well as on television magazine shows. Much of this coverage was stimulated by a public-relations effort by cigar manufactures intended to promote positive stories in the news media linking cigar use to luxury and power (Klein, 1998).

A highly successful race horse named Cigar (Figure 12) appeared on the sports pages beginning in May 1995 with a victory at Pimlico. The horse was featured in 103 stories in these same twenty newspapers in 1995 and in 212 stories the following year.

Women and cigars

Cigar smoking by women has been one of the sub-themes of cigar publicity. Celebrity women and their cigars have frequently been featured in the cigar magazines (Figure 13). Madonna smoked a cigar on the David Letterman show in 1994 (Conrad, 1996). Feature stories in newspapers, popular news magazines, and on television have highlighted this as a new trend (Figure 14). A recent book describes and explains cigar smoking for women (Edmark, 1995), and a retail trade magazine has published an article on how to "capitalize on the marketing differences the gender gap provides" (Ashley, 1997b, p. 162). These phenomena increase the visibility not only of women smoking cigars, but of cigar use itself.

Table 8
News and features about cigars. Twenty daily newspapers Indexed by Dialog 1990-1996

Year	Number of articles
1990	23
1991	19
1992	20
1993	36
1994	24
1995	81
1996	122
Total	325

Source: Dialog

Internet advertising and promotion

Cigars are featured on the world wide web at many sites (Mason, 1996). There are online catalogs for ordering as well as links that provide background information and ratings. Both cigar lifestyle magazines maintain elaborate sites. One site sponsored "Operation Cigar Lift" for U.S. troops stationed in Bosnia in 1996 (*Smoke Signals*, 1996).

Figure 12
The race horse, Cigar

Source: Cigar Aficionado, Winter 1996/1997

Figure 13
Demi Moore

Source: Cigar Aficionado, Autumn 1996

Ashley has described the ins and outs of setting up and running a web site for people in the retail cigar business (Ashley, 1997a). He describes how selling on the Internet has transformed the way a number of retailers operate, with some now providing frequent updates of their inventories online. Websites for cigars may receive tens of thousands of visits monthly. The sites operated by manufacturers not only provide information and images about specific brands but also link customers with retailers who carry the products. There are discussion groups and news groups as well on

Figure 14
Jenny McCarthy

Source: Newsweek, July 21, 1997

these sites. Sites also can offer search capabilities to people looking for particular products or product characteristics.

Catalogs and cigar-related items

Cigars have long been available by mail order, but the resurgence in popularity of expensive cigars has prompted the introduction of new specialty catalogs for cigar users such as one called *The Cigar Enthusiast*. Accessories for cigars have begun appearing in more established upscale catalogs such as those from Herrington, Frontgate, Huntington Clothiers, and Hammacher Schlemmer.

The cigar craze has nourished the cottage industry that produces cigar accessories such as lighters, cutters, ashtrays, and humidors. Oddities such as devices which provide a place to put a lit cigar on a golf course while the user takes a shot have appeared on the market. A "breath cleanser" for cigar smokers is being sold (Cigar Clear, 1996). New cigar-themed clothing companies, selling silk screened whimsy or classical cigar art (based on cigar box paintings and cigar bands) have appeared: The Five Cent Cigar Co., Smoke Rings, and The Original Cigar Clothing Company. The Nat Sherman Catalog (Figure 15) offers a variety of cigar accessories (Figure 16)

Figure 15
The Nat Sherman Catalog

Source: Nat Sherman Catalog, 1998

Books (Hacker, 1996; Shanken, 1996), videos (Dees, 1996), lithographs (Mazur, 1996), and even compact discs related to cigars (Schmorr, 1996) have appeared on the market. One of these books includes a curiously lighthearted chapter on health effects (titled "But will they stunt your growth?") which emphasizes the supposed advantage of cigar tobacco having fewer additives and the fact that inhalation is optional with cigars (because nicotine absorption from cigar smoke, unlike that from cigarette smoke, does not depend on inhalation) (Scott, 1996b).

Figure 16
Cigar accessories – The Nat Sherman Catalog

Source: Nat Sherman Catalog, 1998

Dunhill has long offered high-end men's clothing and accessories in association with its core tobacco products business.

Virtually alone among the major cigar companies, General Cigar has borrowed other marketing techniques prominent in the cigarette industry for some of its mass-market cigars as well (Coeytaux, Altman and Slade, 1995; Altman, Levine, Coeytaux, Slade and Jaffe, 1996). General Cigar has run a series of promotions for its White

Owl and Garcia y Vega brands which involve returning proofs of purchase for branded t-shirts and other premiums. It has even developed a small catalog for the Garcia y Vega brand. Moreover, General Cigar has launched a line of expensive sportswear geared to its premium brands (Culbro Corporation, 1996). It also plans a branded line of cigar smoking accessories (Smoke Signals, 1997). The president of the parent company, Edgar M. Cullman, Jr., is quoted in the annual report as saying, "General Cigar's brand extensions in new classic sportswear set the stage for our lifestyle-driven company of tomorrow" (Culbro Corporation, 1996, p. 8).

There have been other sporadic, small efforts at promoting mass-market cigars, but generally, the makers of these products have not devoted large amounts of money to their promotion in recent years. Swisher International briefly supported a NASCAR race team for Swisher Sweets, and the makers of the little cigar Winchester published booklets of football and baseball statistics and schedules in 1995 that were distributed through some retail outlets.

Sportswear for Macanudo does not imitate the understated elegance of Dunhill. Instead, Culbro features the Macanudo name prominently on each article of clothing, so the caps, sports shirts, jackets, and sweatshirts are themselves advertisements for the brand in much the same manner that cigarette companies promote their brands through promotional items.

Among the ways General Cigar seeks to promote Macanudo is through furniture. The William Allen Company of High Point, North Carolina offers two stuffed armchairs retailing for about $2,500 each which feature the Macanudo crest design on the upholstery. A leather chair has the crest on a kidney pillow and the seat deck, while a mohair chair has it on the seat cushion (William Allen, 1997). On introducing these products to a furniture store, the Allen salesman passes out cigars and offers a $700 Macanudo smoking jacket for sale as well.

Borrowed glory Cigars have become a common prop, on magazine covers (Mott, 1992) (Figure 17), in fashion photography, for men's accessories such as ties, and among popular musicians, movie stars and other celebrities. A popular history recounts many of the famous names, past and present, associated with cigars (Conrad, 1996).

Figure 17
The New Yorker

Source: The New Yorker, September 23, 1996

The cigar may be intended to be provocative or to project "power, authority and self-confidence" (Mott, 1992, p. 46). When the Chicago Bulls won the NBA championship in 1996, Michael Jordan and Dennis Rodman celebrated with cigars, and their smoking was widely seen on television. George Dessart of the American Cancer Society criticized these sports stars, saying, "By displaying these cigars at the moment they were the most visible athletes in the world, Michael Jordan and the Chicago Bulls served as the worst type of role model for millions of children worldwide. After all, if Michael Jordan and the Chicago Bulls smoke, it must be cool and it can't be that bad for you" (Campaign for Tobacco-Free Kids, 1996).

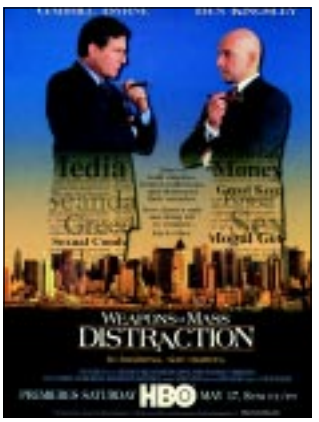
At least some of the gratuitous public cigar display so evident in recent years may be because of commercial sponsorship. In the 50's and 60's, celebrities such as Ernie Kovacs, Danny Thomas, and Sid Caesar did commercials for Dutch Masters,[1] and Edie Adams cooed "Pick me up and smoke me sometime" for Muriel (Kiersh, 1997, p. 105). George Burns smoked another machine-made brand from Consolidated Cigar, El Producto Queens, exclusively for many years. Each month, he received 300 of the stogies from the manufacturer for free. While it is not known if he also received an honorarium or a sponsorship fee in addition to the free cigars, he repeatedly refused to even try any other brand (Kiersh, 1997). Consolidated Cigar is trying to capitalize on this long-standing association by creating a special series of El Producto cigars it is calling the "George Burns Collection" (Kiersh, 1997). It is not known if this venture involves the payment of a licensing fee to the Burns estate, but such considerations are common for other products.

Figure 18
First Wife's Club

Source: Fairfax County TV Guide

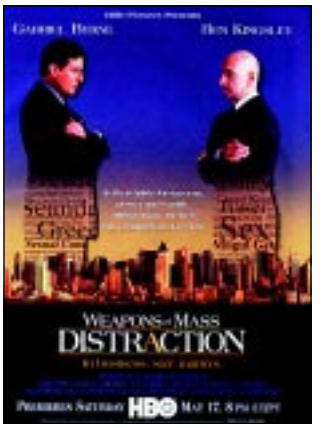
Cigars and the Movies Cigars have become a common prop in movies (*Independence Day*, 1996; *Batman and Robin*, 1997). In at least one case, though, the cigars featured in advertising were not apparent in the movie itself. Ads for the 1996 movie *The First Wives Club* (Paramount) showed Goldie Hawn, Diane Keaton and Bette Midler with stogies (Figure 18) while in both the movie itself and the book on which the movie was based, these characters never used cigars (Thomas, 1996). When the HBO movie *Weapons of Mass Distraction* was advertised in *Cigar Aficionado*, the characters held cigars (*Cigar Aficionado*, 1997c) (Figure 19). When the same movie was advertised in *The New Yorker*, the characters' hands were empty (*New Yorker*, May 19, 1997) (Figure 20). Cigar manufactures paid Hollywood brokers to feature their products in movies including *Independence Day* (Klein, 1998).

Figure 19
Weapons of Mass Distraction–with cigars



Source: Cigar Aficionado, May/ June 1997

Figure 20
Weapons of Mass Distraction–without cigars



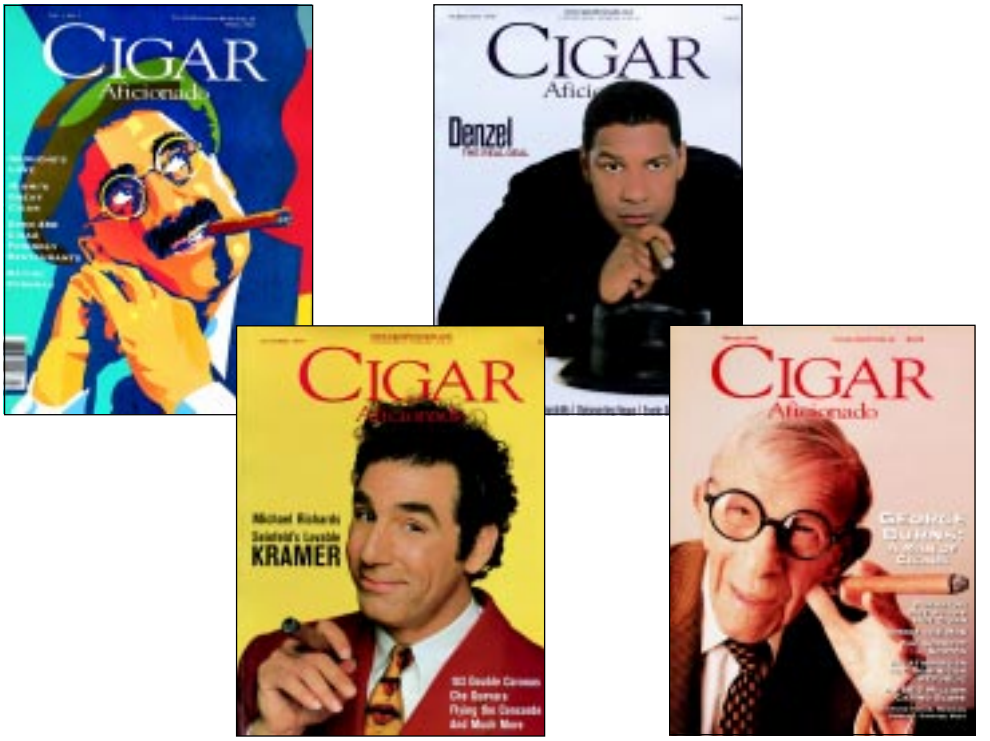
Source: The New Yorker, May 1997

[1] This brand evokes memories of Rembrandt's contemporaries even though tobacco was mainly consumed in pipes throughout the low countries at that time.

AVAILABILITY Inexpensive cigars are mostly sold as self-service items in grocery stores, convenience stores and pharmacies. The growth of the premium cigar trade has been accompanied by an increase in outlets for expensive cigars beyond tobacconists and other specialized retailers. Major manufacturers are seeking to expand traditional outlets for premium cigars to include hotel shops, wine shops, restaurants, and upscale specialty and department stores (Smoke Signals, 1997). Vending machines for premium cigars are commercially available and have begun to appear in some locations (Trendwatch, 1997).

DISCUSSION Cigar use began to increase after promotional activities for cigars stepped up beginning in 1992. The cigar market was stagnant (Chapter 2) before *Cigar Aficionado* was launched, even though Marvin Shanken has said he launched the magazine in response to an increase in use of premium cigars. In a prospectus, Consolidated Cigar Holdings attributes the increase in cigar consumption largely to the magazine, to the use of cigars by celebrities (Figure 21), and to the proliferation of social events that feature cigars (Consolidated Cigar Holdings, 1996). These efforts have increased the visibility of cigar consumption, have normalized cigar use, and have

Figure 21
Groucho Marx, Denzel Washington, Michael Richards, and George Burns



Source: Cigar Aficionado, Spring 1993, February 1998, October 1997, Winter 1994

broken down barriers for cigars. Among the barriers that seem to have been broken has been use by kids (Kaufman et al., 1997). These efforts have a familiar ring. Public relations techniques to normalize and popularize cigarette use in general and among women in particular were used by cigarette makers earlier in the century (Kluger, 1996).

While nearly all promotional energy for cigars has been focused on premium versions, fully 83 percent of the unit growth in the consumption of large cigars and cigarillos has been for inexpensive, non-premium, machine-made brands. Advertising for specific premium brands, which is directed at expanding the market serves the dual role of promoting both cigars and a particular brand (Montego y Cia. 1997; U.S. Tobacco International, 1997). Moreover, despite disclaimers to the contrary (Shanken, 1997b), an inevitable effect of fostering a somewhat outrageous fashion among adults is that its appeal to kids will grow.

Measured marketing expenditures for cigars was only $4 million for the first 9 months of 1996, yet the industry had more than $1.2 billion in sales.

To the extent that they exist at all, the unmeasured marketing expenditures may be devoted to activities such as planting feature stories about cigars in newspapers and television, securing celebrity endorsements of cigar smoking, promoting cigar dinners, financing the expansion of retail tobacco shops, and of restaurants, clubs and bars that encourage cigar smoking, achieving placements in popular entertainment and in fashion magazines, and facilitating the development of communications channels, such as magazines, books and web sites.

It may be that individual cigar companies are working by themselves or in concert to facilitate at least some of these public relations activities, because the bulk of the industry is concentrated in only a few companies (Table 3). Efforts to boost cigar use in general will mainly benefit those companies that are already well positioned.

The more sophisticated companies, especially Culbro (General Cigar) and Consolidated Cigar, seem to be taking integrated marketing approaches to building franchises for their major brands. Although the use of sex and celebrity to sell cigarettes has been forbidden by the cigarette industry's voluntary code since 1965, these appeals are regular features of cigar marketing.

Additional information is needed to better characterize marketing efforts for cigars. Specifically, there should be:

- Continued efforts to describe advertising and promotional efforts for cigars as well as to understand the dynamics of the market and the companies involved in it,
- Compilation of marketing expenditures for cigars as the Federal Trade Commission already does for cigarettes and smokeless tobacco products,

- A survey of prominent people who have been publicly associated with cigar use to learn about the extent to which they have received sponsorship fees or any other consideration from commercial cigar interests,
- Research to learn how different segments of the public understand cigars, especially in relationship to cigarettes. One possibility is that since cigars are often experienced as being more acutely noxious than cigarettes, the increased acceptability of their use may undermine public perceptions of the harmfulness of cigarettes. The public may also have misconceptions about the role of nicotine in cigar use. In other words, apart from the direct toxicity of cigars, does the cigar craze undermine public health efforts to control the cigarette epidemic?
- Research to learn which brands of cigar are popular with the young and how marketing, price, and availability affect brand choice for this group, and
- Research to learn the extent to which advertising and promotion for cigars, including things as commonplace as cigar bands, reaches and affects kids.

CONCLUSIONS

1. Cigar use began to increase in the United States after promotional activities for cigars increased beginning in 1992.
2. Promotional activities for cigars have increased the visibility of cigar consumption, normalized cigar use, and broken down barriers to cigar use.
3. Although the use of sex and celebrity to sell cigarettes has been forbidden by the cigarette industry's voluntary code since 1965, these appeals are a regular feature of cigar marketing.

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References

Altman, D.G., Levine, D.W., Coeytaux, R., Slade, J., Jaffe R. Tobacco promotion and susceptibility to tobacco use among adolescents aged 12 through 17 in a nationally representative sample. *American Journal of Public Health* 86:1590-1593, 1996.

Ashley, B. Internet frenzy: Is the web for you? *Smokeshop* 24(20):66-74, March/April 1997a.

Ashley, B. Retailing cigars to women: Embracing the nuances. *Smokeshop* 24(4):162-166, July/August 1997b.

Barry, S.T. Collegiate smokes. *Smoke* 2(2):138-150, Spring 1997.

Barshafsky, D. The Big Smoke, *Augusta*, August/ September 1997.

Bennet, J. From Chelsea Clinton's dad, pithy advice for graduates. *The New York Times*, p. 1, June 7, 1997.

Campaign for Tobacco-Free Kids. Press release, 17 June 1996.

Caribbean Cigar, Company Advertisement for Alternatives Cigars, *Smoke* 2 (2):33, Spring 1997.

Cattrall, K. Live nude girl? *Smoke* 1(2):134-5, Spring 1996.

Celebrity Smoke '97. *Smoke* 2(2):354, Spring 1997.

Cigar Aficionado, 5(4):9, May/June 1997a.

Cigar Aficionado, 5(4):124-149, May/June 1997b.

Cigar Aficionado, 5(4):113, May/June 1997c.

Cigar Clear. *Smoke* 2(1):168, Winter 1996/97.

Club Macanudo. Savor the good life. *Cigar Aficionado* 5(4):56, May/June 1997.
Coeytaux, R.R., Altman, D.G., Slade, J. Tobacco promotions in the hands of youth. *Tobacco Control: An International Journal* 4(3):253-257, 1995.
Conrad, B., III. The Cigar. San Francisco: Chronicle Books, 1996.
Consolidated Cigar Holdings Inc. Prospectus for the sale of 5.4 million shares of Class A Common Stock (par value 0.01 per share), August, 15 1996.
Coppola, F.F., Shanken M.R. Advertisement for "Napoleon" dinner. *Cigar Aficionado* 5(5):22, August 1997.
Culbro Corporation. 1995 Annual Report. New York: Culbro Corporation, 1996.
Dees, R. Cigars! The New Rage! video. Advertised in *Smoke* 2(2):239, Spring 1997.
Dialog file 483: Newspaper abstracts daily UMI, 1990-1996,
Edmark, T. *Cigar Chic: A Woman's Perspective*. Arlington, TX: The Summit Publishing Group, 1995.
Federal Trade Commission. *Report to Congress Pursuant to the Federal Cigarette Labeling and Advertising Act*. Washington, D.C.: Federal Trade Commission, 1996.
Federal Trade Commission. *Report to Congress Pursuant to the Comprehensive Smokeless Tobacco Health Education Act of 1986*. Washington, D.C.: Federal Trade Commission, 1997.
Finora, J. Bullish on cigars. *Smokeshop* 24(4):168-176, July/August 1997.
Flying High. *Smokeshop* 24(4):122-138, July/August 1997.
Food and Drug Administration. Nicotine in cigarettes and smokeless tobacco is a drug and these products are nicotine delivery devices under the federal Food, Drug, and Cosmetic Act: Jurisdictional determination. *Federal Register* 61(168):44619-45318, August 28, 1996.
French Toast. *Smoke* 2(1):36, winter 1996/97.
Hacker, R.C. *The Ultimate Cigar Book*. (2nd edition). Beverly Hills, CA: Autumn Gold, 1996.
Henderson, M. *Cigar fans puff away for Make-A-Wish*. Asbury Park Press, June 18, 1996.
Henderson, M. *Stepping out*. Asbury Park Press, January 5, 1997a.
Henderson, M. Night of cigars and food to benefit Easter Seals. Asbury Park Press, January 14, 1997b.
Inspired preacher. Out of the humidor (letter to the editor). *Cigar Aficionado* 1(2):9, Winter, 1992/93.
Kaufman, N.J., Emont, S.L., Trimble, C.R., Orleans, C.T., Briton, N., Clark, T., Krakow, M., Celebucki, C., Cullen, D., Connolly, G., Hyland, A., Perla, J., Cummings, K.M., Abdella, A., Tippens, K. Cigar smoking among teenagers — United States, Massachusetts, and New York, 1996. *Morbidity and Mortality Weekly Report* 46(20):433-440, May 23, 1997.
Kiersh, E. Saving El Producto. *Cigar Aficionado* 5(3):96-107, March/April 1997.
Klein, A. *The Cigar Caper: the shaping of an illusion and cigar-changing Hollywood heroes*. *The Sun*, January 11-13, 1998.
Kluger, R. *Ashes to Ashes: America's Hundred-year Cigarette War, the Public Health, and the Unabashed Triumph of Philip Morris*. New York: Alfred A. Knopf, 1996.
Luz, M. Putting your money where your smokes are. *Smoke* 2(3):376- 380, Summer 1997.
Mason, S. Cigar smokers in...cyberspace. *Smoke* 1(1):48-51, 1996.
Maxwell, J.C., Jr. *The Maxwell Consumer Report: The Cigar Industry in 1996*. Richmond, VA: Wheat First Butcher Singer, March 21, 1997.
Mazur, R. Ruby Mazur's cigar art. *Smoke* 2(1):39, Winter 1996/97.
Montego y Cia. Advertisement for Macanudo cigars. *Cigar Aficionado* 5(4):8-9, May/June 1997.
Mott, G. "It's about freedom and pleasure": Marketers and editors look to cigars to make statements. *Cigar Aficionado* 1(2):46-49, Winter 92/93.
The New Yorker, May 19, 1997, p. 9.
New York Times, April 30, 1997. P. 12.
Nights to Remember. *Cigar Aficionado* 3(2):304-306, December 1994.
Pearlman, M.H. A doctor's view. *Cigar Aficionado* 1(3):130, Spring 1993.
Photo Gallery. *Cigar Aficionado* 5(4):33, May/June 1997a.
Photo Gallery. *Cigar Aficionado* 5(5):35, August 1997b.
Smoke 2(1):40-41, The ultimate guide to some of the world's finest cigars. Pinkerton Group, Inc., Winter 1996-97.
Rothstein, M. The golden girl. *Cigar Aficionado* 5(5):168-189, August 1997.
Schmorr, J. Whistle while you work. *Smoke* 2(1):38, Winter 1996/97.
Scott, D. Eat, smoke, and be merry: The truth behind cigar dinners. *Smokeshop* 23(3):44-49, May/June 1996a.
Scott, D. *How to Select and Enjoy Premium Cigars...and Save Money!* Julian, CA: Coast Creative Services, 1996b.
Scott, D. Buying from independent reps. *Smokeshop* 24(4):218-230, July/August 1997.
Shanken, M.R. The real story. *Cigar Aficionado* 1(3):5, Spring 1993.
Shanken, M.R. A big smoke in our nation's capital. *Cigar Aficionado* 3(2):19, Winter 1994.
Shanken, M.R., editor. *Cigar Aficionado's World of Cigars*. Philadelphia: Running Press, 1996.
Shanken, M.R. Scare tactics. *Cigar Aficionado* 5(4):19, May/June 1997a.
Shanken, M.R. Cigars are not for teenagers. http://www.cigaraficionado.com, May 1997b.

Shanken, M.R. Bad science, bad laws. *Cigar Aficionado* 5(5):21, August 1997c.
Shanken, M.R. Selected weekly wrappers. *Cigar Aficionado* 5(5):40, August 1997d.
Shriver, J. Cigar buffs take puffs with pride. *USA Today* D1, 26 May 1992.
Smoker Nights. *Cigar Aficionado* 1(2):125, Winter 1992/93.
Smoker Nights. *Cigar Aficionado* 5(4):420-431, May/June 1997.
Smoke Signals. Bits and pieces. *Smokeshop* 23(6):12, November/December 1996.
Smoke Signals. Strong stock debut for General Cigar IPO: Manufacturer charts course for future expansion. *Smokeshop* 24(2):18, 1997.
Thomas, K. Lighting up: Tobacco has a role in most movies. *USA Today* 17 November 1996, p. 1D.
Tobacco Reporter. *1997 Global Tobacco Industry Guide.* Raleigh, NC: SpecComm International, 1996.
Trendwatch. Vending humidors: Retail opportunity or high-profile competitor? *Smokeshop* 24(2):32, March/April 1997.
U.S. Department of Agriculture. *Tobacco Situation and Outlook Report.* Washington, D.C.: USDA, Economic Research Service, TBS-238, April 1997.
U.S. Tobacco International. What time of day should you light up a cigar? *Cigar Aficionado* 5(3):253, March/April 1997.
Wall Street Report. *Cigar Insider* 2(6):10-11, June 1997.
Washington Post Magazine, November 30, 1998, p. 48.
William Allen Company Catalog. High Point, NC: William Allen Company, 1997.
Wolfson, N. About face: Cosmetic surgery and facial products are not just for women anymore. *Cigar Aficionado* 5(3):308-321, March/April 1997.

Policies Regulating Cigars

Gregory N. Connolly

A number of Federal and State policies cover tobacco products. Table 1 presents the Federal policy approach to the different forms of tobacco use. Table 2 presents the policy approaches of the State level. In general, Cigars are exempted from many of the regulations that apply to other tobacco products, particularly at the Federal level.

REGULATION OF CIGAR PRODUCTS

In 1906, Congress passed the first Federal Food and Drug Law. The Act defined medicines and preparations recognized in the United States Pharmacopoeia (USP) or the National Formulary. Tobacco was listed in the 1890's edition but purportedly was deleted in the 1905 edition in exchange for support from tobacco-state congressmen for passage of the law (Neuberger, 1963). The 1906 act was superseded by the Federal Food, Drug and Cosmetic Act (FFDCA) passed in 1938 (Neuberger, 1963). The Act revised the definition of drug to also include "articles intended for use in the diagnosis, care, mitigation, treatment or prevention of disease in man or animal" and "articles (other than food) intended to affect the structure or any function of the body of man or other animals."

In 1960, the Food and Drug Administration (FDA) received new authority to regulate consumer products with passage of the Federal Hazardous Substances Act (FHSA). Tobacco products were not specifically excluded, but FDA did not assert jurisdiction over tobacco products at that time. In 1972, authority for FHSA was transferred to the newly created Consumer Products Safety Commission (CPSC). The agency was sued in 1974 for failure to consider a petition to set upper limits on tar in cigarettes. Federal court subsequently ruled the CPSC must consider the petition. Within 6 weeks of this decision, Congress amended the FHSA specifically excluding tobacco products, including cigars.

In 1970, Congress passed the Controlled Substances Act to prevent the abuse of drugs, narcotics and other addictive substances. The law specifically excluded tobacco and tobacco products from the definition of a "controlled substance" in 21 U.S.C. 802 (Cigar Association of America, 1986) thus excluding cigars. In 1976, Congress enacted the Toxic Substances Control Act and it also excluded tobacco and tobacco products from the definition (15 USC 802C6). A summary of Federal regulatory policies for tobacco products is included in Table 1. A summary of state policies is included in Table 2.

In 1996, the FDA declared that nicotine in cigarettes and smokeless tobacco was a drug and asserted jurisdiction over these products as devices for delivery of

Table 1
Federal policies on tobacco products

		Cigarettes	Smokeless Tobacco	Cigars
1.	Labeling Requirements	Package and Print Ads Four Rotational Health Warnings	Package and Print Ads Three Rotational Health Warnings	None
2.	Advertising Restrictions	Prohibits Advertising on TV and Radio	Prohibits Advertising on TV and Radio	Prohibits Little Cigar Advertising on TV and Radio
3.	Report to Congress	Biennial	Biennial	None
4.	Nicotine/Toxic Constituent Disclosure	Nicotine, Tar, CO	Nicotine	None
5.	Additive Reporting	Confidential List to DHHS	Confidential List to DHHS	None
6.	Regulation as a Drug Delivery Device	FDA	FDA	None
7.	Youth Access	Synar Amendment FDA 21CFR801	Synar Amendment FDA 21CFR801	Synar Amendment
8.	Taxation	$0.24 Per Pack of 20	$0.027 per container (1.2 oz)	0.00125 small cigar 12.75% of wholesale price of large cigar but not more than $0.03 a cigar

Note: Department of Health and Human Services (DHHS)
Food and Drug Administration

Table 2
State and local policies on tobacco products

		Cigarettes	Smokeless Tobacco	Cigars
1.	Labeling Requirements	Preempted	Preempted	California
2.	Advertising Restriction	Preempted	Preempted	None
3.	Nicotine Disclosure	MA, TX	MA, TX	TX
4.	Nicotine/Toxic Constituent Reporting	MA, TX, MN	MA, TX, MN	TX, MN
5.	Youth Access			
6.	Taxation	50 States (average #0.317 per pack or 37.8% or wholesale price)	42 States (40 state average of 25.3% of wholesale price)	41 States (36 state tax average 21.7% of wholesale price)

the drug nicotine; however, the agency did not assert jurisdiction over cigars. In the proposed rule, little cigars were included, but deleted in the final rule that cited insufficient evidence of use by children and insufficient evidence that cigars were drug delivery devices under the act, as well as differences in definition of little cigars and cigarettes for tax purposes.[1]

HEALTH WARNINGS There is no Federal law requiring health warnings on cigars. At the State level, California adopted in 1986 the Safe Drinking Water and Toxic Substances Enforcement Act that required warnings on products that contain chemicals that cause cancer or reproductive risks. In response to the threat of litigation, cigar manufacturers and retailers agreed to place the following warning label on cigars sold in the state: "Warning: This product contains/produces chemicals known to the state of California to cause cancer and birth defects or other reproductive harm." Manufacturers of cigars also print the California warnings on the packages of manufactured cigars sold nationally. Cigars sold singly generally do not bear the California warning outside of the state.

DISCLOSURE OF CIGAR OR SMOKE PRODUCT CONSTITUENTS

Tar, Nicotine, and CO Following passage of the Federal Cigarette Labeling and Advertising Act in 1965, the Federal Trade Commission (FTC) developed a machine system for measuring tar and nicotine yield of cigarettes and provided, in an annual report to Congress, the yields of tar and nicotine as the most popular brands (Pillsbury et al., 1969). The system was not designed to predict actual tar and nicotine intake among humans, only to provide a relative measure between brands. The system was modified in 1981 to include carbon monoxide (CO). Cigarette manufacturers disclose tar and nicotine yield of their brands in advertisements under a 1971 consent agreement with the FTC. Cigarette manufacturers generally list tar and nicotine levels on packages of low-yield cigarettes, but not on packages containing cigarettes with greater than 8 milligrams of tar.

Cigar manufacturers are not required to report tar, nicotine, and CO content of their products to the Federal Government. Texas and Minnesota require nicotine reporting of cigars. The International Committee for Cigar Smoking Studies, which represents cigar manufacturers, concluded that it is technically possible to smoke cigars by machine (International Committee, 1974). However, the committee notes that, given the range in cigar size and variability of the products, it is very difficult to produce valid tar deliveries, and that ranking cigars by tar content is virtually meaningless and of minimal value to the consumer.

Texas requires cigar manufacturers to disclose nicotine yield of its products to the Department of Health based on standards to be adopted by the Department (Vernon's Texas Codes Annotated, 1998). Minnesota requires cigar manufacturers to disclose "hazardous substances contained in the burned or unburned state, which may include certain components of tar and carbon monoxide" (Minnesota Secretary of State Office, 1997). Massachusetts also requires companies to report nicotine yield of cigarettes and smokeless tobacco products to consumers based on what the user is expected to take within the body.

[1] *44424-federal regulation vol. 61 no. 168 8/28/80.*

.Small cigars and packaged cigars bear the following statement on the package in response: "These cigars are predominantly a natural tobacco with non-tobacco ingredients added." This has been done in response to California law (Wilson, 1988). Cigar manufacturers are not required by Federal law to disclose added constituents or nicotine and tar contents. The manufacturers have neither voluntarily developed a protocol nor voluntarily disclosed their additives.

Added Ingredients Cigarette manufacturers are required to report ingredients added to tobacco to the Secretary of the Department of Health and Human Services (DHHS). The list does not provide the level of the additive or the brand that it is placed in, and is kept confidential by DHHS. DHHS is authorized to report to Congress on its research on additives and health risks, but has yet to do so since it received the authority in 1984. DHHS has no authority to regulate or remove harmful additives.

When the FDA asserted jurisdiction over cigarettes and smokeless tobacco as drug delivery devices, it considered requiring disclosure of ingredients added to these products, but decided not to do so. The comprehensive Smokeless Tobacco Health Education Act of 1986 requires similar ingredient reporting to DHHS for smokeless tobacco products and requires manufacturers to report nicotine yield, but does not require nicotine content to be listed on advertisements or packages. Cigarette and smokeless tobacco manufacturers voluntarily released their list of additives in 1994 in response to public concerns. Cigar manufacturers have not done so.

Massachusetts requires cigarette and smokeless tobacco manufacturers to file an annual report with the Department of Public Health that lists added ingredients by brand in descending order by weight or other measure (Phillips, 1997). Cigars are not included.

Texas requires reporting of ingredients added to cigars and Minnesota requires reporting of constituents in the cigar or cigar smoke that are on the state's "hazardous substances" list.

ADVERTISING RESTRICTIONS Federal advertising restrictions on cigarettes and smokeless tobacco products include the prohibition of electronic advertising, including television, radio, and any other form of electronic communication regulated by the Federal Communications Commission (FCC). Cigarettes and smokeless tobacco are not directly advertised by large manufacturers on the Internet, however, there are over 150 cigar websites on the Internet, many of which sell or advertise cigars (Cigar Association of America, 1986).

In 1973, the Little Cigar Act (PL93-109) banned broadcast advertising of "Little Cigars" defined as "any roll of tobacco wrapped in leaf tobacco or any substance containing tobacco as to which one thousand units weigh not more than 3 pounds." The ban did not extend to large cigars and cigarillos which can still be advertised on electronic medium today.

The advertising and promotion of cigarette and smokeless tobacco products have also been restricted through voluntary measures, adopted by their respective trade associations, the Tobacco Institute and the Smokeless Tobacco Council, ostensibly to protect children from being encouraged to smoke or use smokeless tobacco. The codes have a number of similar provisions, such as prohibiting models in ads who appear to be under the age of 25, not to associate smoking with glamour, physical fitness, or wealth, and not to place brand-name tobacco products in movies. As described in Chapter 7, cigar manufacturers' advertising and promotion of cigars have not adhered to those voluntary codes (Falit, 1997).

If the codes were strictly applied to cigar advertising, current cigar advertising and promotion would be severely restricted. Famous actors and athletes, including Demi Moore, Arnold Schwartzenegger, and Wayne Gretsky promote cigar use (Chapter 7). Major themes presented in cigar advertisements include wealth, athletic fitness, and sexual attractiveness. The tobacco industry stopped marketing of cigarettes on college campuses in the 1960's. A recent story in *Smoke* magazine describes emerging cigar social clubs on college campuses (Barry, 1997).

REGULATION OF CIGAR SMOKING IN PUBLIC PLACES

An earlier chapter of this monograph reports on cigar smoking and environmental tobacco smoke (ETS) generated by cigar use (Chapter 5).

Early restrictions on cigarette smoking included bans on cigars and pipes. In 1971, the Civil Aeronautics Board (CAB) restricted cigarette smoking on airlines to a limited number of seats, and at the same time banned cigar and pipe smoking entirely.

States and local jurisdiction have extensively regulated cigar smoking as part of ordinances that have restricted cigarette smoking. More completed reviews of state and local ordinances are available in an earlier monograph in this series (Monograph 3) and from the Centers for Disease Control and Prevention (State Tobacco Highlights, 1996). In general, cigars are more strictly regulated than cigarettes by these ordinances, probably because of the greater irritation and annoyance produced by cigar smoke.

LITIGATION

Cigarette and smokeless tobacco manufacturers have been sued by , individuals classes of persons, and the majority of states for the alleged harm their products have caused to consumers and for the related health costs of treating tobacco related diseases.

The Culbro Corporation, a major cigar manufacturer, has been named in seven suits in Florida since 1995, although it was served in only four cases. In each case, Culbro was voluntarily dismissed as a defendant. One of the suits in which the company was named but not served as a defendant was a class action suit claiming that the plaintiffs were addicted and harmed by cigar smoking.

A principal defense made by tobacco manufacturers in the litigation is that consumers have been adequately warned of the harm that cigarettes can cause through health warning labels and are knowledgeable about the risks associated with cigarette smoking. Cigarette manufacturers argue that consumers voluntarily assume the risks and therefore they should not be held accountable. Cigarette manufacturers have acknowledged that smoking is a risk factor for certain diseases although they argue the association is not causal. Cigar manufacturers, on the other hand, are not required to place health warnings on their products, except in California. The failure of cigar manufacturers to place warnings on all of their products, coupled with the marketing of their products, may place them at risk of liability in the future.

RESTRICTIONS ON YOUTH ACCESS TO CIGARS

At the Federal level, the FDA adopted a regulation on August 23, 1996, to prohibit the sale of cigarettes and smokeless tobacco products to persons under 18, as well as to restrict advertisements and promotions directed toward youth. The FDA rule does not include cigars. The Federal Alcohol, Drug Abuse and Mental Health Act was amended in 1992 to include a requirement for states to establish 18 years of age as the minimum age for the purchase of tobacco products. If a state did not establish such a requirement, the state would not receive full funding for Federal substance abuse block grants. Cigars are included in this Act.

TAXATION

Federal Tax of Cigars

In 1864, Congress passed a law placing an excise tax on tobacco products, and in the following year collected 11.4 million dollars in revenue, with only .1 percent coming from cigarette taxation. By 1920, cigarettes accounted for almost half of the 58 million dollars collected at the Federal level, and in 1996, cigarettes represented 98 percent.

The current Federal tax on cigars (Table 3) is broken into two categories. Small cigars are taxed at $1.125 per thousand or approximately one tenth of a cent per small cigar. The small cigar is defined as having a weight no more than 3 pounds per 1,000 units, and resembling cigarettes in size and weight. The Federal tax on a package of 20 cigarettes is 24 cents while the tax on 20 small cigars is about one tenth that or 2.25 cents for 20 small cigars.

The tax on large cigars (cigars weighing more than 3 pounds per thousand) is 12.75 percent of the wholesale price, but not more than $30.00 per thousand. At this rate, there is a maximum tax of 3 cents per cigar. Based on this weight classification, cigarillos, manufactured, and premium cigars, would all be classified as large cigars.

The estimated average manufacturers price for a package of five cigarillos is $0.60 per package or $120.00 per thousand. Based on that amount, the tax at 12.75 percent for 1,000 would be $16.20 or $1.62 per cigarillo. The estimated wholesale price of the manufactured cigar is 36 cents per cigar, or $360.00 per thousand. If the thousand were taxed at 12.75 percent, the resulting tax would be $51.00 per thousand above the maximum taxable level of $30.00 per thousand.

The Federal tax on a typical manufactured or premium cigar would therefore be limited to 3 cents per cigar. This tax scheme is particularly favorable to manufacturers of premium cigars whose very costly cigars can only be taxed at a maximum of 3 cents per unit. Thus as price increases due to inflation or demand, Federal tax diminishes as a percent of price. Table 3 summarizes the Federal taxes on different types of cigars and Table 4 compares the tax rate for cigarettes and various types of cigars as a percent of the wholesale price.

Table 3
Estimated weight, price, and federal tax per 1,000 pounds of tobacco products

Tobacco Product (weight Est. Wholesale Price)	Weight/Thousand Units	Price/Thousand Units	Fed Tax/Thousand Units	%Tax of Price
Small Cigars (1 gram @$0.035 each)	2.205 lbs.	$35.00	$1.125	3.2%
Tiparillos (3 grams @$0.12 each)	6.614 lbs.	$120.00	$15.30	12.57%
Manufactured Cigars (8.5 grams @$0.36 each)	18.74 lbs.	$360.00	$30.00	8.3%
Premium (20 grams @$1.50 each)	44.100 lbs.	$150.00	$30.00	2%
Cigarettes (1 gram @$0.042 each)	2.205 LBS.	$42.00	$12.00	28.6%

Table 4
Wholesale price and federal tax per pound of various tobacco products

Products	Wholesale Price per Pound of Tobacco	Federal Tax per Pound of Tobacco	Tax as a % of Wholesale Price
Cigarettes	$19.05	$3.432	28.6%
Small Cigar	$15.87	$0.51	3.2%
Tiparillo	$19.66	$1.95	12.75%
Manufactured Cigar	$19.21	$1.59	8.3%
Premium Cigar	$34.09	$0.68	2%

State Taxation of Cigars As of January 1, 1996, the number of states taxing cigars was 41, with 36 placing a single average tax of 21. 7 percent on the manufacturers' or wholesalers' price (Table 5). Five states have a tax system similar to that of the Federal Government that have multiple rates according to the weight or price of the cigar. Of the 36 states with the single rate, Washington has the highest tax of 74.9 percent of the wholesale price, and North Carolina the lowest, 2 percent. Ten states had rates higher than 25 percent, and 26 lower. By comparison, 50 states tax cigarettes at an average tax of 31.7 cents per pack or 37 percent of the wholesale price of $84.00 per thousand. Forty states tax smokeless tobacco at an average rate of 25.3 percent of the wholesale price. According to the Tobacco Institute, 337.2 million dollars in gross tax revenue was generated from state taxation of tobacco products other than cigarettes in 1996. This represents 4.8 percent of the total tax revenue from all tobacco products.

In recent years, there has been an increasing trend at the state level to impose taxes on tobacco products other than cigarettes. In 1970, 21 states taxed cigars and the number remained virtually constant up until 1995 (22 states). However, by 1990, the number of states rose to 33 and by 1996 was 41 states. Not only did the number of states taxing cigars increase, but also the rate increased by almost 30 percent from 1983 to 1996. In 1983, 14 states levied a flat rate on the wholesale price of cigars of 21.3 percent. By 1996, the same states increased the average rate 28.2 percent. Total state tax revenue for tobacco products other than cigarettes increased from $32.6 million in 1975 to $62.3 million in 1985, and today is $337.2 million. In 1975, other tobacco products made up 3.4 percent of all tobacco tax revenue at the state level, and by 1996 rose to 4.8 percent. Table 5 summarizes the taxation of cigars by individual states.

All 50 states and the District of Columbia have enacted some form of legislation with respect to the sale of cigars to minors. According to NCI's State Cancer Legislative Database, through November 1997, 29 states and DC explicitly prohibit the sale of cigars to minors. The remaining states prohibit the sale of tobacco products to minors, implicitly covering cigars (Table 6).

In conclusion, the number of states taxing cigars has increased sharply over the last 10 years, and the vast majority tax cigars as a percent of wholesale price. Such a tax structure will result in an increase in revenue as cigar prices go up. This is the opposite of the Federal system which sets a maximum rate of 3 cents per large cigar. Thus as the price of large cigars increase, the proportion of tax on the price decreases.

Table 5
State tax rates on cigars

State	Tax rates	States with no tax rates on cigars
Alabama	Cigars, retailing for: (a) 3 1/2 cents each or less, $1.50 per thousand; (b) More than 3 1/2 and not more than 5 cents each, $3.00 per thousand; (c) More than 5 and not more than 8 cents each, $4.50 per thousand; (d) More than 8 and not more than 10 cents each, $7.50 per thousand; (e) More than 10 and not more than 20 cents each, $15 per thousand; (f) More than 20 cents each, $20.25 per thousand. Little Cigars: 2 cents for each 10 or fraction thereof.	District of Columbia Florida Kentucky Maryland Pennsylvania Virginia West Virginia Wyoming
Alaska	75% of wholesale price.	
Arizona	Cigars retailing for: (a) 5 cents each or less, 6.4 cents for each 3 cigars; (b) More than 5 cents, 6.4 cents each Little cigars: 12.9 cents for each 20 or fraction thereof.	
Arkansas	23% of manufacturers' invoice price.	
California	29.37% of wholesale price effective 7/1/97-6/30/98.*	
Colorado	20% of manufacturers' price.	
Connecticut	20% of wholesale price – all OTP.	
Delaware	15% of wholesale price.	
Georgia	Little cigars: weighing not more than 3 pounds per 1,000: 2 mills each. All other cigars: 13% wholesale price.	
Hawaii	40% of wholesale price.	
Idaho	40% of wholesale sales price.	
Illinois	18% of wholesale price.	
Indiana	15% of wholesale price.	
Iowa	22% effective 6/1/91 of wholesale sales price.	
Kansas	15% of original invoice price from the manufacturer to the wholesaler.	
Louisiana	Cigars with a list price of $120 per thousand or less, tax is 8% of net invoice price; Cigars with a list price of over $120 per thousand, tax is 20% of net invoice price.	
Maine	16% of wholesale sales price.	
Massachusetts	15% of wholesale price.	
Michigan	16% of wholesale price.	
Minnesota	35% of wholesale price.	
Mississippi	15% of manufacturers' list price.	

*CA reset at the beginning of each fiscal year.

Table 5 (*Continued*)
State tax rates on cigars

State	Tax rates	States with no tax rates on cigars
Missouri	10% of manufacturers' price.	
Montana	12.5% of wholesale price.	
Nebraska	15% of wholesale price.	
Nevada	30% of wholesale price.	
New Jersey	48% of wholesale price.	
New Mexico	25% of product value.	
New York	20% of wholesale price – all OTP.	
North Carolina	2% of wholesale price.	
North Dakota	28% of wholesale price.	
Ohio	17% of wholesale price.	
Oklahoma	Cigars, cheroots, stogies, etc., weighing more than 3 pounds per thousand, retailing for: (a) 4 cents each or less, $10 per thousand; (b) More than 4 cents each, $30 per thousand; Little cigars: 2 cents for each 8 or fraction thereof.	
South Dakota	10% of wholesale price.	
Tennessee	6% of wholesale price.	
Texas	Tax on cigars is based on weight per 1,000 and retail selling price. (a) Cigars weighing not more than 3 pounds per 1,000, 1 cent for each 10 cigars; (b) Cigars weighing more than 3 pounds per 1,000 and retailing for not more than 3.3 cents each, $7.50 per 1,000; (c) Cigars of all descriptions weighing more than 3 pounds per 1,000 and retailing for over 3.3 cents each, containing no substantial amount of nontobacco ingredients, $11.00 per $1,000; (d) Cigars of all description weighing more than 3 pounds per 1,000 and retailing for over 3.3 cents each, containing a substantial amount of nontobacco ingredients, $15.00 per $1,000.	
Utah	35% of manufacturers' selling price exclusive of any trade discount, special discount, or deal.	
Vermont	41% of distributors' price.	
Washington	74.9% of wholesale price.	
Wisconsin	20% of wholesale price.	

Source: Tobacco Institute, Washington, D.C.

Table 6
States with laws prohibiting the sale of cigars to minors (Through November 30, 1997)

State	Type of Prohibition	State	Type of Prohibition
Alabama[2]	*	Montana	*
Alaska	*	Nebraska	x
Arizona	*	Nevada	x
Arkansas	x	New Hampshire	*
California	x	New Jersey	x
Colorado	*	New Mexico	x
Connecticut	x	New York	*
Delaware	*	North Carolina	x
District of Columbia	*	North Dakota	*
Florida	x	Ohio	x
Georgia	x	Oklahoma	*
Hawaii	x	Oregon	x
Idaho	*	Pennsylvania	x
Illinois	*	Rhode Island	*
Indiana	*	South Carolina	x
Iowa	x	South Dakota	*
Kansas	*	Tennessee	x
Kentucky	x	Texas	*
Louisiana	*	Utah	*
Maine	x	Vermont	*
Maryland	*	Virginia	*
Massachusetts	x	Washington	x
Michigan	*	West Virginia	*
Minnesota	*	Wisconsin	*
Mississippi	*	Wyoming	*
Missouri	*		

Source: National Cancer Institute, State Cancer Legislative Database, Bethesda, MD: SCLD

*Legend: * Denotes states that have enacted laws explicitly prohibiting the sale of cigars to minors*
x Denotes states that have enacted laws prohibiting the sale of tobacco/tobacco products to minors

[2] Alabama does not prohibit the sale of cigars or tobacco products to minors; instead the purchase of cigars by minors is prohibited.

CONCLUSIONS

1. There is less Federal and State regulation of cigars when compared to cigarettes and smokeless tobacco. The Synar Amendment is the only Federal statute, outside of the tax codes, that specifically includes cigars.
2. The voluntary codes restricting marketing practices established by the tobacco trade associations are regularly violated by cigar advertising and promotional activities.
3. Federal tax rates selectively favor premium cigars over other cigars and tobacco products, by capping the tax rate at 3 cents per cigar.
4. With the exception of warnings mandated by California's Proposition 65, cigars do not carry warning labels.

REFERENCES

Barry, S.T. Collegiate smokes. Smoke 2(2): 138-150, 1997.

Cigar Association of America, Inc. *Cigar Advertising Standards*. Washington, DC: Cigar Association of America, Inc., 1986.

Falit, J.L. Cigar advertising targeting "baby-boomers" and other adults. *Tobacco Control*, 6:240-242, 1997.

Federal Register, Vol. 61 No.168, 8/28/80, p. 44424.

International Committee, p. 4, 1974.

Minnesota Secretary of State Office. *Minnesota General Laws Chapter 227* H.F. No. 117. Minneapolis: Minnesota Secretary of State Office, 1997.

Neuberger, M.D. *Smoke Screen: Tobacco and the Public Welfare*. Englewood Cliffs, New Jersey: Prentice-Hall, 1963.

Phillips, F. Cigarette statute is upheld. *Boston Globe*, February 8, 1997.

Pillsbury et al. *Cigar Smoking Studies*, p. 3, 1969.

Centers for Disease Control and Prevention. *State Tobacco Highlights*. Washington, DC: Centers for Disease Control and Prevention, 1996.

Vernon's Texas Codes Annotated. *Disclosure of Ingredients in Cigarettes and Tobacco Products*. Vol.1: Health and Safety. St. Paul: West Group, pp.192-194, 1998.

Wilson, D.S. Cigars and pipe tobacco to get warning labels. *New York Times*, October 19, 1988.