

MORTALITY DIFFERENCES BETWEEN
SMOKERS AND NONSMOKERS

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ABSTRACT

Since the publication of the surgeon general's report *Smoking and Health* in 1964, there has been a growing interest on the part of the life insurance industry in the mortality differentials between smokers and nonsmokers selected for individual coverage. This interest has been heightened with the publication of the surgeon general's even more comprehensive 1979 report.

This paper traces the background of the 1979 report, highlights its principal conclusions with respect to mortality, and summarizes its findings regarding socioeconomic and demographic differences between smokers and nonsmokers.

The paper then outlines the development by the State Mutual Life Assurance Company of a non-cigarette-smoker life insurance policy, and compares the mortality experience between 1973 and 1978 anniversaries under this business with the company's corresponding business issued to individuals who did not meet the nonsmoker criterion. The authors believe this is the first publication of such experience based on a widely used insured-life mortality table.

The paper relates State Mutual's findings to those presented by the surgeon general, and evaluates the significance of smoking habits as a criterion for individual life insurance underwriting. It concludes that the differences between the mortality of smokers and that of nonsmokers are too large to be ignored, and suggests that these differences be recognized in individual life insurance underwriting and pricing.

I. INTRODUCTION

EVER since tobacco smoking was introduced into Europe in the middle of the sixteenth century, people have questioned its effect on human life and health. As early as 1638, the words of a Dr. Venner were recorded as follows:

It [tobacco smoking] drieth the brain, dimmeth the sight, vitiateth the smell, hurteth the stomach, destroyeth the concoction, disturbeth the humours and spirits, corrupteth the breath, induceth a trembling of the limbs, exsiccateth

the winde pipe, lungs and liver, annoyeth the milt, scorcheth the heart and causeth the blood to be adusted. In a word, it overthroweth the spirits, perverteth the understanding, and confoundeth the senses with sudden astonishment and stupiditie of the whole body."¹

It has taken science nearly three hundred years to begin substituting demonstrations for these impressions. By the beginning of the twentieth century, smoking was suspected as a cause of increased incidence of cancer, but it was not until the 1930s that higher mortality was specifically documented as a result of tobacco smoking.² Furthermore, it has been only in the last twenty-five to thirty years that the effects of smoking on mortality and morbidity have been investigated with sufficient scientific thoroughness to command the attention of the medical profession and, subsequently, the general public.

This subject first appears to have been given significant actuarial attention in a 1963 panel discussion on mortality of smokers and nonsmokers.³ That discussion reveals additional historical material and some interesting insights into the attitude toward this subject in the period immediately preceding the publication of the surgeon general's 1964 report. Between 1952 and 1964, approximately three thousand articles were published on smoking and health, and in 1964 the federal government became actively engaged in this issue with the publication of the report *Smoking and Health* by the Advisory Committee to the Surgeon General.⁴

On the basis of numerous studies—principally in the United States, Canada, and Britain—of mortality in the general population and in certain subgroups, and from special studies involving carefully controlled groups of smokers and nonsmokers, the surgeon general's 1964 report⁵ concluded that, relative to those who do not smoke, cigarette smokers experience 70 percent higher age-specific death rates in the case of males and, to a lesser extent, higher rates among females also. Since 1964 the

¹ Quoted by Arthur C. Corcoran, *A Mirror up to Medicine* (Philadelphia: J. B. Lippincott Co., 1961), p. 298, as cited by Richard B. Singer, M.D., "To Smoke or Not to Smoke," *Best's Review (Life and Health)*, January, 1962, p. 50.

² Raymond Pearl, "Tobacco Smoking and Longevity," *Science*, LXXXVIII (March, 1938), 216-17.

³ "Mortality of Smokers and Nonsmokers," *TSA*, XVI, D118-D145.

⁴ United States Department of Health, Education, and Welfare, *Smoking and Health*, Report of the Advisory Committee to the Surgeon General of the Public Health Service, 1964.

⁵ *Ibid.*, pp. 81-120.

Surgeon General's Office has published a number of follow-up studies⁶ to the original report and early in 1979 released advance copies of the 1979 report,⁷ a 1,200-page compendium of evidence accumulated over the intervening fifteen years that, in the surgeon general's opinion, relates increased mortality and morbidity to the effects of smoking. A review, by the authors of this paper, of the surgeon general's 1979 report appears in the September, 1979, issue of *The Actuary*.⁸

The principal findings of the surgeon general's two reports with respect to mortality are the following:⁹

1. Overall mortality for all male cigarette smokers is about 170 percent of that of male nonsmokers.
2. Mortality rates increase with the number of cigarettes smoked. Two-pack-a-day male smokers have mortality rates equal to 200 percent of those of male nonsmokers.
3. Overall mortality rates are directly proportional to the duration of cigarette smoking.
4. Overall mortality rates are higher for those who started smoking at young ages than for those who began later.
5. Although mortality ratios for smokers, as compared with nonsmokers, are highest at the younger ages and decline with increasing age, the number of excess deaths attributable to smoking increases with age.
6. Former cigarette smokers compared with nonsmokers experience declining overall mortality ratios as the years since cessation of smoking increase.
7. A 30-35-year-old male two-pack-a-day smoker has an expectation of life eight to nine years shorter than that of a male nonsmoker of the same age.

II. SOCIOECONOMIC AND DEMOGRAPHIC DIFFERENCES BETWEEN SMOKERS AND NONSMOKERS

The information in this section, excerpted from the various reports and studies of the surgeon general, is intended to give the reader a broad perspective of smoking habits in the United States.

In 1978, according to data compiled by the National Center for Health Statistics,¹⁰ almost one-third—37.5 percent for males and 29.6 percent for females—of the United States population 17 years of age and older

⁶ United States Department of Health, Education, and Welfare, United States Public Health Service, *The Health Consequences of Smoking* (supplements to the 1967 *Public Health Service Review*; published periodically, from 1967 to 1974).

⁷ United States Department of Health, Education, and Welfare, *Smoking and Health*, Report of the Surgeon General, 1979.

⁸ Michael J. Cowell and Brian L. Hirst, "Puffing," review of *Smoking and Health*, Report of the Surgeon General (1979), in *The Actuary*, September, 1979, pp. 6-8.

⁹ *Smoking and Health*, Report of the Surgeon General, 1979, chap. 1, pp. 10-11.

¹⁰ *Ibid.*, Appendix, Table 1, n. 11.

smoked cigarettes regularly. In addition, the National Clearinghouse for Smoking and Health estimated that, in 1974, more than 10 percent of children in the age group 12–16 were regular smokers; the figures were slightly higher for girls (11.4 percent) than for boys (10.1 percent).¹¹ These statistics imply some 54 million smokers in an adult population of just over 150 million, plus an additional 5 million adolescent smokers. These smokers consumed 615 billion cigarettes in 1978—about 11,000 cigarettes annually, or, after adjusting for the young adolescent smokers, 30 cigarettes daily, for each adult cigarette smoker in the United States.

The surgeon general's 1979 report also gives historical data on the incidence of smoking. These are summarized in Table 1. As can be seen from that table, the percentage of cigarette smokers in the adult population increased between 1955 and 1965 but has declined significantly since the 1964 report was issued. Analysis of the data by sex shows that, over the past quarter of a century, the incidence of cigarette smoking among adult males has declined from above 52 percent to 37.5 percent. For females, however, it has increased from 24.5 percent to almost 30 percent, although it is down slightly from the record high of 33 percent in 1965.

Other data from the surgeon general's 1979 report, reproduced in Tables 2–5, show the differences in incidence of smoking by age, race, educational attainment, income, occupation, and marital status. These data suggest that, currently, cigarette smoking is most popular among people aged 35–44, more popular among blacks than among whites, and more popular among those with "some high school education" than among those with higher or lower educational attainment. The incidence of smoking among males is higher at family income levels from \$5,000 to \$15,000 than at lower or higher income levels, while among females the incidence is highest at family income levels of \$25,000 and above. Smoking is also more popular in "blue collar" occupations and among those listed as "unemployed" than in other occupational classes, and is much more popular among separated and divorced people than among single, married, or widowed people.

While this information provides a general profile of the difference in social and demographic characteristics between cigarette smokers and nonsmokers, the presentation of these statistics on a cross-sectional basis creates some problems of interpretation because no characteristic is independent of all the others. The high incidence of smoking among blue-collar occupations, for example, is related to the prevalence in this

¹¹ Ibid., Appendix, Table 4, p. 14. Interpolation based on population statistics.

TABLE 1

ESTIMATES OF PERCENTAGE OF CURRENT, REGULAR CIGARETTE SMOKERS (ADULTS) IN THE UNITED STATES

YEAR	SUPPLEMENT TO CURRENT POPULATION SURVEY (17 YEARS AND OVER)			HEALTH INTERVIEW SURVEY (17 YEARS AND OVER)			NATIONAL CLEARINGHOUSE FOR SMOKING AND HEALTH (21 YEARS AND OVER)			GALLUP POLL (18 YEARS AND OVER)		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
1949										44%		
1954										45		
1955	37.6%	52.6%	24.5%									
1957										42	52%	34%
1958										45		
1964							40.3%	52.9%	31.5%			
1965				41.7%	51.1%	33.3%						
1966	40.6	50.0	32.3				42.2	51.9	33.7			
1967	40.1	49.1	32.1									
1968	38.6	47.0	31.2									
1969										40	44	36
1970				36.9	43.5	31.1	36.2	42.3	30.5			
1971										42	47	37
1972										43	48	38
1973										40		
1974				37.0	42.7	31.9				40	45	36
1975							33.8	39.3	28.9			
1976				36.7	41.9	32.0						
1977										38	41	36
1978				33.2	37.5	29.6				36	39	34

SOURCE.—*Smoking and Health*, Report of the Surgeon General, 1979, Appendix, Table 1, p. 9 (footnotes and citations omitted).

TABLE 2
ESTIMATED PERCENTAGES OF CURRENT AND FORMER SMOKERS (ADULTS)
ACCORDING TO AGE AND SEX, IN THE UNITED STATES

AGE	1955		1964		1966		1970		1975	
	Current Smoker	Former Smoker	Current Smoker	Former Smoker	Current Smoker	Former Smoker	Current Smoker	Former Smoker	Current Smoker	Former Smoker
Males										
21-24.....	51.4%	3.6%	67.0%	9.5%	61.9%	7.2%	49.8%	20.0%	41.3%	16.0%
25-34.....	63.4	9.0	59.9	18.0	59.9	19.7	46.7	27.9	43.9	22.5
35-44.....	62.1	11.1	59.9	22.9	59.0	21.9	48.6	31.4	47.1	25.8
45-54.....	56.9	12.6	53.1	25.3	53.8	26.0	43.1	34.4	41.1	36.0
55-64.....	43.6	15.7	50.9	24.5	47.7	31.0	37.4	41.4	33.7	38.8
over 64.....	22.3	13.6	29.9	27.0	27.8	29.5	22.8	43.8	24.2	36.2
All.....	52.6%	10.9%	52.9%	22.2%	51.9%	23.6%	42.3%	32.6%	39.3%	29.2%
Females										
21-24.....	29.7%	3.5%	41.9%	7.6%	49.2%	7.9%	32.3%	13.2%	34.0%	19.9%
25-34.....	35.8	5.8	40.6	9.3	45.1	12.0	40.3	18.9	35.4	16.5
35-44.....	32.4	4.9	39.2	9.4	40.6	10.5	38.8	15.8	36.4	17.7
45-54.....	22.8	3.9	36.4	6.8	42.0	9.6	36.1	15.5	32.8	15.5
55-64.....	10.8	2.6	20.5	7.0	20.6	10.5	24.2	16.0	25.9	15.0
over 64.....	3.5	1.6	7.8	3.3	7.6	5.2	10.2	8.2	10.2	10.7
All.....	24.5%	3.9%	31.5%	7.4%	33.7%	9.4%	30.5%	14.8%	28.9%	14.5%

SOURCE.—*Smoking and Health*, Report of the Surgeon General, 1979, Appendix, Table 2, p. 10 (footnote and citation omitted).

TABLE 3
ESTIMATES OF PERCENTAGE OF CURRENT REGULAR
CIGARETTE SMOKERS AMONG WHITE AND BLACK
ADULTS, AGED 20 YEARS AND OVER, UNITED STATES

YEAR	WHITE		BLACK	
	Male	Female	Male	Female
1965.....	51.5%	34.2%	60.8%	34.4%
1970.....	43.7	31.9	54.0	33.1
1974.....	41.9	31.8	55.3	36.8
1976.....	41.2	31.8	50.5	35.1

SOURCE.—*Smoking and Health*, Report of the Surgeon General, 1979 Appendix, Table 5, p. 15 (footnote and citation omitted).

TABLE 4
ESTIMATES OF PERCENTAGE OF CURRENT, REGULAR
CIGARETTE SMOKERS AMONG ADULTS, AGED 21 YEARS AND
OVER, ACCORDING TO HIGHEST LEVEL OF EDUCATIONAL
ATTAINMENT, UNITED STATES, 1964-75

HIGHEST LEVEL OF EDUCATIONAL ATTAINMENT	1964	1966	1970	1975
Males				
Grade school or less.....	49.5%	49.9%	39.2%	37.4%
Some high school.....	62.0	60.4	51.0	47.8
High school graduate....	56.8	55.1	47.7	45.6
Some college.....	50.4	53.4	37.3	36.1
College graduate.....	42.5	36.8	30.6	28.1
Females				
Grade school or less....	18.2%	18.2%	19.7%	18.2%
Some high school.....	36.5	39.8	34.4	33.2
High school graduate....	35.4	43.2	32.2	31.9
Some college.....	36.1	35.9	36.3	32.2
College graduate.....	35.0	28.2	26.0	21.1

SOURCE.—*Smoking and Health*, Report of the Surgeon General, 1979, Appendix, Table 6, p. 15 (citations omitted).

group of people at the lower-middle income level and those with lower educational attainment; similarly, the lower incidence of smoking among professionals reflects the prevalence of nonsmokers at the higher income and educational attainment levels.

An appreciation of these demographic and socioeconomic patterns is helpful in determining whether the higher mortality associated with cigarette smokers really is caused by smoking per se or by other characteristics that, although associated with certain groupings of people for which the incidence of smoking is high, may have nothing to do with smoking itself.¹²

III. STATE MUTUAL'S NON-CIGARETTE-SMOKER BUSINESS

In the early 1960s, State Mutual became interested in reports within the life insurance industry of the number of deaths from coronary artery disease, lung cancer, and other diseases of the bronchial and pulmonary systems—deaths that some of the studies of the 1950s and early 1960s

TABLE 5
ESTIMATES OF PERCENTAGE OF CURRENT, REGULAR
CIGARETTE SMOKERS, ADULTS AGED 20 YEARS AND OVER,
ACCORDING TO FAMILY INCOME, SELECTED OCCUPATION
GROUPS, AND MARITAL STATUS, UNITED STATES, 1976

Category	Male	Female
Family income:		
Under \$5,000	42.5%	28.3%
\$5,000-\$9,999	45.5	33.5
\$10,000-\$14,999	45.5	32.5
\$15,000-\$24,999	40.4	33.0
\$25,000 or more	34.7	35.1
Occupation:		
White collar	36.6	34.3
Professional, technical, and kindred workers	30.0	29.1
Managers and administrative, nonfarm	41.0	41.6
Sales workers	39.9	38.1
Clerical and kindred workers	40.4	34.8
Blue collar	50.4	39.0
Farm	36.9	31.3
Currently unemployed	56.8	40.0
Not in labor force	32.9	28.2
Marital status:		
Never married	40.1	28.3
Currently married	41.1	32.4
Widowed	32.6	20.4
Separated	63.3	45.1
Divorced	59.9	54.8

SOURCE.—*Smoking and Health*, Report of the Surgeon General, 1979, Appendix, Table 7, p. 16 (footnote and citation omitted).

¹² *Ibid.*, chap. 2, p. 41.

attributed to an increase in cigarette smoking. However, because individuals were not classified for insurance purposes according to their smoking habits, it was not possible to measure directly the relative incidence of such deaths between smokers and nonsmokers.

Shortly after the surgeon general's 1964 report was published, the company announced that, on the basis of the evidence of a relationship between cigarette smoking and diseases of the lungs and heart, it felt a responsibility as a life insurer to acknowledge the risk people took when they smoked. However, in its advertising over the last fifteen years, State Mutual has maintained that it is not its intent to take a moral position against cigarette smoking. State Mutual's position was then, and continues to be, that non-cigarette-smokers are better life insurance risks than smokers, and that as a mutual insurer the company has a responsibility to policyholders to recognize mortality savings attributable to nonsmoking.

Because there was no published experience on mortality differentials between smokers and nonsmokers who were underwritten specifically for life insurance, State Mutual used the findings of the surgeon general's 1964 report as the basis for estimating conservatively what savings might be expected among a group of insured nonsmokers. These estimated improvements in mortality were reflected in the pricing of a new life insurance policy, the Non-Cigarette Smoker Preferred Protector, a life-paid-up-at-age-95 policy, issued for a minimum insurance amount of \$10,000.

The company commenced selling this new policy in April, 1964. In addition to the usual underwriting information, all the company required of applicants was a statement—which at the time was *not* part of the contract—to the effect that the applicant had not smoked cigarettes for at least a year. In 1972 the nonsmoking statement was incorporated as part of the application. In 1976, encouraged by the success of its non-cigarette-smoker business, the company extended the concept of non-smoker premium discounts to all individual life insurance policies except those in its pension series.

Over the last fifteen years, State Mutual has sold 105,000 life insurance policies, for a total insurance amount of \$3.4 billion, on the non-cigarette-smoker basis, and at midyear 1979 had over 85,000 of these policies in force, for a total insurance amount of \$2.7 billion. New sales of non-cigarette-smoker business currently account for approximately two-thirds of the company's total new individual life production at the adult ages, which corresponds closely to the proportion of the adult United States population that does not smoke.

State Mutual's Mortality Experience

The experience on State Mutual's nonsmoker business presented here is essentially statistical in nature. The clinical aspects of smoking as it affects mortality and the causal (etiological) relationship between smoking and disease, although extensively addressed in the surgeon general's reports, are beyond the scope of this paper.

By limiting the study to specific issue ages, insurance amounts, and plans of insurance, we are comparing the experience of two groups of insured lives with standard underwriting characteristics, where an individual is assigned to one or the other group solely on the basis of classification as a smoker or nonsmoker. To our knowledge, this is the only published mortality experience of lives whose smoking habits were identified at the time they were underwritten for insurance that is expressed in terms of a standard mortality basis.

To this extent, the experience adds to the data already published on the mortality differences between smokers and nonsmokers. However, because of its rather narrow scope, its value as a basis for reaching general conclusions about mortality differentials in other populations is somewhat limited. The authors will welcome comments and suggestions that might broaden this perspective.

As indicated earlier, State Mutual entered the non-cigarette-smoker life insurance business in April, 1964, with a life-paid-up-at-age-95 policy issued for a minimum insurance amount of \$10,000. The company has since broadened its nonsmoker product offerings to all plans in its individual nonpension series, and now issues nonsmoker coverage at the \$5,000 policy size, the minimum issue limit for this business. However, for purposes of comparing mortality between smoker and nonsmoker groups, we limited our study to policies issued standard at ages 20 and over with insurance amounts of at least \$10,000. Our study was confined further to four permanent plans on which the company offered coverage to smokers and, at a premium discount, substantially the same coverage to non-cigarette-smokers. While this has the effect of increasing the similarity of the two groups, there still remains a considerable disparity between the average policy sizes. The average size of new nonsmoker policies has ranged from 20 percent to 55 percent higher than that of comparable regular (other than nonsmoker) sales, and in 1978 was \$32,200 for all permanent nonsmoker issues compared with \$22,000 for corresponding regular sales.

We recognize that the different average sizes of the policies in the two groups may indicate that different socioeconomic groups are involved and that the observed experience may reflect underlying mortality differ-

ences by socioeconomic grouping. However, analysis of mortality experience by policy size indicates that these differences are not distorting the results significantly.

We recognize that while insureds under the nonsmoker policies form a relatively homogeneous group with respect to their smoking habits (except for those who misstated their smoking habits at the time of application and those who have since resumed or taken up smoking, all of them have been nonsmokers for at least one year), those insured under the company's regular policies form a group that is not so homogeneous. For convenience we will refer to this latter group as *smokers*, even though we realize that this is not a perfectly accurate description. It includes insureds who have given up smoking since purchasing life insurance from State Mutual and those who quit smoking within one year prior to issue, since the company requires that applicants for nonsmoker plans not have smoked cigarettes for at least one year. On the basis of data included in the surgeon general's reports, we estimate that these people who have quit smoking may account for as many as 25 percent of the company's "smokers." Also, among those correctly identified as smokers, there probably is a wide variation in smoking habits, ranging from light inhalation of fewer than ten low-tar-and-nicotine cigarettes daily to heavy inhalation of forty or more of the more conventional "strong" tobacco cigarettes daily. The surgeon general's data reproduced in Table 6 indicate that, for most age groups, there is a wider variation in the effects of smoking on mortality between these two extremes of the smoking spectrum than there is between nonsmokers and

TABLE 6

MORTALITY RATIOS FOR MALE CIGARETTE-ONLY SMOKERS, BY
NUMBER OF CIGARETTES SMOKED PER DAY AND AGE:
UNITED STATES VETERANS 1954 COHORT, 16-YEAR FOLLOW-UP

NUMBER OF CIGARETTES PER DAY	AGE				
	30-34	35-44	45-54	55-64	65-74
Nonsmokers.....	1.00	1.00	1.00	1.00	1.00
Fewer than 10.....	1.94	1.44	1.44	1.20	1.15
10-20.....	1.27	1.79	1.64	1.49	1.30
21-39.....	1.76	2.23	2.10	1.67	1.42
40 or more.....	2.33	2.72	2.13	1.86	1.65
All smokers.....	1.52	1.95	1.83	1.53	1.32

SOURCE.—*Smoking and Health*, Report of the Surgeon General, 1979, chap. 2, Table 5, p. 17 (citations omitted).

all smokers. Because State Mutual has not asked the extent of its applicants' smoking habits, we cannot measure results according to intensity of smoking. We are assuming, for the purpose of this paper at least, that the habits of State Mutual's smoker policyholders are similar to those of all smokers in the United States population. As we will show from a comparison of the results with those of the surgeon general, this assumption does not appear to be unreasonable.

Against this further background, and with these qualifications, we turn to State Mutual's mortality experience. This mortality study consists of State Mutual's experience between policy anniversaries in 1973 and 1978 under standard, regularly underwritten policies of at least \$10,000 insurance amount, where both smoker and nonsmoker policies were available. The 1965-70 Male and the 1965-70 Female Select Basic Tables¹³ were used to calculate expected deaths separately for males and females. Then the expected deaths for these two groups were added to produce the total expected deaths. Because State Mutual commenced issuing nonsmoker policies in 1964, the experience is contained entirely within the select period of the Basic Tables.

The experience for insurance issued subject to a medical examination reflects an exposure for smokers of 77,200 policy years for \$2.7 billion of insurance and 340 death claims for \$12,972,000. The corresponding exposure for nonsmokers was 127,000 policy years for \$5.6 billion of insurance with 240 death claims for \$11,004,000. The experience by age group at issue for the first fifteen policy years combined is shown in Table 7 for smokers, for nonsmokers, and for the two groups combined. This experience is shown by quinquennial policy-year groupings in Table 8.

For medically examined business, we also calculated the overall mortality ratios of each group by number of policies. For the smokers, the ratio was 127 percent with a confidence interval of ± 13 percent at the 95 percent confidence level,¹⁴ and for the nonsmokers the ratio was 54 percent with a confidence interval of ± 7 percent. For the two groups combined, the ratio was 82 percent with a confidence interval of ± 7 percent.

The experience for insurance issued without a medical examination is based on an exposure for smokers of 63,900 policy years for \$0.9 billion

¹³ "1965-70 Basic Tables," *TSA, 1973 Reports*, pp. 199-223.

¹⁴ Robert W. Batten, *Mortality Table Construction* (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1978), p. 223. The standard approximation for a 95 percent confidence interval about an actual-to-expected mortality ratio (M.R.) is given by $M.R. \pm 1.96M.R./\sqrt{\theta}$, where θ equals the number of deaths.

TABLE 7
 STATE MUTUAL MORTALITY EXPERIENCE BY AGE AT ISSUE
 STANDARD MEDICALLY EXAMINED ISSUES OF 1964-77
 EXPERIENCE BETWEEN 1973 AND 1978 ANNIVERSARIES
 MALE AND FEMALE LIVES—POLICY YEARS 1-15 COMBINED
 PERMANENT PLANS—POLICIES WITH FACE AMOUNTS OF \$10,000 AND HIGHER
 EXPECTED DEATHS ON 1965-70 SELECT BASIC TABLES
 (Amounts Shown in \$1,000 Units)

AGES AT ISSUE	SMOKERS				NONSMOKERS				COMBINED MORTALITY RATIO
	Exposed to Risk	Actual Deaths	Expected Deaths	Mortality Ratio	Exposed to Risk	Actual Deaths	Expected Deaths	Mortality Ratio	
20-29	\$ 506,421	\$ 831 (25)	\$ 461	180%	\$ 874,081	\$ 195 (6)	\$ 761	26%	84%
30-39	1,031,142	4,167 (101)	2,031	205 [156]*	1,985,563	1,091 (29)	3,751	29	91 [74]*
40-49	856,980	4,853 (124)	3,994	122	1,900,021	4,162 (102)	8,612	48	72
50-59	293,503	2,416 (75)	2,638	92	726,496	4,766 (80)	6,203	77 [45]†	81 [59]‡
60 and over	34,617	705 (15)	674	105	84,576	790 (23)	1,321	60	75
20 and over	\$2,722,663	\$12,972 (340)	\$9,798	132% [122]*	\$5,570,737	\$11,004 (240)	\$20,648	53% [44]†	79% [69]‡

NOTE.—The actual number of deaths is shown in parentheses.

* Excludes one death for \$1 million.

† Excludes one death for \$2 million.

‡ Excludes the two deaths noted above.

TABLE 8
 STATE MUTUAL MORTALITY EXPERIENCE BY POLICY YEAR
 STANDARD MEDICALLY EXAMINED ISSUES OF 1964-77
 EXPERIENCE BETWEEN 1973 AND 1978 ANNIVERSARIES
 MALE AND FEMALE LIVES—ISSUE AGES 20 AND OVER
 PERMANENT PLANS—POLICIES WITH FACE AMOUNTS OF \$10,000 AND HIGHER
 EXPECTED DEATHS ON 1965-70 SELECT BASIC TABLES
 (Amounts Shown in \$1,000 Units)

POLICY YEARS	SMOKERS				NONSMOKERS				COMBINED MORTALITY RATIO
	Exposed to Risk	Actual Deaths	Expected Deaths	Mortality Ratio	Exposed to Risk	Actual Deaths	Expected Deaths	Mortality Ratio	
1-5.....	\$1,191,868	\$ 4,060 (97)	\$2,700	150%	\$2,591,728	\$ 5,394 (67)	\$ 6,333	85% [54]†	105% [83]†
6-10.....	1,191,751	6,759 (153)	4,929	137 [117]*	2,518,473	4,029 (110)	11,275	36	67 [60]*
11-15.....	339,044	2,153 (90)	2,169	99	460,536	1,581 (63)	3,040	52	72
1-15....	\$2,722,663	\$12,972 (340)	\$9,798	132% [122]*	\$5,570,737	\$11,004 (240)	\$20,648	53% [44]†	79% [69]‡

NOTE.—The actual number of deaths is shown in parentheses.

* Excludes one death for \$1 million.

† Excludes one death for \$2 million.

‡ Excludes the two deaths noted above.

of insurance and 73 death claims for \$1,020,000. The nonmedical exposure for nonsmokers was 86,200 policy years for \$1.3 billion of insurance and 65 death claims for \$1,013,000. Division of this experience by decennial issue-age groups or quinquennial policy-year groups produces cells that contain too few claims to be significant. The overall nonmedical mortality ratios by amount of insurance were 109 percent for smokers, 76 percent for nonsmokers, and 90 percent for the two groups combined. By number of policies, the overall nonmedical actual-to-expected ratios, together with 95 percent confidence intervals, were 106 ± 24 percent for smokers, 74 ± 18 percent for nonsmokers, and 88 ± 15 percent for the two groups combined.

Finally, we have calculated mortality rates by cause of death based on this experience. These are shown in Table 9 separately for smokers and nonsmokers, according to the major categories of cause of death. Although the small number of deaths makes it difficult to give statistical significance to any detailed analysis, we can say that, in general, results by cause of death are not inconsistent with those reported by the surgeon general.¹⁵ As might be expected, the largest mortality differentials between smokers and nonsmokers are in the categories of respiratory cancer and arteriosclerotic and degenerative heart disease.

One interesting aspect of the cause-of-death study is the predominantly higher mortality rates for smokers in those categories that have not been associated commonly with smoker mortality (that is, mental disorders, accidents, suicides, homicides, and all other causes). This result could be used to argue that the use of smoking as an underwriting criterion is, in reality, a substitute for the underwriting of life-style. According to this argument, people with a "riskier" life-style have a greater propensity toward smoking and, consequently, their higher mortality is attributable to their life-style rather than to their smoking habits. If these "non-associated" causes were eliminated, the mortality rates per thousand would become 2.677 and 0.966 for smokers and nonsmokers, respectively. The ratio of smoker to nonsmoker mortality rates would increase from 2.5 to 2.8, suggesting that the percentage extra mortality attributable to smoking would be even greater in populations with "identical" lifestyles.

IV. RELATIONSHIPS BETWEEN STATE MUTUAL'S FINDINGS AND THE RESULTS PRESENTED IN THE SURGEON GENERAL'S REPORT

Although State Mutual has been issuing nonsmoker policies for over fifteen years, the experience is still quite limited. While the difference in mortality between smokers and nonsmokers is statistically significant

¹⁵ *Smoking and Health*, Report of the Surgeon General, 1979, chap. 2, p. 40.

TABLE 9
 STATE MUTUAL'S MORTALITY RATES PER THOUSAND OF INSURANCE, BY CAUSE OF DEATH
 STANDARD MEDICAL AND NONMEDICAL ISSUES OF 1964-77
 EXPERIENCE BETWEEN 1973 AND 1978 ANNIVERSARIES
 MALE AND FEMALE LIVES—ISSUE AGES 20 AND OVER
 POLICY YEARS 1-15 COMBINED
 PERMANENT PLANS—POLICIES WITH FACE AMOUNTS OF \$10,000 AND HIGHER

CAUSE OF DEATH	MORTALITY RATE PER 1,000		RATIO OF SMOKERS' TO NONSMOKERS' MORTALITY RATE
	Smokers	Nonsmokers	
Respiratory cancer	0.344 (37)	0.023 (6)	15.0
Pneumonia and influenza	0.147 (6)	0.010 (3)	14.7
Other respiratory diseases	0.118 (10)	0.061 (11)	1.9
Arteriosclerotic and degenerative heart disease and myocardial insufficiencies	1.298 (129)	0.487 (88)	2.7
	[1.020]* (128)		[2.1]*
Hypertensive heart disease and hypertension	0.145 (15)	0.018 (3)	8.1
Other cardiovascular diseases	0.147 (25)	0.076 (21)	1.9
Cancer (excluding respiratory cancer)	0.695 (72)	0.573 (65)	1.2
		[0.280]† (64)	[2.5]†
Mental disorders and diseases of the central nervous system	0.120 (9)	0.051 (8)	2.4
Digestive diseases	0.064 (5)	0.011 (6)	5.8
Motor vehicle accidents	0.134 (22)	0.052 (13)	2.6
Other accidents	0.271 (23)	0.178 (35)	1.5
Suicide	0.199 (26)	0.022 (9)	9.0
Homicide	0.095 (9)	0.044 (12)	2.2
All other causes	0.126 (25)	0.153 (25)	0.8
All causes	3.898 (413)	1.758 (305)	2.2
	[3.620]* (412)	[1.466]† (304)	[2.5]‡

NOTE.—The actual number of deaths is shown in parentheses.

* Excludes one death for \$1 million.

† Excludes one death for \$2 million.

‡ Excludes the two deaths noted above.

almost to the point of certainty (that is, a confidence level in excess of 99.9 percent) for medically examined business, and at the 98 percent confidence level for nonmedical business, the limited size of the experience prevents us from determining precisely the size of the mortality differential between smokers and nonsmokers. The purpose of this section is to compare, where feasible, State Mutual's experience to that reported by the surgeon general. On the basis of these comparisons, we conclude that, when adjustments are made to account for the different populations, State Mutual's experience conforms reasonably well to the findings of the surgeon general's report with respect to the mortality of cigarette smokers. Thus we are reasonably confident that the results closely reflect the actual levels of mortality experienced by smokers and nonsmokers in a population underwritten for individual life insurance.

Ratio of Smoker to Nonsmoker Mortality

Table 10 shows mortality ratios by issue age and duration for the most statistically significant experience from State Mutual's study as summarized in Section III. These results, although based on limited data, suggest a lower ratio of smoker to nonsmoker mortality at the later durations than at the earlier durations. This is largely because the mortality ratios in the smoker experience consistently decrease by duration. Further analysis leads us to conclude that this trend is due, at least in part, to the increase by duration in the number of insureds with smoker policies who have quit smoking since issue. We estimated the size of this group utilizing data in the surgeon general's 1979 report¹⁶ that show a rate of cessation of smoking of approximately 5 percent per year. The application of this annual rate of cessation to State Mutual's exposure by duration suggests that approximately 25 percent of the exposure in the smoker category is being contributed by insureds who were smokers at the time of issue but were ex-smokers at time of exposure in the study. We also have assumed that the number of nonsmoker policyholders who have resumed or taken up smoking since issue is negligible.

Using this estimate of the number of ex-smokers with State Mutual smoker policies, we adjusted the ratios in Table 10 to provide a comparison of current smoker and current nonsmoker mortality. We made this adjustment by estimating, on the basis of the data in the surgeon general's report,¹⁷ the division of our nonsmoker population into those who never have smoked and those who are former smokers. The report

¹⁶ *Ibid.*, Appendix, Tables 2-3, pp. 10-13.

¹⁷ *Ibid.*, Appendix, Table 2, p. 10.

TABLE 10
 STATE MUTUAL'S MORTALITY RATIOS, BY AGE AT ISSUE AND POLICY YEAR
 STANDARD MEDICALLY EXAMINED ISSUES OF 1964-77
 EXPERIENCE BETWEEN 1973 AND 1978 ANNIVERSARIES
 MALE LIVES—PERMANENT PLANS
 POLICIES WITH FACE AMOUNTS OF \$10,000 AND HIGHER
 EXPECTED DEATHS ON 1965-70 MALE SELECT BASIC TABLE

POLICY YEAR	ISSUE AGES 30-39			ISSUE AGES 40-49			ISSUE AGES 50-59		
	Smokers	Nonsmokers	Ratio of Smokers to Nonsmokers	Smokers	Nonsmokers	Ratio of Smokers to Nonsmokers	Smokers	Nonsmokers	Ratio of Smokers to Nonsmokers
1-5.....	197% (19)	18% (5)	10.9	144% (32)	82% (23)	1.8	162% (51)	62% (28)	2.6
6-10.....	148* (47)	36 (17)	4.1	137 (59)	32 (45)	4.3	141* (106)	33 (62)	4.3
11-15.....	135 (29)	32 (6)	4.2	85 (28)	49 (25)	1.7	101 (57)	43 (31)	2.3
1-15.....	157%* (95)	30% (28)	5.2	126% (119)	48% (93)	2.6	137%* (214)	42% (121)	3.2

NOTE.—The actual number of deaths is shown in parentheses.

* Excludes one claim for \$1 million.

also indicates that the mortality ratio of ex-smokers who quit on their own (as contrasted with those who quit because of medical advice) to that of people who never smoked is approximately 1.2.¹⁸ This ratio appears to be fairly constant during the first fifteen years after cessation. Using these assumptions, we modified Table 10 to produce the comparison in Table 11 between current smokers and current nonsmokers. This is the form in which most of the data in the surgeon general's report are presented. An explanation of this derivation is given in Appendix I.

The ratios in Table 11 do not show any clear trend toward narrowing of the mortality differential by duration. They do, however, show a much higher ratio of smoker to nonsmoker mortality than does the surgeon general's report (see Table 6). This latter result is not all that surprising when we consider that State Mutual's experience is that of an insured group with mortality rates much lower than those of the general population. The same absolute difference in mortality rates would yield a much higher ratio of smoker to nonsmoker mortality in an insured population. To test the reasonableness of State Mutual's mortality ratios against those in the surgeon general's report, we compared mortality rates for male smokers and nonsmokers combined with those in the 1969-1971 United States Life Tables. We assumed that the differences in the rates could be attributed to deaths that were a function not of smoking but rather of other characteristics that would produce higher-than-standard select mortality. If the excess deaths are added to both the smoker and the nonsmoker mortality rates, the resulting smoker-to-nonsmoker ratio is 1.9, which compares reasonably well to the data reported in the surgeon general's report for the appropriate age ranges (see Table 6). A more detailed explanation of this derivation is given in Appendix II.

V. SIGNIFICANCE OF CIGARETTE SMOKING AS A CRITERION IN LIFE INSURANCE UNDERWRITING

On the basis of our experience, we have confirmed that the mortality differentials between smokers and nonsmokers are large enough to validate the separate identification of these two groups for life insurance underwriting purposes. As we shall illustrate later in this section, the mortality differentials exceed those between males and females. Since mortality differentials by sex are recognized in the pricing of life insurance, it is difficult to justify not making an underwriting distinction by smoking classification. Ease of underwriting is another factor that makes it difficult to ignore these differences.

¹⁸ *Ibid.*, chap. 2, Table 30, p. 29.

TABLE 11
 STATE MUTUAL'S ADJUSTED MORTALITY RATIOS BY AGE AT ISSUE AND POLICY YEAR
 MORTALITY RATIOS ADJUSTED TO REFLECT CURRENT SMOKING HABITS
 STANDARD MEDICALLY EXAMINED ISSUES OF 1964-77
 EXPERIENCE BETWEEN 1973 AND 1978 ANNIVERSARIES
 MALE LIVES—EXPECTED DEATHS ON 1965-70 MALE SELECT BASIC TABLE

POLICY YEAR	ISSUE AGES 30-39			ISSUE AGES 40-49			ISSUE AGES 50-59		
	Current Smokers (Est.)	Non-smokers	Ratio of Smokers to Nonsmokers	Current Smokers (Est.)	Non-smokers	Ratio of Smokers to Nonsmokers	Current Smokers (Est.)	Non-smokers	Ratio of Smokers to Nonsmokers
1-5.....	216%	18%	12.0	149%	82%	1.8	172%	62%	2.8
6-10.....	193	36	5.4	179	32	5.6	184	33	5.6
11-15.....	212	32	6.6	106	49	2.2	140	43	3.3
1-15.....	197%	30%	6.6	149%	48%	3.1	165%	42%	3.9

A more theoretical question could be addressed, namely, "Should the standard underwriting class include smokers, with nonsmokers being considered preferred risks; or should the standard class include only nonsmokers, with smokers being considered substandard?" From a marketing point of view, any attempt at the present time to classify smokers as substandard probably would be regarded as impractical. The following discussion suggests, however, that the insurance industry eventually may decide to adopt a substandard classification for smokers.

The decision as to which group should be considered standard involves physiological characteristics, underwriting principles, and not a small amount of philosophical consideration. Physiologically, smoking does not have a normal function as does eating or sleeping; smoking does not appear to fulfill any biological need. The chemicals inhaled when a cigarette is smoked do not seem to have any beneficial effects. In fact, some of these chemicals have been identified as toxic substances that should be avoided by the human body. For example, carbon monoxide is present in cigarette smoke in a concentration of 42,000 parts per million; the highest concentration considered safe by industrial standards is 100 parts per million.¹⁹

In order to have useful underwriting classifications, the standard group should be larger than either the preferred or the substandard group. The larger of the two groups being discussed here is the non-smoker group. The surgeon general's report shows that the proportion of non-cigarette-smokers increased from 58 percent of the adult population in 1965 to 67 percent by 1978. This trend may be related to the adverse publicity the surgeon general has given cigarettes; if this trend continues, the extent to which nonsmokers outnumber smokers will increase for the foreseeable future. The proportion of nonsmokers among adults who have been issued insurance policies by State Mutual at standard rates closely parallels that for the entire population. Sixty-seven percent of all the individual nonpension life insurance policies sold by State Mutual in 1978 were issued to nonsmokers. Also, State Mutual's non-smoker business as a percentage of new sales has been increasing for the past several years in a pattern that closely approximates the nonsmoking trend in the general population.

Another underwriting consideration is the practice of classifying as substandard an individual with a known physical impairment and assigning a rating commensurate with the severity of that impairment. As indicated in the preceding section, the surgeon general's report gives

¹⁹ *Smoking and Health*, Report of the Advisory Committee to the Surgeon General, 1964, Table 4, p. 60.

strong evidence that mortality rates do increase significantly with the severity of smoking.

Against this background, we conclude that non-cigarette-smokers could be considered as the population that defines "standard" risks, while smokers could be considered substandard, with the degree of rating increasing with the extent of their smoking habits. Nonsmokers who are better than average in other underwriting considerations (such as build or blood pressure) could be considered preferred risks.

From this conclusion, it follows that a general mortality table could be separated into two component tables, one for smokers and the other for nonsmokers. Taking the 1965-70 Basic Tables as representative of composite smoker and nonsmoker mortality, we separated each mortality rate for a cohort of males aged 32 at issue into its smoker and nonsmoker components. These rates are shown in Table 12. In determining them we assumed that the ratio of smoker to nonsmoker mortality was the same as State Mutual's experience during the select period (see Table 10), and that it graded down to 1.0 at attained age 85, following the pattern shown in the surgeon general's report (see Table 6). It also was assumed that the experience underlying the Basic Tables had the same percentage of smokers (60 percent) as the general population for the same time period (see Table 2).

If we take the nonsmoker rates in Table 12 as standard, the smoker rates represent mortality of up to 340 percent of standard. These rates would apply to "average" (30-cigarette-a-day) smokers. If we assume that the patterns in the surgeon general's mortality data by number of cigarettes smoked also apply to these rates, then the mortality associated with smoking 20 cigarettes a day is approximately 225 percent of standard, and for 40 cigarettes or more a day is in excess of 450 percent of standard.

We also calculated the complete expectation of life for a male aged 32 on the 1965-70 Basic Table and on the basis of the separate smoker and nonsmoker mortality rates shown in Table 12. The results are as follows:

Table	e_{32} (Years)
1965-70 Male Select and Ultimate	42.2
"Smoker"	39.6
"Nonsmoker"	46.9

The difference in expectation of life between smokers and nonsmokers is 7.3 years. Given the modest assumptions used in the construction of Table 12 as to nonsmoker mortality improvements at the higher attained ages, this difference between nonsmokers and "average" cigarette smokers for insured lives compares reasonably with the conclusions in the

NONSMOKER COMPONENTS: MORTALITY RATE PER 1,000—ISSUE AGE 32

Age	Basic Table	Smoker	Nonsmoker	Ratio of Smoker to Nonsmoker	Age	Basic Table	Smoker	Nonsmoker	Ratio of Smoker to Nonsmoker
[32]	0.75	1.05	0.31	3.4	66	28.73	37.12	16.14	2.3
[32]+1	0.87	1.21	0.36	3.4	67	31.40	40.57	17.64	2.3
[32]+2	0.98	1.37	0.40	3.4	68	34.21	43.76	19.89	2.2
[32]+3	1.10	1.53	0.45	3.4	69	36.99	47.31	21.51	2.2
[32]+4	1.19	1.65	0.50	3.3	70	39.92	50.50	24.05	2.1
[32]+5	1.33	1.84	0.56	3.3	71	43.46	54.98	26.18	2.1
[32]+6	1.46	2.02	0.61	3.3	72	47.47	59.34	29.67	2.0
[32]+7	1.68	2.33	0.71	3.3	73	51.73	64.66	32.33	2.0
[32]+8	1.92	2.65	0.83	3.2	74	56.43	69.62	36.64	1.9
[32]+9	2.17	2.99	0.94	3.2	75	61.64	76.05	40.03	1.9
[32]+10	2.47	3.41	1.06	3.2	76	67.41	81.99	45.55	1.8
[32]+11	2.75	3.79	1.19	3.2	77	73.71	89.65	49.80	1.8
[32]+12	3.06	4.20	1.35	3.1	78	80.63	96.53	56.78	1.7
[32]+13	3.46	4.75	1.53	3.1	79	88.00	103.53	64.71	1.6
[32]+14	3.96	5.43	1.75	3.1	80	95.60	110.31	73.54	1.5
47	4.42	6.06	1.96	3.1	81	103.29	116.62	83.30	1.4
48	4.92	6.71	2.24	3.0	82	111.63	122.98	94.60	1.3
49	5.51	7.51	2.50	3.0	83	120.51	129.12	107.60	1.2
50	6.17	8.41	2.80	3.0	84	130.63	135.56	123.24	1.1
51	6.84	9.33	3.11	3.0	85	141.76	141.76	141.76	1.0
52	7.50	10.16	3.50	2.9	86	153.97	153.97	153.97	1.0
53	8.23	11.15	3.85	2.9	87	167.26	167.26	167.26	1.0
54	9.05	12.26	4.23	2.9	88	181.42	181.42	181.42	1.0
55	10.03	13.50	4.82	2.8	89	193.63	193.63	193.63	1.0
56	11.17	15.04	5.37	2.8	90	202.96	202.96	202.96	1.0
57	12.42	16.72	5.97	2.8	91	210.32	210.32	210.32	1.0
58	13.73	18.35	6.80	2.7	92	217.76	217.76	217.76	1.0
59	15.10	20.18	7.48	2.7	93	230.07	230.07	230.07	1.0
60	16.50	21.89	8.42	2.6	94	248.83	248.83	248.83	1.0
61	18.01	23.89	9.19	2.6	95	267.93	267.93	267.93	1.0
62	19.69	25.91	10.36	2.5	96	279.78	279.78	279.78	1.0
63	21.63	28.46	11.38	2.5	97	292.83	292.83	292.83	1.0
64	23.81	31.06	12.94	2.4	98	306.15	306.15	306.15	1.0
65	26.17	34.13	14.22	2.4	99	319.74	319.74	319.74	1.0
					100	333.56	333.56	333.56	1.0

surgeon general's report regarding overall population statistics, namely, that the life expectancy of a 30-35-year-old male two-pack-a-day cigarette smoker is eight to nine years shorter than that of his nonsmoking counterpart.

As one indication of the significance of this 7.3-year difference, we calculated the complete expectation of life for a female aged 32 on the 1965-70 Basic Tables to be 47.2 years, or five years greater than that for a male the same age.

Turning to the practical implications of these differences, although the use of a graded substandard scale by degree of smoking appears to be justified by the data contained in the surgeon general's report, there are two principal areas of difficulty. The primary problem is the verification, at a reasonable expense, of the degree of smoking. Among the criteria that should be considered are the number of cigarettes smoked, the age at which smoking began, tar and nicotine content, and depth of inhalation.

The second major difficulty in utilizing price differentials for smoking is the problem of reclassification. The life insurance industry has traditionally given consideration to reclassification of an insured if the severity of his impairment has been reduced. The surgeon general's report shows mortality improvement for ex-smokers. Are they entitled to some sort of change of dividend or rating class if they stop smoking after issue? It would be inappropriate to include them with insureds who were non-smokers at the time of issue, since that group contains both ex-smokers and those who have never smoked. Also, the insured may have quit smoking because of poor health. It might be possible to allow a change in classification upon evidence of insurability. The authors would welcome discussion on this challenging issue.

The implications of these results for other areas of risk classification and selection also could have significance for the insurance industry. The significant variances between socioeconomic and demographic groups with respect to their smoking characteristics may be causing distortions in mortality patterns among groups that the industry previously considered to be homogeneous for mortality purposes. Two characteristics that illustrate this point are insurance amount and sex.

Past studies conducted by the Society on policies for large amounts²⁰ have shown consistently lower mortality ratios for large-amount policies relative to policies for all sizes combined. The larger proportion of non-smokers among high-income groups may be partly responsible for the

²⁰ "Mortality on Policies for Large Amounts," *TSA, 1975 Reports*, pp. 57-58.

more favorable results; in other words, the additional underwriting on policies for large amounts may have had less impact than has been supposed.

A similar situation exists with respect to Society studies that are sex-distinct. Recent studies show a fairly consistent level of overall female-to-male mortality ratios of approximately 60 percent. The demographic data in the surgeon general's report show a significantly greater percentage of smokers among men than among women. This significant dissimilarity may be distorting the size of the mortality differential between men and women. To the extent that a greater proportion of women are nonsmokers, the mortality differential between men and women with similar smoking habits would be overstated. For example, the ratio of female to male mortality was 68 percent for large amounts, higher than the total ratio of 60 percent. This might have been predicted on the basis of the surgeon general's data, which indicate that the prevalence of smoking among women is higher at the highest income levels than at all income levels, while the reverse is true for males, with the greatest proportion of nonsmoker males at the higher income levels.

The difference in mortality between smokers and nonsmokers affects not only comparisons of different groups but also analysis of the mortality level of a supposedly homogeneous group in which the proportions of smokers and nonsmokers are different from those underlying the expected mortality basis. The experience presented in this paper illustrates this point. The exposure in State Mutual's 1973-78 experience has a smoker-to-nonsmoker ratio of 2:3, contrasted with the 3:2 ratio assumed in the separation of the 1965-70 Male Basic Tables into the smoker and nonsmoker components shown in Table 12. The expected mortality rates for the company's study were determined on a combined basis by weighting the separate smoker and nonsmoker rates by the actual exposure. This resulted in an expected mortality ratio, during the select period, of 80 percent of the Basic Table while the actual mortality ratio was 74 percent. We conclude that the company has not in fact experienced significantly better mortality than that underlying the Basic Table; rather, the aggregate mortality ratio has been distorted by use of a "combined" table as the basis for expected mortality. This distortion is not unique to State Mutual. To the extent that a population's composition with respect to smoking habits differs from that of the expected mortality basis, this distortion will occur in any mortality study. The results of recent Society studies that use the 1965-70 Basic

Tables as the basis of the expected deaths are consistent with this conclusion.²¹

A thorough investigation of these phenomena is beyond the scope of this paper, but we believe that the questions raised merit further study.

VI. CONCLUSIONS

On the basis of the experience described in this paper and the findings in the surgeon general's 1979 report, we conclude that cigarette smokers are subject to a mortality risk significantly higher than that of nonsmokers. We acknowledge that all of this excess mortality may not be attributable to smoking per se, and we have not attempted to investigate the cause-and-effect relationship between cigarette smoking and excess mortality. Nevertheless, regardless of the cause, we conclude that these differences between smokers and nonsmokers are real; they emerge at early durations; contrary to what may have been believed earlier, they are not deferred to older ages; they are statistically significant at any reasonable level; and they are too large to be ignored for individual insurance underwriting and pricing purposes.

Since nonsmokers are the larger segment of the population, we further conclude that they could be considered the basis of the standard classification for life insurance underwriting purposes. If so, then, over a broad range of adult ages, say 20-65, overall mortality rates among smokers who otherwise are evaluated as standard for life insurance underwriting purposes range from two to four times those of "standard" risks. We believe these differences should not be ignored, while characteristics associated with much smaller mortality differences are well established as part of life insurance underwriting and pricing procedures.

We recognize that this paper only scratches the surface of what, we believe, will be a vast new area for mortality investigation, especially since it involves a potential underwriting criterion that is completely within the control of the prospective insured.

Finally, we conclude that the mortality differences between smokers and nonsmokers are so substantial that experience tables developed on a composite basis show rates that, except by coincidence, are not actually experienced by any significant homogeneous group. We foresee the eventual recognition of these differences by the actuarial profession and by a broad segment of the insurance industry, and the publication of separate mortality tables for smokers and nonsmokers.

²¹"Mortality under Standard Ordinary Insurance Issues between 1975 and 1976 Anniversaries," *TSA, 1977 Reports*, p. 6.

VII. ACKNOWLEDGMENTS

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To all those who gave assistance and encouragement on this paper, the authors express their appreciation.

APPENDIX I

Table A of this Appendix illustrates the method used to translate mortality ratios for policyholders issued smoker policies into mortality ratios for policyholders who currently are smokers by removing the impact of those policyholders who have quit smoking since issue. Specifically, for issue ages 30-39 and durations 1-5, the mortality ratios shown in Table 10 are 197 percent and 18 percent for smoker and nonsmoker policyholders, respectively. First, we separated the policyholders into three categories: people who never smoked, ex-smokers, and current smokers. Since the proportion of nonsmoker business in State Mutual's individual life sales is roughly comparable to the proportion of the United States population that does not smoke, as reported by the surgeon general, we relied on data in the 1979 report²² to estimate the relative sizes of these categories. For issue ages 30-39, we estimated that the proportions of "never-smokers," ex-smokers, and current smokers were 25 percent, 27 percent, and 48 percent, respectively. We also assumed that the ratio of ex-smoker to never-smoker mortality rates in an insured population was 1.7 (this was adjusted from the ratio of 1.2 stated in the text, since the latter figure is based on the general population; see Appendix II). By utilizing the proportion of nonsmoker policyholders who are ex-smokers, and their expected mortality relative to never-smokers, we can determine unique mortality ratios for these two groups. For issue ages 30-39 and durations 1-5, for example, the mortality ratio of 18 percent for nonsmokers becomes 13 percent and 22 percent for never-smokers and ex-smokers, respectively. The 22 percent ratio for ex-smokers is then utilized to determine the mortality of smoker policyholders. On the basis of a cessation rate of 5 percent per year, weighted by duration, we estimate that 10 percent of the policyholders who were issued smoker policies were nonsmokers at the time of the study. This proportion, combined with the mortality ratio for ex-smokers, allows us to estimate a mortality ratio for current smokers. In this example, the 197 percent mortality ratio for smoker

²² *Smoking and Health*, Report of the Surgeon General, 1979, Appendix, Tables 2-3, pp. 10-13.

TABLE A—ESTIMATION OF MORTALITY RATIOS BY SMOKING HABIT

ISSUE AGE	SEPARATION OF TOTAL ISSUES BY SMOKING HABIT				SEPARATION OF NONSMOKER ISSUES BY SMOKING HABIT			MORTALITY RATIO OF NONSMOKER ISSUES BY SMOKING HABIT			PERCENTAGE OF SMOKERS WHO HAVE QUIT SINCE ISSUE	MORTALITY RATIO OF SMOKER ISSUES BY SMOKING HABIT			RATIO OF CURRENT SMOKERS TO NON- SMOKERS
	Never Smoked	Former Smokers	Current Smokers	Total	Never Smoked	Former Smokers	Total	Never Smoked	Former Smokers	Total		Former Smokers	Current Smokers	Total	
Policy Years 1-5															
30-39....	25%	27%	48%	100%	48%	52%	100%	13%	22%	18%	10%	22%	216%	197%	12.0
40-49....	23	32	45	100	42	58	100	58	99	82	10	99	149	144	1.8
30-49..	24%	30%	46%	100%	44%	56%	100%	45%	76%	62%	10%	76%	172%	162%	2.8
Policy Years 6-10															
30-39....	23%	25%	52%	100%	48%	52%	100%	26%	44%	36%	30%	44%	193%	148%	5.4
40-49....	22	28	50	100	44	56	100	23	39	32	30	39	179	137	5.6
30-49..	23%	26%	51%	100%	46%	54%	100%	24%	41%	33%	30%	41%	184%	141%	5.6
Policy Years 11-15															
30-39....	20%	20%	60%	100%	50%	50%	100%	24%	41%	32%	45%	41%	212%	135%	6.6
40-49....	19	24	57	100	44	56	100	35	60	49	45	60	106	85	2.2
30-49..	20%	22%	58%	100%	47%	53%	100%	31%	53%	43%	45%	53%	140%	101%	3.3
Policy Years 1-15															
30-39....	23%	24%	53%	100%	49%	51%	100%	22%	37%	30%	25%	37%	197%	157%	6.6
40-49....	21	28	51	100	43	57	100	34	58	48	25	58	149	126	3.1
30-49..	22%	26%	52%	100%	46%	54%	100%	31%	52%	42%	25%	52%	165%	137%	3.9

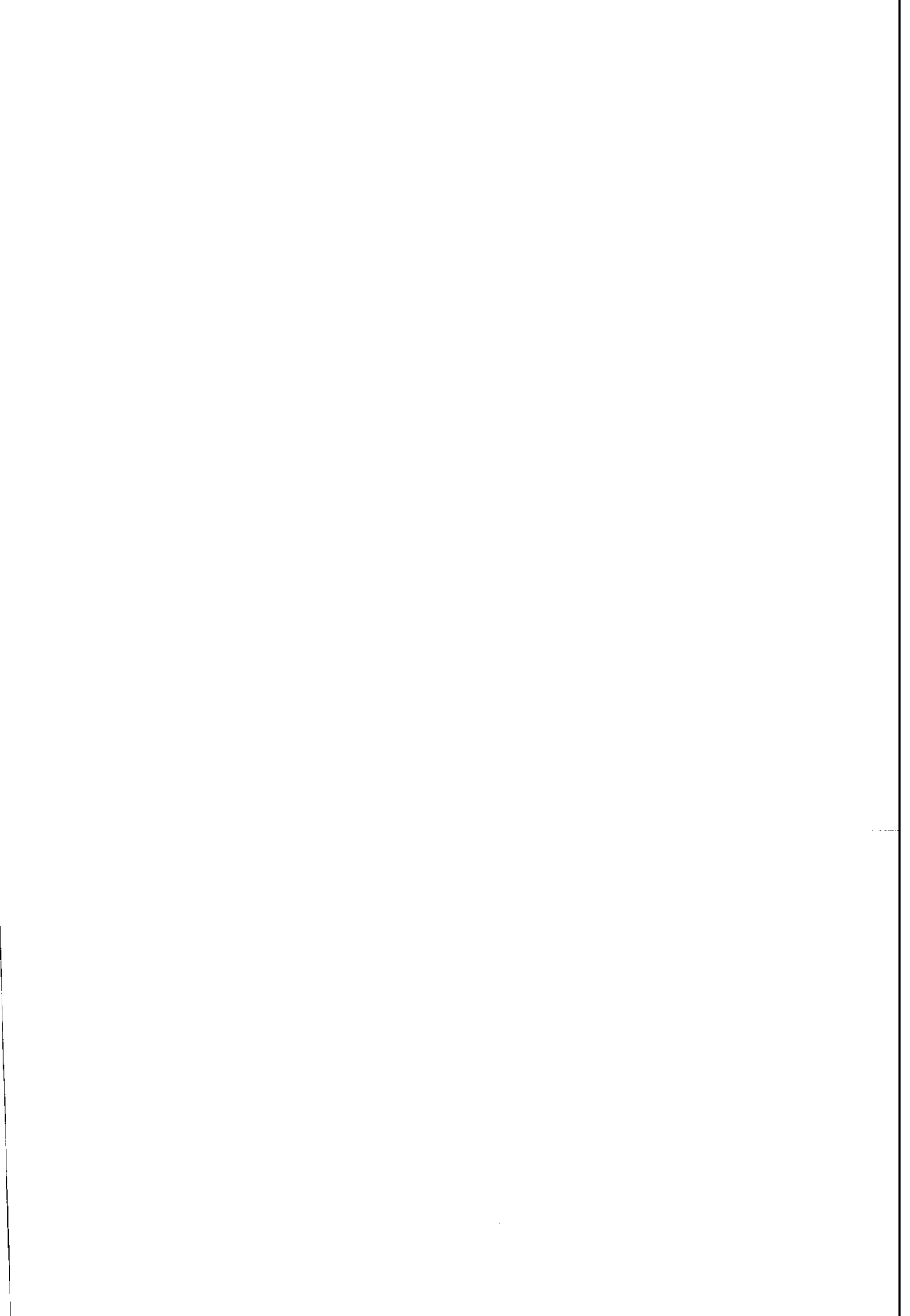
policyholders at issue ages 30-39 and durations 1-5 becomes 22 percent for ex-smokers and 216 percent for current smokers. The 216 percent figure is shown in Table 11.

Obviously, the result for any one cell in Table A is based on too few deaths to be statistically reliable. Our example above illustrates this point. It is not credible that two groups of insured lives, both of which were comprised of smokers at issue, should within an average of three years experience mortality rates differing by a factor of 10 solely because of a change in smoking habits. The cell-by-cell development of the table was undertaken to reflect the different proportions of the population who were never-smokers, ex-smokers, and current smokers at time of issue. This approach should not obscure the fact that in the aggregate the results do have some statistical validity. In addition, the results by duration, while not individually statistically credible, do give credence to our hypothesis that a decline in mortality differentials between smokers and nonsmokers may be a result of the changing composition of the "smoker" group rather than an actual diminution of the impact of smoking.

APPENDIX II

The aggregate results in Table 10 expressed as mortality rates per thousand of insurance are 4.48 for smoker issues and 1.39 for nonsmoker issues. The ratio of smoker to nonsmoker rates is 3.2. Using the technique described in Appendix I, we split the mortality rate for nonsmokers into 1.01 and 1.72 for never-smokers and ex-smokers, respectively. Similarly, the rate of 4.48 for smoker policyholders is split into rates of 1.72 for insureds who have quit smoking since issue and 5.40 for current smokers.

These rates are from an insured population, whereas the surgeon general's data are derived from general population studies. To estimate the differential, we compared the aggregate State Mutual rate for issue ages 30-49 and durations 1-15 to the United States Life Tables for white males. The State Mutual mortality rate is 2.39 per thousand, as compared with the Life Table rate of 5.55 at age 45. The difference between these rates is 3.16, which we attribute to extra deaths eliminated by life insurance underwriting. If we add these excess deaths to both the smoker and nonsmoker rates previously developed, we obtain 8.56 for current smokers and 4.55 for current nonsmokers. These rates generate a ratio of smoker to nonsmoker mortality of 1.9.



DISCUSSION OF PRECEDING PAPER

SUE ANN COLLINS:

Phoenix Mutual Life Insurance Company introduced nonsmoker and build premium discounts in August, 1967, because it was believed that the difference between smoker and nonsmoker mortality was too significant to ignore. The experience presented here will show that premise to be true. In presenting Phoenix Mutual's experience, I will briefly highlight the history of the company's nonsmoker premium discount and summarize the current treatment of smokers and nonsmokers.

History

Phoenix Mutual first examined the influence of cigarette smoking on mortality in the early 1900s. A study was made of 5,000 insureds who had been issued policies during the period 1910-12. This group was separated into three categories: nonsmokers, light smokers (1-5 cigarettes per day), and regular smokers (6 or more cigarettes per day). This study showed that the mortality of light smokers was 107 percent of that of nonsmokers, while the mortality of regular smokers was 126 percent of that of nonsmokers. No attempt was made at that time to translate these results into premium discounts for nonsmokers.

In the mid-1960s, Phoenix Mutual renewed its study of the difference between smoker and nonsmoker mortality with the objective of developing a nonsmoker premium discount. In August, 1967, a discount for nonsmokers meeting specified build requirements was established for five permanent life insurance plans. This discount was available to males aged 22-65 on policies of at least \$15,000. To be eligible for the discount, an applicant not only had to meet the build requirement but also had to sign a statement that he had not smoked cigarettes in the twelve months prior to his application. Phoenix Mutual included the build requirement as a means of justifying a larger discount than otherwise was thought to be appropriate. Mortality experience reported in the 1959 *Build and Blood Pressure Study* was used as a guide to establish build limits for qualifying for the discount. These limits were set below the upper limits for standard insurance.

In 1971, the nonsmoker and build discount was made available on a sixth permanent life insurance plan and to males aged 66-75. The discount was extended to females in 1973 and to two term plans in 1975. More recently, in December, 1979, Phoenix Mutual dropped the build

requirement and the discount became solely a nonsmoker discount. The accompanying tabulation illustrates the build requirements at the time they were discontinued.

HEIGHT	WEIGHT IN POUNDS		HEIGHT	WEIGHT IN POUNDS	
	Male	Female		Male	Female
4'10".....	140	128	5'9".....	187	167
4'11".....	143	130	5'10".....	191	173
5'0".....	147	133	5'11".....	197	180
5'1".....	151	136	6'0".....	202	186
5'2".....	154	139	6'1".....	209	191
5'3".....	158	144	6'2".....	215	196
5'4".....	162	148	6'3".....	221	202
5'5".....	166	151	6'4".....	227	.....
5'6".....	172	154	6'5".....	234	.....
5'7".....	176	158	6'6".....	241	.....
5'8".....	181	162			

Through December, 1979, Phoenix Mutual had sold over 56,000 life insurance policies with the nonsmoker and build discount for a total amount in excess of \$5.1 billion. Nonsmoker business has increased from 19 percent of total sales by volume in 1968 to 60 percent of total sales in 1979. By number of policies, nonsmoker business increased from 6 percent of total individual policies sold in 1968 to over 30 percent of those sold in 1979.

Experience

The data used for comparing nonsmoker and smoker mortality were limited to standard medically examined permanent insurance policies (excluding pension and payroll deduction policies) issued to males aged 20 and over. While the nonsmoker and build discount was not available on all permanent plans, the inclusion of those plans in the comparison does not distort the results significantly. Permanent plans not available with the discount accounted for less than 5 percent of new permanent insurance issued during the period studied.

Because of the underwriting requirements for obtaining the nonsmoker and build discount, Phoenix Mutual's nonsmoker group is relatively homogeneous, while the smoker group is not. At issue, all insureds in the nonsmoker group have been nonsmokers for at least one year and have met the build requirement. The other group, referred to as "smokers," includes smokers; nonsmokers who failed to qualify for the discount by virtue of plan, issue age, amount of insurance, or build; and nonsmokers who had quit for a period of less than twelve months prior to issue.

The reader should keep these characteristics of the smoker and non-smoker groups in mind when reviewing this presentation of Phoenix Mutual's mortality experience. Experience was analyzed for calendar years 1973-78 using the 1965-70 Select Male Basic Table as the basis of expected deaths. Because Phoenix Mutual did not offer a nonsmoker premium reduction until 1967 and had little exposure beyond duration 10, this report is limited to the first ten policy years.

The experience for permanent insurance issued subject to a medical examination produced an exposure for smokers of \$6.5 billion of insurance, with death claims of \$24,624,000. The corresponding exposure for nonsmokers was \$8.1 billion of insurance, with death claims of \$18,004,200. The experience by age group at issue for the first ten policy years combined is shown in Table 1 for smokers, nonsmokers, and the two groups combined. Table 2 shows the same experience by quinquennial policy-year groupings.

Tables 1 and 2 correspond to Tables 7 and 8 in the text of Messrs. Cowell and Hirst's paper. Phoenix Mutual's nonsmoker mortality experience is similar to State Mutual's. The mortality experience for Phoenix Mutual's "smoker" group should not be construed to be illustrative of true smoker mortality, since this is not a homogeneous group and actually includes some nonsmokers.

Current Practices

In May, 1980, Phoenix Mutual introduced its 1980 individual life policy series. Included in the 1980 series are a number of changes in the treatment of the nonsmoker discount. The discount is now available on all plans of insurance, permanent and term, except retirement income plans. The policy-size requirement has been eliminated, and the discount is now available at the minimum issue limit of each plan.

Because of the extremely favorable mortality Phoenix Mutual has experienced on nonsmokers, the 1980 series includes higher discounts for this group. All policyholders currently receiving the old nonsmoker and build discounts (pre-1980 series) are also benefiting from their favorable mortality through higher dividends. Lower fifth-dividend purchase rates are available to insureds receiving a nonsmoker discount (1980 series and pre-1980 series). Also, in those states where the 1976 NAIC amendments have been passed, paid-up dividend additions on 1980 series policies may be purchased by nonsmokers at rates lower than the rates for smokers.

Phoenix Mutual's recognition of the difference between smoker and non-smoker mortality has carried through to its reinsurance operation. Lower reinsurance rates for nonsmokers are available to all companies who distinguish their own premium rates between smokers and nonsmokers.

TABLE 1
 PHOENIX MUTUAL MORTALITY EXPERIENCE BY AGE AT ISSUE
 STANDARD MEDICALLY EXAMINED ISSUES OF 1963-77
 EXPERIENCE FOR CALENDAR YEARS 1973-78
 MALE LIVES—POLICY YEARS 1-10 COMBINED
 PERMANENT PLANS
 EXPECTED DEATHS ON 1965-70 MALE SELECT BASIC TABLE
 (Amounts Shown in \$1,000 Units)

ISSUE AGES	SMOKERS				NONSMOKERS				COMBINED MORTALITY RATIO
	Exposed to Risk	Actual Deaths	Expected Deaths	Mortality Ratio	Exposed to Risk	Actual Deaths	Expected Deaths	Mortality Ratio	
20-29	\$ 731,335	\$ 401	\$ 602	66.5%	\$ 411,406	\$ 320	\$ 304	105.3%	79.5%
30-39	2,012,508	3,858	3,116	123.8	1,671,473	849	2,285	37.2	87.1
40-49	2,118,286	7,601	8,026	94.7	3,214,519	7,256	10,191	71.2 (51.6)*	81.6 (70.6)*
50-59	1,321,173	7,843	9,581	81.9	2,264,901	6,834	13,688	49.9	63.1
60 and over	313,913	4,921	5,034	97.8	523,576	2,746	6,650	41.3	65.6
20 and over	\$6,497,215	\$24,624	\$26,359	93.4%	\$8,085,875	\$18,004	\$33,118	54.4% (48.3)*	71.7% (68.3)*

* Excludes one death for \$2 million.

TABLE 2
 PHOENIX MUTUAL MORTALITY EXPERIENCE BY POLICY-YEAR GROUP
 STANDARD MEDICALLY EXAMINED ISSUES OF 1963-77
 EXPERIENCE FOR CALENDAR YEARS 1973-78
 MALE LIVES—ISSUE AGES 20 AND OVER
 PERMANENT PLANS
 EXPECTED DEATHS ON 1965-70 MALE SELECT BASIC TABLE
 (Amounts Shown in \$1,000 Units)

POLICY YEARS	SMOKERS				NONSMOKERS				COMBINED MORTALITY RATIO
	Exposed to Risk	Actual Deaths	Expected Deaths	Mortality Ratio	Exposed to Risk	Actual Deaths	Expected Deaths	Mortality Ratio	
1-5	\$4,188,839	\$11,669	\$12,645	92.3%	\$6,724,200	\$12,366	\$24,020	51.5% (43.2)*	65.6% (60.1)*
6-10	2,308,376	12,955	13,714	94.5	1,361,675	5,639	9,097	62.0	81.5
1-10	\$6,497,215	\$24,624	\$26,359	93.4%	\$8,085,875	\$18,004	\$33,118	54.4% (48.3)*	71.7% (68.3)*

* Excludes one death for \$2 million.

When Phoenix Mutual first introduced nonsmoker discounts, the mortality difference between insureds who smoked cigarettes and those who did not was a matter of conjecture. Today, the mortality of insured nonsmokers has been shown to be extremely favorable, at least in the early policy years, and nonsmokers should receive the benefit of their favorable mortality, through a premium discount, a separate dividend class, or both. Phoenix Mutual has taken, and will continue to take, the position that nonsmokers are better life insurance risks than smokers.

C. LEE FISCHBECK:

Home Life Insurance Company began issuing nonsmoker policies in January, 1970. As was the case with State Mutual, premium discounts for nonsmokers were based on a conservative evaluation of the 1964 surgeon general's report. Originally, the nonsmoker classification was restricted to males aged 25 and over and to the whole life policy form for face amounts of \$25,000 and over. In January, 1975, nonsmoker discounts were extended to females and to certain additional popular plans of permanent insurance in both the regular and pension product series. In May, 1977, the minimum age was reduced from 25 to 20 and the minimum face amount reduced from \$25,000 to \$10,000.

The only requirement for a nonsmoker premium classification is no cigarette smoking for one year prior to application. A separate nonsmoker declaration is taken with Part I of the application, and smoking status is confirmed by an inspection report. Cigar and pipe smokers qualify for the discount as do substandard risks.

Home Life's statistical base has all the problems of lack of homogeneity noted by State Mutual, plus the following:

1. The gradual extension of nonsmoker discounts to additional classes of insureds has produced additional inconsistencies by duration.
2. The "smoker" experience comprises all permanent business excluding cases that received a nonsmoker classification. Thus it includes cases that failed to qualify because of plan, sex, or amount, where the true smoking status is not known.

Tables 1 and 2 show Home Life's experience in the same format as Tables 7 and 8 of the paper. Expected deaths are based on the 1965-70 Combined Select Basic Tables.

Home Life's overall nonmedical mortality ratios by amount over the same period were 73 and 43 percent for smokers and nonsmokers, respectively. As noted above, Home Life's relatively favorable smoker experience is probably the result of including a large number of cases with un-

TABLE 1
HOME LIFE MORTALITY EXPERIENCE BY AGE AT ISSUE
STANDARD MEDICALLY EXAMINED ISSUES OF 1970-77
EXPERIENCE BETWEEN 1973 AND 1978 ANNIVERSARIES
MALE AND FEMALE LIVES—POLICY YEARS 1-8 COMBINED
ALL PLANS AND FACE AMOUNTS COMBINED
EXPECTED DEATHS ON 1965-70 COMBINED SELECT BASIC TABLES
 (Amounts Shown in \$1,000 Units)

AGES AT ISSUE	SMOKERS				NONSMOKERS				COMBINED MORTALITY RATIO
	Exposed to Risk	Actual Deaths	Expected Deaths	Mortality Ratio	Exposed to Risk	Actual Deaths	Expected Deaths	Mortality Ratio	
20-29.....	\$ 2,581,388	\$ 1,081	\$ 1,895	57%	\$ 994,008	\$ 155	\$ 683	23%	48%
30-39.....	5,552,767	4,960	7,207	69	2,085,213	1,131	2,434	46	63
40-49.....	2,938,422	5,695	9,498	60	1,211,932	925	3,370	27	51
50-59.....	882,568	3,700	5,830	63	467,029	726	2,566	28	53
60 and over.....	106,185	235	1,477	16	62,894	140	644	22	18
20 and over....	\$12,061,330	\$15,671	\$25,908	60%	\$4,821,075	\$3,076	\$9,697	32%	53%

TABLE 2
HOME LIFE MORTALITY EXPERIENCE BY POLICY YEAR
STANDARD MEDICALLY EXAMINED ISSUES OF 1970-77
EXPERIENCE BETWEEN 1973 AND 1978 ANNIVERSARIES
MALE AND FEMALE LIVES—ISSUE AGES 20 AND OVER
ALL PLANS AND FACE AMOUNTS COMBINED
EXPECTED DEATHS ON 1965-70 COMBINED SELECT BASIC TABLES
(Amounts Shown in \$1,000 Units)

POLICY YEARS	SMOKERS				NONSMOKERS				COMBINED MORTALITY RATIO
	Exposed to Risk	Actual Deaths	Expected Deaths	Mortality Ratio	Exposed to Risk	Actual Deaths	Expected Deaths	Mortality Ratio	
1-5	\$ 8,857,708	\$10,479	\$15,406	68%	\$4,247,239	\$2,281	\$7,880	29%	55%
6-8	3,203,622	5,192	10,502	49	573,836	796	1,817	44	49
1-8	\$12,061,330	\$15,671	\$25,908	60%	\$4,821,075	\$3,076	\$9,697	32%	53%

known smoking status in this group. While Home Life's results support the hypothesis that cigarette smoking is a significant determinant of expected mortality, the limited amount of data makes further comparisons between the two companies' experience hazardous.

As was the case with State Mutual, Home Life has a larger average-size case in the nonsmoker class than in the smoker class. Also, as the accompanying table shows, the percentage of nonsmoker business on plans of insurance for which the nonsmoker discount is available has been increasing steadily in recent years.

PERCENTAGE OF BUSINESS
ISSUED TO NONSMOKERS
(Excluding Plans with No
Nonsmoker Premium Class)

YEAR OF ISSUE	PERCENTAGE NONSMOKER	
	By Face Amount	By Number
1976.....	49	28
1977.....	59	41
1978.....	66	49
1979.....	69	52

Home Life also follows the practice of not allowing a reclassification for insureds who have stopped smoking since issue. While the mortality of exsmokers does improve with duration of nonsmoking, there are residual effects that apparently never completely disappear. Certainly it would be unfair to dilute the experience of the nonsmoker class by adding these insureds as early as one year after they stopped smoking. Perhaps it could be done after several years if evidence of insurability were presented at the insured's expense or in connection with an application for new insurance.

One other development that I do not believe has been well publicized is the recent formation of an "Ad Hoc Committee to Look into the Question of Mortality Differentials between Insured Smokers and Insured Nonsmokers" by the Liaison Committee of the Association of Medical Directors of America and the Society of Actuaries. This committee is charged

(1) to research the feasibility of an intercompany study of insured life mortality of smokers versus nonsmokers; (2) to encourage companies to establish records where they do not now exist that will permit future studies of smoker versus

nonsmoker mortality; and (3) to find out if there are any companies who have conducted mortality studies on their own smoker versus nonsmoker experience which they would be willing to make available to the life insurance industry.

While not initially within the scope of the committee's work, an investigation of morbidity experience due to the health hazards of smoking may be attempted.

CHARLES L. F. WATCHORN AND DIKRAN OHANNESSIAN:

Messrs. Cowell and Hirst are to be congratulated on an interesting and most important paper. With the attention being given today in both Canada and the United States to the way in which insurance companies classify risks, it is essential that the industry be able to measure the effects of smoking on mortality adequately. The State Mutual experience is a very valuable addition to the limited published data.

Sun Life of Canada has been obtaining information on the smoking habits of some of its policyholders since 1965, and we have now been able to make some mortality studies using these data. All the lives in our study were examined at issue, with either a full medical or a paramedical examination, since we did not include a smoking question in our non-medical declaration until recently. We feel that our smokers and non-smokers are very similar lives and, therefore, we can discount many of the socioeconomic concerns expressed in the paper. We also feel that our data are of interest because they add to the experience for insured lives in two areas not covered in the paper, namely, separate experience by degree of smoking and separate studies for Canadian and United States business.

Smoking Characteristics

Sun Life's historical data on the incidence of smoking are summarized in Table 1. These figures reveal the following:

1. Since 1966, the percentage of cigarette smokers has been declining in both Canada and the United States.
2. Along with this decline, there has been a tendency for the heavy smokers to reduce the number of cigarettes smoked daily. A heavy smoker is defined as one who smokes more than 20 cigarettes a day.
3. In all the time periods examined, the percentage of Canadians who smoked was greater than the corresponding percentage of Americans. Also, in both Canada and the United States, the percentage of males who smoked was greater than the corresponding percentage of females. (The percentages of female smokers in Canada and the United States were 34 and 29 percent, respectively, for 1976, and 32 and 28 percent, respectively, for 1978.)

The authors suggested that a higher proportion of large-amount policyholders tend to be nonsmokers, which affects their mortality and introduces a bias in any comparison of their mortality with the mortality of all policyholders. This theory is supported by the data presented in Table 2, which demonstrate the inverse relationship between the amount at risk and the percentage of smokers.

TABLE 1
PERCENTAGES OF LIGHT AND HEAVY CIGARETTE SMOKERS
AND PIPE OR CIGAR SMOKERS
MALE LIVES INSURED BY SUN LIFE

YEAR	SMOKING CLASSIFICATION							
	Light Smoker*		Heavy Smoker†		Pipe or Cigar Smoker		All Smokers	
	Canada	United States	Canada	United States	Canada	United States	Canada	United States
1966...	25%	19%	27%	25%	8%	11%	60%	55%
1968...	27	18	24	21	8	11	59	50
1971...	21	16	23	18	8	9	52	43
1972...	33	27	11	9	8	8	52	44
1976...	29	30	16	6	5	6	50	42
1978‡							48	40

* Twenty or fewer cigarettes a day.

† More than 20 cigarettes a day.

‡ A breakdown by smoking classification is not yet available.

TABLE 2
PERCENTAGES OF SMOKERS ACCORDING TO AMOUNT AT RISK
MALE LIVES INSURED BY SUN LIFE, 1978

AMOUNT AT RISK	CANADA		UNITED STATES	
	Cigarette Smokers	Pipe or Cigar Smokers	Cigarette Smokers	Pipe or Cigar Smokers
\$10,000 and under.....	46.8%	4.1%	39.2%	4.0%
\$10,001-\$25,000.....	45.2	4.2	35.7	4.5
\$25,001-\$50,000.....	42.8	5.0	37.3	4.2
\$50,001-\$75,000.....	37.2	5.7	28.8	2.7
\$75,001-\$100,000.....	41.2	5.2	32.2	5.8
More than \$100,000.....	36.8	5.8	25.1	3.9

Mortality Experience

In determining nonsmoker experience, we combined the Canadian and United States data, since it was found that the results for the two groups did not differ greatly. The study was based on the experience between 1973 and 1977 anniversaries for policy issues of 1965-76 inclusive. The results are summarized in Table 3.

The study of male lives indicates that the mortality ratio of pipe or cigar smokers is approximately $1\frac{1}{2}$ and that the mortality ratios of light and heavy smokers are approximately 2 and $2\frac{1}{2}$, respectively, as compared with a ratio of 1 for nonsmokers.

The female data base is not large enough to permit reliable analysis. The mortality among cigarette smokers is, nonetheless, higher than

TABLE 3
SUN LIFE MORTALITY RATIOS BY SMOKING CLASSIFICATION AND AGE
EXPERIENCE BETWEEN 1973 AND 1977 ANNIVERSARIES
STANDARD MEDICAL AND PARAMEDICAL ISSUES OF 1965-76
MALE AND FEMALE LIVES

AGES AT ISSUE	SMOKING CLASSIFICATION			
	Nonsmoker	Light Smoker*	Heavy Smoker†	Pipe or Cigar Smoker
Males				
15-29.....	1.00 (15)	1.57 (15)	1.61 (5)	.....
30-39.....	1.00 (35)	2.15 (43)	2.21 (27)	1.52 (8)
40-49.....	1.00 (95)	1.85 (91)	2.42 (100)	.84 (15)
50-59.....	1.00 (84)	2.38 (97)	3.00 (112)	2.27 (42)
60 and over....	1.00 (83)	2.04 (70)	2.25 (70)	1.46 (28)
All.....	1.00 (312)	2.06 (316)	2.47 (314)	1.48 (93)
Females				
15-29.....	1.00 (1)	3.23 (1)	.....	.....
30-39.....	1.00 (5)	2.25 (4)	1.55 (1)	.....
40-49.....	1.00 (13)	1.39 (6)	2.61 (5)	.....
50-59.....	1.00 (37)	1.80 (21)	1.80 (10)	.....
60 and over....	1.00 (25)	0.92 (5)	1.91 (2)	.....
All.....	1.00 (81)	1.59 (37)	1.80 (18)	.....

NOTE.—Actual number of deaths is shown in parentheses.

* Twenty or fewer cigarettes a day.

† More than 20 cigarettes a day.

among nonsmokers, but not to the same extent as was found for male lives.

Contrary to the findings of State Mutual, our data suggest that the mortality variation between smokers and nonsmokers does not depend on policy duration.

The hazard of smoking relative to lung cancer and circulatory system ailments is measured by the relative mortality ratios of smokers and nonsmokers presented in Table 4. The ratio obtained for lung cancer was

TABLE 4
SUN LIFE MORTALITY RATIOS OF SMOKERS TO
NONSMOKERS BY CAUSE OF DEATH

CAUSE OF DEATH	SMOKING CLASSIFICATION			
	Nonsmoker	Light Smoker*	Heavy Smoker†	Pipe or Cigar Smoker
Lung cancer.....	1.0 (11)	3.6 (19)	8.2 (36)	7.8 (18)
Heart disease.....	1.0 (52)	3.3 (84)	4.8 (100)	1.8 (19)
Circulatory ailment (including heart disease).....	1.0 (87)	3.0 (128)	4.1 (141)	1.7 (30)
Total.....	1.0 (98)	3.1 (147)	4.6 (177)	2.4 (48)

NOTE.—Actual number of deaths is shown in parentheses.

* Twenty or fewer cigarettes a day.

† More than 20 cigarettes a day.

similar to, although lower than, the corresponding ratio obtained in the State Mutual study.

Our examination of the effect of smoking on substandard risks produced results similar to those for standard lives.

Smoking as an Underwriting Criterion

As we have shown, Sun Life's findings are consistent with those of State Mutual and the surgeon general in confirming the validity of classifying smokers and nonsmokers separately for underwriting purposes. This in itself is not new. Even when separate nonsmokers' policies have not been issued, it has been quite common for underwriters to take smoking into account in assessing individual risks through the traditional debit/credit system, particularly in the case of borderline substandard lives, where nonsmoking has been used to reduce or eliminate ratings.

As pointed out in the paper, there are two major areas of concern in the use of smoking habits in underwriting. In these areas, we can only help to define the questions further. We recognize that some companies

have answers to some or most of these questions, but feel that there has not been a complete resolution of the classification problems.

1. Recognizing that the extra mortality of smokers must be taken into account, how can this best be done? Is the public ready to accept the classification of smokers as substandard risks? Alternatively, will the insurance industry be able to use the approach that there are two so-called standard classes, with different rates? Although most companies have rewarded nonsmoking through premium discounts, can this also be done effectively through the dividend scale? Will recognition of the true smoking differential by some companies and not others change the distribution of business? How will agents react to this, particularly those placing their business with a number of different companies?
2. How do you tell reliably whether an applicant smokes or not? Apparently, most companies depend on a declaration from the applicant, but is this sufficient if the rate differential is significant? Could misrepresentation in this declaration be the basis for denial of a claim? Traditionally, we have tended to underwrite on the basis of measurable factors; will regulatory and consumer groups allow us to apply underwriting standards that can be controlled so easily by the applicant? How do you tell the number of cigarettes smoked, and, if significant, the type? As pointed out in the paper, reclassification of risks is a major concern from an underwriting point of view. It is difficult enough to decide whether a person who has lost a substantial amount of weight in a short period of time should be reclassified; it is much more difficult to decide what to do with a person who has just stopped smoking. Finally, what do you do about existing policyholders when you introduce a nonsmokers discount?

Conclusion

We hope that the experience we have presented in this discussion will add to the information available about the effects of smoking on mortality. We share the authors' opinion that this is a most important area for future investigation, and we anticipate a considerable number of developments as the underwriting implications are assessed.

MICHAEL COHEN:

The authors have demonstrated convincingly that the mortality differential between smokers and nonsmokers is a significant risk factor—even greater, in fact, than that between males and females.

The one criticism I have involves the discussion of life-style factors at the end of Section III. To eliminate the effect of these factors, it is not sufficient simply to exclude those deaths that can be ascribed to mental rather than physical disorders. It is obvious that the ratio of mortality rates for causes that are thought to be directly related to smoking will be

higher than the ratio derived from all causes, as demonstrated in the following table (figures are taken from Table 9 of the paper, excluding deaths among jumbo policies).

CAUSE OF DEATH	MORTALITY RATE PER 1,000		RATIO
	Smokers	Nonsmokers	
(1) Smoking-related causes (first seven)	2.616	0.955	2.7
(2) Accidental, etc.	0.699	0.296	2.4
(3) Mental disorders.	0.120	0.051	2.4
(4) Other causes.	0.190	0.164	1.2
(5) "Smoking" and "Other" [(1) + (4)].	2.806	1.119	2.5
All causes.	3.625	1.466	2.5

Excluding mental disorders and accidental deaths (including suicide and homicide) leaves the ratio unchanged. In fact, only if the life-style deaths among the nonsmokers exceeded those among the smokers would the ratio excluding these deaths go down—a contrary result.

In order to control the effect of life-style, comparisons would have to be made between smokers and nonsmokers of homogeneous life-style, however difficult this is to achieve. This analysis probably would show that smoking is more prevalent among those with a "poorer" life-style and that mortality is higher among those with this life-style as compared to those with a "better" life-style. Nevertheless, I am sure that, whatever their life-style, smokers have poorer mortality experience than nonsmokers in the same category, although I suspect the ratio would be somewhat lower than the 2.5 indicated above. I believe that this is what the authors attempted to demonstrate, but without a much deeper statistical analysis the impressions I have outlined above will have to remain impressions.

EDWARD A. LEW:

This paper presents an excellent account of State Mutual's mortality experience among insured smokers and nonsmokers, the latter being defined as applicants for insurance who signed a statement that they had not smoked cigarettes for at least a year. While this definition may be sufficiently practical for underwriting purposes, it throws into a single classification of "nonsmokers" persons who have recently given up smoking on advice of a physician, persons who had smoked for many years before stopping, and persons who had smoked for a relatively short period of time before quitting, as well as those who have never smoked.

In some circumstances, the mortality of ex-smokers who have stopped smoking recently may exceed that of current smokers. A study of a 1954 cohort of United States veterans indicated that individuals who stopped smoking on doctor's orders continued to show distinctly higher mortality than those who quit for other reasons, for periods up to fifteen years after quitting. The same study also indicated that former heavy cigarette smokers who had stopped smoking ten or more years earlier continued to experience death rates close to those of current smokers. E. C. Hammond's analysis of the 1959-63 mortality experience in the Cancer Prevention Study (National Cancer Institute Monograph No. 19) showed the following relationships between the death rates of male ex-cigarette-smokers (and current smokers) and the death rates of men who had never smoked regularly.

MALE CURRENT CIGARETTE
SMOKERS AND EX-CIGARETTE-
SMOKERS AT AGES 50-74

YEARS SINCE LAST CIGARETTE SMOKING	RATIO TO NONSMOKER MORTALITY	
	Smoked 1-19 Cigarettes a Day	Smoked 20 or More Cigarettes a Day
Current smokers	1.72	1.94
Less than 1 year	1.61	2.18
1-4	1.44	1.98
5-9	1.34	1.49
10 or more	1.02	1.32

It is clear that the mortality of nonsmokers, as defined by State Mutual, could vary considerably, depending on the proportion of ex-smokers who were in poor health or had been heavy smokers for a prolonged period of time.

The American Cancer Society's definition of "never smoked regularly" excluded those who had been moderate or heavy smokers in the past. It now appears feasible to select a category of nonsmokers who would experience even lower mortality than that recorded by the nonsmokers insured by State Mutual merely by asking three additional questions in the application: (1) "Did you stop smoking on the advice of a physician?" (2) "How many years did you smoke before stopping?" and (3) "How many cigarettes per day did you smoke before quitting?"

There is some merit in starting out with a larger differential in mortality between smokers and nonsmokers, because this differential is likely to diminish as the tar and nicotine content of cigarettes is progressively decreased and cigarette smokers experience less excess mortality than in the past. For some indication of the effects on mortality of a lower tar-nicotine content of cigarettes the reader is referred to the article "Tar and Nicotine Content of Cigarette Smoke in Relation to Death Rates."¹

It is important to emphasize that the substantial differential in mortality between smokers and nonsmokers is not wholly attributable to excessive cigarette smoking. Socioeconomic, regional, and cultural differences between smokers and nonsmokers suggest that this mortality differential also reflects other factors related to disparate life-styles, such as drinking habits, drug usage, irregular modes of living, self-discipline dictated by religion or custom, dietary patterns, and attitudes toward health maintenance. The relatively high mortality among persons in the entertainment business demonstrates the adverse effects of irregular modes of living, while the low mortality of Mormons and Seventh-Day Adventists illustrates the effects of the salutary health habits built into their religious disciplines. Scientists and university professors, who as a group also exhibit very low death rates, probably benefit from their more intelligent appreciation of health hazards. The effects of high socioeconomic status and associated life-styles may be seen in the experience of the Swiss Reinsurance Company among male reinsured lives from Belgium, France, Luxembourg, The Netherlands, and Switzerland. Despite smoking 20 or more cigarettes a day, these insured lives—drawn predominantly from the higher-income segments of the population and carefully selected—showed only about 25 percent excess mortality over standard during the period 1956-77.

In drawing conclusions from their Table 6, which presents the experience for male cigarette smokers among the United States veterans, 1954 cohort, the authors may have overlooked the difficulties of drawing conclusions from so unusual a population. The process of admission to military service has exerted a marked effect on mortality rates of veterans, which has persisted for more than sixteen years.² Further self-selection by those who retained their United States government life insurance policies produced a population highly slanted toward the better-to-do middle class. The wide variations in mortality observed in this

¹ E. C. Hammond et al., *Environmental Research*, XII (1976), 263.

² Carl C. Seltzer and Seymour Jablon, "Effects of Selection on Mortality," *American Journal of Epidemiology*, C, No. 5 (May, 1974), pp. 367-72.

population at ages 30-34 (at time of entry) reflect mainly the retention of life insurance policies by those in poor health.

Some new information about the relative cancer hazards of smokers and nonsmokers has become available since the release of the paper. It comes from the most comprehensive mortality study of smokers and nonsmokers—the American Cancer Society's Cancer Prevention Study, referred to in the surgeons general's report as the 25 State Study. For the period 1967-71, it shows the relative mortality ratios (ages 40-94 standardized) among those who have never smoked regularly and among cigarette smokers for all sites of cancer and for the principal sites of cancer closely associated with smoking, as follows:

RELATIVE CANCER MORTALITY AMONG CIGARETTE SMOKERS—CANCER PREVENTION STUDY

SMOKING CLASSIFICATION	SITE OF CANCER					
	All Sites	Lung	Esophagus	Oral and Larynx	Bladder	Pancreas
Men:						
Never smoked regularly . . .	1.00	1.00	1.00	1.00	1.00	1.00
Cigarette smokers	1.79	8.53	3.96	6.52	2.35	2.14
Women:						
Never smoked regularly . . .	1.00	1.00	1.00	1.00	1.00	1.00
Cigarette smokers	1.21	3.88	4.89	3.25	2.00	1.42

An analysis of the mortality of nonsmokers in relation to the mortality of the entire population in the Cancer Prevention Study clearly identifies the sites of cancer that are markedly affected by cigarette smoking, as shown below.

RATIOS OF NONSMOKER CANCER MORTALITY TO TOTAL CANCER MORTALITY—CANCER PREVENTION STUDY

Site of Cancer	Men	Women
All sites	64%	96%
Lip, oral cavity, and pharynx	29	80
Esophagus	40	62
Rectum	74	98
Pancreas	64	92
Larynx	11	42
Lung	17	64
Bladder	52	85
Kidney	76	96

The same study indicates that the mortality from cancers of the stomach, intestine and colon, bones and joints, connective tissue, melanoma, male and female genital organs, lymphomas, myelomas, and leukemias was not significantly different between those who had never smoked regularly and those who had.

My sincere congratulations go to the authors for giving us a most valuable analysis of the cigarette-smoking hazard for life insurance purposes.

CARL STRUNK:

The authors deserve a vote of thanks for initiating such a study, and I hope that more statistics soon will become available from others. I have a few comments.

1. The ratio of smoker to nonsmoker mortality may decrease but never reach unity.
2. The lower ratio of select to ultimate mortality by advancing age exhibited in the 1965-70 Select and Ultimate Basic Tables could be unknowingly the result of a nonsmoker selection. This may be due to the elimination of smokers from the standard group by other underwriting criteria.
3. The absence of selection at ages below 15 on these same tables may reflect the absence of smoking; that is, any smoking would not have had time to affect mortality and the selection process.

These are pure hypothesis, but the authors do open up a fertile field for further study.

DONALD G. BARBER:

I welcome the statistical results presented in this paper. As a non-smoker I cynically conclude, however, that many smokers will not stop smoking, because they will be confused by the facts.

In view of a study by University of California researchers James White and Herman Froeb (results recently published in the *New England Journal of Medicine*), which concluded that secondhand smoke can harm nonsmokers, I would suggest that steps be taken to assemble data to study the mortality of the following categories:

1. Nonsmoking insured
 - a) Living in residence with no smoker
 - b) Living in residence with one smoker
 - c) Living in residence with two or more smokers
2. Insured who is a smoker
 - a) Living in residence with no other smoker
 - b) Living in residence with one smoker
 - c) Living in residence with two or more other smokers

A morbidity study of the same categories would also be useful.

THOMAS N. HERZOG:

I congratulate the authors for a stimulating paper. It is most interesting to consider the effects on insured life expectancy of such predictor variables as smoking habit, face amount of insurance, and sex. Unfortunately, the standard actuarial procedures (i.e., those prescribed for the part 5 examination) do not permit the actuary/analyst to examine the interactive effects (if any) among the predictor variables. For example, using standard actuarial procedures it is not possible to determine the extent to which the larger proportion of nonsmokers among high-income groups may be responsible for the higher life expectancy of nonsmokers.

There is, however, a multivariate statistical procedure that can be used to perform this type of analysis. This procedure is referred to in the literature as "discrete multivariate analysis" or, alternatively, as "multidimensional contingency table analysis" or "log-linear modeling." A number of textbooks have been written on this subject in the past few years, including those by Bishop, Fienberg, and Holland [1], Fienberg [3], and Gokhale and Kullback [5]. The procedure entails partitioning the observed data into a multidimensional contingency table; the entry in each cell of the table represents the number of observations having the characteristics specified by that cell.

Although there is no unique method for analyzing the State Mutual data, I will suggest one possible method. The idea is to construct a five-dimensional contingency table consisting of the dependent variable "survival status" (died or survived) and the four independent or predictor variables: sex, issue age, policy amount, and smoking habit. The four predictor variables (which may be viewed as being similar to the predictor variables of ordinary regression analysis, with survival status as the dependent variable) might be partitioned as follows:

1. Sex (male, female)
2. Issue age (30-34, 35-39, 40-44, 45-49, 50-54, 55-59)
3. Policy amount (\$1-\$19,999; \$20,000-\$39,999; and at least \$40,000)
4. Smoking habit (smoker, nonsmoker)

This would result in a $2 \times 2 \times 6 \times 3 \times 2$, or 144-cell, contingency table.

Once this table has been constructed (which the authors tell me is expensive to do), it is relatively simple to perform the analysis using widely available software such as TAB (see Fox [4]) or ECTA (see Fay and Goodman [2]). Thus, given the sex, issue age, policy amount, and smoking habit of an individual, we could use a log-linear model to predict the individual's probability of surviving the time period under considera-

tion. In addition, it is easy to use the contingency table data to carry out tests of various statistical hypotheses. For example, we could test the conditional hypothesis that survival status is independent of smoking habit if sex, issue age, and policy amount are known.

I would be glad to help the present authors or others to perform the types of analysis suggested in this discussion.

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ROBERT L. BROWN AND K. STEPHEN BROWN, PH.D.:*

First, a sincere thank-you to the authors for their excellent presentation of pertinent material on smoker versus nonsmoker mortality. The Society is fortunate that these statistics have been shared so openly with the rest of the industry.

At first glance, the large mortality differential between smokers and nonsmokers is surprising in view of the rather nonspecific question asked on the application. "Nonsmokers" include those who smoke pipes and/or cigars only, anyone who has given up smoking for more than one year regardless of the reason, and anyone who lied on the application. "Smokers" include anyone who has smoked cigarettes in the last year regardless of level of daily consumption, duration of the habit, or type of cigarette (high tar or low tar) smoked. The current epidemiological evidence responds to some, but not all, of these classifications. In the surgeon general's report [6], a summary of a number of studies of pipe and cigar smokers indicated that, except at high levels of consumption, pipe and/or cigar smokers have mortality ratios that are only marginally increased. However, the Dorn study of United States veterans [3] examined the reasons for quitting and found that those who quit on doctor's orders have considerably higher mortality ratios than those who quit for other reasons. In fact, in one of the early studies of cigarette smoking [2],

* Dr. Brown, not a member of the Society, is an associate professor in the Department of Statistics, University of Waterloo.

mortality ratios for ex-smokers in the year following the cessation of smoking were found to be higher than those of continuing smokers, presumably because of the presence in the ex-smoker group of many in poor health.

The State Mutual question requires ex-cigarette-smokers to have stopped for at least one year, and consequently avoids some of the problems with those who have quit because of very poor health. It also forces ex-smokers to have demonstrated a "commitment to quitting." Presumably the number who resume smoking after quitting for at least one year, or the number who take up smoking for the first time in these age groups, will be small.

This necessary first step in demonstrating that the results of epidemiological investigations of the health effects of smoking are applicable to an insured population opens the door for companies to obtain more detailed information on the smoking habits of applicants. This is relevant, since mortality differentials within the smoking group may be larger than those observed between smokers and nonsmokers. For example, in the Dorn study, the relative mortality ratio for heavy to occasional smokers is 2.19, as compared with a ratio of 1.84 for smokers to nonsmokers. Duration of the habit is also an important factor; the multistage models of Doll and Peto (e.g., [1]) suggest that someone who smokes 10 cigarettes a day for ten years has about 8 times as much chance of developing lung cancer as a smoker of the same age who has smoked 20 cigarettes a day for five years. Companies might consider gathering this kind of information now, so that in ten years more precise underwriting may be possible (although there is no reason why these epidemiological results and the available data could not be used now to estimate the appropriate premiums). Eventually, information on cigarette consumption may be used, perhaps with other physiological measurements, to estimate survival probabilities for coronary heart disease, using multivariable models such as that developed in the Framingham study [4]. Information on both consumption and duration of the habit may be used in models such as the multistage models to predict lung cancer mortality rates. The life insurance industry is a logical area in which to apply the kind of modeling developed in epidemiological studies of chronic disease.

There is, however, a difficult problem to overcome: securing truthful responses to questions on cigarette consumption. Survey data, when extrapolated nationwide, underestimate the number of cigarettes sold by up to 30 percent in Canada and the United States [5, 7], and there is some evidence that this underestimation has increased in the past few years, possibly as a conscious or subconscious reaction to antismoking

educational campaigns. It is not clear whether this underestimation is a function of age, sex, or social class, or whether it is due to applicants' lying when questioned about smoking status or merely to understating consumption. Techniques such as using "sham" physiological tests have increased admitted smoking rates in some studies, and biochemical tests now becoming available could prove useful in the case of large policies.

One industry problem not addressed by the paper is that of the complications involved in switching from a one-tier "standard" mortality basis to a two-tiered system for smokers and nonsmokers.

In the areas of term conversions, bonus additions, guaranteed insurability options, and reinstatements, policyholders have certain rights guaranteed in their contracts based on "standard" mortality assumptions. Unfortunately, that standard mortality class no longer exists after the changeover. Rather, everyone now is either a smoker or a nonsmoker (unless the company maintains three mortality classes). As an example, in the case of a term conversion, should the old standard policy be converted to a nonsmoker or a smoker policy?

Has State Mutual seen any need to adjust dividends on old standard policies to prevent nonsmokers from lapsing and buying a new nonsmoker policy? From the sales statistics presented it would appear that the new nonsmoker policy has not generated any extra sales, which must be both a surprise and a disappointment.

In this regard, it would be interesting to know just what size discount is given to nonsmokers by State Mutual. A Canadian company that recently introduced nonsmoking discounts, based, at least in part, on the State Mutual data, ended up with a nonsmoker discount of the order of 5-9 percent, whereas their premium reduction for females was of the order of 20-25 percent. This is despite the fact that the data clearly show a larger differential due to smoking than due to sex. This level of discount is hardly going to send shock waves through the marketplace.

Finally, the authors downplay the life-style aspect of underwriting through the smoking question. In particular, they point out that if life-style causes of death are omitted, the percentage extra mortality from smoking is even greater. While this may be true, there are several reasons for not underestimating the importance of the life-style information provided by the smoking question.

First, these life-style deaths may occur at earlier durations than smoking-related deaths. The authors point out that the extra "smoking" deaths emerge at earlier durations than one might have expected. For example, smokers exhibit a significantly different mortality ratio even at

ages 20-29, well before the long-term effects of smoking could be felt. One would conclude that a large percentage of these early deaths are life-style-related. If so (and further research is encouraged), they are more important financially than their mortality ratios indicate.

The significance of life-style deaths is reinforced by the fact that several casualty companies are now giving nonsmokers sizable discounts on car insurance premiums, in much the same way as they have for abstainers. These policies have been profitable, and the actuaries involved in their pricing admit that in this instance they are underwriting life-style.

It is becoming more difficult all the time for life insurance companies to get reliable information on the habits and morals of the prospective policyholder. In fact, in many jurisdictions, laws are being passed that will limit severely the ability of the underwriter to get life-style information.

If, as the authors seem to indicate in Table 5, cigarette smoking is nicely correlated with life-style underwriting parameters, then perhaps this will be our salvation in the future. Further, despite comments made earlier in the discussion, one is more apt to receive an honest answer to a smoking question than to a drinking question or a morals question.

In summation, we are pleased that the authors provided so much useful information about mortality differences between smokers and nonsmokers, and hope that it will foster more industry research into these problems.

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ALLAN W. RYAN:

The authors have presented an excellent and well-documented paper, which should be of interest to the general reader as well as to the actuary. However, it raises questions as well as providing refinement in classifying risks and predicting future experience. While the statistical results are convincing, and it is clear that desired financial results can be achieved by differentiating between smokers and nonsmokers in the pricing and underwriting of individual life insurance, it is not so clear that the results are satisfactory from the point of view of the individual.

The problem is the lack of homogeneity among individuals of a given underwriting classification. The authors clearly recognize this, noting that because of the apparently significant differences in mortality between smokers and nonsmokers, underwriting practices that have not recognized smoking habits as a criterion have resulted in classifications that are less homogeneous than was previously thought. The implication, which perhaps should be pursued further, is that while aggregate results have been satisfactory, individual equity may not have been served.

The question is a philosophical one, and it may be that true homogeneity cannot be achieved, or even defined. Recent legislation and court decisions have tended to reflect this point of view, although perhaps the conclusions have not always been reached in a logical manner. Automobile insurance underwriting and pricing classifications based on such factors as marital status have been rejected by some states. Such a classification system bears some resemblance to the life insurance practice of rating a group made up of nonsmokers and smokers as "preferred" life insurance risks, even though their differences in mortality are greater than those between the overall preferred group and the standard or even substandard groups.

While further refinement of individual insurance underwriting classifications may appear to represent an improvement in equity, such refinement also demonstrates the elusiveness of this goal and supports the argument for the opposite emphasis. While it is clearly the purpose of underwriting to prevent obvious selection, the purpose of insurance is to

provide protection as widely as possible at a reasonable cost. There is no doubt that underwriting can be and is satisfactorily designed to provide insurance at the lowest possible cost to select groups, but such a system is equitable only if it is certain that the individuals are paying the "true" cost.

ROBERT C. TOOKEY:

"How jarring!" was my reaction, widely shared by our fellow Fellows, to this milestone paper. Most of us were aware of the results of the 1964 surgeon general's report on smoking and health, which concluded that, in the general population, cigarette smokers experienced a mortality 70 percent greater than that of non-cigarette-smokers. However, the Cowell-Hirst study implies an extra mortality of about 150 percent among cigarette smokers in the insured population—double the amount indicated in the general population. The authors deserve a deep and abiding vote of gratitude for their thorough and conscientious approach to a difficult and delicate subject.

The 1,200-page surgeon general's report *Smoking and Health* may be obtained free of charge by ordering it from the Office of Smoking and Health, Park Building, Room 116, 6600 Fishers Lane, Rockville, Maryland 20857, telephone (301) 443-1575. It belongs in the library of every active life and health actuary and underwriter.

Having discontinued all smoking about thirty years ago, I have had an avid interest in the emerging statistics on smokers' mortality. The thrust of this discussion is on ex-smokers' mortality. The surgeon general's report contains the results of no fewer than eight separate studies on smokers' mortality in five different countries. I tried to follow the authors' derivation of an extra mortality of 70 percent for ex-smokers, concluding that the 70 percent figure probably was high for the ex-cigarette-smoker who discontinued all forms of smoking. A significant percentage of current male cigar-only smokers (comprising about 20 percent of the male population) and a smaller percentage of current male pipe-only smokers (about 10 percent of the adult male population) are ex-cigarette-smokers. This factor supports my contention that ex-cigarette-smokers who are total tobacco abstainers enjoy a mortality that steadily, perhaps linearly, approaches nonsmoker mortality, arriving at that level by the fifteenth year of tobacco abstinence, and perhaps earlier if their total cigarette consumption was less than average.

It probably is not practical to refine the pricing structure into subgroups of nonsmokers (never smoked anything, ex-cigarette-smokers who presently abstain, ex-cigarette-smokers who presently smoke cigars

and/or pipes, etc). However, these factors certainly could enter into the underwriting process and provide special credits, when applicable, to offset any debits.

Most life insurance companies probably will incorporate smoking habits into their pricing and underwriting. At least one reinsurance company has smoker and nonsmoker premium rates. Many casualty companies offer nonsmoker discounts to homeowners and automobile insureds. Reserves and cash values based on smoking habits would give rise to numerous problems, not the least of which would be that of proper classification; nonetheless, it would be difficult for a prudent actuary or underwriter to dispute the authors' conclusion that cigarette-smoking status should be incorporated in both the pricing and the underwriting processes of life and disability insurance.

MARVIN A. KASTENBAUM:*

I have approached this study with the critical eye of a statistician because, as the authors note, the State Mutual experience presented "is essentially statistical in nature." My concerns with the paper can be placed conveniently in three major categories. First is the questionable use of the reports of the surgeon general as a standard against which the State Mutual experience data are measured. Second are the serious problems not only of the comparability of the State Mutual data with the findings in the reports but also of the methods used in making such comparisons. Finally, I would like to mention briefly several factual errors, omissions, and possibly misleading statements in the paper, and to suggest factors that may explain the authors' conclusions.

Findings contained in the reports of the surgeon general are regarded by the authors as representative of the experience of the general United States population. Indeed, the emphasis and importance they place on the comparisons of their data with those in the reports are major themes. These reports, however, rely mainly on findings from several studies of specific populations, which have drawn criticism from the scientific community for, among other things, their failure to be representative of any general population ([1]; [2], p. 174; [5]). Further, the reports themselves acknowledge serious problems in the sampling and methodology used in these epidemiological studies ([6], pp. 94 ff.). The authors statement that these population studies involve "carefully controlled groups of smokers and nonsmokers" is inaccurate. The mortality data from the reports cannot be said to be representative of the general population.

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The authors nowhere mention that the reports are selective summaries of research results. Many studies that should have been considered in the preparation of the reports were not even cited [4].

The authors refer to a mortality ratio of 1.2, taken from the 1979 surgeon general's report, and describe it as "based on the general population." In fact, this ratio was reported in a study of mainly white, male United States veterans of World War I, who certainly are not and have not been described as representative of the United States population.

In regard to the methodology in the paper, the mortality ratios tabulated from the State Mutual experience are calculated on the basis of dollar amounts of insurance. As a result, the number of policyholders included in the study cannot be determined; it is entirely possible that some policyholders had several policies. These mortality ratios are distinctly different statistics from the mortality ratios in the reports of the surgeon general. The State Mutual mortality rates appear to be based on total insurance dollars at risk, in contrast with person-years at risk customarily used in epidemiological studies. Nevertheless, the authors make no attempt to justify their comparisons of completely dissimilar mortality ratios.

Information about the frequency distributions of policy amounts by numbers of policyholders is necessary to the understanding of mortality rates and ratios in the State Mutual experience. No such distributions appear in the paper. The importance of different types of distributions is recognized by epidemiologists when they adjust crude mortality rates and ratios for age, sex, and race. In order to compare mortality rates for smoking and nonsmoking policyholders, adjustment must be made for the acknowledged differences between the frequency distributions of policy amounts in these two groups. The impact of even slight changes in these frequency distributions may be readily observed in Table 9, where a cancer mortality rate for nonsmokers is halved by the removal of one death claim, and where the overall mortality rate for nonsmokers is reduced by 17 percent by the elimination of the same claim.

The authors acknowledge the important role that demographic and socioeconomic patterns may play in their mortality experience. Such patterns frequently manifest themselves in larger numbers of deaths than expected among lower socioeconomic groups, in which lower dollar amounts of insurance generally are purchased. The consequence of this phenomenon is to increase the numerators and decrease the denominators of mortality rates in lower socioeconomic groups. Precisely the converse situation might be expected for higher socioeconomic groups. This important factor must be considered in any analysis if the comparisons of mortality rates are to be meaningful.

The methodology by which Table 11 is generated from Table 10 requires clarification. In order to apportion the smokers' mortality ratios between current smokers and former smokers, the authors use a mortality ratio of 1.2, obtained from a study of veterans from the reports of the surgeon general. How this mortality ratio relates to the State Mutual experience is unclear. Moreover, the arbitrary increase of this ratio from 1.2 to 1.7 in generating Table 11 is not adequately explained.

In Appendix II, in an apparent effort to show that their results compare "reasonably well," the authors add the same differential to their nonsmoker and smoker mortality rates. This differential is obtained from the 1969-71 United States Life Tables, which do not distinguish between smokers and nonsmokers. The appropriateness of this technique is, therefore, open to question.

The authors claim that "the difference in mortality between smokers and nonsmokers is statistically significant almost to the point of certainty." However, they do not indicate what statistical test they used or which statistics they compared. In sound statistical practice it is not sufficient to test for significant differences by calculating confidence intervals. Also, the applicability of statistical tests depends upon the fundamental consideration of randomization, which underlies all subsequent probability statements. The data presented in this study can in no way be described as having been acquired by random sampling.

Several inaccuracies or misleading statements may have been included inadvertently in the body of the paper. The authors suggest that the smoker inhales 42,000 parts per million of carbon monoxide. Although the maximum concentration in an undiluted puff of cigarette smoke has been reported to be of this order of magnitude, the concentration inhaled by a smoker is generally recognized to be much lower, as the result of dilution factors among other things. Moreover, the 1979 surgeon general's report suggests that little is known about the effects, if any, of carbon monoxide on chronic disease processes. In urging more research, the report states: "The lack of chronic studies on CO effects in animals and humans suggests that such studies be undertaken to fill this void in our knowledge, especially as it relates to smoking and related diseases."

The statement that cigarette smoking does "not seem to have any beneficial effects" is inconsistent with the 1964 surgeon general's report, which devoted a section to this topic. It concluded: "Medical perspective requires recognition of significant beneficial effects of smoking primarily in the area of mental health."

Seven "principal findings of the surgeon general's two reports" are listed. The first and the sixth are somewhat distorted and could be construed, therefore, as misstatements of fact.

Another important factor that is not discussed is the reliability of personal responses to questions about smoking habits. A recent article in *The Lancet* [3] discussed this issue: "Lying about smoking habits has become so commonplace in smoking-treatment clinics that many researchers have used assays for the biological markers of smoking to confirm their patients' claims to have stopped smoking." It should follow that any proposal to classify smokers as substandard risks for life insurance, and thereby to penalize them financially, might be expected to result in an increase in the level of dishonesty in responses to questions about smoking habits.

Finally, the authors do recognize the confounding roles of socio-economic and demographic factors in their findings. Further investigation of these issues seems warranted.

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(AUTHORS' REVIEW OF DISCUSSION)

MICHAEL J. COWELL AND BRIAN L. HIRST:

The authors are extremely grateful for the contributions of Ms. Collins and Messrs. Fischbeck, Watchorn, and Ohannessian in adding to the data on mortality differences between smokers and nonsmokers. We would also like to acknowledge in this regard the contribution of Mr. Lewis in presenting his company's experience as part of the discussion of our original presentation at the 1979 annual meeting (*Record*, V, No. 4 [1979], 785-86). We believe that the additional information presented in these discussions has greatly enhanced the credibility of our own data and that, in combination, it represents a significant body of data on the mortality of insured nonsmokers.

Mr. Fischbeck's presentation of Home Life's experience suggests certain parallels to State Mutual's. While Home Life's overall level of mortality is remarkably low, the relationship between nonsmoker and combined mortality is quite similar to State Mutual's, especially considering the lack of homogeneity of Home Life's smoker group. In response to the several questions we have received about our nonmedical experience, we note that Home Life's nonmedical mortality ratios are much more consistent with their medical mortality ratios than is the case for State Mutual. As a result, we are now more inclined to view our results as a statistical aberration rather than as reflective of any underlying difference between those smokers who were and those who were not medically examined.

Care must be taken when comparing State Mutual's results with those of Home Life and Phoenix Mutual, since the basis of the expected deaths is not exactly the same for the three cases. Home Life's experience is based on the combined life tables rather than on the separate male and female tables. If the female exposure in Home Life's experience exceeds the corresponding proportion in the 1965-70 combined table, Home Life's actual-to-expected results are understated.

The Phoenix Mutual experience, as presented by Ms. Collins, is for male lives only and uses the male table as the basis for the expected deaths. However, State Mutual's mortality ratios for females, although not significant statistically, were almost identical with those of males in the aggregate. Consequently, the results for Phoenix Mutual and State Mutual are comparable, at least in the aggregate. It should be noted that for Phoenix Mutual, as for Home Life, smokers are not a homogeneous group but include policyholders who did not meet the plan, policy size, or build criteria to be issued a nonsmoker policy. This would tend to account for the lower smoker mortality ratio than State Mutual experienced. In spite of these differences, the ratios of nonsmoker mortality to overall mortality are quite similar for the three companies:

COMPARISON OF NONSMOKER MORTALITY
WITH OVERALL MORTALITY

	Home Life	Phoenix Mutual	State Mutual
Nonsmoker ratio.....	32%	48%	44%
Overall ratio.....	53	68	69
Ratio of ratios.....	60%	71%	64%

One of the most interesting aspects of Ms. Collins' discussion is the discovery that Phoenix Mutual had investigated the influence of smoking on mortality as far back as 1910. We wonder whether any other companies have conducted similar studies but decided not to modify their pricing structure to reflect any mortality differences they may have detected.

By recognizing the nonsmoker differential in its reinsurance rates, Phoenix Mutual is facilitating the entry of its reinsurance customers into the nonsmoker market. As more reinsurers adopt this approach, we can expect the acceptance of separate nonsmoker pricing to accelerate.

Messrs. Watchorn and Ohannessian have provided some extremely valuable information on mortality by degree of smoking habit. Two items of note in the data are the high proportion of light smokers, especially among the United States policyholders, and the degree of extra mortality for pipe and cigar smokers. On the basis of the Sun Life data, over 80 percent of United States cigarette smokers in 1976 were "light smokers" (fewer than 20 cigarettes per day). This seems to be at variance with the population figures shown in the 1979 surgeon general's report and emphasizes the possibility of misrepresentation when data are classified according to degree of smoking habit. However, in spite of these limitations, Sun Life experienced mortality ratios among light smokers of about double the nonsmoker ratios, and among "heavy smokers" of about two and a half times the nonsmoker ratios, both of which results are reasonably in line with those of some of the studies included in the surgeon general's report.

When State Mutual introduced its nonsmoker classification in 1964, it was decided to group pipe and cigar smokers with non-cigarette-smokers. First, it was felt that the pipe and cigar smokers were too small a group to warrant separate underwriting consideration; second, information in the 1964 surgeon general's report suggested that pipe and cigar smokers were much closer to non-cigarette-smokers in mortality characteristics than to the smoker group. On the basis of Sun Life's data, showing "pipe or cigar" smoker mortality almost 50 percent higher than that of nonsmokers, perhaps State Mutual and other companies that took this position should reconsider their stand.

In his discussion for the *Record*, Mr. Lewis shows results for nonsmokers similar to State Mutual's. The results for Mutual Security are significant in that they are based on smaller-size policies, suggesting that that experience represents a different socioeconomic group from the one represented in State Mutual's experience. The similarity of results strengthens our contention that the underwriting criteria should be smok-

ing habits per se and not, as has been suggested, life-style factors or other socioeconomic characteristics.

How can it be determined whether what we have somewhat loosely described as life-style factors contribute more or less to excess mortality among smokers than do the effects of smoking itself? Mr. Cohen believes that to eliminate the effect of life-style factors it is not sufficient to exclude, as we did, only those deaths that can be attributed to mental rather than to physical disorders. It should be obvious, he suggests, that the ratio of mortality rates for causes thought to be related directly to smoking would be higher than the corresponding ratio for all causes, and that only if the deaths attributable to life-style among nonsmokers exceeded those among smokers would the ratio excluding such deaths be lower.

We acknowledge that in order for our statement about the ratio of smoker to nonsmoker mortality in groups with otherwise "identical" life-styles to be meaningful, those "identical" life-styles would have to be essentially accident-free. We were attempting to convey the idea that the effects of smoking on the human organism are greater than the experience actually indicates, because premature fatalities—most notably accidents—diminish the opportunity for the full differential to manifest itself.

Mr. Cohen points out that, to isolate the effects of life-style, comparisons would have to be made between smokers and nonsmokers with "homogeneous" life-styles, conceding that such a comparison would be difficult.

For those who insist on controlled test conditions, any such comparison would probably be viewed as impossible; however, for the purposes for which it was developed—namely, to support the differentials in life insurance pricing—the authors' study is based on experience drawn from populations that come as close to meeting the criterion of homogeneity as does any study of insured lives. Had we represented our study as measuring the effects of smoking on mortality, the criticism regarding the lack of controlled test conditions might have been valid. It is important to emphasize that, although such effects may be inferred by some readers, we do not suggest that our experience measures anything more or less than mortality differences between insured smokers and insured nonsmokers. While this distinction may be subtle, we believe that on reflection our readers will recognize its significance.

Even allowing that we have less than perfect homogeneity of life-style between our smoking and nonsmoking groups, we believe that we should continue to challenge the argument that life-style factors are more im-

portant than is smoking per se. To do otherwise would leave unanswered the question of why such extra mortality declines among those who have given up smoking. Does their life-style also change after they quit? Or are we faced with a tautology, namely, that smoking itself is part of what constitutes an unfavorable life-style?

This issue is also raised by Mr. Lew, who adds to the list of variables defining life-style. Since most of these criteria relate in some way or other to the care that people take of their health—or the extent to which they abuse it—perhaps we should coin a different terminology, such as “health style.” This would avoid the unintended implication that we are making value judgments about other people’s styles of life.

The Swiss Reinsurance Company statistics that Mr. Lew cites are interesting but not too surprising. What is the basis of “standard” mortality, and what were the results for the nonsmokers in the group? If, for example, they were in the vicinity of 50 percent of “standard,” as were ours and those of other companies presented in the discussions, then the 25 percent excess mortality cited by Mr. Lew would represent a $2\frac{1}{2}$:1 ratio.

Mr. Lew suggests that we may have overlooked the difficulties of drawing conclusions from the results of the 1954 United States veterans cohort. We included these statistics in our paper principally as background to provide additional perspective to the reader before we presented our own data. We acknowledge the highly selective effects operating within this group, and cite these mortality ratios only in a general way as one further piece of evidence of the correlation of increased mortality with the number of cigarettes smoked. However, the selective effects of both admission to military service and probable disproportionate representation of the “better-to-do middle class,” as suggested by Mr. Lew, would, if anything, make that group more similar to our insured group rather than less so. Mr. Lew also presents some recent information from an American Cancer Society study on the higher mortality from cancers of various forms among cigarette smokers as compared with those who never have smoked regularly. Although these data do not match those included in Table 9 of our paper, we do not find anything unusual in the results, or anything that directly contradicts our findings.

The authors would like to take this opportunity to acknowledge that, in addition to his numerous contributions to the Society on mortality studies, Mr. Lew is a fellow of the Council on Epidemiology, has served as the consultant on epidemiology to the American Cancer Society, and

has been involved in the analysis of studies by the Cancer Prevention Society of the relationship between smoking and cancer.

Regarding the pattern of extra mortality by age, Mr. Strunk proposes that the ratio of smoker to nonsmoker mortality never will reach unity. If his proposition is valid, then nonsmokers not only would have lower levels of mortality at all ages but also would have a longer span of life—that is, the nonsmoker mortality table would require a higher value of ω . He hypothesizes that the lower ratio of select to ultimate mortality at the higher ages in the 1965–70 Select and Ultimate Basic Tables may be the result of the exclusion of smokers from the standard classification because they did not meet other underwriting requirements. This certainly is plausible and, if true, would be another example of the extent to which the changing pattern of extra mortality from smoking, previously masked by aggregation, may have been responsible for a significant component of what we have thought of as a secular improvement in overall mortality. In other words, the substantial reduction in overall mortality over the past fifteen years or so may have been less the result of changes in the mortality pattern of a given homogeneous group than of the migration of several million people from the smoker category to the nonsmoker category.

Mr. Barber points to studies of the harmful effects of “secondhand” smoke as a rationale for measuring the mortality of groups classified according to the smoking status of those they reside with. We would point out that we have not yet gained universal acceptance of the position that mortality should be differentiated according to the elementary criterion of whether the applicant smokes or not, let alone according to highly refined classifications. We believe that before we can proceed to the type of detailed analysis suggested by Mr. Barber, the industry should attempt to measure mortality differences among current smokers, ex-smokers, and those who never have smoked.

Mr. Herzog cites the recent expansion of literature on the use of multi-dimensional contingency models and suggests their application to the statistics of insured lives as a means of validating the various assumed predictors of mortality. Given the insurance industry’s interest in proper risk classification and the cost of obtaining information needed to classify risks, the application of the type of analysis suggested by Mr. Herzog could spell changes in the basic approach to underwriting. For each new risk, an insurer might obtain information on only those criteria that had sufficient power to predict the likelihood and timing of the loss, and this only after justifying the cost of obtaining each successive item of information as against the corresponding savings in expected claim costs.

Although the work required to develop and apply such multidimensional contingency models could be extremely complex and—except for large companies—of questionable economic feasibility, it could be worthwhile if tackled on an overall industry basis. The value of such results would seem to be considerable.

Dr. Brown and Mr. Brown express surprise over the size of the differential between smoker and nonsmoker mortality in view of what they consider to be the “rather nonspecific” nature of the questions asked of applicants. Their reaction is not uncommon, even from people in companies that have studied these differences. Some have even hinted that they would have made their own statistics available sooner but for the fact that they could not believe the magnitude of the difference they were observing. While ours may be a view that has the benefit of hindsight, we submit that given the findings in the surgeon general’s reports, the fact that over 40 percent of the adult population has never smoked, and the fact that ex-smokers include a substantial number of those who, ten to fifteen years ago, comprised the population of “light smokers,” what surprises us is not that the differences are so large but rather that the industry was able to ignore them for so long.

We would agree with Mr. Ryan that the question of homogeneity of risk classes ultimately resolves into a philosophical issue, with “true homogeneity” perhaps never achievable in the practical sense. We certainly share Mr. Ryan’s concern that the legislative and judicial contribution has often seemed to add to the problem instead of helping to resolve it. At the serious risk of opening up a new line of discussion somewhat tangential to the central theme of our paper, we would observe that actuaries are faced with a dilemma of classic proportions. On the one hand, we have available large bodies of data and mathematically sophisticated analytical tools, such as those described by Mr. Herzog and the Browns, that could enable us to build much greater precision into our pricing processes. On the other hand, some elements of the consumerist movement, generated in part as a backlash to the very technology that has made possible the improvements in our analysis, perceive as dehumanizing the way in which we apply the results of this technology. In this environment, we as actuaries will be challenged and tested to design and support financial security programs that balance considerations of equity against those of equality in such a way as to bring a net benefit to our ultimate consumers. The authors fully recognize the importance of keeping their study in particular, and the question of risk classification in general, in the perspective of these broader societal considerations.

A significant characteristic of smoking is that it is an element of risk

that is within the individual's control. Most individuals exercise the free choice whether or not to smoke. If the effects of smoking are found to be harmful, is it reasonable to expect everyone to pay for the cost, or should the cost be allocated among only the smokers?

Smoking habits, as the Browns acknowledge, are not the sole criterion for underwriting. The other requirements, especially for medically examined cases, provide considerable assurance that we are studying mortality differences between nonsmokers and those smokers who are healthy enough at issue to be classified as "standard." The homogeneity of our nonsmoker group is also questioned by Mr. Lew. He cites Dr. Hammond's statistics covering the period 1959-63 to the effect that among males aged 50-74, the mortality of former heavy smokers who stopped smoking within five years prior to the study was even higher than that for current smokers. The result, Mr. Lew suggests, is that State Mutual's nonsmoker mortality could vary considerably, depending on the proportion of ex-smokers who were in poor health at time of issue or who had been heavy smokers for a prolonged period. The critical difference between our experience and that cited by Mr. Lew is that all the people in our sample were apparently in good health at the time their policies were issued. Each individual satisfied medical underwriting requirements that are considered among the strictest in the industry. It is not likely that many ex-smokers in poor health would qualify for standard insurance. With respect to the risk factors that we are attempting to identify, the process of medical underwriting has the effect of making our groups far less heterogeneous—at least at time of issue—than the groups included in most of the subpopulation studies cited. However, we do not intend to suggest that our group classified as nonsmokers will thereby necessarily experience the same mortality as the subgroup of them that consists of people who have never smoked.

It is interesting, therefore, that Mr. Tookey, a professed ex-smoker of thirty years, should find support in the statistics in our Table 6 for the contention that ex-smokers who abstain totally from tobacco experience mortality that approaches that of nonsmokers. He suggests one factor that we have surmised, namely, that the ex-smokers are not likely to have been heavy smokers and, in the case of those who quit voluntarily at a relatively early age, have not accumulated a large lifetime exposure to the effects of smoking. As we have indicated, this assumption is more or less implicit in the practice of those insurers who accept ex-smokers in their nonsmoker classification. If this assumption is valid for the general population, it probably is even more so for lives that have been medically underwritten and accepted as standard insurance risks.

As noted earlier, we estimate that more than 60 percent of the non-

smokers in our study are "never-smokers." We believe that our medical underwriting process—which requires that the ex-smokers meet the same standards as those who have never smoked—is no less valuable as a screening device for identifying the residual effects of smoking than are some of our more traditionally accepted underwriting methods as ways for screening out the effects of other harmful health habits. Also, we believe that the separation of all applicants according to whether or not they smoke may increase the precision of other aspects of the underwriting process, as the underwriter gains experience in differentiating between these two groups.

As to the need, in measuring mortality, to differentiate further among smokers according to the extent and nature of their tobacco usage, we take the view previously expressed regarding the value of more highly categorized data. Indeed, as Messrs. Watchorn and Ohannessian demonstrated in their discussion, not only are such refinements possible, but they yield results that show the same general pattern as those indicated in the surgeon general's reports.

Throughout our response to the discussions, we have supported the call for more refinements in these investigations, acknowledging that such information will be of little value to the insurance industry unless it becomes the basis for improved risk classification. The development of too refined a set of risk classes could become unworkable if the population of each subgroup is so small as to be statistically insignificant. With the incidence of cigarette smoking on the decline, we might reach a point eventually where the mortality differences among the various subcategories within the smoking group become less relevant from a practical standpoint even as they become more significant statistically. In our paper, we acknowledged that such factors as the tar and nicotine content of the cigarette and the extent of inhalation were also factors to be considered. We agree with the Browns and with Mr. Lew that the duration of the habit and the total cumulative lifetime consumption of cigarettes should be added to this list.

On the subject of the decreased levels of tar and nicotine in today's cigarettes, Mr. Lew suggests that this is likely to lead to smaller mortality differences between smokers and nonsmokers. While this hypothesis will require several years to be validated for insurance statistics, there are also suggestions that lower nicotine levels are causing some smokers to smoke even more cigarettes in order to satisfy a nicotine addiction. The Browns also suggest the application of multivariate contingency models along the lines described by Mr. Herzog.

We did acknowledge the problem of reclassification in Section V of our

paper, but concede that we do not yet have a well-defined solution. Some companies that recently have introduced nonsmoker pricing will, on receipt of a nonsmoking statement by the insured, apply the discount to all policies issued within a recent period. For term conversions, State Mutual recognizes the smoking status of the insured at the time of conversion. Admittedly, these are relatively minor liberalizations and do not address the more significant question, raised by the Browns, regarding the treatment of nonsmokers whose policies were issued many years before the company introduced nonsmoker pricing, or the equally challenging problem of policyholders who have quit smoking since they purchased their insurance. Without attempting to describe a specific solution, we recognize the problem of replacement, particularly during periods when the price of life insurance is being reduced. To conserve business in force we are going to have to give some recognition to the current insurability status of our policyholders, involving, as this will, the difficult questions of reclassification after issue.

As to the size of the discount that we have reflected in our pricing, State Mutual's premiums for a typical sample of permanent plans over a broad range of issue ages are approximately 4 percent lower for nonsmokers than for smokers; on those same plans, illustrated dividends for the first twenty years are higher for nonsmokers by anywhere from just under 5 percent to more than 15 percent, depending on plan and issue age. For whole life policies over a broad range of issue ages and policy amounts, this combination of lower premiums and higher dividends produces twenty-year interest-adjusted (at 5 percent) net costs for nonsmokers that are 25-35 percent lower for males and 35-55 percent lower for females than corresponding costs for smokers. The Browns ask how these discounts compare with the differences between male and female costs. Although the patterns by issue age and amount vary considerably, the rates for females are in the range of 25-40 percent (for smokers) and 35-55 percent (for nonsmokers) below the corresponding rates for males. Our yearly renewable term rates are approximately 20 percent lower for nonsmokers than for smokers across a wide range of issue ages; the corresponding discount for females as compared with males ranges from about 5 percent at the lower issue ages to about 20 percent at the higher ages.

Appendixes I and II of this review show a sample of premium rates, dividends, and cost indexes for our current whole life policy, and premium rates for our nonparticipating yearly renewable term policy.

We come finally to Dr. Kastenbaum's discussion, the only one that takes issue with the fundamental conclusions of our paper. Dr. Kasten-

baum challenges the findings of our study from three standpoints: (1) Our use of the surgeon general's reports as a basis of comparison for State Mutual's experience; (2) the methods we used to make comparisons between State Mutual data and the findings of the surgeon general's reports; and (3) several items that he believes are factual errors, omissions, and possibly misleading statements, and certain factors that may explain our conclusions.

Dr. Kastenbaum's principal criticism of our use of the findings in the surgeon general's various studies is that we have regarded that experience as representative of the general United States population. First, the data contained in Tables 1-5 of our paper, showing recent historic trends and sociodemographic profiles of the incidence of smoking, are in fact representative of the entire adult population of the United States. Second, the only mortality experience that we referenced in any detail was that from the sixteen-year follow-up of the 1954 cohort of United States veterans. As indicated in our response to Mr. Lew's discussion, the principal reason we selected this study as a basis of comparison from among the many presented in the surgeon general's report was—as Mr. Lew suggested—that it represented “a population highly slanted toward the better-to-do middle class.” At the risk of sounding elitist, we have suggested that Mr. Lew's description probably could be applied to State Mutual's medically examined policyholders covered under policies of at least \$10,000 face amount. Further, the United States veterans study provided information on mortality ratios according to cigarette consumption, a classification that we could not measure from our experience.

If by presenting a small sample of the surgeon general's findings we have misled our readers into thinking that we were comparing State Mutual's experience with general population mortality, we apologize. We readily acknowledge that there were many additional population studies that could have been cited; some of these were covered in our review of *Smoking and Health* (see note 8 of our paper). However, our sole purpose in citing selected items from the surgeon general's data, based as that information was on certain subgroups of a larger population than State Mutual's, was to provide a broader perspective for, and some of the background issues involved in, the mortality differences between smokers and nonsmokers. We reported our own company data as representative of the experience of one group of lives underwritten as standard for insurance purposes. Our data stand on their own, regardless of the experience of other groups. The discussions presenting the experience of other companies appear to support our view that State Mutual's experience is representative of insured smoker and nonsmoker mortality. Even in the

absence of comparisons with population or subpopulation experience, our data must be considered valid as a basis for developing underwriting and pricing distinctions, which, after all, is the principal purpose of our paper.

As to the concern Dr. Kastenbaum expresses about the methodology used in our study, we followed the standard procedure on which all mortality statistics compiled by the Society of Actuaries are based. Also, although our data are presented in Tables 7 and 8 by amount of insurance—an appropriate basis if these results are to be used for underwriting and pricing purposes—we do, in the narrative, give the corresponding results by number of policies. Of course, our statements of statistical significance were made on the basis of the results by number of policies. These statements are independent of the frequency distribution of policy amounts. The assumption of normality, appropriate for samples of the size in our study, is well established in the literature of measurement of mortality. The reference we cited (see note 14) is from the prescribed text for the Society of Actuaries' Part 5 syllabus covering construction of mortality tables.

Dr. Kastenbaum challenges the statistical methodology in our paper, claiming that the data in our study cannot be described as having been acquired by random sampling. We submit that mortality among insured lives is inherently a random process. The insurer expects a certain number of policyholders to die in a given time period, the number being a function of in-force and mortality assumptions as represented by a set of mean values of q_x . Provided that the number of actual deaths is at least 35, it is valid from a statistical approach to assume that the ratio of actual deaths to expected deaths is normally distributed with a mean value equal to this ratio, and a standard deviation equal to this ratio divided by the square root of the number of actual deaths (see above reference, pp. 222-23).

We considered our experience as representing two independent normal distributions, one each for smokers and nonsmokers, with mean values and standard deviations of mortality ratios represented by μ_S , μ_{NS} and σ_S , σ_{NS} . Under this assumption, the probability that the underlying level of mortality of the nonsmoker group is not less than that of the smoker group may be represented by the expression

$$P_{\mu_{NS} < \mu_S} = \frac{1}{2\pi} \int_{-\infty}^{\infty} \int_x^{\infty} \frac{\exp \left\{ -\frac{1}{2} \left[\frac{(x - \mu_S)}{\sigma_S} \right]^2 \right\}}{\sigma_S} \\ \times \frac{\exp \left\{ -\frac{1}{2} \left[\frac{(y - \mu_{NS})}{\sigma_{NS}} \right]^2 \right\}}{\sigma_{NS}} dy dx .$$

Using a numerical integration technique, we derived a value, not less than the exact value of P , indicating the probability that the underlying mortality among nonsmokers is *not* less than that of smokers. The value of P was less than 2.4×10^{-21} , and this result was the basis for our statement that for medically examined business the difference in mortality is statistically significant almost to the point of certainty. For business not medically examined, we derived a value for P of 1.9×10^{-2} , which supports our statement that the difference is significant at the 98 percent confidence level. As indicated in our response to Mr. Fischbeck's discussion, we attribute this lower degree of confidence and some of the anomalies in our nonmedical experience to the much smaller number of death claims.

Dr. Kastenbaum asks us to clarify our methodology for generating Table 11. In Appendix II of the paper we describe the split of mortality rates for nonsmokers into separate rates for ex-smokers and "never-smokers" of 1.72 and 1.01 per 1,000, respectively, to produce the ratio of 1.7. We also explain the approach in which we used the excess of United States 1960 Life Table rates over State Mutual's combined smoker and nonsmoker mortality rates as a measure of the mortality eliminated by life insurance underwriting. At male age 45, this amounted to 3.16 deaths per 1,000, which, when added back to the estimated ex-smoker and never-smoker rates, produces a ratio of $(1.72 + 3.16)/(1.01 + 3.16) = 1.17$, consistent with the surgeon general's finding that the ratio of the mortality of ex-smokers who quit on their own, and not because of medical advice, to that of never-smokers is approximately 1.2 (see note 18). We made these same adjustments to the smoker rates to demonstrate that State Mutual's results also conform reasonably well to the surgeon general's ratios of current smoker to current nonsmoker mortality. Dr. Kastenbaum questions these comparisons because our assumption as to the effects of life insurance underwriting (e.g., 3.16 deaths per 1,000 at male age 45) is itself derived from data that do not distinguish between smokers and nonsmokers.

The assumption implicit in our adjustment is that the excess of population mortality over insured life mortality at each age is similar for smokers and nonsmokers. While we concede the point to which Dr. Kastenbaum appears to be alluding, namely, that such an assumption would be difficult to document, we make the following two observations. First, our assumptions are biased in favor of the smokers; if the excess mortality at each age is higher for smokers than for nonsmokers, then the smoker/nonsmoker ratios would be even higher than those we

developed. Second, the sole purpose of this technique was to try to establish a frame of reference for our results. As we emphasized earlier, our results stand on their own and are not affected in the least by the assumptions we have used in comparing them with the surgeon general's findings. At the time we wrote our paper, we did not have access to any other mortality experience differentiated by smoking status, except for that in the surgeon general's report. By publishing our experience, we have elicited sizable bodies of similar experience from other life insurance companies, and we expect that our efforts now can be focused on developing industry statistics on nonsmoker mortality as more companies recognize the distinction in their risk classification.

Although we acknowledge Dr. Kastenbaum's argument that the impact of changes in the frequency distributions of policy amounts between the smoker and nonsmoker groups could account for some of the differences we cite by amount of insurance—perhaps the small differences between the mortality rates by amount of insurance and the rates by number of policies—there is nothing in our data to suggest that the differences we are observing are the result of anomalies in the distribution by amount of insurance. Again, as more companies contribute to the body of nonsmoker statistics, we will be in a better position to conduct studies of the difference between smoker and nonsmoker mortality by policy size to quantify these results more precisely. The inescapable fact is that we have taken a substantial segment of our policyholders that, on the basis of a number of underwriting characteristics, was previously considered homogeneous, and on the basis of only one additional criterion—smoking—divided it into two subsegments that, it turns out, exhibit vastly different mortality patterns. As we have already acknowledged, our experience is drawn largely from what Mr. Lew describes as “better-to-do middle class.” We submit that to homogenize this group further for the purposes of a study that already is showing more than a two-to-one ratio between the mortality of smokers and that of nonsmokers is not likely to produce results that will affect the thrust of our conclusions significantly.

In statistical terms, we believe that in addition to the two traditional predictors of mortality—age and sex—we have identified another highly significant variable: smoking status. Attempts to analyze the significance of this variable as related in some way to other sociodemographic or lifestyle factors may have some explanatory value in quantifying the magnitude of the difference between smoker and nonsmoker mortality more precisely. However, it appears unlikely that such results will change the established trend of applying this difference to life insurance pricing. Indeed, if anything, as the statistics become more precise, the trend ap-

pears to be accelerating. Whatever such additional life-style factors are, they correlate so closely with smoking status that our use of the latter criterion is appropriate for life insurance risk classification. The ultimate proof of the actuarial and underwriting pudding is not how well it relates cause and effect but, rather, how well it identifies groups that, for whatever causes, are homogeneous as to life expectancy.

Among our statements that Dr. Kastenbaum cites as being inaccurate or misleading are the reference to the amount of carbon monoxide inhaled in a puff of cigarette smoke and the question of whether smoking has any beneficial effects on the individual. We attribute the first of these references to the surgeon general. As to the second, and Dr. Kastenbaum's reference to the possibly beneficial effects of smoking on mental health, we defer to the medical profession, and point out that our comments were in reference not to the act of smoking but to the chemicals inhaled when a cigarette is smoked. However, neither of these points is central to our theme. We introduced these arguments solely in the context of how to designate risks that we had already demonstrated to be significantly different; both points could have been ignored without any effect on our conclusions.

Dr. Kastenbaum cites as misstatements of fact our "somewhat distorted" summarization of two of the principal findings of the surgeon general's reports, namely: (1) overall mortality for all male cigarette smokers is about 170 percent that of male nonsmokers, and (2) former cigarette smokers compared with nonsmokers experience declining overall mortality ratios as the years since cessation increase. The pertinent quotations from the surgeon general's 1979 report are given below.

The overall mortality ratio for all male current cigarette smokers, irrespective of quantity, is about 1.7 (70 percent excess) compared to non-smokers [P. I-10.]

Former cigarette smokers experience declining overall mortality ratios as the years of discontinuance increase. After 15 years of cessation, mortality ratios for former cigarette smokers are similar to those who never smoked. Although mortality ratios for any given age for former smokers are directly proportional to the amount smoked before cessation, and inversely related to the age of smoking initiation, cessation of smoking does diminish such individuals' risk regardless of these former factors, provided they are not ill at time of cessation. (Actually, the mortality ratios among those who had discontinued smoking less than 1 year before enrollment in several of the prospective studies were higher than for current cigarette smokers. This was also manifest in the total mortality rates for former cigar and pipe smokers. Further analyses separating those who stopped smoking because of illness from those

ex-smokers who stopped for other reasons revealed higher mortality rates among the former.) [P. I-11.]

We leave it to the reader to judge whether the "distortion" that Dr. Kastenbaum alleges is significant in the context in which we presented the surgeon general's findings.

We do not contest the validity of Dr. Kastenbaum's point—one raised also by the Browns—that many people lie about the extent of their smoking habits. Comparison of reported consumption from studies conducted by the National Center for Health Statistics with total cigarette sales as reported by the tobacco industry shows that aggregate acknowledged cigarette consumption is slightly less than 90 percent of reported cigarette production. We leave the reader to assess whatever significance there may be in this discrepancy. However, we do not consider this to be a serious problem in the aggregate, as long as the results of any mortality statistics developed on the basis of this underreporting are applied consistently to the groups that underreport their smoking. On an individual basis, this problem is another argument for not subdividing the smoker group into too many subcategories.

For our own policyholders, we are satisfied that the vast majority have responded truthfully to the application question on smoking, and we have established a number of additional checks to ensure that this continues to be the case. We have no reason to suspect that this question is answered any less honestly than the other questions on the application. Because such a high percentage of our individual life insurance is sold by our own agents, who also assist in verifying the applicant's smoking status, we believe that our classification of insureds as smokers and nonsmokers may be even more reliable than that on which many of the population studies are based. We suspect that the higher mortality ratios from our experience might be attributable in part to the more precise separation of smokers and nonsmokers that is possible in studies of insured life mortality.

Summary

We acknowledge that we have only scratched the surface of what we expect will be a vast new area for mortality investigation. We are extremely grateful to all those who discussed our paper for enlarging the scope of our investigation. We did not consider it realistic, in the space of one paper, to attempt to write the complete book on this subject. If, in our highly condensed treatment of the subject, we have shortchanged any topics or have not responded fully to all the discussions, we apologize.

In closing this first chapter on the subject, we turn once more to the

pages of history, where we began. In 1662, John Graunt, working from crude records of births and deaths—the only data then available—constructed the first English life table. Reviewing Graunt's work at the tercentenary of the publication of his study, one observer commented: "Graunt did not wait for better statistics; he did what he could with what was available to him. And by so doing, he also produced a much stronger case for supplying better data."¹ The authors will be satisfied if their paper—which is offered as aspiring to the pragmatic ideal ascribed to Graunt—is accepted in that same spirit.

¹ David V. Glass, cited in Abraham M. Lilienfeld, *Foundations of Epidemiology*, (New York: Oxford University Press, 1976), p. 23.

APPENDIX I

PREMIUMS, DIVIDENDS, AND INTEREST-
ADJUSTED NET COSTS (IANC) FOR A
\$25,000 WHOLE LIFE POLICY*

State Mutual Life Assurance Company of America

Age	Smoker Status	Annual Premium per \$1,000	Sum of First 20 Dividends†	20-Year IANC Index at 5%
Male Lives				
35....	Smoker	\$21.09	\$184.17	\$ 3.85
	Nonsmoker	20.37	195.65	2.67
45....	Smoker	30.89	254.35	8.06
	Nonsmoker	20.66	282.83	5.56
55....	Smoker	47.85	388.01	16.64
	Nonsmoker	45.68	443.74	11.89
Female Lives				
35....	Smoker	\$19.78	\$184.17	\$ 2.54
	Nonsmoker	19.12	195.65	1.42
45....	Smoker	28.61	254.35	5.78
	Nonsmoker	27.51	282.83	3.41
55....	Smoker	43.78	388.01	12.57
	Nonsmoker	41.84	443.74	8.05

* For \$100,000 policy, reduce premiums and net cost indexes by \$0.45; for \$10,000 policy, increase by \$1.05.

† Illustration based on 1980 dividend scale for policies with 8% policy loan provision.

APPENDIX II

PREMIUMS PER \$1,000 FOR \$100,000 OF
YEARLY RENEWABLE TERM
TO AGE 75*

American Variable Annuity Life Assurance
Company†

Age	Smoker	Nonsmoker
Male Lives		
35.....	\$ 2.34	\$ 1.88
45.....	4.79	3.84
55.....	11.54	9.44
65 (renewal only).....	31.32	27.83
Female Lives		
35.....	\$ 2.17	\$ 1.73
45.....	4.19	3.29
55.....	9.51	7.55
65 (renewal only).....	25.69	22.64

* For \$250,000 policy, subtract \$0.15; for \$50,000 policy (minimum size issued), add \$0.20.

† A stock life insurance company, wholly owned by State Mutual.

