

REVIEW OF ADEQUACY OF 1983 INDIVIDUAL ANNUITY
MORTALITY TABLE

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ABSTRACT

The paper analyzes recent individual annuity mortality experience, derives comparative annual mortality improvement rates and, in particular, examines in detail the 1976–86 experience in the most recent Report of the Individual Annuity Experience Committee. Some anomalies in the 1976–86 experience are pointed out, and some attempts to explain them are offered. Finally, the paper suggests that the 1983 Table *a* should be replaced as soon as possible—that it will not be viable for the second half of the 1990s.

After discussing some special tests of the 1976–86 annuity experience, the paper concludes that instead of constructing a new table from the 1976–86 experience, Improvement Scale G should be used to derive an interim table from the 1983 Table *a*. The 1996 IAM Table in the paper is intended to be used for valuation until a larger, more detailed study of annuitant mortality can be compiled and analyzed—a task that might not be completed until the early 2000s. The new study would examine the comparative mortality of different classes of individual annuity business. It would also study the use of mortality improvement rates as an integral part of the valuation system similar to that adopted for group annuity valuation.

INTRODUCTION

Improving mortality is a sign of advances in medical diagnostics and treatments, advances in public health, and improvements in socioeconomic factors generally. However, improving mortality creates problems for systems that must pay for medical and custodial care for the aged, and it threatens the solidity of old age income programs in Canada and the U.S.

Improving mortality widens mortality margins in life insurance valuation but reduces the safety in annuity valuation tables. In fact, improving mortality has rendered obsolete not only the 1949 and earlier tables but also the more recent 1971 Individual Annuity Table. The 1983 Group Annuity Table is being replaced by the 1994 Group Annuity Table. This paper examines the 1983 Table *a* in light of the results of the 1976–86 individual annuity mortality study and recent population data and proposes a replacement.

The paper also proposes a cooperative effort by life insurers issuing individual annuities to contribute to a large and detailed study of annuitant mortality. Such a study is needed to keep the annuity business growing and profitable with adequate safety margins over the longer term.

DISCUSSION OF 1976-86 INDIVIDUAL ANNUITY MORTALITY EXPERIENCE

The 1976-86 Individual Annuity Mortality Study

The Individual Annuity Experience Committee well deserves the gratitude of the actuarial profession for producing the first individual annuity study since the 1971-76 study was published nearly 20 years ago [1]. Unfortunately, the new 1976-86 study [2] included only eight companies versus fifteen in the earlier study [3]. In its report, the 1976-86 study committee (the Annuity Committee) expressed the hope that publication of the study would encourage other companies to contribute to future studies. I join with the Annuity Committee in appealing to companies to contribute their experiences to future studies. The importance of additional contributors cannot be stressed too much. Because improving mortality causes annuity valuation tables to become inadequate, it is vital to have up-to-date, representative annuity mortality data to keep annuity valuation standards current.

While the Annuity Committee called attention to "significant differences in percentages of exposures from the various companies for different annuity types," the individual company percentages of contributed exposures in the new study were mostly less than the largest percentages in the 1971-76 study [4], where five companies each contributed 10% or more to the various sections of the mortality experience: two to nonrefund life income settlements (with one contributing more than half) and four to refund; three to matured deferred annuities, with one company contributing half to two-thirds of the nonrefund experience and one-third to half of the refund. As compared with the 1971-76 study, the 1976-86 experience did not have a worse distribution by company despite the smaller number of companies. Nevertheless, the 1976-86 experiences must be viewed with caution considering (1) the small number of companies in the study, (2) the fact that no one company contributed for all ten years, and (3) the wide dispersion of mortality ratios by company, as shown in Appendix Tables C-1 and C-2 of the 1976-86 study [2].

Analysis of the 1976–1986 Mortality Experience

The Annuity Committee noted that the mortality ratios under refund business were generally lower than those under nonrefund business, a finding that was “counter to expectations and prior trends.” The self-selection exercised by annuitants has long been recognized—historically it has been evident in low mortality in the early contract years and in higher mortality on refund annuities than on nonrefund. Nonrefund annuities were traditionally considered more likely to be purchased by only the healthiest lives. Possibly the environment (which I will not attempt to define) has changed. I have pursued several avenues, which are described below, to explain the apparent anomaly, but none held the answer.

The report on the derivation of the 1983 Table *a* [5] made use of a table in the 1971–76 study comparing historical mortality ratios over the period 1948–76 to construct a table of trends in selection. A summary of that table, extended to include the 1976–86 study, appears as Table 1. It presents selection trends over the periods 1948–63, 1963–76, and 1976–86. Comparison of 1963–76 with 1948–63 shows that the effects of selection decreased for male nonrefund and increased for female nonrefund and both refund groups. Comparing 1976–86 with 1963–76 shows that selection has increased in both nonrefund groups and for female refund. While the analysis fails to explain the shift of lower mortality from nonrefund to refund, it at least indicates that the 1976–86 experience is not out of line with prior studies.

Using some data kindly supplied by the Annuity Committee, I was able to analyze nonrefund mortality versus refund separately for nonpension trust and pension trust business. Analyses by experience year (all companies combined) and by company code (all years combined) showed general consistency in refund mortality being lower than nonrefund. An unnumbered table early in the 1976–86 report [6] compares average amounts of annual income based on first-contract-year exposures for the current study and the five preceding studies for male and female refund and nonrefund business—the nonrefund business consistently shows the larger amounts of average income. Considering that the current study shows mortality is lower for larger amounts of income, the larger income of nonrefund annuitants does not explain anything.

Table 2 compares mortality for contract years 11 and over in the 1976–86 study with that for years 6 and over in the 1971–76 study—essentially successive experiences of the same groups of annuitants (differences in

TABLE 1
TRENDS IN SELECTION
BASED ON RATIOS OF MORTALITY IN CONTRACT YEARS 1-5
TO MORTALITY IN CONTRACT YEARS 6 AND OVER

	Attained Age Group	Average 1948-63 ^a	Average 1963-76 ^a	1976-86 ^b
Immediate Nonrefund Annuities				
Males	Under 60	— ^c	—	—
	60-69	83%	79%	64%
	70-79	72	91	53
	80 & up	74	79	79
	All	76	88	74
Females	Under 60	—	—	—
	60-69	76	62	28
	70-79	72	60	53
	80 & up	68	71	62
	All	72	67	62
Immediate Refund Annuities				
Males	Under 60	126% ^d	131% ^d	222%
	60-69	87	79	82
	70-79	88	86	84
	80 & up	93	78	88
	All	96	85	90
Females	Under 60	54	78	46
	60-69	91	103	49
	70-79	93	87	84
	80 & up	87	79	68
	All	91	87	75

^aExpected deaths on 1949 Annuity Table.

^bExpected deaths on 1971 IAM.

^cIndicates numerator and/or denominator based on small number of deaths.

^dExcludes pension trust business.

constituent companies aside) during two different time periods. We would not expect a shift of lower mortality from nonrefund to refund in this comparison. However, Table 2 indicates that there has been such a shift.

The problem is to determine why the shift occurred. Is it due to a shift in sales emphasis? The exposures indicate that refund products have been more popular than nonrefund, at least among clients of the companies in the study. But this does not answer the question, Why are refund annuitants healthier than nonrefund? Or the corollary question, Why do the less healthy apparently choose nonrefund over refund? On the face of it, the results do not make sense; at least general reasoning does not explain the results. Further, any hypothesis based on sales or other factors affecting selection at issue does not explain the shift (see Table 2) from the 1971-76 experience

TABLE 2
COMPARISON OF 1971-76 VERSUS 1976-86 EXPERIENCE
BY AMOUNTS OF ANNUAL INCOME
EXPECTED DEATHS BASED ON 1971 IAM

	Attained Age Group	Experience Years 1971-76 ^a Contract Years 6 and Over		Experience Years 1976-86 Contract Years 11 and Over	
		Nonrefund	Refund	Nonrefund	Refund
Male	60-90	208%	160%	238% ^b	122%
	70-79	136	112	214	92
	80-89	107	111	122	99
	90 & over	83	102	85	94
Female	60-69	179	136	251 ^b	164
	70-79	129	107	173	89
	80-89	95	101	99	83
	90 & over	90	104	90	87

^aExcludes pension trust business.

^bMay not be reliable because of small number of deaths.

for contract years 6 and over to that of 1976-86 for contract years 11 and over.

A hint to a possible explanation can be garnered from Table 40 in the 1971-76 Report [7], which, for refund life income settlements arising from maturities and surrenders and for matured deferred annuities, compares mortality under (a) pension trust issues, (b) qualified nonpension trust issues, and (c) nonqualified business. The qualified nonpension trust mortality ratios were markedly lower than those of the other two groups. A significant increase in the proportion of such qualified business in the refund annuity experience might account for the shift. Qualified nonpension trust business probably includes a substantial amount of 403(b) contracts issued to teachers, an occupation group known for low mortality. The next annuity mortality study should examine qualified nonpension trust business as a separate class to test this hypothesis. The use of special adjustments for valuation of such business could also be explored.

In any case, the nonrefund-to-refund shift bears out the wisdom of the respective committees that constructed the 1971 IAM Table and the 1983 Table *a* in deciding to combine refund and nonrefund immediate annuities, settlement options, and matured deferred annuities in building tables for valuation of all kinds of annuities.

ADEQUACY OF 1983 TABLE *a*

Was the 1983 Table a Adequate in 1983?

Availability of the 1976–86 annuity mortality study permitted completion of the second part of a test of the adequacy of the 1983 Table *a*. Starting in 1984, several members of the National Association of Insurance Commissioners (NAIC) Life and Health Actuarial Task Force (LHATF) expressed misgivings about the adequacy and continued safety of the 1983 IAM tables. The tables had been projected to 1983 from the 1973 Experience Tables constructed [8] from the Society of Actuaries study of annuitant mortality from 1971 to 1976 contract anniversaries. The 1983 Table *a* Committee proposed two tests of the adequacy of the table [9]. Both tests would compare actual mortality improvement rates with those used to project the 1983 Basic Tables from the 1973 Experience Tables.

One test was to compare the 1973 to 1983 improvement rates with those experienced from the 1969–71 U.S. Population Life Tables to the 1979–81 Tables. Results of the population test were described in a discussion of the Myers and Bayo paper on the 1979–81 U.S. Life Tables [10]. The test indicated that the 1983 tables were “adequate” for males and “probably adequate” for females.

The second test was to compare the mortality improvement between the 1971–76 annuity experience and the next Society of Actuaries annuity study, at that time assumed to cover the period 1976–81. The “next” Society annuity mortality study is now available; it covers the experience from 1976 to 1986 contract anniversaries [2]. In the section, “Adequacy of 1983 IAM Table,” the Annuity Committee concluded that the 1983 table was adequate in 1983, the average year of the study.

Is the 1983 Table a Adequate for 1996 and Beyond?

There is no quarrel about the 1983 Table *a* being adequate in 1983—the immediate question is whether, taking improving mortality into account, the 1983 tables are still adequate for valuation in 1996 and later. In the absence of up-to-date annuity mortality experience, it is necessary to rely on available past mortality improvement rates and trends to draw a conclusion. Two approaches, one based on annuity experience, the other based on population data, may provide some answers.

Two sets of annual mortality improvement rates based on annuity experience are shown in Table 3: one from 1969 (the 1967–71 study [11]) to

1973 (the 1971–76 study [1]) and one from 1973 to 1983 (the 1976–86 study [2]). (A negative number indicates an increase in mortality.) The table compares them with the improvement rates used to derive the 1983 Basic Table from the 1973 Experience Table and with Projection Scale G [5]. The 1973 to 1983 projection factors are the same for males and females; Scale G has separate improvement rates for males and females. Note that the 1973 to 1983 nonrefund improvement rates are not consistent with those for the other kinds of contracts in Table 3, nor are they consistent with the population improvement rates in Table 4.

Table 4 compares U.S. 1980 population mortality (based on the 1979–81 Life Tables) for white males and white females with corresponding estimated mortality rates for the year 1990 constructed by averaging interpolated abridged tables for 1989, 1990, and 1991. (The 1989–91 Life Tables will not be available until 1996.) Shown for comparison are the annual improvement rates of Projection Scale G. We might expect population mortality improvement to be somewhat different from that of annuitants because of self-selection and socioeconomic factors. Appendix A contains a discussion of a *MetLife Statistical Bulletin* article on the effects of socioeconomic status on population mortality, which may be helpful in evaluating Table 4.

It is likely that annuitants in general represent the higher-income, more highly educated segment of the population. Even so, differences in socioeconomic class may be the reason why annuitant mortality for amounts of annual income of \$2,500 and over is somewhat lower than that for all income amounts in both the 1971–76 study and the 1976–86 study for males and females, refund and nonrefund annuities. Unfortunately, the threshold of \$2,500 is low, and incompatibilities in the tabular presentations of the two studies discouraged more detailed comparisons.

Allowing for the effects of socioeconomic class on population mortality, it seems reasonable to state that both the annuity experience and the population data indicate that the 1973–83 annuity projection factors used to derive the 1983 Basic Table from the 1973 Experience Table are close to the observed improvement rates. This means that for an improvement rate of 1.5%, mortality will have decreased by about 18% during the 13 years from 1983 to 1996, suggesting that a new table will be needed for 1996.

The 10% loading in 1983 Table *a* was not intended to provide a margin for future mortality improvement; rather, it provides a margin for companies that experience lower-than-average annuitant mortality. The 1983 Table *a* Committee tested the 10% loading using data from the 1971–76 annuity study and noted that it covered all but three of the companies tested and

TABLE 3
COMPARISON OF ANNUITANT MORTALITY ANNUAL IMPROVEMENT RATES EXPERIENCE
BY AMOUNTS OF ANNUAL INCOME—ALL CONTRACT YEARS

Attained Age Groups	Annual Improvement Rates, %				1973 to 1983 Projection Factors, ^a %	Projection Scale G, ^c %	
	Male Lives		Female Lives			Male	Female
	1969 to 1973	1973 to 1983	1969 to 1973	1973 to 1983			
Nonrefund Annuities							
<60		3.49*		1.47*	2.25 ^b	1.60	1.85
60-69	-0.24	1.79	0.25	1.13	2.25	1.50	1.75
70-79	1.05	-0.86	-0.42	-2.52	2.125	1.25	1.60
80 and up	0.60	-0.22	1.66	-0.12	1.625 ^c	1.25	1.50
All	0.63	0.10	1.17	0	—	—	—
Refund Annuities							
<60		-0.06		1.42	2.25 ^b	1.60	1.85
60-69	1.50	2.44	-2.53	2.41	2.25	1.50	1.75
70-79	1.15	2.40	0.67	1.97	2.125	1.25	1.60
80 and up	0.82	1.65	-0.32	2.21	1.625 ^c	1.25	1.50
All	1.07	1.98	-0.10	2.10	—	—	—
Settlements from Maturities and Surrenders (Excluding Pension Trust)—Refund							
50-59		4.55		2.89*	2.25 ^b	1.60	1.85
60-69		0.84		1.22	2.25	1.50	1.75
70-79		1.67		0.81	2.125	1.25	1.60
80-89		1.68		1.97	1.625 ^c	1.25	1.50
90 and up		1.32		2.84	1.50 ^d	1.00	1.25
All		1.57		1.71	—	—	—
Matured Deferred Annuities (Excluding Pension Trust)—Refund							
60-69		0.84		0.83	2.25	1.60	1.85
70-79		2.26		1.24	2.125	1.50	1.75
80-89		0.79		1.00	1.625	1.25	1.60
90 and up		1.02		0	1.50 ^d	1.25	1.50
All		1.30		0.82	—	—	—
Matured Deferred Annuities (Excluding Pension Trust)—Nonrefund							
60-69		0.65		—	2.25	1.60	1.85
70-79		-2.31		1.29	2.125	1.50	1.75
80-89		0.81		2.28	1.625	1.25	1.60
90 and up		2.05		1.87	1.50 ^d	1.25	1.50
All		0.91		2.14	—	—	—

*Indicates 10-49 deaths in numerator or denominator or both.

^aThe 1973 to 1983 projection factors were the same for males and females.

^bAges 37-62.

^cAges 82-87.

^dAges 92-97.

^eAges 55, 65, 75, 85, 95.

that the mortality of only one fell much below the 10% corridor. A review of Table C-2 of the 1976-86 annuity mortality study indicates that for some companies in the 1976-86 study, the 10% margin might fall short. However, with only eight companies in the study, there is reason not to accept the results as definitive. The use of 10% as a margin is retained in the derivation of the new annuity table described below.

TABLE 4
COMPARISON OF ANNUAL RATES OF MORTALITY IMPROVEMENT

Attained Ages	U.S. White Population Annual Improvement Rates				Projection Scale G	
	Male Lives		Female Lives		Male	Female
	1970-80	1980-90	1970-80	1980-90		
57	2.62%	1.82%	1.83%	0.78%	1.50%	1.75%
62	2.24	1.66	1.19	0.66	1.50	1.75
67	2.10	1.82	1.65	0.55	1.50	1.75
72	1.42	1.70	1.90	0.60	1.25	1.75
77	1.64	1.30	2.67	0.71	1.25	1.50
82	1.21	0.98	2.22	1.13	1.25	1.50
87	1.18	N.A.	1.88	N.A.	1.25	1.50
92	0.99	N.A.	1.51	N.A.	1.00	1.25

The Need for a New Individual Annuity Valuation Table

While the 1983 annuity tables seem to have been adequate for the period around 1983, the recent annuity and population mortality improvement rates suggest that the tables are probably now (1995) no longer adequate and almost certainly not adequate for the remainder of this century. If an inadequate table is used for annuity valuation, then unassigned surplus will be overstated and margins that should be retained may be paid out. The situation may be more serious for companies issuing variable annuities because investment margins are not available to make up for mortality losses, although the usual charge for mortality guarantees provides some offset. A test of adequacy of the mortality guarantee charge appears later in this paper.

To construct new, adequate individual annuity valuation tables, a new annuity study should be compiled with at least 20 contributing companies and with a breakout of experience on qualified nonpension trust business. In addition, a suitable source of mortality rates at ages below 60 must be found and evaluated. The 1949 individual annuity tables used group annuity active life experience on persons in clerical occupations; the 1971 IAM Table made use of the 1966 GAM Table at ages under 60. For the 1973 Experience Table from which the 1983 tables were derived, the unloaded 1971 IAM mortality rates were used. The study will also have to focus on the shape of the mortality curve at very high ages; the methods used for the 1994 GAM Tables could be considered.

A set of mortality improvement factors should be included as part of the valuation standard, as was done for the 1994 GAM Table; use of improvement rates on a continuing basis is the only way to keep annuity mortality tables reasonably current, although indefinite extension of mortality improvement is debatable. The use of generation mortality tables as an integral part of the valuation process should be explored in depth: it can affect not only annuity pricing, design, and valuation but also life insurance settlement options.

The long-range effects of reduced smoking, healthier diet, new prescription drugs, and new diagnostic and surgical procedures will have to be evaluated, while changes in Medicare policy in the U.S. may adversely affect mortality improvement, leaving mainly the "flywheel" effects of extended vaccination of children, effective treatment of infections such as rheumatic fever in young people and the reduction in smoking. All the necessary studies will take considerable time to complete and a date of no earlier than 2000 seems likely for collection of data and for the development of a totally new individual annuity valuation system. Meanwhile we need a replacement table for the 1983 Table *a*.

CONSTRUCTION OF AN INTERIM INDIVIDUAL ANNUITY VALUATION MORTALITY TABLE

We should immediately proceed to construct a new table for, say, the year 1996. Tables 3 and 4 suggest that Scale G, which was developed along with the 1983 Table *a* to "keep the 1983 Table *a* (with projection) reasonably up to date during the remainder of the century but not cause it to become unduly conservative" [5], is appropriate for updating the table. Consequently, my recommendation is to apply Scale G to update the 1983 Basic Table to 1996, graduate the resulting table to form a 1996 Basic Table, and then subtract a 10% loading. This method is suggested to quickly derive an updated table whose antecedents are known and which reasonably reflects annuitant mortality improvement from 1983 to 1996.

A set of computer procedures was developed that exactly reproduced the 1983 Basic tables and the 1983 Table *a* from the 1973 Experience Tables. (See Appendix B for a detailed description. Interpolated values of Scale G appear in Appendix C.) A set of 1996 basic (unloaded) tables was constructed by applying Scale G improvement rates to the 1983 Basic Tables; then a Jenkins osculatory graduation formula and a cubic curve at the high ages were used to obtain the 1996 Basic Tables. A 10% loading was

deducted and the tables regraduated to produce the final 1996 IAM Tables. The new table could be referred to, if necessary, as a modification of the 1983 Table *a*.

Like the 1983 Table *a*, the age basis for the 1996 IAM is Age Nearest Birthday because the ages used in submissions to the Society of Actuaries annuity mortality studies (on which the tables are based) are age nearest birthday.

The 1996 Individual Annuity Basic tables and the 1996 IAM Tables appear in Appendixes D and E, respectively. Table 5 compares the 1983 and 1996 annuity mortality rates for every fifth age from 50 to 90. Table 6 is similar to Table 17 in the report on the derivation of the 1983 Table *a* [12]. It shows illustrative values of life annuities on both the 1983 and 1996 tables calculated at 5%, 7% and 9% interest and ratios of annuity values on the 1996 table to those on the 1983 table.

TABLE 5
COMPARISON OF MORTALITY RATES PER 1,000—1983 TABLE *a* VERSUS 1996 IAM

Age	Male			Female		
	1983 Table <i>a</i>	1996 IAM	1996/1983	1983 Table <i>a</i>	1996 IAM	1996/1983
50	4.057	3.213	79.20%	1.830	1.403	76.67%
55	5.994	4.833	80.63	2.891	2.260	78.17
60	8.338	6.834	81.96	4.467	3.566	79.83
65	12.851	10.564	82.20	7.336	5.762	78.54
70	21.371	17.913	83.82	11.697	9.256	79.13
75	35.046	29.761	84.92	20.127	16.345	81.21
80	57.026	48.449	84.96	36.395	29.786	81.84
85	90.987	77.080	84.72	65.518	54.057	82.51
90	134.887	117.140	86.84	113.605	95.846	84.37

Comparison with 1994 Group Annuity Static Tables

Two comparisons have been made with the new 1994 GAM Static Tables [13]. The first comparison, in Table 7, shows, for every fifth age from 50 to 90, 1996 IAM mortality rates and 1994 GAM Static Table rates projected to 1996 using Improvement Scale AA.

The second comparison updates Graphs 1 and 2 from the report, "Development of the 1983 Group Annuity Mortality Table" [14, p. 879], which compared 1966 and 1983 group and individual basic (unloaded) tables. The updated graphs (Appendix F), tracing ratios of group to individual mortality rates, include comparisons of the 1996 IAM Basic Tables with the 1994 GAM Basic Table projected to 1996 by Scale AA. Values are graphed every

TABLE 6
COMPARISON OF ANNUITY RESERVES:
1996 IAM VERSUS 1983 TABLE *a* IMMEDIATE ANNUITY—\$1 PER ANNUM

Age	5% Interest			7% Interest			9% Interest		
	1983 Table <i>a</i>	1996 IAM	Ratio 1996 to 1983	1983 Table <i>a</i>	1996 IAM	Ratio 1996 to 1983	1983 Table <i>a</i>	1996 IAM	Ratio 1996 to 1983
Male									
55	13.601	14.050	1.03	11.105	11.397	1.03	9.304	9.503	1.02
60	12.355	12.845	1.04	10.279	10.614	1.03	8.736	8.974	1.03
65	10.918	11.446	1.05	9.265	9.644	1.04	7.999	8.280	1.04
70	9.362	9.909	1.06	8.106	8.519	1.05	7.115	7.433	1.04
75	7.775	8.330	1.07	6.867	7.306	1.06	6.130	6.481	1.06
80	6.237	6.779	1.09	5.613	6.060	1.08	5.092	5.465	1.07
85	4.861	5.351	1.10	4.450	4.869	1.09	4.097	4.459	1.09
90	3.722	4.121	1.11	3.459	3.810	1.10	3.228	3.538	1.10
Female									
55	14.772	15.188	1.03	11.874	12.129	1.02	9.831	9.995	1.02
60	13.613	14.091	1.04	11.148	11.459	1.03	9.356	9.567	1.02
65	12.262	12.799	1.04	10.246	10.616	1.04	8.734	8.997	1.03
70	10.728	11.305	1.05	9.158	9.577	1.05	7.941	8.253	1.04
75	9.016	9.621	1.07	7.868	8.331	1.06	6.948	7.310	1.05
80	7.239	7.850	1.08	6.455	6.946	1.08	5.807	6.208	1.07
85	5.543	6.118	1.10	5.041	5.524	1.10	4.615	5.024	1.09
90	4.100	4.608	1.12	3.793	4.234	1.12	3.525	3.912	1.11

TABLE 7
COMPARISON OF MORTALITY RATES PER 1,000
1996 IAM VERSUS 1994 GAM STATIC PROJECTED TO 1996

Age	Male			Female		
	1994 GAM Static Projected to 1996	1996 IAM	Ratio GAM/IAM	1994 GAM Static Projected to 1996	1996 IAM	Ratio GAM/IAM
50	2.487	3.213	0.77	1.380	1.403	0.98
55	4.258	4.833	0.88	2.257	2.260	1.00
60	7.723	6.834	1.13	4.395	3.566	1.23
65	14.131	10.564	1.34	8.550	5.762	1.48
70	23.023	17.913	1.29	13.593	9.256	1.47
75	36.176	29.761	1.22	22.324	16.345	1.37
80	60.793	48.449	1.25	38.846	29.786	1.30
85	95.883	77.080	1.24	66.928	54.057	1.24
90	151.710	117.140	1.30	115.568	95.846	1.21

fifth age from 50 to 80. The 1983 Group Annuity Table report identified the 1966 rates as the 1966 Group Annuity Experience Table and the 1963 (individual annuity) Experience Table projected to 1966. The graph shows remarkable consistency over the three decades from 1966 to 1996.

Financial Tests

To test the effect on liabilities (reserves) of adopting the 1996 IAM Tables, a model office was constructed using life table methods assuming that the same amount of immediate life annuity premium was issued at each of ages 60 through 85 over 10 years. At interest rates of 5%, 7%, and 9%, aggregate reserves on the 1996 table were 6.8%, 6.1%, and 5.5%, respectively, higher than reserves on the 1983 tables at the end of 10 years. There was little change when the model office was extended to 20 years. To put the test in perspective, the ratio of capital stock and surplus (excluding Asset Valuation Reserves) to total assets for all U.S. life insurance companies was 8.6% at the end of 1994. The life table functions used in constructing the model office were based on the 1996 IAM.

Since one of the reasons for adopting an up-to-date annuity mortality table is to avoid future mortality losses on variable annuities where interest gains cannot be used to make up such losses, a simple test was made of the adequacy of the usual 0.5% of funds charge for mortality guarantees. Assuming a contract is issued with annual payments of \$1,000 consideration accumulated for 13 years from 1983 to 1996 when it matures at age 65, would the accumulated charges be sufficient to make up the difference between the amount of a single premium at 7% on the 1983 Table and one on the 1996 Table?

Two tests were made. In one test the variable annuity fund was accumulated at 10% over the period and in the other, at 15%. In both tests, the mortality guarantee charges were accumulated at 7% assuming they were not carried in a separate account. A 0.5% annual expense guarantee charge was also deducted. No other charges were deducted.

Under the 10% accumulation rate, there is a small profit for both male and female contracts (0.15% and 0.63% of the fund, respectively). If the separate account fund does very well, as illustrated by a 15% accumulation rate, then there is a small loss (0.42%) for male contracts and a small gain (0.06%) for female contracts.

CONCLUSION

This paper was written (1) to call attention to the increasing inadequacy of the 1983 Table *a* as a valuation standard, (2) to call for a much enlarged study of annuity mortality including an evaluation of qualified nonpension trust business, further study of refund versus nonrefund mortality experience and investigation of possible sources of mortality rates at ages under 60, and (3) to propose adoption of an interim table such as the 1996 IAM Table as a valuation standard. I believe that the paper provides food for thought on each of these points. If the 1996 table is adopted, I will make available a set of blended mortality tables [15, 16] corresponding to those on the 1983 Table *a*.

END NOTES

1. COMMITTEE ON ORDINARY INSURANCE AND ANNUITIES. "Mortality under Individual Annuities, Life Income Settlements, and Matured Deferred Annuities between 1971 and 1976 Anniversaries," *TSA 1979 Reports of Mortality and Morbidity Experience* (1980): 65-219.
2. INDIVIDUAL ANNUITY EXPERIENCE COMMITTEE. "Mortality under Individual Immediate Annuities, Life Income Settlements, and Matured Deferred Annuities between 1976 and 1986 Anniversaries," *TSA 1991-92 Reports of Mortality, Morbidity and Other Experience* (1993): 65-116.
3. There were 21 companies in the 1967-71 study.
4. See Appendix Table A in both the 1971-76 [1] and 1976-86 [2] studies.
5. "Report of the Committee to Recommend a New Mortality Basis for Individual Annuity Valuation (Derivation of the 1983 Table *a*)," *TSA XXXIII* (1981): 675-751.
6. See page 70 of the 1976-86 study [1].
7. See Table 40 on page 119 of the 1971-76 study [1].
8. See the 1971-76 study [1] and "Report of the Committee to Recommend a New Mortality Basis for Annuity Valuation (Derivation of the 1983 Table *a*)" [5].
9. JOHANSEN, R.J. "NAIC Adopts Annuity Table Test," *The Actuary* 19, no. 5 (May 1985): 1, 4.
10. JOHANSEN, R.J. Discussion of "United States Life Tables for 1979-81," by R.J. Myers and F.R. Bayo, *TSA XXXVII* (1985): 345.
11. COMMITTEE ON ORDINARY INSURANCE AND ANNUITIES. "Mortality under Individual Immediate Annuities between 1967 and 1971 Contract Anniversaries," *TSA 1973 Reports of Mortality and Morbidity Experience* (1974): 59-126.
12. See Table 17, "Report of the Committee to Recommend a New Mortality Basis for Annuity Valuation (Derivation of the 1983 Table *a*)" [5].
13. SOCIETY OF ACTUARIES GROUP ANNUITY VALUATION TABLE TASK FORCE. "1994 Group Annuity Mortality Table and 1994 Group Annuity Reserving Table," *TSA XLVII* (1995): 865-920.

14. COMMITTEE ON ANNUITIES. "Development of the 1983 Group Annuity Mortality Table," *TSA XXXV* (1983): 879.
15. SOCIETY OF ACTUARIES COMMITTEE ON NONFORFEITURE AND VALUATION MORTALITY PROBLEMS—INDIVIDUAL LIFE INSURANCE AND ANNUITIES. "Blended 1980 CSO and CET Mortality Tables," *TSA XXXVII* (1985): 393–448.
16. JOHANSEN, ROBERT J. "Blended Mortality Tables—Life Insurance and Annuities," *TSA XXXIV* (1987): 41–105.

APPENDIX A

DISCUSSION ON "THE WIDENING GAP BETWEEN SOCIOECONOMIC STATUS AND MORTALITY"

The April–June 1994 edition of the *MetLife Statistical Bulletin* included an article on "The Widening Gap Between Socioeconomic Status and Mortality."* The article, attributed to several authors at the National Center for Health Statistics, compared 1986 data with a similar 1960 study by Kitagawa and Hauser. The authors stated that their studies "showed that the disparity in U.S. mortality rates according to income and education has increased over the years for men and women and for whites and blacks." Further, the studies showed that mortality over the period 1960 to 1986 improved more among persons with higher levels of education and income for both men and women. The table below shows some of the results for which numerical values were provided in the article—unfortunately only the published results from the 1960 study were available to the authors; backup material had not been archived.

AGE-ADJUSTED MORTALITY RATES—U.S. WHITE POPULATION, AGES 25–64*

		Low Education	High Education	Low Income	High Income
Male	1960	9.0	5.8	NA	NA
	1986	7.6	2.8	16.0	2.4
Female	1960	5.3	3.4	NA	NA
	1986	3.4	1.8	6.5	1.6

*Rates per 1,000 adjusted on 1940 U.S. total population.

NA: Rates were not provided in the article.

The *Statistical Bulletin* article showed that mortality for white men with low education decreased 16% from 1960 to 1986, while that for men with high

*QUEEN, S., PAPPAS, G., HADDEN, W., AND FISHER, G. (all at the National Center for Health Statistics). "The Widening Gap Between Socioeconomic Status and Mortality," *MetLife Statistical Bulletin* (April–June 1994): 31–5; based on data from the 1986 National Mortality Followback Survey, the 1986 National Health Interview Survey, and the 1960 Matched Record Study.

education decreased 52%. Mortality for white women with low education decreased 36% from 1960 to 1986, while that for women with high education decreased 40%. Note that in 1986 mortality for white men with high education was lower than that for women with low education; the same was true in the comparison by income for 1986.

APPENDIX B

SUMMARY OF CALCULATION METHOD FOR 1996 INDIVIDUAL ANNUITY MORTALITY TABLES

The method outlined here was briefly described in the Report of the Committee to Recommend a New Mortality Basis for Individual Annuity Valuation.* The computer programs that implemented this method were tested by reproducing from the 1973 Experience Tables both the 1983 Basic Table and the 1983 Table *a* appearing in the report.

If s_x is the annual improvement rate percentage at age x , then multiply $1000q_x$ by $(1-s_x/100)^{13}$ at each age to produce an ungraduated 1996 mortality table. Selecting values of q_x at every fifth age from 7 to 97, the table was graduated by a Jenkins fifth difference osculatory formula. A cubic interpolation formula was fitted to values of q_x at ages 95, 96, and 97 and a value of unity at the limiting age, 115. Mortality rates at ages 5 and 6 were obtained by applying the ratio of $q_7^{1996 \text{ Basic}}/q_7^{1983 \text{ Basic}}$ to $q_5^{1983 \text{ Basic}}$ and $q_6^{1983 \text{ Basic}}$, respectively. This is the same calculation that was used to derive values of q_5 and q_6 in the 1983 Table *a*. The resulting tables are referred to as 1996 Basic Tables.

A loading of 10%, the same loading percentage as that used for the 1983 tables, was deducted from the graduated 1996 Basic Tables to produce ungraduated, loaded tables. Proceeding in the same way as for the 1996 Basic Tables, I applied the Jenkins graduation formula and the cubic curve to produce the graduated 1996 Individual Annuity Mortality Table. Values of q_5 and q_6 were obtained as above for the 1996 Basic Tables except that the numerator of the ratio was the mortality rate for age 7 on the graduated 1996 Annuity Table.

*"Report of the Committee to Recommend a New Mortality Basis for Individual Annuity Valuation (Derivation of the 1983 Table *a*)," *TSA XXXIII* (1981): 694-704.

APPENDIX C
ANNUITY IMPROVEMENT SCALE G

Age Nearest Birthday	Annual Improvement Rate	Age Nearest Birthday	Annual Improvement Rate	Age Nearest Birthday	Annual Improvement Rate
Male					
5	1.50%	45	1.85%	85	1.25%
6	1.50	46	1.80	86	1.25
7	1.50	47	1.75	87	1.25
8	1.25	48	1.75	88	1.20
9	1.00	49	1.75	89	1.15
10	0.75	50	1.75	90	1.10
11	0.50	51	1.75	91	1.05
12	0.25	52	1.75	92	1.00
13	0.24	53	1.70	93	1.00
14	0.23	54	1.65	94	1.00
15	0.22	55	1.60	95	1.00
16	0.21	56	1.55	96	1.00
17	0.20	57	1.50	97	1.00
18	0.18	58	1.50	98	0.80
19	0.16	59	1.50	99	0.60
20	0.14	60	1.50	100	0.40
21	0.12	61	1.50	101	0.20
22	0.10	62	1.50	102	0.00
23	0.10	63	1.50	103	0.00
24	0.10	64	1.50	104	0.00
25	0.10	65	1.50	105	0.00
26	0.10	66	1.50	106	0.00
27	0.10	67	1.50	107	0.00
28	0.23	68	1.45	108	0.00
29	0.36	69	1.40	109	0.00
30	0.49	70	1.35	110	0.00
31	0.62	71	1.30	111	0.00
32	0.75	72	1.25	112	0.00
33	1.00	73	1.25	113	0.00
34	1.25	74	1.25	114	0.00
35	1.50	75	1.25	115	0.00
36	1.75	76	1.25		
37	2.00	77	1.25		
38	2.00	78	1.25		
39	2.00	79	1.25		
40	2.00	80	1.25		
41	2.00	81	1.25		
42	2.00	82	1.25		
43	1.95	83	1.25		
44	1.90	84	1.25		

Sum = 109.50

APPENDIX C—Continued

Age Nearest Birthday	Annual Improvement Rate	Age Nearest Birthday	Annual Improvement Rate	Age Nearest Birthday	Annual Improvement Rate
Female					
5	1.50	45	2.10%	85	1.50%
6	1.50	46	2.05	86	1.50
7	1.50	47	2.00	87	1.50
8	1.40	48	2.00	88	1.45
9	1.30	49	2.00	89	1.40
10	1.20	50	2.00	90	1.35
11	1.10	51	2.00	91	1.30
12	1.00	52	2.00	92	1.25
13	0.90	53	1.95	93	1.25
14	0.80	54	1.90	94	1.25
15	0.70	55	1.85	95	1.25
16	0.60	56	1.80	96	1.25
17	0.50	57	1.75	97	1.25
18	0.50	58	1.75	98	1.00
19	0.50	59	1.75	99	0.75
20	0.50	60	1.75	100	0.50
21	0.50	61	1.75	101	0.25
22	0.50	62	1.75	102	0.00
23	0.55	63	1.75	103	0.00
24	0.60	64	1.75	104	0.00
25	0.65	65	1.75	105	0.00
26	0.70	66	1.75	106	0.00
27	0.75	67	1.75	107	0.00
28	0.85	68	1.75	108	0.00
29	0.95	69	1.75	109	0.00
30	1.05	70	1.75	110	0.00
31	1.15	71	1.75	111	0.00
32	1.25	72	1.75	112	0.00
33	1.45	73	1.70	113	0.00
34	1.65	74	1.65	114	0.00
35	1.85	75	1.60	115	0.00
36	2.05	76	1.55		
37	2.25	77	1.50		
38	2.25	78	1.50		
39	2.25	79	1.50		
40	2.25	80	1.50		
41	2.25	81	1.50		
42	2.25	82	1.50		
43	2.20	83	1.50		
44	2.15	84	1.50		

Sum = 140.00

APPENDIX D
1996 INDIVIDUAL ANNUITY BASIC TABLE

Age Nearest Birthday	1000 q_x	Age Nearest Birthday	1000 q_x	Age Nearest Birthday	1000 q_x
Male					
5	0.344	45	2.097	85	85.600
6	0.320	46	2.363	86	93.466
7	0.304	47	2.647	87	101.851
8	0.342	48	2.943	88	110.762
9	0.373	49	3.253	89	120.192
10	0.398	50	3.576	90	130.139
11	0.419	51	3.914	91	140.593
12	0.436	52	4.266	92	151.547
13	0.450	53	4.634	93	162.997
14	0.462	54	5.017	94	174.935
15	0.473	55	5.411	95	187.361
16	0.485	56	5.816	96	200.266
17	0.498	57	6.230	97	213.647
18	0.513	58	6.655	98	227.911
19	0.531	59	7.109	99	243.465
20	0.552	60	7.616	100	260.717
21	0.575	61	8.196	101	280.073
22	0.600	62	8.874	102	301.940
23	0.628	63	9.670	103	326.726
24	0.658	64	10.603	104	354.838
25	0.687	65	11.691	105	386.683
26	0.716	66	12.951	106	422.667
27	0.742	67	14.402	107	463.199
28	0.764	68	16.055	108	508.685
29	0.783	69	17.910	109	559.532
30	0.798	70	19.958	110	616.148
31	0.808	71	22.194	111	678.939
32	0.815	72	24.609	112	748.312
33	0.818	73	27.206	113	824.676
34	0.822	74	30.019	114	908.436
35	0.831	75	33.093	115	1,000.000
36	0.852	76	36.470		
37	0.889	77	40.194		
38	0.947	78	44.305		
39	1.028	79	48.825		
40	1.134	80	53.775		
41	1.268	81	59.175		
42	1.432	82	65.042		
43	1.627	83	71.396		
44	1.850	84	78.246		

Sum = 11853.681

APPENDIX D—Continued

Age Nearest Birthday	1000 q_x	Age Nearest Birthday	1000 q_x	Age Nearest Birthday	1000 q_x
Female					
5	0.176	45	0.948	85	59.601
6	0.146	46	1.045	86	67.043
7	0.122	47	1.154	87	75.446
8	0.123	48	1.276	88	84.869
9	0.126	49	1.411	89	95.169
10	0.132	50	1.560	90	106.162
11	0.140	51	1.723	91	117.658
12	0.151	52	1.900	92	129.468
13	0.163	53	2.093	93	141.412
14	0.177	54	2.301	94	153.330
15	0.192	55	2.526	95	165.074
16	0.207	56	2.767	96	176.488
17	0.223	57	3.025	97	187.422
18	0.239	58	3.303	98	198.488
19	0.255	59	3.607	99	210.299
20	0.271	60	3.949	100	223.465
21	0.288	61	4.338	101	238.601
22	0.305	62	4.783	102	256.317
23	0.322	63	5.291	103	277.226
24	0.340	64	5.858	104	301.940
25	0.357	65	6.475	105	331.072
26	0.374	66	7.135	106	365.232
27	0.390	67	7.829	107	405.034
28	0.404	68	8.560	108	451.090
29	0.418	69	9.365	109	504.011
30	0.429	70	10.291	110	564.410
31	0.440	71	11.385	111	632.900
32	0.448	72	12.694	112	710.091
33	0.455	73	14.258	113	796.597
34	0.463	74	16.089	114	893.029
35	0.472	75	18.194	115	1,000.000
36	0.486	76	20.578		
37	0.505	77	23.247		
38	0.531	78	26.215		
39	0.566	79	29.523		
40	0.608	80	33.224		
41	0.659	81	37.366		
42	0.718	82	41.999		
43	0.785	83	47.185		
44	0.861	84	53.016		

Sum = 10422.897

APPENDIX E
1996 INDIVIDUAL ANNUITY MORTALITY TABLE

Age Nearest Birthday	1000 q_x	Age Nearest Birthday	1000 q_x	Age Nearest Birthday	1000 q_x
Male					
5	0.310	45	1.887	85	77.080
6	0.288	46	2.124	86	84.158
7	0.274	47	2.377	87	91.701
8	0.307	48	2.643	88	99.715
9	0.335	49	2.922	89	108.196
10	0.358	50	3.213	90	117.140
11	0.376	51	3.516	91	126.540
12	0.392	52	3.829	92	136.392
13	0.405	53	4.153	93	146.691
14	0.417	54	4.487	94	157.432
15	0.427	55	4.833	95	168.615
16	0.438	56	5.190	96	180.232
17	0.451	57	5.560	97	192.282
18	0.465	58	5.947	98	205.218
19	0.481	59	6.365	99	219.494
20	0.500	60	6.834	100	235.563
21	0.520	61	7.372	101	253.878
22	0.543	62	7.997	102	274.893
23	0.567	63	8.728	103	299.061
24	0.593	64	9.579	104	326.834
25	0.618	65	10.564	105	358.668
26	0.642	66	11.696	106	395.014
27	0.664	67	12.989	107	436.326
28	0.682	68	14.456	108	483.057
29	0.697	69	16.096	109	535.662
30	0.709	70	17.913	110	594.592
31	0.718	71	19.903	111	660.302
32	0.724	72	22.068	112	733.244
33	0.729	73	24.414	113	813.872
34	0.735	74	26.967	114	902.640
35	0.747	75	29.761	115	1,000.000
36	0.770	76	32.829		
37	0.807	77	36.205		
38	0.862	78	39.919		
39	0.937	79	43.993		
40	1.034	80	48.449		
41	1.155	81	53.305		
42	1.301	82	58.582		
43	1.473	83	64.299		
44	1.669	84	70.462		

Sum = 11195.038

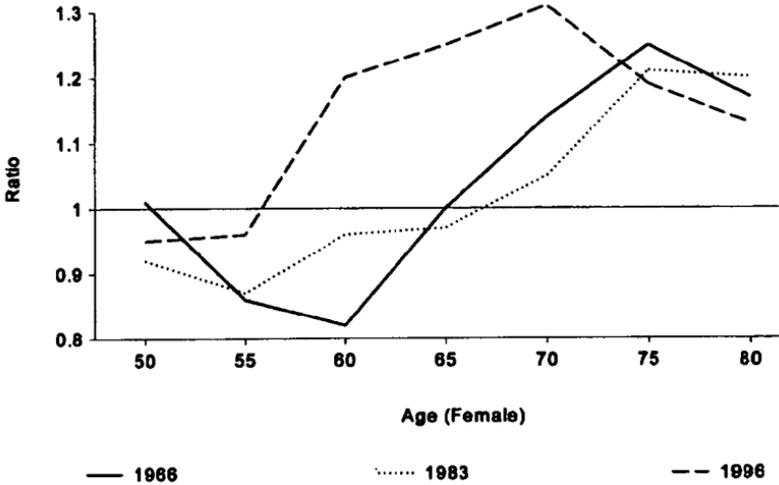
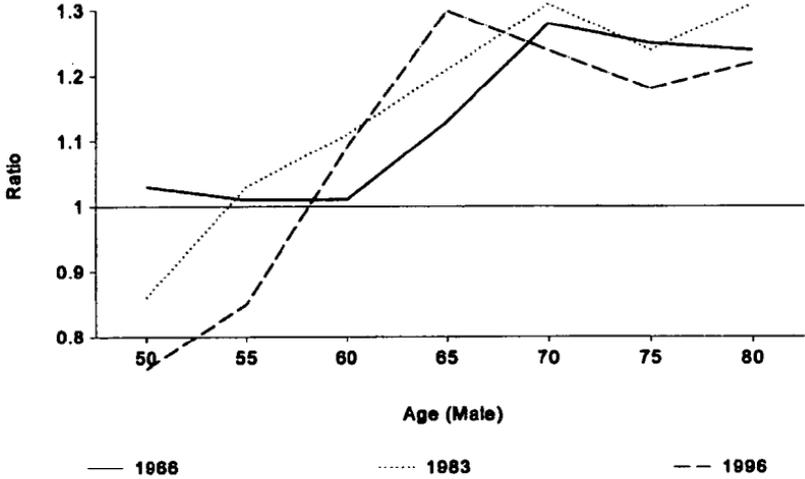
APPENDIX E—Continued

Age Nearest Birthday	1000 q_x	Age Nearest Birthday	1000 q_x	Age Nearest Birthday	1000 q_x
Female					
5	0.159	45	0.853	85	54.057
6	0.131	46	0.941	86	60.857
7	0.110	47	1.039	87	68.464
8	0.111	48	1.149	88	76.911
9	0.114	49	1.270	89	86.087
10	0.119	50	1.403	90	95.846
11	0.127	51	1.548	91	106.039
12	0.136	52	1.705	92	116.521
13	0.147	53	1.876	93	127.149
14	0.159	54	2.060	94	137.798
15	0.172	55	2.260	95	148.351
16	0.186	56	2.477	96	158.684
17	0.200	57	2.713	97	168.680
18	0.215	58	2.970	98	178.961
19	0.230	59	3.252	99	190.149
20	0.245	60	3.566	100	202.865
21	0.260	61	3.916	101	217.733
22	0.276	62	4.308	102	235.373
23	0.291	63	4.746	103	256.408
24	0.307	64	5.231	104	281.459
25	0.322	65	5.762	105	311.150
26	0.336	66	6.339	106	346.100
27	0.350	67	6.963	107	386.933
28	0.362	68	7.637	108	434.271
29	0.373	69	8.390	109	488.734
30	0.383	70	9.256	110	550.947
31	0.392	71	10.268	111	621.529
32	0.400	72	11.459	112	701.104
33	0.407	73	12.859	113	790.292
34	0.415	74	14.484	114	889.717
35	0.426	75	16.345	115	1,000.000
36	0.439	76	18.454		
37	0.457	77	20.822		
38	0.481	78	23.469		
39	0.512	79	26.439		
40	0.549	80	29.786		
41	0.593	81	33.560		
42	0.646	82	37.814		
43	0.706	83	42.605		
44	0.775	84	47.995		

Sum = 9942.177

APPENDIX F

RATIOS OF GROUP ANNUITY MORTALITY TO INDIVIDUAL ANNUITY MORTALITY



DISCUSSION OF PRECEDING PAPER

JOHN M. BRAGG:

Mr. Johansen is to be congratulated for producing this fine paper, which includes a badly needed new valuation table, the 1996 Individual Annuity Mortality Table.

I very much agree with Mr. Johansen that a new annuity study should be compiled. I hope that it could be completed before the year 2000.

It is unfortunate that the 1996 Individual Annuity Basic Table again had to be projected from an earlier table; the original data were for contract anniversaries 1971–1976, which is a long way back. However, that is all that could be done in the absence of new data.

In 1993, Bragg Associates created the 1993 Bragg Old Age Aggregate Tables from insured-life records. The exposure period was 1985–1991; total exposure was \$50.5 billion. The tables are “aggregate” for smoking and for duration but not for sex. The only policy durations included were 6 and up, so that much of the effect of initial selection would have worn off. (This is the basis used in the past to create CSO Basic Tables.)

This is individual insured-life experience, not annuitant experience. However, it is fairly recent, centering in 1989. A comparison with 1996 Individual Annuity Basic is shown below.

Age Nearest Birthday	1000 _q			
	Male		Female	
	1996 IA Basic	1993 Bragg Old Age Aggregate	1996 IA Basic	1993 Bragg Old Age Aggregate
55	5.411	4.82	2.526	3.67
65	11.691	12.20	6.475	7.64
75	33.093	30.73	18.194	19.02
85	85.600	87.30	59.601	66.78
95	187.361	214.69	165.074	210.86

In general, these values are quite similar except at the high age 95. Marginally, the annuitant numbers are perhaps lower than the Bragg Aggregate numbers (as preconceived expectations would expect for annuitant business). I concluded from the above that Improvement Scale G, used by

Mr. Johansen, had done an adequate job. However, Bragg Old Age Aggregate values, centered in 1996 rather than 1989, might be lower than those shown above.

The 10% margin taken off, to arrive at the 1996 IAM Table itself, gives considerable comfort.

Mr. Johansen discusses the question: "Why are mortality ratios under refund business generally lower than those under nonrefund business, a finding that was counter to expectations and prior trends?" I have no magic answers to this question. However, it does occur to me that people who opt for nonrefund annuities are perhaps straining for maximum annuity payments, at all costs, because of economic necessity; economic necessity could go along with higher mortality. We may be entering a period when many preconceived expectations will prove faulty.

(AUTHOR'S REVIEW OF DISCUSSION)

ROBERT J. JOHANSEN:

First let me express my thanks to John M. Bragg for his discussion of my paper. I especially appreciate his seconding of my appeal for a substantial new annuity experience study. The need was illustrated by the effort to develop the interim Annuity 2000 valuation tables described later in this review.

Mr. Bragg's recent insurance mortality rates add some additional foundation to the construction of an annuity table from improvement factors. He may also have come up with the most reasonable argument yet that accounts for higher mortality among nonrefund than among refund annuitants—that nonrefund annuitants are likely to have sought additional income because of economic necessity and that such persons are also likely to experience somewhat higher mortality.

Subsequent to publication of my paper in preprint form, the National Association of Insurance Commissioners (NAIC) Life and Health Actuarial Task Force Annuity Working Group (AWG) decided that a new individual annuity table was needed. However, the working group wanted a more conservative table than the 1996 IAM included in my paper. Initially the AWG wanted a generation table but agreed to an interim static table to be constructed by projecting the 1983 Table *a* for 17 years to the year 2000 using Improvement Scale G. I agreed to produce a set of projected basic and

loaded mortality tables. The Society of Actuaries Committee on Life Insurance Research (COLIFER) appointed a Project Oversight Group* (POG) to review the new tables.

The POG examined recent U.S. population and Social Security improvement rates and also took into consideration the annuitant mortality experience of the company of one of the POG members. This annuity experience indicated that female mortality improvement since 1983 had been only about half that of male annuitants. The POG suggested using only half the female Scale G improvement rates. The new Annuity 2000 Basic and (loaded) Mortality Tables (included with this discussion) reflect this modification. The loading consisted of a deduction of 10% of the Basic Table rates. The resulting rates were then graduated. An adjustment was made to the male table to remove a small dip in the 30s.

The Society of Actuaries Board of Governors authorized COLIFER to make a statement of opinion accepting the table. The opinion states:

The attached Annuity 2000 *Basic* Table represents the Committee on Life Insurance Research's best estimate of the mortality pattern that has resulted from the mortality improvement experienced since 1983. The Committee believes that the Annuity 2000 *Mortality* Table is a suitable basis for the statutory valuation of individual annuity business written on lives in the United States.

Note that this recommendation does not apply to structured settlements.

The following table compares Mr. Bragg's insurance mortality rates with the Annuity 2000 Basic mortality rates. The male and female ratios are quite comparable.

COMPARISON OF 1993 BRAGG OLD AGE AGGREGATE TABLES
WITH ANNUITY 2000 BASIC TABLES

Age Nearest Birthday	Male			Female		
	Annuity 2000 Basic	1993 Bragg Old Age Aggregate	Ratio % 2000 to 1993	Annuity 2000 Basic	1993 Bragg Old Age Aggregate	Ratio % 2000 to 1993
55	5.077	4.82	105.3	2.746	3.67	74.8
65	10.993	12.20	90.1	7.017	7.64	91.8
75	31.477	30.73	102.4	19.551	19.02	102.8
85	81.326	87.30	93.2	63.907	66.78	95.7
95	180.245	214.69	84.0	174.492	210.86	82.8

*Harry Klaristenfeld, Chair, Steve Garavaglia, John Paddon, Mark Peavy, and Jonathan Wooley.

The following tables were attached to my August 21, 1996 report on annuity valuation to the Society's Individual Annuity Mortality Table Project Oversight Group.

- Table 1 is the Annuity 2000 Basic (unloaded) Table.
- Table 2 is the Annuity 2000 (loaded) Mortality Table.
- Table 3 compares the Annuity 2000 Mortality Table with the 1983 Table *a*.
- Table 4 compares immediate annuity single premiums on the 1983 Table *a* and Annuity 2000 Basic Table at 5%, 7%, and 9% interest.
- Tables 5, 6, and 7 summarize pertinent data on annuitant mortality.
- Table 8 provides some annual improvement rates based on U.S. population mortality.
- Table 9 shows a test of smoothness of the Annuity 2000 Mortality Table using first and second differences.

TABLE 1
ANNUITY 2000 BASIC TABLE

Age Nearest Birthday (x)	1000q _x		Age Nearest Birthday (x)	1000q _x	
	Male	Female*		Male	Female*
5	0.324	0.189	61	7.714	4.699
6	0.301	0.156	62	8.348	5.181
7	0.286	0.131	63	9.093	5.732
8	0.328	0.131	64	9.968	6.347
9	0.362	0.134	65	10.993	7.017
10	0.390	0.140	66	12.188	7.734
11	0.413	0.148	67	13.572	8.491
12	0.431	0.158	68	15.160	9.288
13	0.446	0.170	69	16.946	10.163
14	0.458	0.183	70	18.920	11.165
15	0.470	0.197	71	21.071	12.339
16	0.481	0.212	72	23.388	13.734
17	0.495	0.228	73	25.871	15.391
18	0.510	0.244	74	28.552	17.326
19	0.528	0.260	75	31.477	19.551
20	0.549	0.277	76	34.686	22.075
21	0.573	0.294	77	38.225	24.910
22	0.599	0.312	78	42.132	28.074
23	0.627	0.330	79	46.427	31.612
24	0.657	0.349	80	51.128	35.580
25	0.686	0.367	81	56.250	40.030
26	0.714	0.385	82	61.809	45.017
27	0.738	0.403	83	67.826	50.600
28	0.758	0.419	84	74.322	56.865
29	0.774	0.435	85	81.326	63.907
30	0.784	0.450	86	88.863	71.815
31	0.789	0.463	87	96.958	80.682
32	0.789	0.476	88	105.631	90.557
33	0.790	0.488	89	114.858	101.307
34	0.791	0.500	90	124.612	112.759
35	0.792	0.515	91	134.861	124.733
36	0.794	0.534	92	145.575	137.054
37	0.823	0.558	93	156.727	149.552
38	0.872	0.590	94	168.290	162.079
39	0.945	0.630	95	180.245	174.492
40	1.043	0.677	96	192.565	186.647
41	1.168	0.732	97	205.229	198.403
42	1.322	0.796	98	218.683	210.337
43	1.505	0.868	99	233.371	223.027
44	1.715	0.950	100	249.741	237.051
45	1.948	1.043	101	268.237	252.985
46	2.198	1.148	102	289.305	271.406
47	2.463	1.267	103	313.391	292.893
48	2.740	1.400	104	340.940	318.023
49	3.028	1.548	105	372.398	347.373
50	3.330	1.710	106	408.210	381.520
51	3.647	1.888	107	448.823	421.042
52	3.980	2.079	108	494.681	466.516
53	4.331	2.286	109	546.231	518.520
54	4.698	2.507	110	603.917	577.631
55	5.077	2.746	111	668.186	644.427
56	5.465	3.003	112	739.483	719.484
57	5.861	3.280	113	818.254	803.380
58	6.265	3.578	114	904.945	896.693
59	6.694	3.907	115	1000.000	1000.000
60	7.170	4.277			

*Based on 50% of Female Improvement Scale G.

TABLE 2
ANNUITY 2000 MORTALITY TABLE

Age Nearest Birthday (x)	1000q _x		Age Nearest Birthday (x)	1000q _x	
	Male	Female*		Male	Female*
5	0.291	0.171	61	6.933	4.242
6	0.270	0.141	62	7.520	4.668
7	0.257	0.118	63	8.207	5.144
8	0.294	0.118	64	9.008	5.671
9	0.325	0.121	65	9.940	6.250
10	0.350	0.126	66	11.016	6.878
11	0.371	0.133	67	12.251	7.555
12	0.388	0.142	68	13.657	8.287
13	0.402	0.152	69	15.233	9.102
14	0.414	0.164	70	16.979	10.034
15	0.425	0.177	71	18.891	11.117
16	0.437	0.190	72	20.967	12.386
17	0.449	0.204	73	23.209	13.871
18	0.463	0.219	74	25.644	15.592
19	0.480	0.234	75	28.304	17.564
20	0.499	0.250	76	31.220	19.805
21	0.519	0.265	77	34.425	22.328
22	0.542	0.281	78	37.948	25.158
23	0.566	0.298	79	41.812	28.341
24	0.592	0.314	80	46.037	31.933
25	0.616	0.331	81	50.643	35.985
26	0.639	0.347	82	55.651	40.552
27	0.659	0.362	83	61.080	45.690
28	0.675	0.376	84	66.948	51.456
29	0.687	0.389	85	73.275	57.913
30	0.694	0.402	86	80.076	65.119
31	0.699	0.414	87	87.370	73.136
32	0.700	0.425	88	95.169	81.991
33	0.701	0.436	89	103.455	91.577
34	0.702	0.449	90	112.208	101.758
35	0.704	0.463	91	121.402	112.395
36	0.719	0.481	92	131.017	123.349
37	0.749	0.504	93	141.030	134.486
38	0.796	0.532	94	151.422	145.689
39	0.864	0.567	95	162.179	156.846
40	0.953	0.609	96	173.279	167.841
41	1.065	0.658	97	184.706	178.563
42	1.201	0.715	98	196.946	189.604
43	1.362	0.781	99	210.484	201.557
44	1.547	0.855	100	225.806	215.013
45	1.752	0.939	101	243.398	230.565
46	1.974	1.035	102	263.745	248.805
47	2.211	1.141	103	287.334	270.326
48	2.460	1.261	104	314.649	295.719
49	2.721	1.393	105	346.177	325.576
50	2.994	1.538	106	382.403	360.491
51	3.279	1.695	107	423.813	401.054
52	3.576	1.864	108	470.893	447.860
53	3.884	2.047	109	524.128	501.498
54	4.203	2.244	110	584.004	562.563
55	4.534	2.457	111	651.007	631.645
56	4.876	2.689	112	725.622	709.338
57	5.228	2.942	113	808.336	796.233
58	5.593	3.218	114	899.633	892.923
59	5.988	3.523	115	1000.000	1000.000
60	6.428	3.863			

*Based on 50% of Female Improvement Scale G.

TABLE 3
COMPARISON OF ANNUITY 2000 MORTALITY TABLE WITH 1983 TABLE α

Age Nearest Birthday (x)	1000q _x		Ratio 2000/1983	Age Nearest Birthday (x)	1000q _x		Ratio 2000/1983
	1983 Mortality Table α	Annuity 2000 Mortality Table			1983 Mortality Table α	Annuity 2000 Mortality Table	
Male				Male			
5	0.377	0.291	77.19	61	8.983	6.933	77.18
6	0.350	0.270	77.14	62	9.740	7.520	77.21
7	0.333	0.257	77.18	63	10.630	8.207	77.21
8	0.352	0.294	83.52	64	11.664	9.008	77.23
9	0.368	0.325	88.32	65	12.851	9.940	77.35
10	0.382	0.350	91.62	66	14.199	11.016	77.58
11	0.394	0.371	94.16	67	15.717	12.251	77.95
12	0.405	0.388	95.80	68	17.414	13.657	78.43
13	0.415	0.402	96.87	69	19.296	15.233	78.94
14	0.425	0.414	97.41	70	21.371	16.979	79.45
15	0.435	0.425	97.70	71	23.647	18.891	79.89
16	0.446	0.437	97.98	72	26.131	20.967	80.24
17	0.458	0.449	98.03	73	28.835	23.209	80.49
18	0.472	0.463	98.09	74	31.794	25.644	80.66
19	0.488	0.480	98.36	75	35.046	28.304	80.76
20	0.505	0.499	98.81	76	38.631	31.220	80.82
21	0.525	0.519	98.86	77	42.587	34.425	80.83
22	0.546	0.542	99.27	78	46.951	37.948	80.82
23	0.570	0.566	99.30	79	51.755	41.812	80.79
24	0.596	0.592	99.33	80	57.026	46.037	80.73
25	0.622	0.616	99.04	81	62.791	50.643	80.65
26	0.650	0.639	98.31	82	69.081	55.651	80.56
27	0.677	0.659	97.34	83	75.908	61.080	80.47
28	0.704	0.675	95.88	84	83.230	66.948	80.44
29	0.731	0.687	93.98	85	90.987	73.275	80.53
30	0.759	0.694	91.44	86	99.122	80.076	80.79
31	0.786	0.699	88.93	87	107.577	87.370	81.22
32	0.814	0.700	86.00	88	116.316	95.169	81.82
33	0.843	0.701	83.16	89	125.394	103.455	82.50
34	0.876	0.702	80.14	90	134.887	112.208	83.19
35	0.917	0.704	76.77	91	144.873	121.402	83.80
36	0.968	0.719	74.28	92	155.429	131.017	84.29
37	1.032	0.749	72.58	93	166.629	141.030	84.64
38	1.114	0.796	71.45	94	178.537	151.422	84.81
39	1.216	0.864	71.05	95	191.214	162.179	84.82
40	1.341	0.953	71.07	96	204.721	173.279	84.64
41	1.492	1.065	71.38	97	219.120	184.706	84.29
42	1.673	1.201	71.79	98	234.735	196.946	83.90
43	1.886	1.362	72.22	99	251.889	210.484	83.56
44	2.129	1.547	72.66	100	270.906	225.806	83.35
45	2.399	1.752	73.03	101	292.111	243.398	83.32
46	2.693	1.974	73.30	102	315.826	263.745	83.51
47	3.009	2.211	73.48	103	342.377	287.334	83.92
48	3.343	2.460	73.59	103	372.086	314.649	84.56
49	3.694	2.721	73.66	105	405.278	346.177	85.42
50	4.057	2.994	73.80	106	442.277	382.403	86.46
51	4.431	3.279	74.00	107	483.406	423.813	87.67
52	4.812	3.576	74.31	108	528.989	470.893	89.02
53	5.198	3.884	74.72	109	579.351	524.128	90.47
54	5.591	4.203	75.17	110	634.814	584.004	92.00
55	5.994	4.534	75.64	111	695.704	651.007	93.58
56	6.409	4.876	76.08	112	762.343	725.622	95.18
57	6.839	5.228	76.44	113	835.056	808.336	96.80
58	7.290	5.593	76.72	114	914.167	899.633	98.41
59	7.782	5.988	76.95	115	1000.000	1000.000	100.00
60	8.338	6.428	77.09				

TABLE 3—Continued

Age Nearest Birthday (x)	1000q _x		Ratio 2000/1983	Age Nearest Birthday (x)	1000q _x		Ratio 2000/1983
	1983 Mortality Table a	Annuity 2000 Mortality Table			1983 Mortality Table a	Annuity 2000 Mortality Table	
Female*				Female*			
5	0.194	0.171	88.14	61	4.908	4.242	86.43
6	0.160	0.141	88.13	62	5.413	4.668	86.24
7	0.134	0.118	88.06	63	5.990	5.144	85.88
8	0.134	0.118	88.06	64	6.633	5.671	85.50
9	0.136	0.121	88.97	65	7.336	6.250	85.20
10	0.141	0.126	89.36	66	8.090	6.878	85.02
11	0.147	0.133	90.48	67	8.888	7.555	85.00
12	0.155	0.142	91.61	68	9.731	8.287	85.16
13	0.165	0.152	92.12	69	10.653	9.102	85.44
14	0.175	0.164	93.71	70	11.697	10.034	85.78
15	0.188	0.177	94.15	71	12.905	11.117	86.14
16	0.201	0.190	94.53	72	14.319	12.386	86.50
17	0.214	0.204	95.33	73	15.980	13.871	86.80
18	0.229	0.219	95.63	74	17.909	15.592	87.06
19	0.244	0.234	95.90	75	20.127	17.564	87.27
20	0.260	0.250	96.15	76	22.654	19.805	87.42
21	0.276	0.265	96.01	77	25.509	22.328	87.53
22	0.293	0.281	95.90	78	28.717	25.158	87.61
23	0.311	0.298	95.82	79	32.328	28.341	87.67
24	0.330	0.314	95.15	80	36.395	31.933	87.74
25	0.349	0.331	94.84	81	40.975	35.985	87.82
26	0.368	0.347	94.29	82	46.121	40.552	87.93
27	0.387	0.362	93.54	83	51.889	45.690	88.05
28	0.405	0.376	92.84	84	58.336	51.456	88.21
29	0.423	0.389	91.96	85	65.518	57.913	88.39
30	0.441	0.402	91.16	86	73.493	65.119	88.61
31	0.460	0.414	90.00	87	82.318	73.136	88.85
32	0.479	0.425	88.73	88	92.017	81.991	89.10
33	0.499	0.436	87.37	89	102.491	91.577	89.35
34	0.521	0.449	86.18	90	113.605	101.758	89.57
35	0.545	0.463	84.95	91	125.227	112.395	89.75
36	0.574	0.481	83.80	92	137.222	123.349	89.89
37	0.607	0.504	83.03	93	149.462	134.486	89.98
38	0.646	0.532	82.35	94	161.834	145.689	90.02
39	0.691	0.567	82.05	95	174.228	156.846	90.02
40	0.742	0.609	82.08	96	186.535	167.841	89.98
41	0.801	0.658	82.15	97	198.646	178.563	89.89
42	0.867	0.715	82.47	98	211.102	189.604	89.82
43	0.942	0.781	82.91	99	224.445	201.557	89.80
44	1.026	0.855	83.33	100	239.215	215.013	89.88
45	1.122	0.939	83.69	101	255.953	230.565	90.08
46	1.231	1.035	84.08	102	275.201	248.805	90.41
47	1.356	1.141	84.14	103	297.500	270.326	90.87
48	1.499	1.261	84.12	103	323.390	295.719	91.44
49	1.657	1.393	84.07	105	353.414	325.576	92.12
50	1.830	1.538	84.04	106	388.111	360.491	92.88
51	2.016	1.695	84.08	107	428.023	401.054	93.70
52	2.215	1.864	84.15	108	473.692	447.860	94.55
53	2.426	2.047	84.38	109	525.658	501.498	95.40
54	2.650	2.244	84.68	110	584.462	562.563	96.25
55	2.891	2.457	84.99	111	650.646	631.645	97.08
56	3.151	2.689	85.34	112	724.750	709.338	97.87
57	3.432	2.942	85.72	113	807.316	796.233	98.63
58	3.739	3.218	86.07	114	898.885	892.923	99.34
59	4.081	3.523	86.33	115	1000.000	1000.000	100.00
60	4.467	3.863	86.48				

*Based on 50% of Female Improvement Scale G.

TABLE 4
COMPARISON OF ANNUITY SINGLE PREMIUMS
1983 TABLE α VERSUS ANNUITY 2000 MORTALITY TABLE
IMMEDIATE ANNUITY \$1 PER ANNUM

Age	5% Interest			7% Interest			9% Interest		
	1983 Table α	Annuity 2000 Table	Ratio 2000/1983	1983 Table α	Annuity 2000 Table	Ratio 2000/1983	1983 Table α	Annuity 2000 Table	Ratio 2000/1983
Male									
60	12.355	12.991	1.051	10.279	10.712	1.042	8.736	9.042	1.035
65	10.918	11.603	1.063	9.265	9.756	1.053	7.999	8.362	1.045
70	9.362	10.075	1.076	8.106	8.643	1.066	7.115	7.528	1.058
75	7.775	8.501	1.093	6.867	7.439	1.083	6.130	6.588	1.075
80	6.237	6.946	1.114	5.613	6.197	1.104	5.092	5.578	1.095
85	4.861	5.502	1.132	4.450	4.996	1.123	4.097	4.568	1.115
90	3.722	4.247	1.141	3.459	3.919	1.133	3.228	3.634	1.126
95	2.757	3.208	1.164	2.598	3.004	1.156	2.455	2.822	1.149
Female									
60	13.613	13.929	1.023	11.148	11.354	1.018	9.356	9.497	1.015
65	12.262	12.617	1.029	10.246	10.491	1.024	8.734	8.909	1.020
70	10.728	11.107	1.035	9.158	9.434	1.030	7.941	8.147	1.026
75	9.016	9.411	1.044	7.868	8.171	1.039	6.948	7.186	1.034
80	7.239	7.635	1.055	6.455	6.774	1.049	5.807	6.068	1.045
85	5.543	5.913	1.067	5.041	5.353	1.062	4.615	4.880	1.057
90	4.100	4.429	1.080	3.793	4.079	1.075	3.525	3.776	1.071
95	3.033	3.318	1.094	2.845	3.101	1.090	2.677	2.908	1.086
Ratio of Female to Male Annuity Single Premiums									
60	1.102	1.072		1.085	1.060		1.071	1.050	
65	1.123	1.087		1.106	1.075		1.092	1.065	
70	1.146	1.102		1.130	1.092		1.116	1.082	
75	1.160	1.107		1.146	1.098		1.133	1.091	
80	1.161	1.099		1.150	1.093		1.140	1.088	
85	1.140	1.075		1.133	1.071		1.126	1.068	
90	1.102	1.043		1.097	1.041		1.092	1.039	
95	1.100	1.034		1.095	1.032		1.090	1.030	

TABLE 5
 RATIOS OF ACTUAL TO EXPECTED MORTALITY ON VARIOUS TABLES
 FROM 1971-76, 1976-86, AND 1987-91^a ANNUITY MORTALITY STUDIES
 BY AMOUNTS OF ANNUAL INCOME FOR ALL CONTRACT YEARS
 (EXPECTED DEATHS BASED ON TABLE INDICATED)

Age Group	A/E Ratio for Male Lives (%)					A/E Ratio for Female Lives (%)				
	Based on 1983 Table a			Based on 1996 Table	Based on 2000 Table	Based on 1983 Table a			Based on 1996 Table	Based on 2000 Table
	1971-76 ^b	1976-86	1987-91	1987-91 ^b	1987-91 ^b	1971-76 ^b	1976-86	1987-91	1987-91 ^b	1987-91 ^b
Nonrefund Annuities										
<50	c	c	c	c	c	c	c	c	c	c
50-59	93 ^d	84 ^d	c	c	c	308 ^d	338 ^d	c	c	c
60-69	129	138	82 ^d	99 ^d	106 ^d	107	131	84 ^d	107 ^d	99
70-79	104	151	92	108	114	91	156	82	101	94
80-89	81	114	83	98	103	93	115	90	109	102
90 and Up	102	112	137	155	162	92	114	77	90	86
All	94	121	98			94	120	82		
Refund Annuities										
<50	352 ^d	508 ^d	c	c	c	354 ^d	442 ^d	c	c	c
50-59	174	158 ^d	c	c	c	264	242 ^d	c	c	c
60-69	108	105	93	112	120	129	129	174	222	204
70-79	100	99	88	104	109	94	105	109	134	125
80-89	96	101	80	94	99	105	98	98	119	111
90 and Up	107	119	86	98	101	102	96	92	108	102
All	102	104	86			104	103	102		
Settlements from Maturities and Surrenders (Excluding Pension Trust)—Refund										
<50	c	c	c	c	c	c	1,891 ^a	c	c	c
50-59	239	105	c	c	c	154 ^d	103	c	c	c
60-69	135	123	108	130	140	126	110	110	140	129
70-79	143	117	87	102	108	132	121	102	126	117
80-89	144	118	111	131	138	134	105	93	113	105
90 and Up	136	117	127	144	150	133	90	109	128	121
All	142	118	106			132	108	101		
Matured Deferred Annuities (Excluding Pension Trust)—Refund										
<50	c	c	c	c	c	c	c	c	c	c
50-59	c	c	c	c	c	c	389 ^d	c	c	c
60-69	147	134	c	c	c	141	129	c	c	c
70-79	132	99	88	104	109	132	115	124	153	142
80-89	139	128	96	113	119	137	123	110	133	124
90 and Up	141	126	107	121	126	129	130	118	139	131
All	138	119	102			136	124	115		
Matured Deferred Annuities (Excluding Pension Trust)—Nonrefund										
<50	c	c	c	c	c	c	c	c	c	c
50-59	c	c	c	c	c	c	c	c	c	c
60-69	117	109 ^d	c	c	c	131	c	c	c	c
70-79	141	167	c	c	c	147	127	81 ^d	100 ^d	93
80-89	161	124	90	106	112	140	105	95	115	107
90 and Up	138	107	131	149	154	138	110	100	117	111
All	139	126	111			143	109	97		

^aBased on unpublished data.

^bEstimated.

^cLess than 10 deaths.

^d10-49 deaths.

^eAnnuity 2000 using 50% of Scale G.

Note: The 1987-91 Study contains contributions from only five companies.

TABLE 6
ANNUAL MORTALITY IMPROVEMENT RATES 1973 TO 1989
1971-76 ANNUITY MORTALITY STUDY AND 1987-91 ANNUITY MORTALITY STUDY*
BY AMOUNTS OF ANNUAL INCOME FOR ALL CONTRACT YEARS
(EXPECTED DEATHS BASED ON 1983 TABLE a;
1971-76 ACT/EXP ADJUSTED TO 1983 TABLE a)

Age Group	Male Lives			Female Lives		
	1971-76 A/E Ratio (%)	1987-91 A/E Ratio (%)	Annual Improvement Rate (%)	1971-76 A/E Ratio (%)	1987-91 A/E Ratio (%)	Annual Improvement Rate (%)
Nonrefund Annuities						
<50	b	b	b	b	b	b
50-59	93 ^c	b	b	308 ^c	b	b
60-69	129	82 ^c	2.78 ^c	107	84 ^c	1.51 ^c
70-79	104	92	0.75	91	82	0.66
80-89	81	83	-0.16	93	90	0.17
90 and Up	102	137	-1.84	92	77	1.12
All Ages	94	98	-0.24	94	82	0.84
Refund Annuities						
<50	352 ^c	b	b	354 ^c	b	b
50-59	174	b	b	264	b	b
60-69	108	93	0.91	129	174	-1.89
70-79	100	88	0.81	94	109	-0.95
80-89	96	80	1.16	105	98	0.40
90 and Up	107	86	1.34	102	92	0.67
All Ages	102	86	1.04	104	102	0.14
Settlements from Maturities and Surrenders (Excluding Pension Trust)—Refund						
<50	b	b	b	b	b	b
50-59	239	b	b	154 ^c	b	b
60-69	135	108	1.37	126	110	0.86
70-79	143	87	3.05	132	102	1.60
80-89	144	111	1.62	134	93	2.25
90 and Up	136	127	0.43	133	109	1.24
All Ages	142	106	1.80	132	101	1.68
Matured Deferred Annuities (Excluding Pension Trust)—Refund						
<50	b	b	b	b	b	b
50-59	b	b	b	b	b	b
60-69	147	b	b	141	b	b
70-79	132	88	2.50	132	124	0.40
80-89	139	96	2.31	137	110	1.38
90 and Up	141	107	1.71	129	118	0.56
All Ages	138	102	1.87	136	115	1.02
Matured Deferred Annuities (Excluding Pension Trust)—Nonrefund						
<50	b	b	b	b	b	b
50-59	b	b	b	b	b	b
60-69	117	b	b	131	b	b
70-79	141	b	b	147	81 ^c	3.66 ^c
80-89	161	90	3.58	140	95	2.41
90 and Up	138	131	0.33	138	100	2.00
All Ages	139	111	1.40	143	97	2.39

*Based on unpublished data.

^bLess than 10 deaths in 1971-76 and/or 1987-91 Study.

^c10-49 deaths in 1976-86 and/or 1987-91.

Note: The 1987-91 Study contains contributions from only five companies.

TABLE 7
 ANNUAL MORTALITY IMPROVEMENT RATES 1983 TO 1989
 1976-86 ANNUITY MORTALITY STUDY AND 1987-91 ANNUITY MORTALITY STUDY^a
 BY AMOUNTS OF ANNUAL INCOME FOR ALL CONTRACT YEARS
 (EXPECTED DEATHS BASED ON 1983 TABLE a)

Age Group	Male Lives			Female Lives		
	1976-86 A/E Ratio (%)	1987-91 A/E Ratio (%)	Annual Improvement Rate (%)	1976-86 A/E Ratio (%)	1987-91 A/E Ratio (%)	Annual Improvement Rate (%)
Nonrefund Annuities						
<50	b	b	b	b	b	b
50-59	84 ^c	b	b	338 ^c	b	b
60-69	138	82 ^c	8.31 ^c	131	84 ^c	7.14 ^c
70-79	151	92	7.93	156	82	10.16
80-89	114	83	5.15	115	90	4.00
90 and Up	112	137	-3.42	114	77	6.33
All Ages	121	98	3.45	120	82	6.15
Refund Annuities						
<50	508 ^c	b	b	442 ^c	b	b
50-59	158 ^c	b	b	242 ^c	b	b
60-69	105	93	2.00	129	174	-5.11
70-79	99	88	1.94	105	109	-0.63
80-89	101	80	3.81	98	98	0.00
90 and Up	119	86	5.27	96	92	0.71
All Ages	104	86	3.12	103	102	0.16
Settlements from Maturities and Surrenders (Excluding Pension Trust)—Refund						
<50	b	b	b	1,891	b	b
50-59	105	b	b	103	b	b
60-69	123	108	2.14	110	110	0.00
70-79	117	87	4.82	121	102	2.81
80-89	118	111	1.01	105	93	2.00
90 and Up	117	127	-1.38	90	109	-3.24
All Ages	118	106	1.77	108	101	1.11
Matured Deferred Annuities (Excluding Pension Trust)—Refund						
<50	b	b	b	b	b	b
50-59	b	b	b	389 ^c	b	b
60-69	134	b	b	129	b	b
70-79	99	88	1.94	115	124	-1.26
80-89	128	96	4.68	123	110	1.84
90 and Up	126	107	2.69	130	118	1.60
All Ages	119	102	2.54	124	115	1.25
Matured Deferred Annuities (Excluding Pension Trust)—Nonrefund						
<50	b	b	b	b	b	b
50-59	b	b	b	b	b	b
60-69	109 ^c	b	b	b	b	b
70-79	167	b	b	127	81 ^c	7.22 ^c
80-89	124	90	5.20	105	95	1.65
90 and Up	107	131	-3.43	110	100	1.58
All Ages	126	111	2.09	109	97	1.93

^aBased on unpublished data.

^bLess than 10 deaths in 1976-86 and/or 1987-91.

^c10-49 deaths in 1976-86 and/or 1987-91.

Note: The 1987-91 Study contains contributions from only five companies.

TABLE 8
ANNUAL MORTALITY IMPROVEMENT RATES 1985 TO 1995
FOR THE U.S. WHITE POPULATION

Sex and Age Group	Mortality Rates per 100,000				Improvement Rates (%)			
	1985	1993 ^b	1994 ^b	1995 ^{a,b}	1985-93	1993-94	1994-95	1985-95
Male Lives								
5-14	30.1	26.1	22.8	23.3	1.77	12.64	-2.19	2.53
14-24	134.2	121.7	129.9	127.1	1.21	-6.74	2.16	0.54
25-34	158.8	186.2	179.1	181.0	-2.01	3.81	-1.06	-1.32
35-44	243.1	282.2	288.6	285.5	-1.88	-2.27	1.07	-1.62
45-54	611.7	540.7	523.1	533.6	1.53	3.26	-2.01	1.36
55-64	1625.8	1391.3	1382.4	1314.8	1.93	0.64	4.89	2.10
65-74	3770.7	3334.7	3260.7	3188.8	1.52	2.22	2.21	1.66
75-84	8486.1	7672.1	7433.9	7354.5	1.25	3.10	1.07	1.42
85 and Up	18980.1	18229.2	18126.6	17962.8	0.50	0.56	0.90	0.55
Female Lives								
5-14	19.5	17.6	17.2	16.1	1.27	2.27	6.40	1.90
15-24	48.1	44.9	43.2	42.8	0.86	3.79	0.93	1.16
25-34	59.4	62.9	62.8	64.6	-0.72	0.16	-2.87	-0.84
35-44	121.9	117.1	119.9	122.5	0.50	-2.39	-2.17	-0.05
45-54	341.7	295.7	291.2	297.5	1.79	1.52	-2.16	1.38
55-64	869.1	810.1	788.7	785.5	0.87	2.64	0.41	1.01
65-74	2027.1	1929.2	1928.7	1909.7	0.62	0.03	0.99	0.59
75-84	5111.6	4787.9	4878.4	4823.8	0.81	-1.89	1.12	0.58
85 and Up	14745.4	14669.1	14460.4	14496.0	0.06	1.42	-0.25	0.17

^a12 months ending November.

^bRates for 1993, 1994 and 1995 are provisional.

Source: *Monthly Vital Statistics Report* (NCHS) Vol. 43, no. 13 (October 23, 1995); Vol. 44, no. 12 (July 24, 1996).

TABLE 9
VALUES OF $1000q_x$ AND FIRST AND SECOND DIFFERENCES
ANNUITY 2000 MORTALITY TABLE

Age (x)	Annuity 2000 Mortality Table $1000q_x$	First Difference	Second Difference	Age (x)	Annuity 2000 Mortality Table $1000q_x$	First Difference	Second Difference
Male				Male			
5	0.291	-0.021	0.008	61	6.933	0.587	0.100
6	0.270	-0.013	0.050	62	7.520	0.687	0.114
7	0.257	0.037	-0.006	63	8.207	0.801	0.131
8	0.294	0.031	-0.006	64	9.008	0.932	0.144
9	0.325	0.025	-0.004	65	9.940	1.076	0.159
10	0.350	0.021	-0.004	66	11.016	1.235	0.171
11	0.371	0.017	-0.003	67	12.251	1.406	0.170
12	0.388	0.014	-0.002	68	13.657	1.576	0.170
13	0.402	0.012	-0.001	69	15.233	1.746	0.166
14	0.414	0.011	0.001	70	16.979	1.912	0.164
15	0.425	0.012	0.000	71	18.891	2.076	0.166
16	0.437	0.012	0.002	72	20.967	2.242	0.193
17	0.449	0.014	0.003	73	23.209	2.435	0.225
18	0.463	0.017	0.002	74	25.644	2.660	0.256
19	0.480	0.019	0.001	75	28.304	2.916	0.289
20		0.020	0.003	76	31.220	3.205	0.318
21	0.499	0.023	0.001	77	34.425	3.523	0.341
22	0.519	0.024	0.002	78	37.948	3.864	0.361
23	0.542	0.026	-0.002	79	41.812	4.225	0.381
24	0.566	0.024	-0.001	80	46.037	4.606	0.402
	0.592						
25	0.616	0.023	-0.003	81	50.643	5.008	0.421
26	0.639	0.020	-0.004	82	55.651	5.429	0.439
27	0.659	0.016	-0.004	83	61.080	5.868	0.459
28	0.675	0.012	-0.005	84	66.948	6.327	0.474
29	0.687	0.007	-0.002	85	73.275	6.801	0.493
30	0.694	0.005	-0.004	86	80.076	7.294	0.505
31	0.699	0.001	0.000	87	87.370	7.799	0.487
32	0.700	0.001	0.000	88	95.169	8.286	0.467
33	0.701	0.001	0.001	89	103.455	8.753	0.441
34	0.702	0.002	0.013	90	112.208	9.194	0.421
35	0.704	0.015	0.015	91	121.402	9.615	0.398
36	0.719	0.030	0.017	92	131.017	10.013	0.379
37	0.749	0.047	0.021	93	141.030	10.392	0.365
38	0.796	0.068	0.021	94	151.422	10.757	0.343
39	0.864	0.089	0.023	95	162.179	11.100	0.327
40	0.953	0.112	0.024	96	173.279	11.427	0.813
41	1.065	0.136	0.025	97	184.706	12.240	1.298
42	1.201	0.161	0.024	98	196.946	13.538	1.784
43	1.362	0.185	0.020	99	210.484	15.322	2.270
44	1.547	0.205	0.017	100	225.806	17.592	2.755
45	1.752	0.222	0.015	101	243.398	20.347	3.242
46	1.974	0.237	0.012	102	263.745	23.589	3.726
47	2.211	0.249	0.012	103	287.334	27.315	4.213
48	2.460	0.261	0.012	104	314.649	31.528	4.698
49	2.721	0.273	0.012	105	346.177	36.226	5.184
50	2.994	0.285	0.012	106	382.403	41.410	5.670
51	3.279	0.297	0.011	107	423.813	47.080	6.155
52	3.576	0.308	0.011	108	470.893	53.235	6.641
53	3.884	0.319	0.012	109	524.128	59.876	7.127
54	4.203	0.331	0.011	110	584.004	67.003	7.612
55	4.534	0.342	0.010	111	651.007	74.615	8.099
56	4.876	0.352	0.013	112	725.622	82.714	8.583
57	5.228	0.365	0.030	113	808.336	91.297	9.070
58	5.593	0.395	0.045	114	899.633	100.367	
59	5.988	0.440	0.065	115	1000.000		
60	6.428	0.505	0.082				

TABLE 9—Continued

Age (x)	Annuity 2000 Mortality Table 1000q _x	First Difference	Second Difference	Age (x)	Annuity 2000 Mortality Table 1000q _x	First Difference	Second Difference
Female*				Female*			
5	0.171	-0.030	0.007	61	4.242	0.426	0.050
6	0.141	-0.023	0.023	62	4.668	0.476	0.051
7	0.118	0.000	0.003	63	5.144	0.527	0.052
8	0.118	0.003	0.002	64	5.671	0.579	0.049
9	0.121	0.005	0.002	65	6.250	0.628	0.049
10	0.126	0.007	0.002	66	6.878	0.677	0.055
11	0.133	0.009	0.001	67	7.555	0.732	0.083
12	0.142	0.010	0.002	68	8.287	0.815	0.117
13	0.152	0.012	0.001	69	9.102	0.932	0.151
14	0.164	0.013	0.000	70	10.034	1.083	0.186
15	0.177	0.013	0.001	71	11.117	1.269	0.216
16	0.190	0.014	0.001	72	12.386	1.485	0.236
17	0.204	0.015	0.000	73	13.871	1.721	0.251
18	0.219	0.015	0.001	74	15.592	1.972	0.269
19	0.234	0.016	-0.001	75	17.564	2.241	0.282
20	0.250	0.015	0.001	76	19.805	2.523	0.307
21	0.265	0.016	0.001	77	22.328	2.830	0.353
22	0.281	0.017	-0.001	78	25.158	3.183	0.409
23	0.298	0.016	0.001	79	28.341	3.592	0.460
24	0.314	0.017	-0.001	80	31.933	4.052	0.515
25	0.331	0.016	-0.001	81	35.985	4.567	0.571
26	0.347	0.015	-0.001	82	40.552	5.138	0.628
27	0.362	0.014	-0.001	83	45.690	5.766	0.691
28	0.376	0.013	0.000	84	51.456	6.457	0.749
29	0.389	0.013	-0.001	85	57.913	7.206	0.811
30	0.402	0.012	-0.001	86	65.119	8.017	0.838
31	0.414	0.011	0.000	87	73.136	8.855	0.731
32	0.425	0.011	0.002	88	81.991	9.586	0.595
33	0.436	0.013	0.001	89	91.577	10.181	0.456
34	0.449	0.014	0.004	90	101.758	10.637	0.317
35	0.463	0.018	0.005	91	112.395	10.954	0.183
36	0.481	0.023	0.005	92	123.349	11.137	0.066
37	0.504	0.028	0.007	93	134.486	11.203	-0.046
38	0.532	0.035	0.007	94	145.689	11.157	-0.162
39	0.567	0.042	0.007	95	156.846	10.995	-0.273
40	0.609	0.049	0.008	96	167.841	10.722	0.319
41	0.658	0.057	0.009	97	178.563	11.041	0.912
42	0.715	0.066	0.008	98	189.604	11.953	1.503
43	0.781	0.074	0.010	99	201.557	13.456	2.096
44	0.855	0.084	0.012	100	215.013	15.552	2.688
45	0.939	0.096	0.010	101	230.565	18.240	3.281
46	1.035	0.106	0.014	102	248.805	21.521	3.872
47	1.141	0.120	0.012	103	270.326	25.393	4.464
48	1.261	0.132	0.013	104	295.719	29.857	5.058
49	1.393	0.145	0.012	105	325.576	34.915	5.648
50	1.538	0.157	0.012	106	360.491	40.563	6.243
51	1.695	0.169	0.014	107	401.054	46.806	6.832
52	1.864	0.183	0.014	108	447.860	53.638	7.427
53	2.047	0.197	0.016	109	501.498	61.065	8.017
54	2.244	0.213	0.019	110	562.563	69.082	8.611
55	2.457	0.232	0.021	111	631.645	77.693	9.202
56	2.689	0.253	0.023	112	709.338	86.895	9.795
57	2.942	0.276	0.029	113	796.233	96.690	10.387
58	3.218	0.305	0.035	114	892.923	107.077	
59	3.523	0.340	0.039	115	1000.000		
60	3.863	0.379	0.047				

*Based on 50% of Female Improvement Scale G.

