Continuous Mortality Investigation Reports

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THE EXECUTIVE COMMITTEE OF THE CONTINUOUS MORTALITY INVESTIGATION BUREAU

as on 6th July 1993

INTRODUCTION

THE Executive Committee of the Continuous Mortality Investigation Bureau of the Institute of Actuaries and the Faculty of Actuaries has pleasure in presenting this, the thirteenth number of its Reports. This number contains a variety of reports relating both to the mortality investigations and to the PHI investigations.

The routine report on the Mortality of Assured Lives, Pensioners and Annuitants for 1983–86 was published in *C.M.I.R.* **11** in 1991. The first report in this number of *C.M.I.R.* updates that report, by comparing the experience with the new mortality tables, The "80" Series Tables, which were first published in *C.M.I.R.* **10**.

The "80" Series Tables have also been published in a printed volume with that title, and in the Standard Tables Programme, a computer program for use on PCs, which has replaced the former system of publishing extensive monetary functions in printed volumes. Many actuaries are already making use of the Standard Tables Programme. Others who wish to find out more about it can apply to the Secretariat of the Bureau for information.

The second paper in this number of *C.M.I.R.* is a routine report on the Mortality of Assured Lives for 1983–86 according to Cause of Death. This continues to identify certain causes of death that seem to be successfully eliminated by medical underwriting of new policies, and also shows the differences between the causes of death among assured lives and among the general population.

The third paper presents graduated mortality tables that form a supplement to the "80" Series, based on the Combined Pensioners Experience 1979–82, that is including both pensioners who retire at or after their normal retirement date and those who retire before their normal retirement date. It is hoped that this table will find certain uses, but potential users are warned that it is not appropriate for every purpose.

In previous reports the Committee has often shown a way in which a recent standard table can be adjusted to approximate to current experience. This has been done in a comprehensive way for all the mortality experiences for 1983–86, and what have been styled "mini-graduations" are presented in the next paper in this number.

An important investigation by the Bureau into the mortality experience of smokers and non-smokers, as defined by life offices at the time policies are effected, commenced in 1988. After two year's data had been collected the

Committee felt that the results were of sufficient interest to present them immediately, before waiting until the data to the end of the quadrennium (1990) was also available. The results for 1988 and 1989 confirm what was known from American studies, that the mortality rates of smokers are approximately double those of non-smokers. It will be interesting to see whether this continues as the investigation continues.

From time to time the Committee is asked how the mortality experience of individual offices varies around the average for all offices. After the 1924–29 investigation, tables of "light" and "heavy" mortality, constructed by putting together the data from selected offices, were published. It is difficult to find a way to let people know the inter-office variation, without releasing information that is confidential to individual offices. A method of doing this has now been devised, and the results are presented in the paper entitled "Inter-Office Comparisons".

In its large report published in *C.M.I.R.* **12**. "The Analysis of Permanent Health Insurance Data", the PHI Sub-Committee presented certain methods of calculation that could be applied whatever the mathematical formulae for representing forces of recovery and of mortality among those claiming sickness benefits under PHI policies. In fact the formulae used were such that analytical methods of integration are possible, and these are presented in the next paper in this number. There are advantages in being able to do certain calculations exactly, without resorting to approximation.

A report as large as the one that appeared in *C.M.I.R.* **12** is unlikely to be entirely free of errors, and the Errata to that report appear next.

Finally, an Index to the first thirteen numbers of *C.M.I. Reports* has been prepared.

I should like to take the opportunity to thank Raymond Hayward for his many years of work as Secretary of the PHI Sub-Committee. His place as Secretary of that Sub-Committee and as Assistant Secretary of the Bureau has been taken by Peter McGurk, but Raymond continues to give us his assistance and advice as a member of the PHI Sub-Committee.

Others who have retired from the Committees of the Bureau are Bernard Brindley and Iain Lumsden, who have served on the Executive Committee, and Alan Jefferies who has served on the PHI Sub-Committee for some years. I thank all of them for their services.

I should like to welcome also John Lockyer and Ralph Garden to the Executive Committee. John Lockyer has been Chairman of the AIDS Working Party of the Institute of Actuaries, which has now been transformed into the AIDS Sub-Committee of the Bureau. We welcome him and the members of his Sub-Committee. Ralph Garden has served on the PHI Sub-Committee for several years.

Finally, I should like to pay tribute to the work of a former employee of the Bureau, Miss Kitty Hicks, who served the Bureau from 1961 to 1975. She died in 1992 in her 90th year.

August, 1993

A. D. Wilkie
Chairman, Executive Committee

CONTENTS

THE MORTALITY OF ASSURED LIVES, PENSIONERS AND ANNUITANTS EXPERIENCE FOR 1983–86: UPDATE

The main report on the mortality experiences for the quadrennium 1983–86 was published in 1990 in *C.M.I.R.* **11**. In that report the standard tables used for the calculation of the expected deaths and the ratios 100A/E were the latest such tables available at that time. These were for male assured lives the A1967–70 table, for female assured lives the FA1975–78 table, for pensioners the PA(90) table and for retirement annuitants and immediate annuitants the a(90) table. The experience of female assured lives was also compared using the A1967–70 table minus four years.

It was noted in the report in *C.M.I.R.* **11** that a new set of standard tables of mortality, based on the 1979–82 experiences, was in course of preparation and that a comparison of the mortality experience of 1983–86 with that expected using the new standard tables would form the subject of a separate report to appear in a later number of *C.M.I.R.*. The standard tables were duly published as the "80" series and the comparisons have now been completed. The results are contained in the tables which make up the bulk of this report. For each investigation the actual deaths are shown, together with the statistic 100A/E for both the appropriate new table and the old table which it replaces. Comparisons for female assured lives using the A1967–70 table minus four years are not shown. Keen observers will note that for pensioners and relicts of pensioners the actual deaths and the ratios 100A/E on the old bases differ marginally from those shown in *C.M.I.R.* **11**. The reason for this is two-fold; a small amount of additional data was received which has been included while a revised data vetting procedure has resulted in the exclusion of a certain amount of data at very high ages.

The new tables for pensioners, widows and annuitants were published in the form of a base table, appropriate to the year 1980, together with a formula for projection factors to allow for future improvements in mortality. This allows rates for any future year, based on the projections, to be calculated. For comparison purposes for these groups the Executive Committee has decided to use the projected rates for the calendar year 2010. There is room for debate as to which is the most appropriate year to use; however, the essential point is that, whichever year is chosen, it provides a constant standard by which secular changes can be measured. For pensioners, the ratios 100A/E are also shown for each year of the quadrennium using the projected rates for the year under investigation.

Part of the value of the regular reports of the Bureau lies in the study of trends from quadrennium to quadrennium. The tables in this report form a bridge

between the series published using the old comparison bases and those to be published using the new; it is hoped that by this means any disruption caused by the change in bases can be minimised. The table numbers used are broadly the same as those for the corresponding tables in *C.M.I.R.*11, which publication also included a detailed commentary on the results. No further commentary is included in this volume.

ASSURED LIVES, PENSIONERS AND ANNUITANTS EXPERIENCE
1983-86

List of tables

Table 1.1.1 Permanent (whole life and endowment) assurances, males, 1983–86, medical and non-medical combined: actual deaths and ratios of actual deaths to those expected using the A1967–70 table and the AM80 table.

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Duration 0			
−20	51	81	90
21–25	84	88	91
26–30	97	126	127
31–35	89	105	114
36–40	121	90	105
41–45	135	79	94
46–50	176	74	87
51–55	276	86	98
56–60	192	86	93
61–65	131	90	92
66–70	99	109	107
71–	95	151	136
All ages	1,546	91	99
Duration 1			
−20	37	79	88
21–25	91	89	96
26–30	84	83	91
31–35	103	91	106
36–40	128	73	85
41–45	186	85	98
46–50	227	75	84
51–55	324	77	85
56–60	279	81	88
61–65	188	90	98
66–70	153	99	107
71–	122	116	126
All ages	1,922	84	93

Table 1.1.1. (continued).

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Durations 2 and over			
–20	61	91	103
21–25	300	76	86
26–30	698	87	101
31–35	1,386	83	101
36–40	3,074	76	96
41–45	4,604	71	89
46–50	7,770	71	89
51–55	12,115	69	86
56–60	17,282	72	88
61–65	17,363	77	94
66–70	5,225	71	86
71–75	5,472	74	87
76–80	5,730	81	94
81–85	4,118	86	97
86–90	2,111	85	94
91–95	883	79	85
96–100	226	57	60
101–	24	31	22
All ages	88,442	74	90

Note: a proportion of the data received for this investigation is returned with a combined medical code. The figures in Table 1.1.1 are, therefore, greater than the sum of the corresponding figures for Table 1.1.2 and Table 1.1.3.

Table 1.1.2 Permanent (whole life and endowment) assurances, males, 1983–86, medical data: actual deaths and ratios of actual deaths to those expected using the A1967–70 table and the AM80 table.

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Duration 0			
−20	2	250	282
21–25	2	108	111
26–30	3	135	136
31–35	3	100	109
36–40	0	–	–
41–45	2	26	31
46–50	12	103	121
51–55	20	89	101
56–60	21	82	89
61–65	27	68	71
66–70	27	80	78
71–	32	120	109
All ages	151	84	87
Duration 1			
−20	3	461	508
21–25	3	138	148
26–30	3	90	99
31–35	3	62	73
36–40	4	50	59
41–45	12	104	119
46–50	15	90	101
51–55	25	78	86
56–60	29	72	79
61–65	38	75	82
66–70	34	69	75
71–	55	104	113
All ages	224	82	90

Table 1.1.2. (continued).

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Durations 2 and over			
–20	3	261	300
21–25	10	112	127
26–30	31	86	100
31–35	131	102	124
36–40	379	90	113
41–45	632	73	93
46–50	1,256	68	86
51–55	2,213	66	82
56–60	3,690	67	82
61–65	4,655	68	84
66–70	2,365	66	79
71–75	3,044	71	84
76–80	3,747	79	91
81–85	2,886	86	97
86–90	1,541	85	94
91–95	697	79	85
96–100	190	57	60
101–	20	21	22
All ages	27,490	72	86

Table 1.1.3 Permanent (whole life and endowment) assurances, males, 1983–86, non-medical data: actual deaths and ratios of actual deaths to those expected using the A1967–70 table and the AM80 table.

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Duration 0			
–20	49	79	87
21–25	82	88	91
26–30	93	124	126
31–35	86	106	114
36–40	120	93	108
41–45	132	81	97
46–50	163	73	85
51–55	253	85	97
56–60	171	87	94
61–65	103	98	100
66–70	72	129	126
71–	63	180	161
All ages	1,387	91	101
Duration 1			
–20	34	74	82
21–25	88	88	95
26–30	81	83	91
31–35	100	92	107
36–40	124	74	87
41–45	173	84	96
46–50	211	74	83
51–55	298	77	85
56–60	250	82	90
61–65	145	92	100
66–70	117	112	122
71–	65	130	141
All ages	1,686	84	93

Table 1.1.3. (continued).

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Durations 2 and over			
−20	57	87	99
21–25	286	74	84
26–30	661	87	100
31–35	1,245	81	99
36–40	2,680	75	94
41–45	3,922	70	89
46–50	6,445	71	90
51–55	9,789	70	88
56–60	13,397	73	90
61–65	12,473	80	98
66–70	2,755	76	92
71–75	2,301	78	93
76–80	1,821	87	101
81–85	1,058	87	98
86–90	467	84	93
91–95	155	80	86
96–100	30	53	56
101–	3	30	31
All ages	59,545	75	92

Table 1.2.1 Permanent (whole life and endowment) assurances, females, 1983–86, medical and non-medical combined: actual deaths and ratios of actual deaths to those expected using the FA1975–78 table and the AF80 table.

Age group (nearest ages)	Actual deaths	100 A/E by FA1975–78	100 A/E by AF80
Duration 0			
−25	15	44	48
26–35	51	88	124
36–45	73	71	86
46–55	97	60	65
56–65	111	80	93
66–	135	116	166
All ages	482	79	95
Duration 1			
−25	30	105	98
26–35	49	80	87
36–45	99	87	86
46–55	181	96	83
56–65	162	96	78
66–	141	108	89
All ages	662	96	84
Durations 2 and over			
−20	7	66	60
21–25	60	78	85
26–30	125	69	90
31–35	241	68	88
36–40	459	71	90
41–45	625	79	96
46–50	993	90	105
51–55	1,291	81	92
56–60	1,473	80	88
61–65	1,214	85	92
66–70	554	72	77
71–75	463	75	79
76–80	404	77	83
81–85	307	98	109
86–90	212	112	134
91–	143	75	104
All ages	8,571	81	92

Note: a proportion of the data received for this investigation is returned with a combined medical code. The figures in Table 1.2.1 are, therefore, greater than the sum of the corresponding figures for Table 1.2.2 and Table 1.2.3.

Table 1.2.2 Permanent (whole life and endowment) assurances, females, 1983–86, medical data: actual deaths and ratios of actual deaths to those expected using the FA1975–78 table and the AF80 table.

Age group (nearest ages)	Actual deaths	100 A/E by FA1975–78	100 A/E by AF80
Duration 0			
All ages	59	97	127
Duration 1			
All ages	76	99	83
Durations 2 and over			
−30	6	78	98
31–35	16	95	124
36–40	30	84	105
41–45	44	83	101
46–50	73	86	101
51–55	124	96	108
56–60	130	62	69
61–65	180	67	73
66–70	140	63	67
71–75	158	63	66
76–80	178	66	70
81–85	137	83	92
86–90	120	109	130
91–	85	70	97
All ages	1,421	73	81

Table 1.2.3 Permanent (whole life and endowment) assurances, females, 1983–86, non-medical data: actual deaths and ratios of actual deaths to those expected using the FA1975–78 table and the AF80 table.

Age group (nearest ages)	Actual deaths	100 A/E by FA1975–78	100 A/E by AF80
Duration 0			
All ages	419	76	92
Duration 1			
All ages	579	95	84
Durations 2 and over			
–20	7	68	61
21–25	60	80	88
26–30	116	67	87
31–35	225	67	87
36–40	425	71	89
41–45	575	79	96
46–50	914	91	106
51–55	1,155	80	91
56–60	1,332	82	91
61–65	1,019	90	97
66–70	394	75	80
71–75	294	85	89
76–80	206	89	95
81–85	155	122	136
86–90	71	121	145
91–	47	89	122
All ages	6,995	83	94

Table 1.3.1 Level and decreasing temporary assurances combined, males, 1983–86, medical and non-medical combined: actual deaths and ratios of actual deaths to those expected using the A1967–70(5) table and the TM80 table.

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70(5)	100 A/E by TM80
Duration 0			
−30	75	127	152
31–45	222	92	111
46–60	237	78	92
61–	62	94	125
All ages	596	89	107
Durations 1–4			
−25	25	58	74
26–30	92	72	92
31–35	189	83	109
36–40	300	71	98
41–45	372	72	95
46–50	388	63	81
51–55	453	69	90
56–60	424	77	101
61–65	220	73	96
66–	79	65	85
All ages	2,542	71	93
Durations 5 and over			
−30	33	68	87
31–35	157	71	95
36–40	478	68	98
41–45	710	63	88
46–50	1,057	66	88
51–55	1,198	63	82
56–60	1,276	67	87
61–65	930	68	88
66–	272	63	83
All ages	6,111	66	87

Table 1.3.2 Level and decreasing temporary assurances combined, females, 1983–86, medical and non-medical combined: actual deaths and ratios of actual deaths to those expected using the FA1975–78 table and the AF80 table.

Age group (nearest ages)	Actual deaths	100 A/E by FA1975–78	100 A/E by AF80
Duration 0			
All ages	85	65	80
Durations 1–4			
–30	35	58	69
31–45	167	62	74
46–60	103	56	60
61–	30	74	74
All ages	335	61	69
Durations 5 and over			
–45	132	62	78
46–60	120	75	85
61–	26	79	85
All ages	278	69	82

Table 1.4.1 Linked contracts of life assurance, males, 1983–86, medical and non-medical combined: actual deaths and ratios of actual deaths to those expected using the A1967–70 table and the AM80 table.

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Duration 0			
−30	53	127	133
31–45	79	84	98
46–60	187	71	80
61–75	216	126	125
76–	60	227	189
All ages	595	100	107
Duration 1			
−30	28	86	94
31–45	85	95	110
46–60	229	82	90
61–75	230	107	116
76–	101	216	234
All ages	673	102	112
Durations 2 and over			
−20	8	134	159
21–25	22	80	90
26–30	37	74	86
31–35	89	106	129
36–40	110	64	80
41–45	167	62	78
46–50	308	66	83
51–55	465	58	72
56–60	709	57	71
61–65	727	58	70
66–70	387	61	73
71–75	280	60	71
76–80	284	78	91
81–85	143	76	86
86–90	54	57	63
91–	19	86	93
All ages	3,809	62	76

Table 1.4.2 Linked contracts of life assurance, females, 1983–86, medical and non-medical combined: actual deaths and ratios of actual deaths to those expected using the FA1975–78 table and the AF80 table.

Age group (nearest ages)	Actual deaths	100 A/E by FA1975–78	100 A/E by AF80
Duration 0			
–30	6	77	93
31–45	18	71	89
46–60	43	60	67
61–75	70	88	115
76–	181	302	499
All ages	318	130	169
Duration 1			
–30	3	57	57
31–45	21	100	101
46–60	57	90	76
61–75	56	74	60
76–	220	261	239
All ages	357	143	125
Durations 2 and over			
–30	14	119	142
31–35	10	63	82
36–40	25	79	99
41–45	29	62	75
46–50	65	86	101
51–55	89	66	75
56–60	145	72	80
61–65	116	55	60
66–70	130	77	82
71–75	129	67	71
76–80	208	96	103
81–85	237	116	130
86–90	165	109	131
91–	58	55	75
All ages	1,420	81	90

Table 1.5.1 Joint life first death assurances written on one male life and one female life, 1983–86, medical and non-medical combined: actual male deaths and ratios of actual male deaths to those expected using the A1967–70 table and the AM80 table.

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Duration 0			
−30	10	39	40
31–35	12	74	80
36–40	12	53	62
41–45	6	27	32
46–50	13	48	57
51–55	37	68	77
56–60	32	108	118
61–	15	119	121
All ages	137	65	73
Duration 1			
−30	17	77	83
31–35	15	91	106
36–40	24	111	131
41–45	18	87	100
46–50	18	78	87
51–55	35	73	81
56–60	22	67	73
61–	12	77	83
All ages	161	80	90
Durations 2 and over			
−30	40	67	77
31–35	53	64	77
36–40	80	70	87
41–45	71	61	77
46–50	75	59	75
51–55	81	54	67
56–60	81	58	71
61–65	59	68	83
66–70	24	68	82
71–	11	45	53
All ages	575	61	76

Table 1.5.2 Joint life first death assurances written on one male life and one female life, 1983–86, medical and non-medical combined: actual female deaths and ratios of actual female deaths to those expected using the FA1975–78 table and the AF80 table.

Age group (nearest ages)	Actual deaths	100 A/E by FA1975–78	100 A/E by AF80
Duration 0			
−30	10	55	71
31–45	9	25	32
46–60	27	67	74
61–	1	29	35
All ages	47	48	57
Duration 1			
−30	6	43	45
31–45	17	54	55
46–60	31	88	75
61–	3	82	67
All ages	57	68	63
Durations 2 and over			
−30	20	38	49
31–35	38	59	76
36–40	35	43	54
41–45	50	75	91
46–50	34	57	66
51–55	28	48	54
56–60	23	54	60
61–65	17	74	80
66–	14	90	96
All ages	259	56	67

Table 1.6.1 Guaranteed acceptance assurances, males, 1983–86: actual deaths and ratios of actual deaths to those expected using the A1967–70 table and the AM80 table. At durations 0 and 1 comparisons using both the select and the ultimate rates are shown.

Age group (nearest ages)	Actual deaths	100A/E A1967–70 Select	100A/E A1967–70 Ultimate	100A/E AM80 Select	100A/E AM80 Ultimate
Duration 0					
–30	16	119	82	122	94
31–40	28	192	134	217	166
41–50	25	123	80	145	101
51–60	13	216	120	243	151
61–	2	1,429	606	1,429	667
All ages	84	154	102	172	124
Duration 1					
–30	16	89	76	97	87
31–40	37	155	132	181	163
41–50	47	130	102	147	129
51–60	19	134	94	148	117
61–	3	492	291	536	375
All ages	122	132	105	148	129
Durations 2 and over					
–30	18		80		92
31–35	18		107		129
36–40	15		60		76
41–45	32		100		126
46–50	44		100		126
51–55	37		105		131
56–60	16		145		179
61–	5		195		238
All ages	185		98		121

Table 1.6.2 Guaranteed acceptance assurances, females, 1983–86: actual deaths and ratios of actual deaths to those expected using the FA1975–78 table and the AF80 table. At durations 0 and 1 comparisons using both the select and the ultimate rates are shown.

Age group (nearest ages)	Actual deaths	100A/E FA1975–78 Select	100A/E FA1975–78 Ultimate	100A/E AF80 Select	100A/E AF80 Ultimate
Duration 0					
All ages	15	168	101	205	123
Duration 1					
All ages	25	167	111	161	134
Durations 2 and over					
All ages	29		80		96

Table 1.7.1a Minimum evidence assurances written on one life only, males, 1983–86: actual deaths and ratios of actual deaths to those expected using the A1967–70 table and the AM80 table.

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Duration 0			
−25	13	81	83
26–30	24	149	151
31–35	20	160	172
36–40	21	116	135
41–45	20	94	112
46–50	19	83	97
51–	1	43	48
All ages	118	108	120
Duration 1			
−25	5	69	74
26–30	10	86	94
31–35	10	103	120
36–40	4	29	34
41–45	20	124	143
46–50	13	70	78
51–	5	83	91
All ages	67	80	91
Durations 2 and over			
−30	12	123	141
31–40	12	54	67
41–50	37	92	116
51–60	14	75	94
61–	0	0	0
All ages	75	82	101

Table 1.7..b Minimum evidence assurances written on one male life and one female life, 1983–86: actual male deaths and ratios of actual male deaths to those expected using the A1967–70 table and the AM80 table.

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Duration 0			
−25	11	59	61
26–30	16	77	78
31–35	17	84	91
36–40	17	57	67
41–45	16	51	61
46–50	13	45	53
51–	0	0	0
All ages	90	60	67
Duration 1			
−25	6	77	83
26–30	8	67	73
31–35	9	81	94
36–40	10	65	76
41–45	15	93	107
46–50	10	66	74
51–	1	35	39
All ages	59	73	83
Durations 2 and over			
−30	6	137	158
31–40	4	53	65
41–50	6	59	74
51–	0	0	0
All ages	16	66	82

Table 1.7.2a Minimum evidence assurances written on one life only, females, 1983–86: actual deaths and ratios of actual deaths to those expected using the FA1975–78 table and the AF80 table.

Age group (nearest ages)	Actual deaths	100 A/E by FA1975–78	100 A/E by AF80
Duration 0			
All ages	8	45	55
Duration 1			
All ages	7	96	95
Durations 2 and over			
All ages	2	85	104

Table 1.7.2b Minimum evidence assurances written on one male life and one female life, 1983–86: actual female deaths and ratios of actual female deaths to those expected using the FA1975–78 table and the AF80 table.

Age group (nearest ages)	Actual deaths	100 A/E by FA1975–78	100 A/E by AF80
Duration 0			
–30	14	53	68
31–40	17	55	73
41–50	13	60	68
51–	0	0	0
All ages	44	56	70
Duration 1			
–30	4	34	35
31–40	15	101	107
41–50	10	92	85
51–	2	426	364
All ages	31	82	82
Durations 2 and over			
All ages	6	44	55

Table 2.1.1a Permanent (whole life and endowment) assurances, policies issued in the Republic of Ireland, males 1983–86, medical and non-medical combined: actual deaths and ratios of actual deaths to those expected using the A1967–70 table and the AM80 table.

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Duration 0			
All ages	76	128	140
Duration 1			
All ages	64	100	111
Durations 2 and over			
−25	8	67	76
26–30	36	111	129
31–35	46	72	88
36–40	97	74	93
41–45	169	71	91
46–50	310	77	97
51–55	472	75	93
56–60	780	93	115
61–65	869	93	114
66–70	326	107	128
71–75	193	83	99
76–80	211	104	121
81–85	138	104	117
86–90	51	74	82
91–	22	96	102
All ages	3,728	88	107

Table 2.1.1b Permanent (whole life and endowment) assurances, policies issued in the Republic of Ireland, males 1983–86, medically examined: actual deaths and ratios of actual deaths to those expected using the A1967–70 table and the AM80 table.

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Duration 0			
All ages	10	110	117
Duration 1			
All ages	8	70	77
Durations 2 and over			
–30	6	271	316
31–35	5	61	74
36–40	21	81	102
41–45	37	63	80
46–50	79	65	82
51–55	169	75	93
56–60	309	85	105
61–65	421	90	110
66–70	253	110	133
71–75	158	82	97
76–80	179	102	118
81–85	112	97	109
86–90	42	70	78
91–	21	103	110
All ages	1,812	88	106

Table 2.1.1c Permanent (whole life and endowment) assurances, policies issued in the Republic of Ireland, males 1983–86, non-medical data: actual deaths and ratios of actual deaths to those expected using the A1967–70 table and the AM80 table.

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Duration 0			
All ages	66	131	145
Duration 1			
All ages	56	106	119
Durations 2 and over			
−25	7	60	68
26–30	31	102	118
31–35	41	74	90
36–40	76	72	90
41–45	132	74	94
46–50	231	82	104
51–55	303	74	93
56–60	471	99	123
61–65	448	97	118
66–70	73	96	116
71–75	35	90	107
76–80	32	121	140
81–85	26	149	168
86–	10	85	94
All ages	1,916	88	109

Table 2.1.2 Permanent (whole life and endowment) assurances, policies issued in the Republic of Ireland, females, 1983–86, medical and non-medical combined: actual deaths and ratios of actual deaths to those expected using the FA1975–78 table and the AF80 table.

Age group (nearest ages)	Actual deaths	100 A/E by FA1975–78	100 A/E by AF80
Duration 0			
All ages	3	31	37
Duration 1			
All ages	12	122	113
Durations 2 and over			
−30	10	117	146
31–35	9	98	128
36–40	17	132	166
41–45	23	136	165
46–50	28	138	161
51–55	17	70	79
56–60	20	70	78
61–65	24	84	91
66–70	9	73	78
71–75	12	147	155
76–	19	66	77
All ages	188	95	109

Table 2.2.1 Linked contracts of life assurance, policies issued in the Republic of Ireland, males, 1983–86, medical and non-medical combined: actual deaths and ratios of actual deaths to those expected using the A1967–70 table and the AM80 table.

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70	100 A/E by AM80
Duration 0			
−30	26	123	127
31–40	12	81	92
41–50	23	95	112
51–60	18	75	83
61–	0	0	0
All ages	79	93	103
Duration 1			
−30	24	91	99
31–40	15	72	84
41–50	36	113	128
51–60	26	79	87
61–	4	159	174
All ages	105	92	102
Durations 2 and over			
−25	33	117	133
26–30	37	91	106
31–35	54	98	119
36–40	86	96	120
41–45	86	65	82
46–50	188	103	130
51–55	211	92	115
56–60	220	94	116
61–65	148	88	107
66–	38	76	91
All ages	1,101	91	112

Table 2.2.2 Linked contracts of life assurance, policies issued in the Republic of Ireland, females, 1983–86, medical and non-medical combined: actual deaths and ratios of actual deaths to those expected using the FA1975–78 table and the AF80 table.

Age group (nearest ages)	Actual deaths	100 A/E by FA1975–78	100 A/E by AF80
Duration 0			
All ages	13	61	72
Duration 1			
All ages	32	121	113
Durations 2 and over			
–30	13	84	101
31–45	27	58	72
46–60	78	99	112
61–	25	93	100
All ages	143	85	99

Table 3.1.1a Pensioners who retired at or after the normal age, 1983–86, males,'lives': actual deaths and ratios of actual deaths to those expected using the PA(90) table for males and the PMA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths	100 A/E by PA(90) males	100 A/E by PMA80C10
–60	68	107	248
61–65	996	91	175
66–70	11,725	94	156
71–75	21,736	101	145
76–80	23,294	107	137
81–85	17,233	111	130
86–90	6,720	109	123
91–	2,089	101	111
All ages	83,861	104	138

Table 3.1.1b Pensioners who retired before the normal age, 1983–86, males, 'lives': actual deaths and ratios of actual deaths to those expected using the PA(90) table for males and the PMA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths	100 A/E by PA(90) males	100 A/E by PMA80C10
–55	301	266	559
55–60	1,465	149	342
61–65	5,132	123	243
66–70	7,172	118	199
71–75	7,099	114	164
76–80	5,388	115	147
81–85	1,953	111	131
86–90	417	104	117
91–	108	110	121
All ages	29,035	119	180

Table 3.1.1c Pensioners normal, late and early retirements combined, 1983–86, males, 'lives': actual deaths and ratios of actual deaths to those expected using the PA(90) table for males and the PMA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths	100 A/E by PA(90) males	100 A/E by PMA80C10
–55	313	260	546
56–60	1,521	147	335
61–65	6,128	117	229
66–70	18,897	102	170
71–75	28,835	104	149
76–80	28,682	109	138
81–85	19,186	111	130
86–90	7,137	109	122
91–	2,197	101	112
All ages	112,896	108	147

Table 3.1.2a Pensioners who retired at or after the normal age, 1983–86, males, 'amounts': actual deaths and ratios of actual deaths to those expected using the PA(90) table for males and the PMA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths (£000 pa)	100 A/E by PA(90) males	100 A/E by PMA80C10
–60	144	115	259
61–65	1,326	78	153
66–70	6,404	75	125
71–75	8,014	82	117
76–80	6,534	91	117
81–85	4,096	101	119
86–90	1,422	104	116
91–	461	105	116
All ages	28,401	86	121

Table 3.1.2b Pensioners who retired before the normal age, 1983–86, males, 'amounts': actual deaths and ratios of actual deaths to those expected using the PA(90) table for males and the PMA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths (£000pa)	100 A/E by PA(90) males	100 A/E by PMA80C10
−55	225	209	440
56–60	1,117	117	267
61–65	4,052	101	200
66–70	3,903	90	152
71–75	2,949	97	140
76–80	1,710	103	132
81–85	531	110	130
86–90	84	96	108
91–	25	162	178
All ages	14,596	99	163

Table 3.1.2c Pensioners normal, late and early retirements combined, 1983–86, males, 'amounts': actual deaths and ratios of actual deaths to those expected using the PA(90) table for males and the PMA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths (£000pa)	100 A/E by PA(90) males	100 A/E by PMA80C10
−55	234	204	429
56–60	1,252	117	266
61–65	5,378	94	186
66–70	10,307	80	134
71–75	10,963	85	123
76–80	8,244	94	119
81–85	4,627	102	120
86–90	1,506	103	116
91–	486	107	118
All ages	42,997	90	132

Table 3.1.3a Pensioners who retired at or after the normal age, 1983–86, females, 'lives': actual deaths and ratios of actual deaths to those expected using the PA(90) table for females and the PFA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths	100 A/E by PA(90) females	100 A/E by PFA80C10
–60	69	116	197
61–65	1,026	114	191
66–70	1,414	100	164
71–75	2,083	96	143
76–80	2,779	100	130
81–85	2,675	102	122
86–90	1,410	101	118
91–	589	104	132
All ages	12,045	101	136

Table 3.1.3b Pensioners who retired before the normal age, 1983–86, females, 'lives': actual deaths and ratios of actual deaths to those expected using the PA(90) table for females and the PFA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths	100 A/E by PA(90) females	100 A/E by PFA80C10
–55	89	255	414
56–60	328	180	303
61–65	554	146	245
66–70	405	121	198
71–75	378	105	157
76–80	327	104	136
81–85	229	94	112
86–90	147	109	127
91–	36	90	112
All ages	2,493	123	179

Table 3.1.3c Pensioners normal, late and early retirements combined, 1983–86, females, 'lives': actual deaths and ratios of actual deaths to those expected using the PA(90) table for females and the PFA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths	100 A/E by PA(90) females	100 A/E by PFA80C10
–55	100	260	422
56–60	386	162	274
61–65	1,580	124	207
66–70	1,819	104	171
71–75	2,461	97	145
76–80	3,106	100	130
81–85	2,904	102	121
86–90	1,557	102	119
91–	625	103	130
All ages	14,538	104	142

Table 3.1.4a Pensioners who retired at or after the normal age, 1983–86, females, 'amounts': actual deaths and ratios of actual deaths to those expected using the PA(90) table for females and the PFA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths (£000pa)	100 A/E by PA(90) females	100 A/E by PFA80C10
–60	33	85	143
61–65	422	102	171
66–70	401	82	135
71–75	455	85	127
76–80	465	88	114
81–85	352	87	103
86–90	176	102	119
91–	75	109	139
All ages	2,379	90	127

Table 3.1.4b Pensioners who retired before the normal age, 1983–86, females, 'amounts': actual deaths and ratios of actual deaths to those expected using the PA(90) table for females and the PFA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths (£000pa)	100 A/E by PA(90) females	100 A/E by PFA80C10
−55	39	230	372
56–60	132	156	263
61–65	201	137	230
66–70	102	104	171
71–75	76	102	153
76–80	41	93	122
81–85	23	84	100
86–90	11	108	125
91–	2	99	123
All ages	627	124	193

Table 3.1.4c Pensioners normal, late and early retirements combined, 1983–86, females, 'amounts': actual deaths and ratios of actual deaths to those expected using the PA(90) table for females and the PFA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths (£000pa)	100 A/E by PA(90) females	100 A/E by PFA80C10
−55	44	221	360
56–60	160	133	224
61–65	623	111	186
66–70	503	86	141
71–75	531	87	130
76–80	506	88	115
81–85	375	87	103
86–90	187	102	119
91–	77	109	138
All ages	3,006	95	137

Table 3.1.5a Pensioners who retired at or after the normal age, males, 1983-86: actual deaths for individual years, on the basis of 'amounts', expressed as a percentage of those expected using the projected rates for the year from the PMA80 table.

Age group (nearest ages)	1983	1984	1985	1986
-60	66	187	260	167
61-65	94	112	108	120
66-70	94	99	95	86
71-75	91	93	96	87
76-80	101	90	90	97
81-85	103	106	100	93
86-90	107	99	103	98
91-	100	106	120	93
All ages	97	97	96	92

Table 3.1.5b Pensioners who retired at or after the normal age, females, 1983-86: actual deaths for individual years, on the basis of 'amounts', expressed as a percentage of those expected using the projected rates for the year from the PFA80 table.

Age group (nearest ages)	1983	1984	1985	1986
-60	93	89	85	124
61-65	132	139	132	92
66-70	146	100	87	83
71-75	95	97	104	100
76-80	93	104	100	77
81-85	84	86	95	83
86-90	115	94	104	102
91-	90	183	130	98
All ages	108	105	103	88

Table 3.2.1a Widows 1983–86, 'lives': actual deaths and ratios of actual deaths to those expected using the PA(90) table for females and the projected rates for calendar year 2010 from the PFA80 table and the WA80 table.

Age group (nearest ages)	Actual deaths	100A/E by PA(90) females	100A/E by PFA80C10	100A/E by WA80C10
–55	55	196	313	212
56–60	89	163	274	189
61–65	173	126	211	147
66–70	326	140	228	161
71–75	347	103	155	118
76–80	333	99	130	112
81–85	299	106	126	118
86–90	135	87	102	95
91–	47	84	107	97
All ages	1,804	112	154	127

Table 3.2.1b Widows, 1983–86, 'amounts': actual deaths and ratios of actual deaths to those expected using the PA(90) table for females and the projected rates for the calendar year 2010 from the PFA80 table and the WA80 table.

Age group (nearest ages)	Actual deaths (£000pa)	100A/E by PA(90) females	100A/E by PFA80C10	100A/E by WA80C10
–55	50	163	258	188
56–60	52	120	201	138
61–65	120	129	216	151
66–70	173	128	209	147
71–75	176	105	157	120
76–80	113	81	106	92
81–85	84	91	108	101
86–90	38	91	106	100
91–	13	80	101	91
All ages	819	108	155	123

Table 3.2.2a Widowers, 1983–86, 'lives': actual deaths and ratios of actual deaths to those expected using the PA(90) table for males and the PMA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths	100 A/E by PA(90) males	100 A/E by PMA80C10
–65	5	78	160
66–75	10	99	154
76–85	13	153	184
86–	6	273	308
All ages	34	125	182

Table 3.2.2b Widowers, 1983–86, 'amounts': actual deaths and ratios of actual deaths to those expected using the PA(90) table for males and the PMA80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths (£000 p.a.)	100 A/E by PA(90) males	100 A/E by PMA80C10
–65	3	133	276
66–75	2	58	90
76–85	8	112	132
86–	2	146	163
All ages	15	108	146

Table 3.3.1a Retirement annuity policies in deferment, 1983–86, males: actual deaths and ratios of actual deaths to those expected using the ultimate rates from the A1967–70 table and the AM80 table.

Age group (nearest ages)	Actual deaths	100 A/E by A1967–70 ult	100 A/E by AM80 ult
–25	52	77	87
26–30	118	75	86
31–35	293	87	106
36–40	677	79	99
41–45	1,090	72	92
46–50	1,883	70	88
51–55	2,922	65	81
56–60	4,406	70	86
61–65	4,067	63	77
66–70	1,351	54	65
71–75	369	47	55
76–	7	30	34
All ages	17,235	66	81

Table 3.3.1b Retirement annuities in course of payment, 1983–86, males: actual deaths and ratios of actual deaths to those expected using the ultimate section of the a(90) table for males and the IM80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths	100 A/E by a(90) males ult	100 A/E by IM80C10 ult
–55	103	1,011	1,532
56–60	216	352	558
61–65	1,414	124	183
66–70	3,637	93	130
71–75	4,531	94	125
76–80	3,601	96	123
81–85	1,602	102	122
86–90	393	91	106
91–	66	73	79
All ages	15,563	99	130

Table 3.3.1c Retirement annuity policies in deferment and in payment combined, 1983–86, males: actual deaths and ratios of actual deaths to those expected using the ultimate section of the a(90) table for males and the IM80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths	100 A/E by a(90) males ult	100 A/E by IM80C10 ult
–25	52	73	118
26–30	118	73	118
31–35	293	92	145
36–40	677	88	135
41–45	1,100	83	126
46–50	1,898	80	122
51–55	3,000	75	114
56–60	4,622	78	122
61–65	5,481	76	115
66–70	4,988	81	114
71–75	4,900	89	119
76–80	3,606	96	123
81–85	1,604	100	122
86–90	393	91	105
91–	66	72	77
All ages	32,798	83	118

Table 3.3.2a Retirement annuity policies in deferment, 1983–86, females: actual deaths and ratios of actual deaths to those expected using the ultimate rates from the FA1975–78 table and the AF80 table.

Age group (nearest ages)	Actual deaths	100 A/E by FA1975–78 ult	100 A/E by AF80 ult
–30	9	73	92
31–35	22	80	104
36–40	64	81	101
41–45	107	70	85
46–50	232	85	100
51–55	280	67	76
56–60	410	77	85
61–65	279	73	79
66–70	98	62	66
71–75	46	92	97
76–	0	0	0
All ages	1,547	74	84

Table 3.3.2b Retirement annuities in course of payment, 1983–86, females: actual deaths and ratios of actual deaths to those expected using the ultimate rates from the a(90) table for females and the IF80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths	100 A/E by a(90) females ult	100 A/E by IF80C10 ult
–55	14	452	787
56–60	35	253	379
61–65	164	94	135
66–70	321	111	150
71–75	330	88	111
76–80	303	89	106
81–85	203	114	127
86–90	73	123	128
91–	8	84	85
All ages	1,451	100	126

Table 3.3.2c Retirement annuity policies, in deferment and in payment combined, 1983–86, females: actual deaths and ratios of actual deaths to those expected using the ultimate section of the a(90) table for females and the IF80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths	100 A/E by a(90) females ult	100 A/E by IF80C10 ult
–30	9	75	147
31–35	22	99	166
36–40	64	94	161
41–45	108	73	137
46–50	236	87	162
51–55	289	73	123
56–60	445	92	139
61–65	443	85	122
66–70	419	95	129
71–75	376	89	113
76–80	303	89	106
81–85	203	114	127
86–90	73	122	127
91–	8	78	79
All ages	2,998	89	126

Table 3.4.1a Immediate annuitants, 1983–86, males, 'lives': actual deaths and ratios of actual deaths to those expected using the a(90) table for males and the IM80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths	100 A/E by a(90) males	100 A/E by IM80C10
Duration 0			
−70	13	115	126
71–80	58	117	132
81–	47	110	116
All ages	118	114	125
Durations 1 and over			
−60	5	102	161
61–65	38	149	221
66–70	132	100	139
71–75	406	90	120
76–80	927	97	124
81–85	1076	103	126
86–90	815	105	122
91–95	421	105	114
96–	128	96	96
All ages	3,948	101	122

Table 3.4.1b Immediate annuitants, 1983–86, males, 'amounts': actual deaths and ratios of actual deaths to those expected using the a(90) table for males and the IM80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths (£000 pa)	100 A/E by a(90) males	100 A/E by IM80C10
Duration 0			
–70	12	98	107
71–80	133	108	122
81–	147	87	92
All ages	292	96	104
Durations 1 and over			
–60	1	39	64
61–65	28	158	235
66–70	98	111	155
71–75	299	83	110
76–80	915	108	139
81–85	911	86	105
86–90	865	99	115
91–95	581	114	124
96–	137	73	74
All ages	3,835	97	117

Table 3.4.2a Immediate annuitants, 1983–86, females, 'lives': actual deaths and ratios of actual deaths to those expected using the a(90) table for females and the IF80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths	100 A/E by a(90) females	100 A/E by IF80C10
Duration 0			
−70	5	126	119
71–80	55	109	112
80–	114	122	116
All ages	174	120	115
Durations 1 and over			
−60	10	185	287
61–65	33	144	206
66–70	97	104	140
71–75	399	108	136
76–80	1,070	98	116
81–85	2,070	110	121
86–90	2,408	114	118
91–95	1,634	117	118
96–	671	112	113
All ages	8,392	111	119

Table 3.4.2b Immediate annuitants, 1983–86, females, 'amounts': actual deaths and ratios of actual deaths to those expected using the a(90) table for females and the IF80 table projected rates for calendar year 2010.

Age group (nearest ages)	Actual deaths (£000 pa)	100 A/E by a(90) females	100 A/E by IF80C10
Duration 0			
−70	28	574	542
71–80	110	101	96
81–	331	121	116
All ages	469	121	116
Durations 1 and over			
−60	2	63	97
61–65	15	108	156
66–70	52	93	125
71–75	241	91	114
76–80	696	90	106
81–85	1,477	113	125
86–90	1,774	116	120
91–95	1,177	118	118
96–	505	110	110
All ages	5,939	110	118

Table 3.4.3a Immediate annuitants, males, 1983–86, durations 1 and over; actual deaths for individual years, on the basis of 'lives', expressed as a percentage of those expected using the projected rates for the year from the IM80 table.

Age group (nearest ages)	1983	1984	1985	1986
–60	167	83	0	222
61–65	200	161	133	132
66–70	95	85	126	116
71–75	88	94	97	94
76–80	88	107	102	105
81–85	107	100	113	102
86–90	101	94	119	108
91–95	103	98	104	105
96–	82	104	58	126
All ages	98	100	107	105

Table 3.4.3b Immediate annuitants, females, 1983–86, durations 1 and over; actual deaths for individual years, on the basis of 'lives', expressed as a percentage of those expected using the projected rates for the year from the IF80 table.

Age group (nearest ages)	1983	1984	1985	1986
–60	133	214	250	222
61–65	123	115	218	136
66–70	113	100	95	106
71–75	107	100	120	93
76–80	99	95	94	87
81–85	103	101	96	108
86–90	111	91	108	101
91–95	112	98	113	100
96–	109	106	102	105
All ages	107	97	104	101

MORTALITY IN 1983–86 OF LIVES ASSURED UNDER PERMANENT (WHOLE LIFE AND ENDOWMENT) ASSURANCES, ACCORDING TO CAUSE OF DEATH

T H E last report on the mortality of lives assured under permanent (whole life and endowment) assurances according to cause of death related to the years 1979–82 and appeared in *C.M.I.R.* **9**, 103. The present report relates to 1983–86.

The cause-specific central rates of mortality were again calculated for each of the years of experience by reference to the Home Populations and the distributions of deaths by cause in England and Wales from the publication *Mortality Statistics—Cause* (series DH2). These rates were applied to the exposed to risk for the year in question, adjusted to allow for the proportion of cases where the cause was unknown, either because the office was unable to produce copies of the death certificate, or because consular or foreign certificates were produced which did not show the cause of death. The product of the cause-specific rate and the adjusted exposed to risk gave the expected deaths by cause.

Causes were coded according to the *Ninth Revision* of the *Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death,* which was also used by the Office of Population Censuses and Surveys over the years in question.

The assured lives experience excludes industrial business, and probably does not include many members of social classes IV and V. Standardization Factors (SF) have been calculated by reference to the OPCS volume *Occupational Mortality: Decennial Supplement, Series DS, 1979–80 and 1982–83,* and these were published in *C.M.I.R.* **9**, 115; for ease of comparison they are repeated in Table 11 of this report. Two sets of factors are shown, one calculated by taking the ratio between the cause-specific mortality rate in social classes I, II and III (Non-Manual) combined, and the corresponding rate in all classes combined, and the other by taking a similar ratio including figures for social class III (Manual) in the numerator. The cause groups from the Occupational Mortality publication differed slightly in some cases from the groupings employed in these reports. The Standardization Factors were based on national figures for ages 20–64 (males) and 20–59 (females) as the social classification becomes blurred at higher ages.

The actual deaths by cause experienced by those offices making cause-of-death returns, together with the ratios 100A/E, are shown in Tables 1 to 5 for males and Tables 6 to 10 for females. These tables also show, for each cause-group, the SF applicable to social classes, I, II, III (Non-Manual) and III (Manual) combined, as the 100A/E ratios should be compared with the SF rather than with 100. Readers who prefer to use the SF excluding social class III (Manual) should refer to Table 11. The distribution of assured lives by

social class may vary from office to office, but the Bureau collects no information about this distribution.

In the report on the 1979–82 experience a comparison between male and female assured lives was attempted by tabulating 100A/E for females with the expected deaths based on the *male* cause-specific mortality rates. This comparison has not been repeated.

Commentaries on the results shown in Tables 1 to 10 appear in tabular form in Tables 12 (males) and 13 (females). The H/L results are to some degree subjective. Broadly, the difference between 100 A/E for the sub-group and 100 A/E for all causes combined is deemed significant if it is more than $200 \div \sqrt{A}$, where A is the actual deaths for the sub group. No comparison is made where the subgroup contains fewer than 10 deaths. Tables 1 to 10, 12 and 13 all show results for medical and non-medical business separately. Tables 14 (males) and 15 (females) give an all age summary (separately for durations 0–4 and 5 and over) for each cause group with medical and non-medical business combined.

Tables 1 to 15 follow on pages 50 to 75 inclusive

Table 1. Permanent assurances, males, cause of death experience 1983–86: actual deaths due to neoplasms, and comparison with deaths expected from these causes according to national male mortality.

Duration	Age group	150–159 (SF 97) Malignant neoplasms of digestive system				160–165 (SF 91) Malignant neoplasms of respiratory system				170–175 (SF 105) Malignant neoplasms of bone, connective tissue and skin				179–189 (SF 101) Malignant neoplasms of genito-urinary organs			
		Med		Non-med		Med		Non-med		Med		Non-med		Med		Non-med	
		A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	12	30	99	44	18	34	86	33	0	(3)	14	47	1	6	20	28
1–2	All ages	56	69	306	64	49	46	285	51	3	56	38	64	12	37	108	71
3–4	All ages	76	80	406	81	57	46	345	59	6	90	64	108	22	60	105	67
5 and over	-44	70	93	407	75	26	50	208	57	22	113	156	100	10	55	119	84
	45–59	635	74	2540	75	445	42	2007	49	75	108	276	97	165	71	678	75
	60–74	938	72	1767	76	822	43	1913	56	65	115	107	103	445	83	695	80
	75-	526	75	240	82	404	53	224	67	24	84	11	95	510	102	159	78
	All ages	2169	74	4954	76	1697	45	4352	53	186	107	550	99	1130	88	1651	78

Table 1. (continued)

Duration	Age group	190–192 (SF 103) Malignant neoplasms of nervous system Med A	100 A/E	Non-med A	100 A/E	140–149 & 193–194 (SF 89) Malignant neoplasms of oral cavity, pharynx and endocrine glands Med A	100 A/E	Non-med A	100 A/E	200–208 (SF 101) Neoplasms of lymphatic and haematopoietic tissue Med A	100 A/E	Non-med A	100 A/E	140–239 (SF 95) All neoplasms (including ill-defined and unspecified sites not included in the sub-groups) Med A	100 A/E	Non-med A	100 A/E
0	All ages	2	48	23	51	0	(3)	3	15	0	(9)	18	21	33	24	297	37
1–2	All ages	13	149	74	79	2	37	14	33	12	63	98	57	160	58	1004	60
3–4	All ages	10	92	88	93	3	46	17	39	21	91	130	75	208	64	1235	71
5 and over	-44	37	138	226	106	8	100	44	75	47	96	374	94	234	87	1655	82
	45–59	173	131	622	115	29	38	122	40	233	112	824	98	1897	67	7616	69
	60–74	150	151	204	102	27	34	67	45	290	115	458	100	2945	65	5633	70
	75-	34	298	8	153	28	101	7	61	138	110	59	112	1784	76	764	77
	All ages	394	146	1060	111	92	48	240	46	708	112	1715	98	6860	69	15668	71

Notes: A = Actual deaths, E = Deaths expected according to 1983–86 national experience of England and Wales (males) calculated from figures published by the Office of Population Censuses and Surveys. Where A = 0 or E ≤1 the figure shown in brackets is E calculated to the nearer integer. SF = Standardization Factor for Social Class (including Class III (Manual)).

Table 2. Permanent assurances, males, cause of death experience 1983–86: actual deaths from diseases of the circulatory system, and comparison with deaths expected from these causes according to national male mortality.

| | | 410 (SF 98) Acute myocardial infarction | | | | 411–414 (SF 96) Other forms of ischaemic heart disease | | | | 401–405 (SF 87) Hypertensive disease not classified elsewhere | | | | 430–438 (SF 91) Cerebrovascular disease | | | |
| | | Med | | Non-med | | Med | | Non-med | | Med | | Non-med | | Med | | Non-med | |
Duration	Age group	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	50	44	327	50	10	20	114	41	1	29	6	33	8	24	65	42
1–2	All ages	104	45	718	52	33	33	272	46	6	86	14	36	19	28	163	50
3–4	All ages	126	46	755	52	40	34	328	53	2	25	16	40	29	37	155	46
5 and over	-44	115	61	767	58	41	49	319	54	4	73	22	56	34	65	242	61
	45–59	1520	58	6962	68	507	47	2373	56	20	30	109	42	244	50	993	52
	60–74	2445	66	4981	76	778	49	1714	61	62	54	87	44	545	51	975	58
	75-	1632	82	722	87	791	69	310	67	45	60	20	65	1172	83	438	79
	All ages	5712	67	13432	71	2117	54	4716	58	131	50	238	45	1995	66	2648	58

Table 2. (continued)

Duration	Age group	390–398 and 420–429 (SF 90) Other diseases of the heart				415–417 and 440–459 (SF 95) Other circulatory diseases				390–459 (SF 96) All diseases of the circulatory system (combined)			
		Med		Non-med		Med		Non-med		Med		Non-med	
		A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	4	36	31	44	2	14	26	46	75	33	569	46
1–2	All ages	8	35	69	48	8	29	67	56	178	39	1303	50
3–4	All ages	14	53	66	45	12	38	57	46	223	42	1377	51
5 and over	-44	17	53	135	54	6	41	87	79	217	57	1572	58
	45–59	109	52	474	57	103	58	415	61	2503	54	11326	62
	60–74	214	67	364	68	278	59	515	68	4322	60	8636	69
	75-	426	88	146	83	458	86	158	76	4524	80	1794	80
	All ages	766	73	1119	63	845	71	1175	67	11566	65	23328	65

Notes: A = Actual deaths, E = Deaths expected according to 1983–86 national experience of England and Wales (males) calculated from figures published by the Office of Population Censuses and Surveys. SF = Standardization Factor for Social Class (including Class III (Manual)).

Table 3. Permanent assurances, males, cause of death experience 1983–86: actual deaths from diseases of the respiratory system, and comparison with deaths expected from these causes according to national male mortality.

		480–486 (SF 72) Pneumonia				490–496 (SF 81) Bronchitis				460–478 and 500–519 (SF 81) Other respiratory diseases				460–486 and 490–519 (SF 78) All respiratory diseases (combined)			
		Med		Non-med		Med		Non-med		Med		Non-med		Med		Non-med	
Duration	Age group	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	4	40	11	26	1	4	18	18	1	35	3	19	6	16	32	20
1–2	All ages	2	10	17	20	4	8	29	14	1	17	16	49	7	9	62	19
3–4	All ages	8	34	33	38	9	15	37	17	4	58	19	57	21	24	89	26
5 and over	-44	7	43	70	56	13	67	44	29	3	48	32	66	23	55	146	45
	45–59	21	19	139	33	65	21	293	25	24	54	93	53	110	24	525	30
	60–74	95	33	172	42	224	25	515	36	45	49	84	54	364	28	771	38
	75-	477	51	177	55	414	44	177	46	80	70	26	59	971	49	380	51
	All ages	600	45	558	44	716	33	1029	33	152	59	235	55	1468	39	1822	38

Notes: A = Actual deaths, E = Deaths expected according to 1983–86 national experience of England and Wales (males) calculated from figures published by the Office of Population Censuses and Surveys. SF = Standardization Factor for Social Class (including Class III (Manual)).

Table 4. Permanent assurances, males, cause of death experience 1983–86: actual deaths due to suicide, accident and violence, and comparison with deaths expected from these causes according to national male mortality.

Duration	Age group	E810-E825 (SF 91) Motor vehicle accidents				E950-E959 (SF 86) Suicide				E800-E807, E826-E949 and E960-E999 (SF 71) All other accidental and violent causes				E800-E999 (SF 82) All accidental and violent causes			
		Med		Non-med		Med		Non-med		Med		Non-med		Med		Non-med	
		A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	7	109	115	74	2	25	60	40	8	83	138	80	17	71	313	66
1–2	All ages	12	88	186	67	9	51	148	50	15	71	260	79	36	69	594	66
3–4	All ages	10	59	161	66	15	65	150	52	19	71	228	71	44	66	539	63
5 and over	-44	77	101	467	66	57	49	451	46	85	68	789	74	219	69	1707	62
	45–59	97	79	357	69	143	67	437	49	190	82	688	70	430	75	1482	62
	60–74	40	64	64	53	33	37	113	62	80	62	201	81	153	54	378	69
	75-	10	35	6	50	15	69	4	43	74	70	27	68	99	63	37	61
	All ages	224	77	894	66	248	56	1005	49	429	72	1705	73	901	68	3604	63

Notes: A = Actual deaths, E = Deaths expected according to 1983–86 national experience of England and Wales (males) calculated from figures published by the Office of Population Censuses and Surveys. SF = Standardization Factor for Social Class (including Class III (Manual)).

Table 5. Permanent assurances, males, cause of death experience 1983–86: actual deaths from miscellaneous causes, and from all causes combined, and comparison with deaths expected from these causes according to national male mortality.

Duration	Age group	001–139 and 487 (SF79) Infective and parasitic diseases, including influenza				250 (SF 92) Diabetes mellitus				291, 303, 305 and 571 (SF 93) Cirrhosis of the liver and/or alcoholism				520–579 excluding 571 (SF 82) Diseases of the digestive system other than cirrhosis			
		Med		Non-med		Med		Non-med		Med		Non-med		Med		Non-med	
		A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	1	44	6	28	0	(4)	3	13	0	(4)	17	38	3	36	14	28
1–2	All ages	1	21	16	37	1	12	7	14	1	12	40	43	5	29	46	43
3–4	All ages	3	52	17	39	0	(10)	8	16	2	19	32	34	9	44	60	55
5 and over	-44	3	24	58	58	2	23	10	15	13	41	71	29	22	91	70	38
	45–59	33	63	85	40	10	13	79	26	92	71	279	52	77	49	314	51
	60–74	29	48	43	39	40	32	90	43	79	86	84	45	109	42	235	54
	75-	50	106	17	92	63	50	32	62	16	103	7	102	222	78	79	72
	All ages	115	67	203	46	115	34	211	33	200	75	441	46	430	60	698	52

Table 5. (continued)

Duration	Age group	580–589 (SF 88) Nephritis Med A	100 A/E	Non-med A	100 A/E	590–676 (SF 78) Other diseases of the genito-urinary system Med A	100 A/E	Non-med A	100 A/E	240–389 and 680–779 excluding 250,291,303 305 and 571 (SF 77) All other specified causes Med A	100 A/E	Non-med A	100 A/E	All causes (SF 92) (including ill-defined causes not tabulated elsewhere) Med A	100 A/E	Non-med A	100 A/E
0	All ages	0	(2)	3	30	0	(2)	4	58	3	20	25	19	138	30	1287	44
1–2	All ages	3	72	3	15	1	31	5	35	13	41	80	31	406	44	3166	52
3–4	All ages	1	21	12	57	0	(4)	3	20	21	57	71	28	533	48	3451	55
5 and over	-44	1	24	18	56	1	41	5	26	37	52	254	42	774	66	5580	61
	45–59	6	22	48	45	4	22	24	33	143	58	484	48	5309	58	22298	61
	60–74	35	61	81	91	21	45	21	29	226	58	400	63	8345	58	16395	66
	75-	95	73	41	84	71	69	35	93	434	77	192	88	8361	73	3384	74
	All ages	137	62	188	68	97	57	85	42	840	66	1330	54	22789	63	47657	64

Notes: A = Actual deaths, E = Deaths expected according to 1983–86 national experience of England and Wales (males) calculated from figures published by the Office of Population Censuses and Surveys. Where A = 0 or E ≤ 1 the figure shown in brackets is E calculated to the nearer integer. SF = Standardization Factor for Social Class (including Class III (Manual)).

Assurances, According to Cause of Death

Table 6. Permanent assurances, females, cause of death experience 1983–86: actual deaths due to neoplasms, and comparison with deaths expected from these causes according to national female mortality.

		150–159 (SF 97) Malignant neoplasms of digestive system				160–165 (SF 88) Malignant neoplasms of respiratory system				170–175 (SF 103) Malignant neoplasms of bone, connective tissue and skin				179–189 (SF 94) Malignant neoplasms of genito-urinary organs			
		Med		Non-med		Med		Non-med		Med		Non-med		Med		Non-med	
Duration	Age group	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	9	100	18	31	1	17	11	26	0	(10)	17	15	1	16	20	31
1–2	All ages	12	62	64	60	10	77	41	52	4	19	80	41	12	88	68	59
3–4	All ages	14	72	70	73	18	138	31	44	14	67	125	73	5	36	51	51
5 and over	-44	4	107	29	79	2	96	8	40	11	88	131	106	6	84	46	64
	45–59	27	85	147	84	10	40	98	72	55	95	308	93	22	69	163	91
	60–74	40	65	66	72	22	45	43	55	38	72	65	75	15	38	56	87
	75-	24	73	11	77	13	115	6	111	16	100	7	100	10	84	5	93
	All ages	95	73	253	79	47	54	155	65	120	86	511	93	53	58	270	84

Table 6. (continued)

Duration	Age group	190–192 (SF 105) Malignant neoplasms of nervous system				140–149 & 193–194 (SF 93) Malignant neoplasms of oral cavity, pharynx and endocrine glands				200–208 (SF 101) Neoplasms of lymphatic and haematopoietic tissue				140–239 (SF 98) All neoplasms (including ill-defined and unspecified sites not included in the sub-groups)			
		Med		Non-med		Med		Non-med		Med		Non-med		Med		Non-med	
		A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	0	(1)	2	16	0	(1)	1	23	0	(2)	6	27	14	37	84	25
1–2	All ages	1	51	17	79	1	91	4	51	5	105	20	52	47	58	318	53
3–4	All ages	2	101	18	98	1	91	4	58	2	42	32	97	60	74	358	68
5 and over	-44	3	191	20	121	0	(0)	4	114	2	76	28	100	30	95	277	87
	45–59	4	75	42	139	5	226	7	57	7	80	40	81	136	78	840	86
	60–74	1	19	11	122	1	29	1	18	8	62	21	107	133	55	297	77
	75-	0	(1)	1	368	1	77	0	(1)	4	68	4	152	75	83	37	92
	All ages	8	62	74	132	7	95	12	54	21	70	93	93	374	70	1451	85

Notes: A = Actual deaths, E = Deaths expected according to 1983–86 national experience of England and Wales (females) calculated from figures published by the Office of Population Censuses and Surveys. Where A = 0 or E ≤ 1 the figure shown in brackets is E calculated to the nearer integer. SF = Standardization Factor for Social Class (including Class III (Manual)).

Table 7. Permanent assurances, females, cause of death experience 1983–86: actual deaths from diseases of the circulatory system, and comparison with deaths expected from these causes according to national female mortality.

Duration	Age group	410 (SF 83) Acute myocardial infarction				411–414 (SF 81) Other forms of ischaemic heart disease				401–405 (SF 82) Hypertensive disease not classified elsewhere				430–438 (SF 88) Cerebrovascular disease			
		Med		Non-med		Med		Non-med		Med		Non-med		Med		Non-med	
		A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	11	65	32	45	1	13	17	56	0	(1)	0	(6)	10	79	27	49
1–2	All ages	15	41	62	48	14	84	31	56	0	(2)	5	64	17	62	60	61
3–4	All ages	14	38	51	43	4	24	20	39	2	73	1	9	6	21	52	59
5 and over	-44	2	90	8	37	0	(1)	7	71	0	(0)	0	(2)	2	48	22	52
	45–59	15	43	92	49	7	46	23	28	2	94	4	34	12	52	72	57
	60–74	58	49	114	69	19	40	34	50	2	34	1	12	28	41	43	47
	75-	60	68	39	103	30	54	7	32	4	77	2	93	63	61	44	107
	All ages	135	55	253	61	56	47	71	39	8	60	7	29	105	53	181	60

Table 7. (continued)

Duration	Age group	390–398 and 420–429 (SF 81) Other diseases of the heart				415–417 and 440–459 (SF 85) Other circulatory diseases				390–459 (SF 84) All diseases of the circulatory system (combined)			
		Med		Non-med		Med		Non-med		Med		Non-med	
		A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	1	25	4	20	0	(3)	3	20	23	50	83	42
1–2	All ages	0	(8)	12	35	1	14	13	51	47	48	183	52
3–4	All ages	8	95	17	56	3	42	14	60	37	37	155	48
5 and over	-44	1	72	2	14	3	281	4	36	8	79	43	43
	45–59	3	35	14	30	3	51	13	41	42	47	218	45
	60–74	5	24	16	54	12	65	10	40	124	44	218	56
	75-	19	51	9	66	23	82	7	65	199	63	108	85
	All ages	28	41	41	39	41	77	34	43	373	54	587	53

Notes: A = Actual deaths, E = Deaths expected according to 1983–86 national experience of England and Wales (females) calculated from figures published by the Office of Population Censuses and Surveys. Where A = 0 or E ≤ 1 the figure shown in brackets is E calculated to the nearer integer. SF = Standardization Factor for Social Class (including Class III (Manual)).

Table 8. Permanent assurances, females, cause of death experience 1983–86: actual deaths from diseases of the respiratory system, and comparison with deaths expected from these causes according to national female mortality.

Duration	Age group	480–486 (SF 68) Pneumonia				490–496 (SF 76) Bronchitis				460–478 and 500–519 (SF 72) Other respiratory diseases				460–486 and 490–519 (SF 72) All respiratory diseases (combined)			
		Med		Non-med		Med		Non-med		Med		Non-med		Med		Non-med	
		A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	0	(4)	5	42	1	25	4	16	0	(1)	1	26	1	12	10	25
1–2	All ages	4	53	8	40	3	34	13	29	0	(1)	1	15	7	40	22	31
3–4	All ages	3	41	5	28	2	23	14	35	3	210	5	83	8	45	24	38
5 and over	-44	1	136	6	77	0	(1)	6	44	0	(0)	3	87	1	42	15	60
	45–59	3	67	7	29	5	40	16	24	0	(2)	5	58	8	43	28	28
	60–74	2	13	9	48	8	27	14	31	1	27	4	72	11	23	27	39
	75-	30	58	17	96	13	83	12	179	2	41	1	53	45	63	30	114
	All ages	36	50	39	57	26	44	48	36	3	29	13	66	65	46	100	45

Notes: A = Actual deaths, E = Deaths expected according to 1983–86 national experience of England and Wales (females) calculated from figures published by the Office of Population Censuses and Surveys. Where A = 0 or E ≤ 1 the figure shown in brackets is E calculated to the nearer integer. SF = Standardization Factor for Social Class (including Class III (Manual)).

Table 9. Permanent assurances, females, cause of death experience 1983–86: actual deaths due to suicide, accident and violence, and comparison with deaths expected from these causes according to national female mortality.

Duration	Age group	E810-E825 (SF 85) Motor vehicle accidents				E950-E959 (SF 77) Suicide				E800-E807, E826-E949 and E960-E999 (SF 66) All other accidental and violent causes				E800-E999 (SF 74) All accidental and violent causes			
		Med		Non-med		Med		Non-med		Med		Non-med		Med		Non-med	
		A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	0	(1)	8	47	0	(1)	10	46	0	(2)	19	67	0	(4)	37	55
1–2	All ages	2	116	26	100	1	39	23	63	4	94	33	71	7	82	82	75
3–4	All ages	1	61	16	81	2	77	18	60	5	118	26	68	8	94	60	68
5 and over	-44	0	(2)	15	58	4	115	12	32	3	69	49	101	7	70	76	68
	45–59	3	105	22	134	9	130	28	70	2	26	33	74	14	80	83	82
	60–74	5	176	1	23	1	23	4	54	7	94	11	97	13	88	16	69
	75-	2	172	0	(1)	0	(1)	0	(0)	10	121	2	63	12	118	2	49
	All ages	10	111	38	80	14	90	44	51	22	79	95	89	46	88	177	74

Notes: A = Actual deaths, E = Deaths expected according to 1983–86 national experience of England and Wales (females) calculated from figures published by the Office of Population Censuses and Surveys. Where A = 0 or E ≤ 1 the figure shown in brackets is E calculated to the nearer integer. SF = Standardization Factor for Social Class (including Class III (Manual)).

Table 10. Permanent assurances, females, cause of death experience 1983–86: actual deaths from miscellaneous causes, and from all causes combined, and comparison with deaths expected from these causes according to national female mortality.

Duration	Age group	001–139 and 487 (SF 83) Infective and parasitic diseases, including influenza				250 (SF 78) Diabetes mellitus				291, 303, 305 and 571 (SF 85) Cirrhosis of the liver and/or alcoholism				520–579 excluding 571 (SF 79) Diseases of the digestive system other than cirrhosis			
		Med		Non-med		Med		Non-med		Med		Non-med		Med		Non-med	
		A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	0	(1)	2	34	1	71	0	(7)	1	106	2	17	1	36	8	53
1–2	All ages	0	(1)	4	40	4	128	2	15	1	50	7	34	2	33	16	60
3–4	All ages	2	161	5	60	0	(3)	1	8	1	49	5	28	2	33	12	51
5 and over	-44	3	444	9	120	0	(0)	2	38	0	(1)	8	55	2	164	4	32
	45–59	0	(2)	3	26	1	31	0	(18)	2	35	13	41	4	61	5	14
	60–74	1	33	4	84	1	11	6	48	0	(5)	5	54	6	37	16	69
	75-	1	37	2	188	0	(8)	2	59	0	(1)	0	(0)	18	92	1	13
	All ages	5	59	18	73	2	10	10	26	2	15	26	46	30	69	26	33

Table 10. (continued)

Duration	Age group	580–589 (SF 79) Nephritis				590–676 (SF 75) Other diseases of the genito-urinary system				240–389 and 680–779 excluding 250,291,303,305 and 571 (SF 80) All other specified causes				All causes (SF 88) (including ill-defined causes not tabulated elsewhere)			
		Med		Non-med		Med		Non-med		Med		Non-med		Med		Non-med	
		A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E	A	100 A/E
0	All ages	0	(1)	2	65	0	(1)	2	42	1	17	9	20	42	39	239	33
1–2	All ages	0	(1)	3	56	0	(1)	1	13	2	16	20	27	117	50	659	51
3–4	All ages	1	68	0	(5)	1	80	2	30	5	39	23	36	125	53	645	56
5 and over	-44	0	(0)	0	(3)	2	351	5	75	2	40	25	46	55	86	465	70
	45–59	0	(1)	2	31	1	81	1	14	6	41	35	42	214	64	1231	66
	60–74	0	(3)	1	23	1	35	3	75	10	34	26	60	300	46	620	64
	75-	4	66	2	84	3	82	2	136	21	50	9	54	384	67	195	84
	All ages	4	37	5	31	7	84	11	57	39	43	95	48	953	59	2511	68

Notes: A = Actual deaths, E = Deaths expected according to 1983–86 national experience of England and Wales (females) calculated from figures published by the Office of Population Censuses and Surveys. Where A = 0 or E ≤ 1 the figure shown in brackets is E calculated to the nearer integer. SF = Standardization Factor for Social Class (including Class III (Manual)).

Assurances, According to Cause of Death

Table 11. Factors for standardizing national mortality rates (Great Britain 1979–80 and 1982–83) according to social class
100 × death rate for classes shown ÷ death rate for all classes combined

Cause group	Classes I,II,III (NM) and III (M) combined males aged 20–64	Classes I,II and III (NM) combined males aged 20–64	Classes I,II,III (NM) and III (M) combined females aged 20–59	Classes I,II and III (NM) combined females aged 20–59
Malignant neoplasms, digestive	97	85	97	191
Malignant neoplasms, respiratory	91	65	88	69
Malignant neoplasms, connective tissue etc	105	108	103	105
Malignant neoplasms, genito-urinary	101	93	94	87
Malignant neoplasms, nervous system	103	104	105	102
Malignant neoplasms, other sites	89	78	93	90
Neoplasms, lymphatic etc	101	98	100	98
All neoplasms, combined	**95**	**80**	**98**	**92**
Acute myocardial infarction	98	88	83	62
Other ischaemic heart disease	96	84	81	61
Hypertensive disease	87	72	82	58
Cerebrovascular disease	91	76	88	74
Other diseases of the heart	90	81	81	66
Other circulatory diseases	95	89	85	72
All circulatory diseases, combined	**96**	**85**	**84**	**66**

Table 11. (continued)

Cause group	Classes I,II,III (NM) and III (M) combined males aged 20–64	Classes I,II and III (NM) combined males aged 20–64	Classes I,II,III (NM) and III (M) combined females aged 20–59	Classes I,II and III (NM) combined females aged 20–59
Pneumonia	72	56	68	55
Bronchitis	81	57	76	58
Other respiratory diseases	81	61	72	56
All respiratory diseases, combined	**78**	**57**	**72**	**57**
Motor vehicle accidents	91	77	85	97
Suicide	86	85	77	89
Other accidents and violence	71	57	66	68
All accidental and violent causes, combined	**82**	**72**	**74**	**82**
Infective and parasitic diseases	79	71	83	71
Diabetes mellitus	92	85	78	63
Cirrhosis of the liver	93	97	85	84
Other digestive diseases	82	71	79	65
Nephritis and nephrosis	88	77	79	70
Other genito-urinary diseases	78	75	75	57
All other diseases	77	72	80	74
All causes combined	**92**	**80**	**88**	**80**

Table 12. Permanent assurances, males, cause of death experience 1983–86: tabular commentary on the results shown in Tables 1 to 5 and comparison with the experience for 1979–82.

Cause group	Comparison with all causes combined (durations 5 and over)		Apparent duration of initial selection (years)		Comparison with 1979–82 (durations 5 and over)		Comparison with S.F. including Class III (Manual)		Comparison with S.F. excluding Class III (Manual)	
	Medical	Non-med	Medical	Non-med	Medical	Non-med	Medical	Non-med	Medical	Non-med
M.N.* digestive	H	H	3	3	H	-	L	L	L	L
M.N.* respiratory	L	L	1	1	-	-	L	L	L	L
M.N.* connec-tissue	H	H	-	3	-	-	-	-	-	-
M.N.* genito-urinary	H	H	3	1	-	-	L	L	L	L
M.N.* nervous	H	H	1	5	H	-	H	H	H	H
M.N.* other	L	L	-	-	-	-	L	L	L	L
N. lymphatic etc	H	H	3	5	H	-	H	-	H	-
All neoplasms	H	H	3	3	-	-	L	L	L	L
Acute M.I.**	H	H	5	5	-	-	L	L	L	L
Other I.H.D.***	L	L	5	3	-	-	L	L	L	L
Hypertensive	L	L	-	-	-	-	L	L	L	L
Cerebrovascular	-	L	5	5	-	-	L	L	L	L
Other HD	H	-	3	5	H	H	L	L	L	L
Other circulatory	-	-	3	5	-	-	L	L	L	L
All circulatory	-	-	5	5	-	-	L	L	L	L

* = Malignant Neoplasm
** = Myocardial Infarction
*** = Ischaemic Heart Disease

Table 12. (continued)

Cause group	Comparison with all causes combined (durations 5 and over)		Apparent duration of initial selection (years)		Comparison with 1979–82 (durations 5 and over)		Comparison with S.F. including Class III (Manual)		Comparison with S.F. excluding Class III (Manual)	
	Medical	Non-med	Medical	Non-med	Medical	Non-med	Medical	Non-med	Medical	Non-med
Pneumonia	L	L	-	-	-	-	L	L	L	L
Bronchitis	L	L	-	-	-	-	L	L	L	L
Other respiratory	-	L	-	-	-	-	L	L	L	L
All respiratory	L	L	-	-	-	-	L	L	L	L
M.V.A.[†]	H	-	0	0	H	-	L	L	-	L
Suicide	L	L	-	-	L	-	L	L	L	L
Other acc/violence	-	H	0	0	L	-	-	-	H	H
All acc/violence	-	-	0	0	L	-	L	L	L	L
Infective/parasitic	-	L	-	1	H	H	-	L	-	L
Diabetes mellitus	L	L	5	5	-	-	L	L	L	L
Cirrhosis of the liver	H	L	5	-	-	L	L	L	L	L
Other digestive	-	L	3	1	-	-	L	L	L	L
Nephritis/nephrosis	-	-	-	3	-	-	L	L	L	L
Other genito-urinary	-	L	-	-	-	-	L	L	L	L
All other diseases	-	L	3	5	-	-	L	L	L	L
All causes combined	-	-	5	5	-	-	L	L	L	L

[†] = Motor Vehicle Accidents.

Notes: In these columns H or L indicates that the 1983–86 mortality experience for a particular cause group was in general either significantly higher (H) or lower (L) than the criterion indicated in the relevant heading. If neither of the letters appears the comparison in question indicates no significant difference.

In some groups the experience was too small for the effect of initial selection to be measured. For those cases a dash is shown in the relevant column.

Assurances, According to Cause of Death

Table 13. Permanent assurances, females, cause of death experience 1983–86: tabular commentary on the results shown in Tables 6 to 10 and comparison with the experience for 1979–82.

Cause group	Comparison with all causes combined (durations 5 and over)		Apparent duration of initial selection (years)		Comparison with 1979–82 (durations 5 and over)		Comparison with S.F. including Class III (Manual)		Comparison with S.F. excluding Class III (Manual)	
	Medical	Non-med	Medical	Non-med	Medical	Non-med	Medical	Non-med	Medical	Non-med
M.N.* digestive	H	H	0	3	L	-	L	L	L	L
M.N.* respiratory	-	-	1	1	-	-	L	L	L	-
M.N.* connec-tissue	H	H	5	5	L	-	L	L	L	L
M.N.* genito-urinary	-	H	1	5	L	-	L	L	L	-
M.N.* nervous	-	H	-	5	L	H	L	H	L	H
M.N.* other	H	-	-	-	L	-	-	L	-	L
N. lymphatic etc.	H	H	-	3	L	L	L	-	L	-
All neoplasms	**H**	**H**	**3**	**5**	**L**	**-**	**L**	**L**	**L**	**L**
Acute M.I.**	-	-	0	0	-	-	L	L	-	-
Other I.H.D.***	-	-	0	0	H	-	L	L	L	L
Hypertensive	-	-	-	-	-	-	L	L	-	L
Cerebrovascular	-	-	0	1	L	L	L	L	L	L
Other HD	L	L	-	-	L	-	L	L	L	L
Other circulatory	H	L	-	-	-	-	-	L	-	L
All circulatory	**-**	**L**	**0**	**0**	**-**	**-**	**L**	**L**	**L**	**L**

* = Malignant Neoplasm
** = Mycardial Infarction
*** = Ischaemic Heart Disease

Table 13. (continued)

Cause group	Comparison with all causes combined (durations 5 and over)		Apparent duration of initial selection (years)		Comparison with 1979–82 (durations 5 and over)		Comparison with S.F. including Class III (Manual)		Comparison with S.F. excluding Class III (Manual)	
	Medical	Non-med	Medical	Non-med	Medical	Non-med	Medical	Non-med	Medical	Non-med
Pneumonia	L	L	-	-	-	H	L	L	-	-
Bronchitis	L	L	-	1	H	H	L	L	L	L
Other respiratory	L	-	-	-	-	L	L	-	L	-
All respiratory	L	L	1	3	-	H	L	L	L	L
M.V.A.†	H	H	-	-	-	L	H	-	-	-
Suicide	H	L	5	0	H	L	-	L	-	L
Other acc./violence	H	H	0	5	L	L	-	H	H	H
All acc./violence	H	H	0	1	L	L	-	-	-	L
Infective/parasitic	-	-	-	-	-	-	L	-	L	-
Diabetes mellitus	L	L	-	-	-	-	L	L	L	L
Cirrhosis of the liver	L	L	-	-	L	L	L	L	L	L
Other digestive	H	L	-	-	-	L	-	L	-	L
Nephritis/nephrosis	L	L	-	-	L	-	L	L	L	L
Other genito-urinary	H	-	-	-	H	H	-	L	H	-
All other diseases	L	L	-	5	L	L	L	L	L	L
All causes combined	-	-	1	5	L	L	L	L	L	L

† = Motor Vehicle Accidents.

Notes: In these columns H or L indicates that the 1983–86 mortality experienced for a particular cause group was in general either significantly higher (H) or lower (L) than the criterion indicated in the relevant heading. If neither of the letters appears the comparison in question indicates no significant difference.

In some groups the experience was too small for the effect of initial selection to be measured. For those cases a dash is shown in the relevant column.

Table 14. Permanent assurances, males, cause of death experience 1983–86, medical and non-medical combined: actual deaths by cause and ratios of actual deaths to those expected from each cause using national male mortality rates for England and Wales.

Cause group	Durations 0-4			Durations 5 and over			SF (including Class III (M))
	Actual Deaths	100A/E	$\frac{100A/E \text{ (group)}}{100A/E \text{ (all causes)}}$	Actual Deaths	100A/E	$\frac{100A/E \text{ (group)}}{100A/E \text{ (all causes)}}$	
M.N.* digestive	955	67	1.33	7123	75	1.19	97
M.N.* respiratory	840	50	.98	6049	51	.80	91
M.N.* connec-tissue	125	77	1.52	736	101	1.59	105
M.N.* genito-urinary	268	58	1.14	2781	82	1.29	101
M.N.* nervous	210	82	1.62	1454	119	1.87	103
M.N.* other	39	32	.64	332	46	.73	89
N. lymphatic etc	279	58	1.15	2423	102	1.61	101
All neoplasms	**2937**	**59**	**1.18**	**22528**	**70**	**1.11**	**95**
Acute M.I.**	2080	51	1.01	19144	70	1.10	98
Other I.H.D.***	797	46	.90	6833	57	.89	96
Hypertensive	45	39	.78	369	47	.74	87
Cerebrovascular	439	44	.87	4643	61	.97	91
Other H.D.	192	45	.90	1885	67	1.05	90
Other circulatory	172	46	.91	2020	68	1.08	95
All circulatory	**3725**	**48**	**.95**	**34894**	**65**	**1.03**	**96**

* = Malignant Neoplasm
** = Myocardial Infarction
*** = Ischaemic Heart Disease

Table 14. (continued)

Cause group	Durations 0–4			Durations 5 and over			SF (including Class III (M))
	Actual Deaths	100A/E	$\dfrac{100\text{A/E (group)}}{100\text{A/E (all causes)}}$	Actual Deaths	100A/E	$\dfrac{100\text{A/E (group)}}{100\text{A/E (all causes)}}$	
Pneumonia	75	28	.55	1158	44	.70	72
Bronchitis	98	15	.29	1745	33	.52	81
Other respiratory	44	45	.90	387	57	.89	81
All respiratory	**217**	**21**	**.42**	**3290**	**38**	**.60**	**78**
M.V.A.†	491	69	1.37	1118	68	1.07	91
Suicide	384	49	.98	1253	50	.79	86
Other acc./violence	668	76	1.51	2134	73	1.15	71
All acc./violence	**1543**	**65**	**1.29**	**4505**	**64**	**1.00**	**82**
Infective/parasitic	44	37	.73	318	52	.82	79
Diabetes mellitus	19	13	.26	326	33	.53	92
Cirrhosis of the liver	92	36	.72	641	52	.82	93
Other digestive	137	44	.87	1128	54	.86	82
Nephritis/nephrosis	22	35	.70	325	65	1.03	88
Other genito-urinary	13	29	.58	182	49	.77	78
All other diseases	213	30	.59	2170	58	.92	77
All causes combined	**8981**	**50**	**1.00**	**70446**	**64**	**1.00**	**92**

† = Motor Vehicle Accidents

Table 15. Permanent assurances, females, cause of death experience 1983–86, medical and non-medical combined: actual deaths by cause and ratios of actual deaths to those expected from each cause using national female mortality rates for England and Wales.

Cause group	Durations 0—4			Durations 5 and over			SF (including Class III (M))
	Actual Deaths	100A/E	100A/E (group) / 100A/E (all causes)	Actual Deaths	100A/E	100A/E (group) / 100A/E (all causes)	
M.N.* digestive	187	61	1.25	348	78	1.20	97
M.N.* respiratory	112	50	1.02	202	62	.95	88
M.N.* connec-tissue	240	45	.93	631	92	1.42	103
M.N.* genito-urinary	157	50	1.03	323	78	1.21	94
M.N.* nervous	40	70	1.43	82	119	1.83	105
M.N.* other	11	51	1.04	19	65	1.00	93
N. lymphatic etc	65	62	1.26	114	88	1.35	101
All neoplasms	**881**	**53**	**1.08**	**1825**	**81**	**1.25**	**98**
Acute M.I.**	185	45	.93	388	59	.91	83
Other I.H.D.***	87	49	1.00	127	42	.65	81
Hypertensive	8	26	.54	15	40	.62	82
Cerebrovascular	172	56	1.14	286	57	.88	88
Other H.D.	42	40	.82	69	40	.61	81
Other circulatory	34	42	.86	75	57	.87	85
All circulatory	**528**	**47**	**.97**	**960**	**53**	**.82**	**84**

* = Malignant Neoplasm
** = Myocardial Infarction
*** = Ischaemic Heart Disease

Table 15. (continued)

Cause group	Durations 0–4			Durations 5 and over			SF (including Class III (M))
	Actual Deaths	100A/E	$\dfrac{100\text{A/E (group)}}{100\text{A/E (all causes)}}$	Actual Deaths	100A/E	$\dfrac{100\text{A/E (group)}}{100\text{A/E (all causes)}}$	
Pneumonia	25	36	.75	75	54	.83	68
Bronchitis	37	28	.58	74	39	.59	76
Other respiratory	10	49	1.01	16	53	.82	72
All respiratory	**72**	**33**	**.67**	**165**	**46**	**.70**	**72**
M.V.A.[†]	53	79	1.63	48	85	1.31	85
Suicide	54	57	1.17	58	57	.89	77
Other acc./violence	87	71	1.45	117	87	1.34	66
All acc./violence	**194**	**68**	**1.40**	**223**	**76**	**1.18**	**74**
Infective/parasitic	13	48	.98	23	69	1.07	83
Diabetes mellitus	8	20	.41	12	20	.31	78
Cirrhosis of the liver	17	31	.63	28	40	.62	85
Other digestive	41	51	1.05	56	46	.70	79
Nephritis/nephrosis	6	36	.74	9	34	.52	79
Other genito-urinary	6	27	.55	18	65	1.01	75
All other diseases	60	28	.57	134	46	.71	79
All causes combined	**1827**	**49**	**1.00**	**3464**	**65**	**1.00**	**88**

[†] = Motor Vehicle Accidents

MORTALITY TABLES BASED ON
THE COMBINED PENSIONERS EXPERIENCE, 1979–82

THE Bureau collects data for life office pensioners, males and females, on the basis both of Lives and of Amounts, subdivided into those who retired at or after their normal retiring age (referred to as 'normal') and those who retired before their normal retiring age (referred to as 'early'). In their report on 'The Graduation of the 1979–82 Mortality Experiences' (*C.M.I.R.* **9**, 1, 1988, Section 11) the Committee presented graduations of the normal and early experiences separately. The Committee subsequently prepared standard tables on the basis of the experience of normal retirements, tables denoted PML80, PMA80, PFL80 and PFA80, described in 'Standard Tables of Mortality based on the 1979–82 Experiences' (*C.M.I.R.* **10**, 1, 1990).

It has been drawn to the attention of the Committee that for some pension schemes the records do not conveniently distinguish between those who retired early and those who retired at or after the normal retiring age, particularly in respect of those pensioners now past the normal retiring age, whose records may be grouped together regardless of their original retirement age. For measuring the experience of such schemes, and possibly also for valuation purposes, it may be useful to have available a table based on the combined experience of normal and early retirements. It should be noted, however, that such a table would not be appropriate for calculating premium rates or commutation factors for those retiring at any particular age, especially those retiring at or after the normal retiring age. Further, the practice among different employers in respect of ill-health and other early retirements is so variable, and hence the mortality experience of those who retire early is likely to vary so much from one scheme to another, that the use of a combined table for calculating premium rates for ill-health or other early retirements might be dangerous.

Subject to these caveats, however, the Committee has considered it appropriate to take the combined experience of early and normal retirements, graduate the 1979–82 experiences, and construct tables on the same lines as the "80" series standard tables already published. This note presents the results of these calculations. It would not be appropriate to give these tables the authority of standard tables, but they may nevertheless prove useful in the circumstances described above.

The sizes of the experiences, measured by the total numbers of exposed to risk and of deaths for the normal and early sections separately, were shown in the report in *C.M.I.R.* **9**. These figures are repeated overleaf, together with the totals, representing the combined experience.

	Lives		Amounts	
	Deaths	Central exposed	Deaths	Central exposed
Males				
Normal	85,426	1,377,059·5	20,021,034	446,740,045·5
Early	23,717	515,356·5	7,859,664	237,973,172·4
Combined	109,143	1,892,416·0	27,880,698	684,713,217·9
Females				
Normal	10,536	336,887·0	1,445,796	64,781,941·0
Early	1,899	90,280·5	298,077	20,555,273·0
Combined	12,435	427,167·5	1,743,873	85,337,214·0

Three age ranges are considered below: first the extreme limits of the data; secondly the continuous range over which the Exposed to Risk at each age is at least 100; thirdly the continuous range over which the number of Deaths at each age is at least 10. These are shown on the basis of Lives.

	Range of data	Exposed $\geqslant 100$	Deaths $\geqslant 10$
Males	15–108	45–98	50–100
Females	26–104	48–94	53–95

The early experience is substantially smaller than the normal, for both sexes, representing between about 20% and 30% of the combined total. However, at the younger ages the combined data is dominated by early retirements, with the normals taking over the majority above the typical retirement ages of 65 for males and 60 for females. This can be seen from the table below, which shows the exposed to risk over the ages near to these typical retirement ages.

Central Exposed to Risk (Lives)

	Males			Females	
Age	Early	Normal or Late	Age	Early	Normal or Late
63	25,189·00	2,884·75	58	4,337·00	335·00
64	31,029·25	3,271·75	59	5,681·50	420·00
65	38,063·00	36,460·25	60	6,870·75	7,128·00
66	39,192·50	90,619·00	61	6,359·25	16,313·50
67	37,657·50	101,939·00	62	5,500·75	16,797·50

Before the experiences by Amounts were graduated, the numbers of Exposed to Risk and of Deaths were divided by the average amount per life in the central Exposed to Risk in each investigation. The average amounts for the Normal, Early and Combined experiences are shown below.

	Males	Females
Normal	324·42	192·30
Early	461·76	227·68
Combined	361·82	199·77

In the Report in *C.M.I.R.* **9**, the Committee showed graduations of all the normal experiences (males and females, Lives and Amounts) using a GM(1,3) formula. For all the early experiences a GM(2,2) formula was found appropriate. The higher order formula GM(2,3) seemed a possible candidate for the graduation of the combined experience. However, when this formula is applied to the combined experience it produces graduated mortality rates that increase with reducing age, a feature that was statistically significant for the male experience but could be justified only marginally for the female experience. A GM(1,3) formula, on the other hand, shows almost level mortality at ages up to about 50, with the usual shape of curve thereafter. At higher ages the experiences are dominated by the normal retirements, and for each sex the graduations follow fairly closely the corresponding graduations of the normal retirements. Summaries of the graduations are given in Table 1 for Lives and Table 2 for Amounts, showing the results for both the GM(1,3) and GM(2,3) formulae.

The values of χ^2 for the Lives graduations are high. For the male experience this derives from low numbers of actual deaths at ages 66 and 67, compared with those expected on the graduated rates, and high numbers of actual deaths at ages 63 and 64. For the GM(1,3) formula there are in addition high numbers of actual deaths at ages 47 to 51. For the female experience the actual number of deaths is low at ages 61 and 63, and high at ages 57 and 66.

The values of χ^2 are also particularly high for the Amounts experiences, but this is not unexpected.

On balance, the Committee considered that it was appropriate to use the GM(1,3) graduated rates as the basis of a usable table. The graduated rates, however, needed adjustment, and this was done in the same way as the graduated GM(1,3) rates have been adjusted to produce the 1980Base Tables (PML80Base, PMA80Base, PFL80Base and PFA80Base). No adjustment seemed necessary at younger ages, where the graduated combined rates were substantially higher than the corresponding P..80Base rates. The rates came closer together as age advanced, and in the late 80s of age the graduated combined rates fell below the P..80Base rates. It seemed appropriate that the adjusted combined rates should never fall below the P..80Base rates, and the combined rates were therefore adjusted above a particular age (87, 88 or 89 depending on the table) so as to bear a constant ratio (a little over unity) to the P..80Base rates.

The values of q_x were calculated from the graduated values of μ_x in the same way as for the standard tables. The resulting values of q_x are shown in Table 3. The tables are denoted PCML80Base, PCMA80Base, PCFL80Base and PCFA 80Base for males Lives, males Amounts, females Lives and females Amounts respectively. If forecast rates are required, these should be calculated in the same way as for the P..80 and other standard tables.

The precise formulae for calculating these tables, on the same lines as shown in Appendix B in *C.M.I.R.* **10**, are shown in the Appendix, in which cross-reference is made to the graduated formulae and ratios defined in that Appendix B.

Table 1. Pensioners, Combined, Lives, males and females.
Statistics for graduations of $\mu_x = GM(r,s)$

Sex	Males		Females	
Formula	GM(1,3)	GM(2,3)	GM(1,3)	GM(2,3)
Values of parameters at optimum point:				
$100a_1$	2·091243	−0·866071	0·922019	0·600969
T-ratio	36·43	−1·05	19·10	2·15
$100a_2$	—	−8·966797	—	−1·102127
T-ratio	—	−4·44	—	−1·24
b_1	−7·102170	−4·600424	−7·537036	−6·594653
T-ratio	−33·72	−10·48	−16·64	−8·19
b_2	8·205642	5·454160	9·172735	8·095204
T-ratio	41·26	11·59	21·21	9·18
b_3	−3·292980	−1·638885	−3·051377	−2·362462
T-ratio	−17·81	−5·80	−7·57	−3·82
Signs test: p(pos)	0·7017	0·3991	0·9648	0·9648
Runs test: p(runs)	0·0036	0·0009	0·8008	0·7119
K-S test: p(KS)	0·0591	0·4293	0·9895	0·9862
Serial correlation test:				
T-ratio 1	4·58	3·62	−0·40	−0·92
T-ratio 2	2·10	1·43	1·56	1·46
T-ratio 3	−0·22	−1·00	−1·45	−1·41
χ^2 test:				
χ^2	226·18	159·24	95·54	98·90
Degrees of freedom	53	56	48	47
$p(\chi^2)$	0·0000	0·0000	0·0001	0·0000
Specimen values of q_x and percentage standard errors:				
Age 20	0·020695	0·076994	0·009178	0·016778
percentage s.e.	2·44	14·25	4·68	36·03
Age 30	0·020696	0·060368	0·009178	0·014610
percentage s.e.	2·44	12·44	4·67	29·73
Age 40	0·020713	0·043913	0·009184	0·012458
percentage s.e.	2·42	9·58	4·64	21·31
Age 50	0·021021	0·029612	0·009302	0·010554
percentage s.e.	2·21	5·51	4·28	10·90
Age 60	0·024294	0·024391	0·010748	0·010680
percentage s.e.	1·23	3·57	2·50	3·84
Age 70	0·043983	0·044083	0·021348	0·021419
percentage s.e.	0·41	2·11	1·44	2·16
Age 80	0·107580	0·107109	0·066068	0·065981
percentage s.e.	0·50	0·78	1·34	1·46
Age 90	0·207627	0·208354	0·167137	0·167107
percentage s.e.	1·14	1·11	2·59	2·38
Age 100	0·263688	0·303892	0·275523	0·294191
percentage s.e.	3·63	4·44	8·14	10·14
Age 110	0·219398	0·341717	0·299311	0·367244
percentage s.e.	8·38	11·11	18·60	24·45

Table 2. Pensioners, Combined, Amounts, males and females.
Statistics for graduations of $\mu_x = GM(r,s)$

Sex	Males		Females	
Formula	GM(1,3)	GM(2,3)	GM(1,3)	GM(2,3)
Values of parameters at optimum point:				
$100a_1$	1·622668	−4·330401	0·837116	0·848045
T-ratio	39·11	−2·24	24·46	7·48
$100a_2$	—	14·537731	—	0·041520
T-ratio	—	−4·39	—	0·10
b_1	−7·432327	−3·268192	−8·797317	−8·850867
T-ratio	−31·85	−6·06	−17·33	−11·74
b_2	8·692000	4·094853	10·232256	10·292140
T-ratio	42·10	6·96	21·73	13·30
b_3	−3·459376	−0·726544	−4·107207	−4·148364
T-ratio	−16·39	−2·44	−8·92	−6·56
Signs test: p(pos)	0·7478	0·4022	0·3417	0·2483
Runs test: p(runs)	0·1190	0·5062	0·1141	0·1228
K-S test: p(KS)	0·0165	0·2488	0·7672	0·7685
Serial correlation test:				
T-ratio 1	1·02	0·51	1·02	1·02
T-ratio 2	1·05	−0·69	−1·01	−1·01
T-ratio 3	0·99	−1·04	−0·44	−0·44
χ^2 test:				
χ^2	782·40	510·31	274·23	275·06
Degrees of freedom	52	60	50	49
$p(\chi^2)$	0·0000	0·0000	0·0001	0·0000
Specimen values of q_x and percentage standard errors:				
Age 20	0·016096	0·096021	0·008336	0·008037
percentage s.e.	2·28	13·85	3·65	37·72
Age 30	0·016096	0·070210	0·008336	0·008119
percentage s.e.	2·28	12·40	3·65	27·44
Age 40	0·016106	0·045636	0·008337	0·008203
percentage s.e.	2·26	11·18	3·65	17·35
Age 50	0·016314	0·025841	0·008385	0·008330
percentage s.e.	2·08	13·86	3·48	8·04
Age 60	0·018863	0·018472	0·009307	0·009312
percentage s.e.	1·13	19·62	2·26	2·47
Age 70	0·036092	0·036590	0·018382	0·018376
percentage s.e.	0·47	9·13	1·68	1·59
Age 80	0·097252	0·095793	0·061267	0·061274
percentage s.e.	0·67	2·61	1·79	1·90
Age 90	0·200511	0·203608	0·149222	0·149240
percentage s.e.	1·58	1·78	3·49	3·15
Age 100	0·262150	0·346513	0·205724	0·204870
percentage s.e.	4·78	5·00	10·67	13·02
Age 110	0·217846	0·491213	0·160600	0·158491
percentage s.e.	10·72	10·07	25·22	34·00

Table 3. Pensioners—Combined Normal and Early, PCML80Base, PCMA80Base, PCFL80Base and PCFA80Base

Values of q_x

Age	Males		Females	
	Lives	Amounts	Lives	Amounts
x	PCML80Base	PCMA80Base	PCFL80Base	PCFA80Base
16	0·020695	0·016096	0·009178	0·008336
17	0·020695	0·016096	0·009178	0·008336
18	0·020695	0·016096	0·009178	0·008336
19	0·020695	0·016096	0·009178	0·008336
20	0·020695	0·016096	0·009178	0·008336
21	0·020695	0·016096	0·009178	0·008336
22	0·020695	0·016096	0·009178	0·008336
23	0·020695	0·016096	0·009178	0·008336
24	0·020695	0·016096	0·009178	0·008336
25	0·020695	0·016096	0·009178	0·008336
26	0·020695	0·016096	0·009178	0·008336
27	0·020695	0·016096	0·009178	0·008336
28	0·020696	0·016096	0·009178	0·008336
29	0·020696	0·016096	0·009178	0·008336
30	0·020696	0·016096	0·009178	0·008336
31	0·020696	0·016096	0·009178	0·008336
32	0·020696	0·016096	0·009178	0·008336
33	0·020697	0·016097	0·009178	0·008336
34	0·020698	0·016097	0·009179	0·008336
35	0·020699	0·016097	0·009179	0·008336
36	0·020700	0·016098	0·009179	0·008336
37	0·020702	0·016099	0·009180	0·008337
38	0·020704	0·016101	0·009181	0·008337
39	0·020708	0·016103	0·009182	0·008337
40	0·020713	0·016106	0·009184	0·008337
41	0·020719	0·016110	0·009186	0·008338
42	0·020728	0·016115	0·009189	0·008339
43	0·020740	0·016122	0·009193	0·008340
44	0·020755	0·016132	0·009199	0·008342
45	0·020776	0·016146	0·009207	0·008345
46	0·020803	0·016164	0·009217	0·008348
47	0·020838	0·016187	0·009230	0·008354
48	0·020884	0·016219	0·009248	0·008361
49	0·020944	0·016260	0·009271	0·008371

Table 3. (continued)
Pensioners—Combined Normal and Early, PCML80Base, PCMA80Base, PCFL80Base and PCFA80Base
Values of q_x

	Males		Females	
Age x	Lives PCML80Base	Amounts PCMA80Base	Lives PCFL80Base	Amounts PCFA80Base
50	0·021021	0·016314	0·009302	0·008385
51	0·021119	0·016385	0·009341	0·008404
52	0·021245	0·016475	0·009392	0·008429
53	0·021403	0·016592	0·009457	0·008464
54	0·021603	0·016741	0·009540	0·008510
55	0·021852	0·016929	0·009646	0·008572
56	0·022162	0·017167	0·009780	0·008653
57	0·022546	0·017466	0·009949	0·008760
58	0·023018	0·017837	0·010160	0·008898
59	0·023594	0·018297	0·010423	0·009078
60	0·024294	0·018863	0·010748	0·009307
61	0·025140	0·019555	0·011148	0·009600
62	0·026155	0·020396	0·011638	0·009970
63	0·027365	0·021411	0·012235	0·010435
64	0·028801	0·022629	0·012958	0·011014
65	0·030492	0·024081	0·013829	0·011731
66	0·032472	0·025800	0·014872	0·012610
67	0·034775	0·027823	0·016115	0·013681
68	0·037438	0·030187	0·017586	0·014977
69	0·040495	0·032930	0·019319	0·016531
70	0·043983	0·036092	0·021348	0·018382
71	0·047933	0·039711	0·023709	0·020567
72	0·052379	0·043824	0·026440	0·023128
73	0·057346	0·048465	0·029580	0·026103
74	0·062856	0·053662	0·033168	0·029533
75	0·068925	0·059440	0·037243	0·033453
76	0·075560	0·065813	0·041841	0·037895
77	0·082760	0·072790	0·046995	0·042884
78	0·090514	0·080367	0·052737	0·048439
79	0·098798	0·088530	0·059088	0·054567
80	0·107580	0·097252	0·066068	0·061267
81	0·116813	0·106493	0·073685	0·068522
82	0·126441	0·116200	0·081938	0·076302
83	0·136395	0·126308	0·090817	0·084563
84	0·146596	0·136738	0·100300	0·093247

Table 3. (continued)
Pensioners—Combined Normal and Early, PCML80Base, PCMA80Base,
PCFL80Base and PCFA80Base

Values of q_x

| Age | Males | | Females | |
x	Lives PCML80Base	Amounts PCMA80Base	Lives PCFL80Base	Amounts PCFA80Base
85	0·156957	0·147402	0·110353	0·102279
86	0·167381	0·158200	0·120930	0·111572
87	0·177768	0·169024	0·131973	0·121278
88	0·188009	0·180751	0·143754	0·131418
89	0·198719	0·193725	0·156372	0·141710
90	0·210116	0·207145	0·169519	0·152055
91	0·222877	0·220976	0·183138	0·162351
92	0·237182	0·235179	0·197163	0·172490
93	0·251873	0·249767	0·211521	0·182361
94	0·267142	0·264932	0·226133	0·191854
95	0·283040	0·280724	0·238820	0·201042
96	0·299560	0·297139	0·249860	0·210586
97	0·316694	0·314168	0·261508	0·220681
98	0·334428	0·331797	0·273790	0·231357
99	0·352744	0·350010	0·286734	0·242644
100	0·371619	0·368784	0·300366	0·254569
101	0·391027	0·388093	0·314711	0·267164
102	0·410934	0·407906	0·329795	0·280457
103	0·431303	0·428185	0·345638	0·294477
104	0·452092	0·448889	0·362261	0·309251
105	0·473253	0·469971	0·379679	0·324807
106	0·494733	0·491380	0·397905	0·341167
107	0·516475	0·513059	0·416946	0·358352
108	0·538417	0·534946	0·436803	0·376381
109	0·560492	0·556977	0·457470	0·395265
110	0·582631	0·579082	0·478931	0·415011
111	0·604761	0·601190	0·501163	0·435618
112	0·626806	0·623225	0·524130	0·457080
113	0·648689	0·645110	0·547784	0·479377
114	0·670332	0·666768	0·572065	0·502480
115	0·691656	0·688121	0·596894	0·526348
116	0·712583	0·709090	0·622181	0·550926
117	0·733039	0·729601	0·647816	0·576142
118	0·752950	0·749581	0·673672	0·601908
119	0·772247	0·768959	0·699606	0·628119

APPENDIX

Graduated formulae and their parameter values

This Appendix should be read in conjunction with Appendix B of the Report in *C.M.I.R.* **10**

Combined pensioners

Formula No		GM(r,s)	$100a_0$	b_1	b_2	b_3
			Males			
F44	Lives	GM(1,3)	2·091243	−7·102170	8·205642	−3·292980
F45	Amounts	GM(1,3)	1·622668	−7·432327	8·692000	−3·459376
			Females			
F54	Lives	GM(1,3)	0·922019	−7·537036	9·172735	−3·051377
F55	Amounts	GM(1,3)	0·837116	−8·797317	10·232256	−4·107207

Males PCML80Base and PCMA80Base

B4.3	Lives	$x \leqslant 89$	F44		
		$89 < x \leqslant 91$	$k43.F41$	where $k43$	$= F44/F41$ at $x = 89$ $= 1.00536651$
		$91 < x \leqslant 93$	$k43.k44.F42$	where $k44$	$= F41/F42$ at $x = 91$ $= 1.01216060$
		$x > 93$	$k43.k44.F43$		
B4.4	Amounts	$x \leqslant 88$	F45		
		$88 < x \leqslant 93$	$k45.F42$	where $k45$	$= F45/F42$ at $x = 88$ $= 1.00773281$
		$x > 93$	$k45.F43$		

Females PCFL80Base and PCFA80Base

B5.3	Lives	$x \leqslant 88$	F54		
		$88 < x \leqslant 95$	$k53.F51$	where $k53$	$= F54/F51$ at $x = 88$ $= 1.00155039$
		$x > 95$	$k53.k54.F53$	where $k54$	$= F51/F52$ at $x = 95$ $= 1.21543261$
B5.4	Amounts	$x \leqslant 87$	F55		
		$87 < x \leqslant 95$	$k55.F52$	where $k55$	$= F55/F52$ at $x = 87$ $= 1.00123661$
		$x > 95$	$k55.F53$		

F41, F42, F43, F51, F52 and F53 are defined as in Appendix B of the Report in *C.M.I.R.* **10**.

MINI-GRADUATIONS OF THE MORTALITY
EXPERIENCES OF ASSURED LIVES, PENSIONERS
AND ANNUITANTS, 1983-86

It is customary for the Committee, when making their quadrennial reports on the mortality experience of assured lives, pensioners and annuitants, to quote a linear relationship between the observed rates of mortality of male lives effecting permanent (whole life and endowment) assurances, at durations 2 and over, and the mortality rates according to the latest standard table. The last such relationship, for the quadrennium 1983-86, using as a standard the A1967-70 table, was published in *C.M.I.R.*, **11** (1991). The Committee considers that it may be of use to practitioners to have available similar relationships for each of the major experiences, as compared with the appropriate standard table in the new "80" series, first published in *C.M.I.R.*, **10** (1990), and in 'Standard Tables of Mortality: the "80" series' (1992). This report presents such relationships.

In each case the function to be graduated is q_x, using the formula

$$q_x = a + (1 - b)q_x^*,$$

where q_x^* is the value of q_x from an appropriate standard table. The form using $(1 - b)$ is chosen so that the value of b can be compared with zero rather than unity. The values of the parameters, a and b, have been calculated using the graduation methods described by Forfar, McCutcheon and Wilkie (1988), using the method of maximum likelihood. The resulting graduation according to a standard table can be described as a 'mini-graduation' of the data.

The methodology is straightforward. The only small technical points to note are that, in all cases, the age range of the data used has been restricted to the age range of the mortality rates in the standard table, and that the values of q_x^* for half ages, required to correspond to the age grouping of the data, have been calculated by geometric interpolation:

$$q_{x-1/2}^* = \sqrt{(q_{x-1}^* \cdot q_x^*)}.$$

The way the results are presented is discussed in detail in Section 1.1, and thereafter the results are presented with only the minimum of commentary.

Only those experiences where there is sufficient data to be worth graduating have been considered. This includes the following experiences:

1. *Policies of assurance issued in the United Kingdom*
    1.1   Permanent assurances (whole life and endowment assurances) on male lives;
    1.2   Permanent assurances on female lives;
    1.3   Temporary assurances on male lives;
    1.4   Temporary assurances on female lives;
    1.5   Linked contracts on male lives;
    1.6   Linked contracts on female lives;
    1.7   Joint life first death assurances, male lives.

2. *Policies of assurance issued in the Republic of Ireland*
    2.1   Permanent assurances on male lives;
    2.2   Linked contracts on male lives.

3. *Pension and annuity policies issued in the United Kingdom*
    3.1   Pensioners under life office pension schemes;
    3.2   Widows of pensioners;
    3.3   Retirement annuities;
    3.4   Immediate annuity contracts.

Certain experiences for which data for 1983-86 has been gathered have too few deaths for this mini-graduation procedure to be worth applying. These are:

Policies of assurance issued in the United Kingdom
    Joint life first death assurances, female lives.
    Non-selection assurances, male and female lives.
    Permanent assurances, minimum evidence, male and female lives.
    Joint life minimum evidence assurances, male and female lives.

Policies of assurance issued in the Republic of Ireland
    Permanent assurances on female lives.
    Linked contracts on female lives.

Pension and annuity policies issued in the United Kingdom
    Widowers of female pensioners.

1. POLICIES OF ASSURANCE ISSUED IN THE UNITED KINGDOM

1.1 *Permanent assurances on male lives*

By 'permanent assurances' are meant whole life and endowment assurances. The investigation into the mortality experienced by male lives insured under such permanent assurances is the oldest and largest of the C. M. I. investigations. Two standard tables were constructed on the basis of the experience for 1979-82 for this investigation, both in the "80" series, AM80 with a two-year select period, and AM80(5) with a five-year select period. The experience is first compared with the AM80 table, and the results are shown in Table 1.1a.

Table 1.1a shows comparisons of the experiences for durations 0, 1 and 2 and over (2 +) with the corresponding mortality rates from the AM80 table, durations 0, 1 and 2 +. In the experience for the ultimate durations there are sufficiently many duplicates for 'variance ratios' to be used to adjust the data before graduation. These variance ratios have been based on the distribution of the numbers of policies per 'life' among the recorded deaths for the corresponding period 1983-86, at least in so far as these are available through the cause of death investigation. Results are shown for durations 2 + both without and with variance ratios. It can be seen that there is little difference in the estimated values of the parameters.

The numbers of deaths in the experience for each duration are shown. It can be seen that there are enough deaths at each duration in this investigation for results to be clearly significant. The value of 100A/E on the comparison basis is shown next. From this number the estimated value of b assuming that a is zero can readily be derived. Then follow the estimated vales of a and b, and the corresponding T-ratios. A T-ratio less than 2.0 suggests that the parameter is not significantly different from zero.

Table 1.1a shows the full set of results of diagnostic tests such as were shown in the paper by Forfar, McCutcheon and Wilkie, and in the Report in *C.M.I.R.*, **9**. For all other experiences only the overall result is shown, indicated by 'Yes' if all the relevant diagnostic tests, signs test, runs test, K-S test, serial correlation test, and χ^2 test, are satisfactory, and by 'No' and a numbered footnote if they are not. Where the diagnostic tests are not satisfactory it is possible that, if a new complete graduation were to be carried out, a formula with different parameters and possibly more terms would be required. But the Committee considers such refinements inappropriate for these mini-graduations.

Actual deaths for the experience for duration 0 are 99.447% of those expected by AM80 D0, very close to being just the same. The T-ratios of the parameters are 1.40 and 1.18 respectively, less than 2.0, and indicating that it would not be unreasonable to take both a and b as zero. The fit is satisfactory, all the diagnostic tests being well within reasonable bounds. In fact when the experience is compared with AM80 D0 without adjustment, all the diagnostic tests are also satisfactory.

Table 1.1a. Permanent assurances, males, United Kingdom,
durations 0,1 and 2+
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	0	1	2+	2+
Variance ratios used?	No	No	No	Yes
Comparison basis	AM80 D0	AM80 D1	AM80 D2+	AM80 D2+
Ages used	All	All	Up to 90	Up to 90
Number of deaths	1,545	1,922	88,442	54,731.0
100A/E on comparison basis	99.447	93.082	90.127	90.141
Values of parameters at optimum point:				
a	0.000049	−0.000008	0.000038	0.000037
T-ratio	1.40	−0.24	4.11	3.21
b	0.042309	0.064001	0.107419	0.107105
T-ratio	1.18	2.20	30.38	24.36
Signs test: $p(\text{pos})$	0.7371	0.6482	0.3760	0.3760
Runs test: $p(\text{runs})$	0.4613	0.0805	0.0001	0.0001
K-S test: $p(\text{KS})$	0.5653	0.1690	0.0003	0.0204
Serial correlation test:				
T-ratio 1	0.91	2.23	4.96	5.10
T-ratio 2	0.24	0.46	4.74	4.83
T-ratio 3	1.41	1.60	3.64	3.71
χ^2 test:				
χ^2	78.41	97.85	461.87	359.29
Degrees of freedom	60	60	88	88
$p(\chi^2)$	0.0555	0.0015	0.0000	0.0000
Diagnostics satisfactory?	Yes	No (1)	No (2)	No (2)

(1) Signs test, runs test, etc, satisfactory; value of χ^2 large because of erratic numbers of actual deaths at a few ages.

(2) Actual deaths above expected for most ages from 25 to 38 and 76 to 90, and below expected for most ages from 47 to 60.

Actual deaths for the experience for duration 1 are 93.082% of those expected by AM80 D1, significantly lower. The estimated value of a is -0.000008 and its T-ratio is -0.24, showing that this estimate of a is not significantly different from zero. The estimated value of b, however, is significantly different from zero (T-ratio 2.20). The diagnostic tests are not wholly satisfactory, and footnote (1) indicates that the value of χ^2 is large because the numbers of actual deaths are erratic at a few ages.

The graduation for durations 2+ was restricted to ages only up to 90, the same as the graduation on which the AM80 table was based, because the observed deaths for ages above 90 in this investigation are normally both

Table 1.1b. Permanent assurances, males, United Kingdom, durations 2, 3, 4, 2-4 and 5+.
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	2	3	4	2-4	5+
Variance ratios used?	No	No	No	No	Yes
Comparison basis	AM80(5) D2-4	AM80(5) D2-4	AM80(5) D2-4	AM80(5) D2-4	AM80(5) D5+
Ages used	All	All	All	All	Up to 90
Number of deaths	2,188	2,322	2,383	6,893	50,873.1
100A/E on comparison basis	91.236	94.644	95.349	93.772	91.578
Values of parameters at optimum point:					
a	0.000049	−0.000053	−0.000009	−0.000005	0.000028
T-ratio	1.35	−1.48	−0.24	−0.23	2.10
b	0.111441	0.027952	0.042063	0.059618	0.088860
T-ratio	4.31	1.07	1.62	3.97	19.00
Diagnostics satisfactory?	Yes	Yes	Yes	No (3)	No (4)

(3)   Actual deaths erratic at a few ages.
(4)   See footnote (2) relating to durations 2+.

erratic and unexpectedly low. Actual deaths up to age 90 are 90.127% of those expected by AM80 D2+ when variance ratios are not used, and 90.141% when they are. The parameter estimates are very significantly different from zero, and quite similar whether variance ratios are used or not. Footnote (2) indicates why the diagnostic tests are not satisfactory; the shape of the experience in 1983-86 is rather different from that in 1979-82, particularly because of higher than expected deaths at most ages from 25 to 38, which may perhaps be attributable to deaths from AIDS or otherwise associated with HIV infection, although the Committee has no direct evidence that this is the case.

Comparison of the experiences for durations 2, 3, 4, 2-4 and 5+ (with variance ratios) are shown in Table 1.1b. As for durations 2+, the graduation for durations 5+ was restricted to ages only up to 90. The results for durations 5+ are similar to those for durations 2+ shown in Table 1.1a.

1.2 *Permanent assurances on female lives*

This experience is compared with the AF80 standard table, which was derived from the corresponding experience for 1979-82. The results for durations 0, 1 and 2+ are shown in Table 1.2.

The value of 100A/E for duration 0 is 95.202, indicating that the mortality rates in 1983-86 are a little lower than the standard table. However, the parameter estimation gives negative values for both a and b, neither of which is significantly different from zero. A negative value of b means that $(1 - b)$ is greater than unity; thus the duration 0 experience is represented by adding

Table 1.2. Permanent assurances, females, United Kingdom
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	0	1	2+	2+
Variance ratios used?	No	No	No	Yes
Comparison basis	AF80 D0	AF80 D1	AF80 D2+	AF80 D2+
Number of deaths	482	662	8,571	6,728.3
100A/E on comparison basis	95.202	84.309	91.692	91.116
Values of parameters at optimum point:				
a	−0.000051	0.000021	0.000002	0.000001
T-ratio	−1.80	0.63	0.13	0.09
b	−0.017378	0.172449	0.083378	0.089054
T-ratio	−0.30	4.20	6.99	6.72
Diagnostics satisfactory?	No (5)	Yes	No (6)	No (6)

(5) Actual deaths below expected for most ages from 38 to 59, above expected for most ages from 60 upwards.

(6) Actual deaths below expected for all ages from 65 to 80, and above expected for most ages above 80; also actual deaths erratic at a few ages.

1.7378% to the basic mortality rates, and then taking off 0.000051 from the result. The net effect is a reduction in the value of q_x up to age 58 and an increase thereafter. This correctly reflects the tendency of the data.

The value of 100A/E for duration 1 is 84.309. Actual deaths are well below those expected. The experience can be satisfactorily represented by taking 17.2449% off the value of q_x and then adding back 0.000021.

Variance ratios are available for female assured lives, and results are shown for durations 2 + both with and without the use of variance ratios. The results are similar, but show, as indicated in footnote (6), that the experience mortality rates have reduced more between ages 65 and 80 than at other ages.

1.3 *Temporary assurances on male lives*

For 1983-86 data has been gathered for level temporary assurances and decreasing temporary assurances separately, though only one standard table, TM80, based on the combined data for 1979-82, was constructed. Table 1.3a compares the combined experience for 1983-86 with TM80; Tables 1.3b and 1.3c show the results for level temporary assurances and decreasing temporary assurances respectively.

For duration 0 of the combined experience 100A/E was 106.937. The mortality rates are best represented by multiplying q_x by (1 - 0.115163) and then adding 0.000197.

The experiences for durations 1-4 and 5 + show overall mortality below the corresponding durations of TM80, and a satisfactory adjustment can be derived as shown in Table 1.3a.

The results for level temporary assurances are shown in Table 1.3b, and for decreasing temporary assurances in Table 1.3c. It is worth noting that the experience at durations 5 + for level temporary assurances is relatively small, suggesting that the average duration in this part of the experience is not

Table 1.3a. Temporary assurances, males, United Kingdom, combined
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	0	1-4	5+
Comparison basis	TM80 D0	TM80 D1-4	TM80 D5 +
Number of deaths	596	2,542	6,111
100A/E on comparison basis	106.937	93.330	87.081
Values of parameters at optimum point:			
a	0.000197	0.000039	0.000077
T-ratio	3.43	1.29	2.72
b	0.115163	0.091729	0.156830
T-ratio	1.79	3.46	10.61
Diagnostics satisfactory?	Yes	Yes	Yes

Table 1.3b. Level temporary assurances, males, United Kingdom
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	0	1-4	5+
Comparison basis	TM80 D0	TM80 D1-4	TM80 D5+
Number of deaths	378	1,246	994
100A/E on comparison basis	110.584	90.854	79.113
Values of parameters at optimum point:			
a	0.000280	0.000116	0.000144
T-ratio	3.76	2.75	2.59
b	0.169265	0.172691	0.275072
T-ratio	2.03	4.59	8.03
Diagnostics satisfactory?	Yes	Yes	Yes

Table 1.3c. Decreasing temporary assurances, males, United Kingdom
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	0	1-4	5+
Comparison basis	TM80 D0	TM80 D1-4	TM80 D5+
Number of deaths	218	1,296	5,117
100A/E on comparison basis	101.152	95.840	88.818
Values of parameters at optimum point:			
a	0.000052	−0.000041	0.000070
T-ratio	0.59	−0.94	2.12
b	0.033299	0.017621	0.135608
T-ratio	0.33	0.47	8.26
Diagnostics satisfactory?	Yes	No (7)	Yes

(7)   Actual deaths erratic at a few ages.

much greater than 5 years. This may account for the low mortality rates in this section as compared with decreasing temporary assurances. The same feature was found in the 1979-82 experiences.

1.4 *Temporary assurances on female lives*
There was insufficient data in the 1979-82 experience to warrant even graduating it, far less producing a standard table. There is still only a relatively small amount of data, but it is worth comparing what there is with the table for permanent assurances on female lives, AF80. The results are shown in Table 1.4.

The values of 100A/E are consistently well below 100, being roughly 80 for each of durations 0, 1-4 and 5+. The experiences can be satisfactorily

Table 1.4. Temporary assurances, females, United Kingdom, combined
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	0	1-4	5+
Comparison basis	AF80 D0	AF80 D1	AF80 D2+
Number of deaths	85	335	278
100A/E on comparison basis	79.792	78.221	81.601
Values of parameters at optimum point:			
a	−0.000002	0.000034	−0.000121
T-ratio	−0.03	0.90	−1.95
b	0.198612	0.266452	0.074943
T-ratio	1.35	3.95	0.96
Diagnostics satisfactory?	Yes	Yes	Yes

represented by the rates for corresponding durations from AF80, adjusted by the parameters shown. Most of the parameters are, however, not significantly different from zero; this is not surprising in view of the relatively small size of the experience.

1.5 *Linked contracts on male lives*

Although the experience for linked contracts on male lives for 1979-82 was graduated (see the report in *C.M.I.R.*, **9**), no standard table based on the experience of linked contracts was produced. The experience for 1983-86 has therefore

Table 1.5. Linked contracts, males, United Kingdom
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	0	1	2+	2+
Variance ratios used?	No	No	No	Yes
Comparison basis	AM80 D0	AM80 D1	AM80 D2+	AM80 D2+
Ages used	Up to 75	Up to 75	All	All
Number of deaths	535	572	3,809	2,463.2
100A/E on comparison basis	101.606	102.489	75.549	74.991
Values of parameters at optimum point:				
a	0.000015	−0.000041	0.000164	0.000171
T-ratio	0.22	−0.49	4.02	3.99
b	−0.008425	−0.041439	0.276251	0.290750
T-ratio	−0.15	−0.77	19.62	16.69
Diagnostics satisfactory?	No (8)	No (8)	No (9)	No (9)

(8)   Actual deaths erratic at a few ages.
(9)   Actual deaths erratic at several ages.

been compared with the standard table for permanent assurances, AM80. At durations 0 and 1 the experience above age 75 is particularly heavy. The Committee presumes that this is because certain offices still include cases where there is no significant mortality risk in the experience, in spite of the Bureau's instructions not to do so. The experiences for these durations have therefore been compared using only the data up to age 75. The results are shown in Table 1.5.

For durations 2 + the overall level of the experiences is reasonable at all ages, though the results for individual ages are rather erratic. Variance ratios have been calculated, based only on a proportion of the actual deaths, and these too are very erratic. The methodology of using variance ratios assumes that the distribution of numbers of policies among the in-force can be satisfactorily represented by the distribution among the deaths. It is clear that for this experience this is unlikely to be the case. The difficulty probably results from certain offices still including 'bundles' of simultaneous policies in the experience, in spite of the Bureau's instructions not to do so. Results both with and without variance ratios are shown in Table 1.5. The values for the parameters are not very different, but in both cases the value of χ^2 is particularly high, because of several ages where actual deaths are erratic.

1.6 *Linked contracts on female lives*

No standard table has been produced based on the experience of linked contracts on female lives, so comparison is with the standard table for permanent assurances, AF80. Results are shown in Table 1.6. The same observations apply to females as to males: the experience at durations 0 and 1 above age 75 is exceptionally high, and these ages have been omitted from the

Table 1.6. Linked contracts, females, United Kingdom
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	0	1	2+	2+
Variance ratios used?	No	No	No	Yes
Comparison basis	AF80 D0	AF80 D1	AF80 D2+	AF80 D2+
Ages used	Up to 75	Up to 75	All	All
Number of deaths	137	137	1,420	1,117.8
100A/E on comparison basis	90.106	70.481	90.239	89.641
Values of parameters at optimum point:				
a	−0.000030	0.000043	−0.000008	−0.000004
T-ratio	−0.45	0.50	−0.14	−0.07
b	0.073908	0.315730	0.091877	0.097421
T-ratio	0.77	4.44	3.53	3.31
Diagnostics satisfactory?	Yes	Yes	No (10)	No (10)

(10)   Actual deaths erratic at several ages.

calculations. Variance ratios have been used for durations $2+$, but they themselves are erratic, and do not reduce the value of χ^2 to a satisfactory level.

1.7 *Joint life first death assurances, male lives*

The investigation into the mortality experienced by those effecting joint life assurances, payable on the first death of a male and a female, began only in 1982, so no data for 1979–82 was available to graduate. For males the experience for 1983–86 is large enough for a comparison with a standard table to be worth while; although the exposed to risk for females is the same as for males, the number of deaths is too small to make such a comparison valid.

The male experiences for durations 0, 1 and $2+$ are compared with the corresponding durations of AM80 and the results are shown in Table 1.7. The experience is substantially lighter than that of AM80, but the adjustment parameters shown provide a satisfactory fit for each duration.

Table 1.7. Joint life first death assurances, males, United Kingdom
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	0	1	$2+$
Comparison basis	AM80 D0	AM80 D1	AM80 D2+
Number of deaths	137	161	575
100A/E on comparison basis	72.613	89.643	75.616
Values of parameters at optimum point:			
a	−0.000180	0.000168	0.000066
T-ratio	−2.46	1.50	1.21
b	0.114622	0.221229	0.282998
T-ratio	1.16	2.23	6.47
Diagnostics satisfactory?	Yes	Yes	Yes

2. POLICIES OF ASSURANCE ISSUED IN THE REPUBLIC OF IRELAND

2.1 *Permanent assurances on male lives*

No standard table has been produced for permanent assurances on male lives in the Republic of Ireland, so comparison is with the UK Table, AM80. Results are shown in Table 2.1. The experience is substantially heavier than in the UK, as shown by the values of 100A/E, all above 100, and by the negative values of b compensated for to some extent by negative values of a.

2.2 *Linked contracts on male lives*

No standard table has been constructed for linked contracts on male lives in the Republic of Ireland, so comparisons are with the AM80 table. Results are shown in Table 2.2. The values of 100A/E exceed 100 for durations 0, 1 and

Table 2.1 Permanent assurances, males, Republic of Ireland
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	0	1	2+
Comparison basis	AM80 D0	AM80 D1	AM80 D2+
Number of deaths	76	64	3,728
100A/E on comparison basis	140.378	111.133	107.293
Values of parameters at optimum point:			
a	−0.000486	−0.000094	−0.000146
T-ratio	−2.70	−0.48	−2.97
b	−0.871320	−0.183930	−0.103250
T-ratio	−3.24	−0.86	−5.02
Diagnostics satisfactory?	Yes	Yes	No (11)

(11)   Actual deaths erratic at a few ages.

$2+$, and the experiences can be satisfactorily represented by the AM80 table adjusted in accordance with the parameters shown. However, most of the T-ratios are less than 2.0, indicating that the values of the parameters are not significantly different from zero.

Table 2.2 Linked contracts, males, Republic of Ireland
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	0	1	2+
Comparison basis	AM80 D0	AM80 D1	AM80 D2+
Number of deaths	79	105	1,101
100A/E on comparison basis	103.496	102.353	112.477
Values of parameters at optimum point:			
a	0.000157	−0.000151	0.000023
T-ratio	1.02	−1.03	0.35
b	0.137052	−0.156678	−0.113763
T-ratio	0.71	−0.92	−2.53
Diagnostics satisfactory?	Yes	Yes	No (12)

(12)   Actual deaths erratic at a few ages.

3. PENSION AND ANNUITY POLICIES ISSUED IN THE UNITED KINGDOM

3.1 *Pensioners under life office pension schemes*

Standard tables for pensioners insured under life office pension schemes retiring at or after their normal retirement age were constructed on the basis of the

Table 3.1a. Male pensioners retiring at or after normal retirement age
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Investigation	Lives	Lives	Amounts	Amounts
Variance ratios used?	No	No	Yes	Yes
			R = 519.05	R = 519.05
Comparison basis	PML80Base	PML80C84	PMA80Base	PMA80C84
Number of deaths	84,303	84,303	55,254.7	55,254.7
100A/E on comparison basis	91.188	96.580	88.951	94.581
Values of parameters at optimum point:				
a	−0.001079	−0.000956	0.000096	0.000622
T-ratio	−3.28	−3.11	0.38	2.49
b	0.070712	0.018219	0.111194	0.067656
T-ratio	12.35	3.16	16.89	9.71
Diagnostics satisfactory?	No (13)	No (13)	No (14)	No (14)

(13) Actual deaths generally below expected at ages 66 to 78, above expected at ages 79 to 95; the formula produces negative values of q_x at ages below 39 (Base) or 38 (C84).

(14) Satisfactory fit, but χ^2 too high as is usual for amounts data.

1979-82 experience for both males and females and both lives and amounts, and were designated PML80Base, PMA80Base, PFL80Base and PFA80Base. Projected tables were also proposed by the Committee, and tables projected for four years ahead (i.e. to 1984) are denoted by the suffix C84 instead of Base. It is appropriate to compare each experience both with the Base table and the projected C84 table. The results for male pensioners retiring at or after normal retirement age are shown in Table 3.1a, and corresponding results for female pensioners retiring at or after normal retirement age are shown in Table 3.1b.

The male experience is very large, with 84,303 deaths. By 1983-86 the experience had improved to below the Base rates (100A/E = 91.188), but was also below the PML80C84 projected rates (100A/E = 96.580). Optimum values of the parameters a and b are shown in the Table, but have the inconvenience that, since the values of a are sufficiently large and negative, the resulting values of q_x are negative at ages below 39 (Base) or 38 (C84). There is, of course, little data as low as these ages, but in those cases where there are genuine normal retirements at young retirement ages such an adjusted table is hardly satisfactory.

In spite of this adjustment, actual deaths remained below those expected according to the adjusted table at most ages from 66 to 78, remaining above the adjusted table at ages 79 to 95.

Before graduating the amounts experience, the exposed to risk and numbers of actual deaths were divided by a constant 'variance ratio', R,

Table 3.1b. Female pensioners retiring at or after normal retirement age
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Investigation	Lives	Lives	Amounts	Amounts
Variance ratios used?	No	No	Yes	Yes
			R = 317.12	R = 317.12
Comparison basis	PFL80Base	PFL80C84	PFA80Base	PFA80C84
Number of deaths	12,273	12,273	7,793.2	7,793.2
100A/E on comparison basis	92.863	98.206	92.893	98.715
Values of parameters at optimum point:				
a	0.001172	0.001572	0.001229	0.001512
T-ratio	3.83	5.19	4.81	5.98
b	0.105330	0.066642	0.127179	0.086679
T-ratio	8.96	5.42	8.41	5.47
Diagnostics satisfactory?	No (15)	No (15)	No (16)	No (16)

(15) Actual deaths erratic at a few ages.
(16) Satisfactory fit, but χ^2 too high, as is usual for amounts data.

with a value of 519.05. This equals the average amount of pension among the exposed to risk. A similar adjustment has been made for all amounts experiences, with different values of R, each appropriate to the particular experience.

The adjustments to PMA80Base and PMA80C84 produce reasonably satisfactory fits for the data, though the value of χ^2 is much too high, as is usual for amounts data.

The results for female pensioners retiring at or after normal retirement age are shown in Table 3.1b. The improvement for females since 1979-82 is not as great as that for males, and the experiences for 1983-86 for lives and amounts are only a little below the projected PFL80C84 and PFA80C84 tables respectively. Nevertheless they are satisfactorily represented by these tables with adjustments as indicated by the parameters in Table 3.1b.

In the paper on pages 77–85 of this number of *C.M.I. Reports*, 'Mortality Tables Based on the Combined Pensioners Experience, 1979-82' the Committee present tables based on the combined experience of pensioners who had retired early and those who had retired at or after normal retirement age. These tables are denoted PCML80Base, PCMA80Base, PCFL80Base and PCFA80Base, with tables projected for four years ahead denoted by the suffix C84.

The combined experience for 1983-86 is compared with these PC..80 tables in Tables 3.1c and 3.1d for males and females respectively. The results are not very different from those for normal retirements, though the large negative values of *a* for the male lives experience do not on this occasion produce negative values of q_x, because at younger ages the combined experience has quite high values of q_x.

Table 3.1c. Male pensioners, combined early, normal and late retirements
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Investigation	Lives	Lives	Amounts	Amounts
Variance ratios used?	No	No	Yes	Yes
			R = 519.30	R = 519.30
Comparison basis	PCML80Base	PCML80C84	PCMA80Base	PCMA80C84
Number of deaths	113,349	113,349	73,192.8	73,192.8
100A/E on comparison basis	91.080	96.736	88.990	94.983
Values of parameters at optimum point:				
a	−0.002446	−0.001245	−0.001154	−0.000363
T-ratio	−8.87	−4.60	−5.07	−1.63
b	0.047806	0.010266	0.080158	0.039818
T-ratio	9.04	1.87	12.18	5.79
Diagnostics satisfactory?	No (17)	No (17)	No (18)	No (18)

(17) Actual deaths erratic at a few ages.
(18) Satisfactory fit, but χ^2 too high, as is usual for amounts data.

Table 3.1d. Female pensioners, combined early, normal and late retirements
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Investigation	Lives	Lives	Amounts	Amounts
Variance ratios used?	No	No	Yes	Yes
			R = 328.44	R = 328.44
Comparison basis	PCFL80Base	PCFL80C84	PCFA80Base	PCFA80C84
Number of deaths	14,769	14,769	9,439.3	9,439.3
100A/E on comparison basis	91.913	97.431	91.365	97.431
Values of parameters at optimum point:				
a	0.000342	0.000828	0.000285	0.000662
T-ratio	1.25	3.07	1.12	2.67
b	0.091797	0.054250	0.100154	0.060947
T-ratio	8.13	4.61	6.45	3.76
Diagnostics satisfactory?	No (19)	No (19)	No (20)	No (20)

(19) Actual deaths erratic at a few ages.
(20) Satisfactory fit, but χ^2 too high, as is usual for amounts data.

3.2 *Widows of pensioners*

The experience of widows of pensioners for 1979-82 formed the basis of new standard tables WL80Base and WA80Base; these tables, projected forwards for four years, form the WL80C84 and WA80C84 tables. The experience of widows

Table 3.2. Widows of pensioners
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Investigation	Lives	Lives	Amounts	Amounts
Variance ratios used?	No	No	Yes	Yes
			R = 688.31	R = 688.31
Comparison basis	WL80Base	WL80C84	WA80Base	WA80C84
Number of deaths	1,804	1,804	1,190.0	1,190.0
100A/E on comparison basis	82.370	87.761	88.143	94.155
Values of parameters at optimum point:				
a	0.000690	0.000879	0.001022	0.001142
T-ratio	1.47	1.86	2.93	3.25
b	0.200857	0.156939	0.178942	0.130611
T-ratio	8.15	5.99	5.84	4.00
Diagnostics satisfactory?	Yes	Yes	No (21)	No (21)

(21)   Satisfactory fit, but χ^2 too high, as is usual for amounts data.

of pensioners for 1983-86 is compared with these tables and the results are shown in Table 3.2.

The 1983-86 experience is much lighter than that for 1979-82, and well below that forecast for 1984. The parameters shown provide a satisfactory adjustment to the comparison tables.

3.3 *Retirement annuities*

No standard table was produced in the '80' series based on the experience

Table 3.3a. Retirement annuities, males, in deferment
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Variance ratios used?	No	No	No
Comparison basis	AM80 D2 +	IM80Base D1 +	IM80C84 D1 +
Number of deaths	17,235	17,235	17,235
100A/E on comparison basis	81.060	69.971	76.135
Values of parameters at optimum point:			
a	0.000209	0.000193	0.000198
T-ratio	9.64	8.89	9.14
b	0.236959	0.338027	0.280867
T-ratio	31.37	51.70	39.51
Diagnostics satisfactory?	No (22)	No (22)	No (22)

(22)   Actual deaths below expected from age 64 upwards; IM80Base fits rather less badly than the others

Table 3.3b. Retirement annuities, females, in deferment
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Variance ratios used?	No	No	No
Comparison basis	AF80 D2+	IF80Base D1+	IF80C84 D1+
Number of deaths	1,547	1,547	1,547
100A/E on comparison basis	83.673	81.143	88.328
Values of parameters at optimum point:			
a	0.000104	0.000142	0.000146
T-ratio	1.91	2.60	2.68
b	0.201687	0.239471	0.173806
T-ratio	7.08	8.74	5.83
Diagnostics satisfactory?	No (23)	No (23)	No (23)

(23) Actual deaths erratic at a few ages; fits are all reasonable, with AF80 D2+ marginally the best.

of retirement annuities, either in deferment, vested or combining these two experiences. It is not immediately obvious what is the correct table to use for comparison, and some experimentation has been done using different tables.

Tables 3.3a and 3.3b show comparisons, for males and females respectively, for retirement annuities in deferment; Tables 3.3c and 3.3d show comparisons

Table 3.3c. Retirement annuities, males, vested
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Comparison basis	IM80Base D1+	PML80Base	PCML80Base	PCML80C84
Ages used	60 upwards	60 upwards	60 upwards	60 upwards
Number of deaths	15,327	15,327	15,327	15,327
100A/E on comparison basis	93.775	75.741	72.356	77.127
Values of parameters at optimum point:				
a	0.004048	0.006677	0.001763	0.002571
T-ratio	6.63	11.90	2.73	4.07
b	0.162501	0.376127	0.310095	0.281151
T-ratio	9.92	31.01	23.15	20.13
Diagnostics satisfactory?	No (24)	No (25)	No (26)	No (26)

(24) Actual deaths above expected at ages from 60 to 64 and from 76 to 86, below expected at ages from 65 to 75.

(25) Actual deaths above expected at ages from 60 to 64 and from 79 to 91, below expected at ages from 65 to 78.

(26) Actual deaths above expected at ages 60 to 64; much the best fits.

Table 3.3d. Retirement annuities, females, vested
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Comparison basis	IF80Base D1+	PFL80Base	PCFL80Base	PCFL80C84
Ages used	60 upwards	60 upwards	60 upwards	60 upwards
Number of deaths	1,417	1,417	1,417	1,417
100A/E on comparison basis	89.948	80.079	77.182	82.244
Values of parameters at optimum point:				
a	0.000648	0.001066	−0.000511	−0.000127
T-ratio	0.88	1.46	−0.63	−0.16
b	0.129452	0.242053	0.207803	0.171957
T-ratio	3.22	6.86	5.54	4.38
Diagnostics satisfactory?	Yes	Yes	Yes	Yes

for vested annuities; Tables 3.3e and 3.3f show comparisons for the combined experience.

The mortality of retirement annuitants in deferment has been shown to be relatively low, and is particularly light for higher ages, from age 64 upwards. The mortality of those whose annuities have vested is particularly high at lower ages. In combination the shape of the mortality experience is reasonable compared with that of other experiences. These considerations need to be kept in mind when comparisons with various tables are made.

The experiences in deferment have been compared with the standard tables

Table 3.3e. Retirement annuities, combined, males
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Variance ratios used?	No	No	No	No
Comparison basis	IM80Base D1+	AM80 D2+	PML80Base	PML80C84
Number of deaths	32,798	32,798	32,798	32,798
100A/E on comparison basis	79.977	88.453	69.096	74.495
Values of parameters at optimum point:				
a	−0.000025	0.000064	0.000065	0.000085
T-ratio	−1.32	3.27	3.33	4.32
b	0.195826	0.124393	0.315804	0.264861
T-ratio	39.17	22.73	73.83	57.56
Diagnostics satisfactory?	No (27)	No (28)	No (28)	No (28)

(27) Actual deaths below expected at most ages from 47 to 70 and above expected at most ages from 71 to 89.

(28) Actual deaths erratic at a few ages; all fits are satisfactory, with PML80C84 rather better than either of the others.

Table 3.3f. Retirement annuities, combined, females
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Variance ratios used?	No	No	No	No
Comparison basis	IF80Base D1+	IF80C84 D1+	PFL80Base	PFL80C84
Number of deaths	2,998	2,998	2,998	2,998
100A/E on comparison basis	85.914	92.606	75.494	81.380
Values of parameters at optimum point:				
a	0.000054	0.000072	0.000015	0.000032
T-ratio	1.15	1.51	0.33	0.69
b	0.152044	0.090237	0.247480	0.192497
T-ratio	8.28	4.57	15.25	11.03
Diagnostics satisfactory?	No (29)	No (29)	No (29)	No (29)

(29) Actual deaths erratic at a few ages; all fits are satisfactory, with IF80C84 D1+ and PFL80C84
equally good and slightly better than the others

for permanent assurances, AM80 and AF80, durations 2+, and also with the standard tables for immediate annuitants, IM80Base and IF80Base, durations 1+, and the same tables projected to 1984, IM80C84 and IF80C84. None of these tables fits the male experience particularly well; IM80Base is the least bad of the three. The experience of retirement annuitants is very much lighter than any of the three tables, and, as noted above, is particularly light from age 64 upwards.

The experience of those whose annuities have vested is compared with standard tables IM80Base, durations 1+, PML80Base and the combined pensioners experience PCML80Base, for males, and the corresponding tables for females. The mortality of those whose annuities have vested is particularly heavy at young ages, so only the data for 60 upwards has been used in the comparisons. The results are shown in Table 3.3c for males and Table 3.3d for females. For males, PCML80Base gives much the best fit, since the mortality rates even at ages 60 to 64 are much higher than for the other two tables. The experiences are therefore also compared for both sexes with the combined pensioners table forecast for four years, ie the PCML80C84 and PCFL80C84 tables.

Although these tables provide a better fit to the data, actual deaths still exceed those expected according to the tables, adjusted by means of the parameters shown, at ages 60 to 64. And it can be observed that the mortality experienced by retirement annuitants, of both sexes, is very much lower than that of the tables used for comparison. The experience for females is much smaller than that for males, so it is not unexpected that parameters can be found to adjust any of the comparison tables to produce a reasonable fit.

The combined experience of retirement annuities, putting together those in deferment and those vested, is compared with a number of different tables and the results are shown in Table 3.3e for males and Table 3.3f for females. Comparisons were made with the tables for immediate annuitants, IM80Base and IF80Base, durations $1+$, the tables for permanent assurances, AM80 and AF80, durations $2+$, and the tables for pensioners, PML80Base and PFL80Base. For males, IM80 Base, durations $1+$, does not provide a very satisfactory fit, but AM80, durations $2+$ and PML80Base do, subject to a high value of χ^2 because of erratic numbers of actual deaths at a few ages. Comparison has therefore been made also with the pensioners table forecast for four years, PML80C84, and these results are shown in Table 3.3e.

For females both IF80Base, durations $1+$ and PFL80Base showed reasonable fits, subject to a high value of χ^2 because of erratic numbers of actual deaths at a few ages, and comparisons with each of these tables forecast for four years, ie IF80C84, durations $1+$, and PFL80C84, are shown in Table 3.3f. AF80, durations $2+$, did not provide a satisfactory fit, and the results have not been shown.

3.4 *Immediate annuity contracts*

The experiences for immediate annuities, both males and females, for durations 0 and $1+$, as compared with the mortality rates of the standard tables, IM80Base and IF80Base, durations 0 and $1+$, and the same tables forecast for four years, IM80C84 and IF80C84, are shown in Table 3.4a for males and Table 3.4b for females.

Table 3.4a. Immediate annuities, males.
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	0	0	$1+$	$1+$
Variance ratios used?	No	No	No	No
Comparison basis	IM80Base D0	IM80C84 D0	IM80Base D1+	IM80C84 D1+
Number of deaths	118	118	3,948	3,948
100A/E on comparison basis	95.655	101.014	97.177	101.943
Values of parameters at optimum point:				
a	−0.009685	−0.008793	−0.000380	0.000703
T-ratio	−1.92	−2.36	−0.27	0.45
b	−0.166628	−0.211316	0.024434	−0.008631
T-ratio	−1.13	−1.57	1.10	−0.35
Diagnostics satisfactory?	No (30)	No (30)	No (31)	No (31)

(30) Satisfactory fit, but the formula produces negative values of q_x at ages below 57 or 56.

(31) Actual deaths erratic at a few ages.

Table 3.4b. Immediate annuities, females.
Statistics for graduations of $q_x = a + (1 - b)q_x^*$

Duration	0	0	1+	1+
Variance ratios used?	No	No	No	No
Comparison basis	IF80Base D0	IF80C84 D0	IF80Base D1+	IF80C84 D1+
Number of deaths	174	174	8,392	8,392
100A/E on comparison basis	91.679	96.147	97.956	102.134
Values of parameters at optimum point:				
a	−0.003674	−0.003283	−0.000260	0.000322
T-ratio	−1.65	−1.57	−0.41	0.41
b	−0.009698	−0.048943	0.014572	−0.018795
T-ratio	−0.11	−0.54	1.12	−1.28
Diagnostics satisfactory?	Yes	Yes	No (32)	No (32)

(32) Actual deaths erratic at a few ages.

The experience for 1983-86 is, in each case, a little lighter than that for 1979–82, and is very close to that for the forecast tables, the values of 100A/E in the latter case ranging from 96.147 (females duration 0) to 102.134 (females durations 1+). All the comparisons are satisfactory, and almost all the parameters are not significantly different from zero. However, for males duration 0 the negative value of a produces negative values of q_x at ages below 57 (Base) or 56 (C84); this may make the use of the table with adjusted parameters inconvenient.

References
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THE MORTALITY OF SMOKERS AND NON-SMOKERS, 1988–89

As from 1st January 1988 the Bureau has been collecting data differentiated according to the smoking habits of the policyholder. In the investigations the designation 'smoker' relates primarily to lives who have taken out policies where a non-smoker discount was available at the date of issue of the policy but who have not availed themselves of the offer. The term 'non-smoker discount' includes not only cases where a monetary or percentage reduction is allowed against the standard premium but all cases where non-smokers are offered preferential terms eg. the use of an age deduction when determining the premium rate. 'Non-smoker' relates to lives who have been granted policies on a non-smoker basis. This may vary from office to office but the most frequent requirement appears to be that the proposer has not smoked cigarettes for at least twelve months prior to the date of the proposal. There is additionally a small amount of data where, although the terms of the policy do not differentiate, the smoking status is known to the issuing company. There is no information available on the number of cigarettes smoked or on the experience of smokers of pipes or cigars.

A circular to offices in 1987 indicated widespread support for such an investigation and arrangements were duly made. In the event only a small number of offices have so far actually submitted returns containing split data. It is not unusual for new investigations to take a year or two to get established; the necessary changes to systems providing the data take time to organise and the task has to take its place in the queue for resources. Now that the investigation is fully established the Bureau would welcome additional contributions of data; the larger the data base the greater the credibility and the predictive value of the results.

Notwithstanding the above the Bureau now has differentiated data for the years 1988 and 1989 in sufficient quantity, for permanent (i.e whole life and endowment) assurances and for temporary assurances, to make a worthwhile analysis. It is customary when an investigation begins part of the way through a quadrennium to delay publication of the first results until the normal quadrennial reports are produced. However, the Executive Committee considered that the preliminary results for this investigation were sufficiently interesting to warrant publication at the earliest opportunity.

The bulk of the data received has been for permanent assurances. Six offices submitted data giving a combined exposed to risk for male lives for the two years of 184,177 policy-years in the smoker category and 368,107 policy-years in the non-smoker category. The corresponding figures for policies on female lives were 74,288 and 236,409 respectively. In the case of temporary assurances, although the number of offices submitting data was greater, nine as against six,

Table 1. Permanent assurances, males, medical and non-medical combined, 1988 and 1989: actual deaths and ratios of actual deaths to those expected using the AM80 table.

Age group (nearest ages)	Smokers		Non-Smokers		All policies*		Excess Mortality Index** (per cent)
	Actual deaths	100A/E by AM80	Actual deaths	100A/E by AM80	Actual deaths	100A/E by AM80	
Duration 0							
–30	4 ⎫	219	18	118	28	121 ⎫	115
31–45	20 ⎭		18	89	42	135 ⎭	
46–60	19	127	31	65	61	85	95
61–75	8 ⎫	135	9 ⎫	45	22 ⎫	77	200
76–	0 ⎭		1 ⎭		2 ⎭		
All ages	51	160	77	73	155	99	119
Duration 1							
–30	5 ⎫	207	8	63	16	85 ⎫	180
31–45	17 ⎭		18	80	41	116 ⎭	
46–60	33	164	38	62	79	82	165
61–75	5 ⎫	81	21 ⎫	83	28 ⎫	78	–
76–	1 ⎭		3 ⎭		4 ⎭		
All ages	61	160	88	70	168	88	129
Durations 2 and over							
–30	9	118	24	84	56	80	40
31–45	57	86	57	52	820	74	65
46–60	286	90	182	50	3450	69	80
61–75	167	91	116	53	2597	77	72
76–	75	98	30	61	1054	85	61
All ages	594	91	409	53	7977	74	72

* Includes cases where smoking habits are not known.
** 100x(100A/E Smokers ÷ 100A/E Non-Smokers − 1)

the number of policies covered was much smaller. The combined exposed to risk for male lives in the smoker category was 39,108 with 101,226 in the non-smoker category. The corresponding figures for females were 20,675 and 67,063 respectively. For cases where the smoking category is known therefore, the grand total of policy-years of exposure in the experience was 1,091,053.

Some of the offices contributing data were unable to provide a split by smoking category for policies issued before the start of the investigation. For completeness, these policies have been included in the 'All policies' category in Tables 1

Table 2. Permanent assurances, females, medical and non-medical combined, 1988 and 1989: actual deaths and ratios of actual deaths to those expected using the AF80 table.

Age group (nearest ages)	Smokers		Non-Smokers		All policies*		Excess Mortality Index** (per cent)
	Actual deaths	100A/E by AF80	Actual deaths	100A/E by AF80	Actual deaths	100A/E by AF80	
Duration 0							
–60	9	85	13	36	24	46	136
61–	12	462	13	129	29	206	258
All ages	21	158	26	56	53	80	182
Duration 1							
–60	15	122	34	78	55	88	56
61–	10	181	12	60	22	80	202
All ages	25	140	46	73	77	85	92
Durations 2 and over							
–45	18	102	48	95	179	86	7
46–60	62	143	74	66	514	94	117
61–75	25	104	35	50	243	75	108
76–	10	97	13	40	128	82	142
All ages	115	120	170	64	1064	86	88

* Includes cases where smoking habits are not known.
** 100x(100A/E Smokers ÷ 100A/E Non-Smokers − 1)

to 5 and the 'combined' category in Table 6, which thus represent the full data for those offices contributing to this particular investigation.

In the original returns to the Bureau the policies included were categorised by medical type according to whether a full medical examination had been required at the date of issue (medical cases), or whether completion of a full medical questionnaire was deemed sufficient (non-medical cases). For most groups analysed the amount of medical data was too small to warrant separate analysis; in the only group where the data were sufficient, males, permanent assurances at durations 2+ (i.e. 2 and over), the results for the medical and non-medical cases were remarkably similar. All results are, therefore, shown on a combined medical basis.

COMPARISON BASES AND RESULTS

The experience of male lives has been investigated using as a comparison basis

Table 3. Temporary assurances, males, medical and non-medical combined, 1988 and 1989: actual deaths and ratios of actual deaths to those expected using the AM80 table.

Age group (nearest ages)	Smokers		Non-Smokers		All policies*		Excess Mortality Index** (per cent)
	Actual deaths	100A/E by AM80	Actual deaths	100A/E by AM80	Actual deaths	100A/E by AM80	
Duration 0							
−45	11	165	9	48	21	79	244
46−	14	173	13	48	32	87	260
All ages	25	169	22	48	53	84	252
Duration 1							
−45	5	110	7	56	13	68	96
46−	3	42	8	34	13	38	24
All ages	8	69	15	42	26	49	64
Durations 2 and over							
−45	10	78	17	57	216	77	37
46−60	21	82	22	37	489	65	122
61−	7	70	7	25	186	70	180
All ages	38	79	46	39	891	69	103

* Includes cases where smoking habits are not known.
** 100x(100A/E Smokers ÷ 100A/E Non-Smokers − 1)

the AM80 table for assured lives. The comparison basis for female lives is the AF80 table. The results for permanent assurances are shown in Table 1 for males and Table 2 for females. For temporary assurances the results for males are shown in Table 3 and for females in Table 4. In order to give the largest possible database the data for permanent assurances and temporary assurances, for all durations, were combined. The results are shown in Table 5.

Permanent assurances

For both males and females, in almost every group and at each duration, the mortality of smokers is heavier than that of non-smokers, in most cases substantially so. This can be measured by defining the excess mortality index (per cent) of smokers as compared with non-smokers as 100x(100 A/E for smokers ÷ 100A/E for non-smokers − 1). For all ages combined, the excess is even greater at durations 0 and 1 than at durations 2+. At durations 2+ the excess was 72% for males and 88% for females. In the case of males (durations 2+) the excess rose to a peak at the middle ages, 46 to 60, and fell away again. For females

Table 4. Temporary assurances, females, medical and non-medical combined, 1988 and 1989; actual deaths and ratios of actual deaths to those expected using the AF80 table.

Age group (nearest ages)	Smokers		Non-Smokers		All policies*		Excess Mortality Index** (per cent)
	Actual deaths	100A/E by AM80	Actual deaths	100A/E by AM80	Actual deaths	100A/E by AM80	
Duration 0							
All ages	5	155	4	38	13	90	308
Duration 1							
All ages	2	69	7	69	10	68	–
Durations 2 and over							
–45	5 ⎫	90	10	62	68	83 ⎫	18
46–	4 ⎭		14	90	90	101 ⎭	
All ages	9	90	24	76	158	92	18

* Includes cases where smoking habits are not known.
** 100x(100A/E Smokers ÷ 100A/E Non-Smokers − 1)

(durations 2+), except at ages below 45, the level of mortality of smokers was more than twice that of non-smokers.

Temporary assurances
    As mentioned above, the number of policies included in the temporary assurance investigation is smaller than the number in the permanent assurance investigation. There is a reasonable number of deaths in total in the male experience; the numbers in the individual age groups are too small for reliable conclusions to be drawn for individual cells. Overall, however, the results do not conflict with those found for permanent assurances; if anything, the additional mortality of smokers in the temporary assurance experience appears to be greater than that found in the permanent experience.
    The number of deaths in the female experience is insufficient to provide useful results. Apart from duration 0, this is the one section of the investigations where the observed differential between mortality of smokers and non-smokers is smaller. However, the numbers of deaths are such that the statistics 100A/E for smokers and for non-smokers have wide confidence intervals about their observed values.

The combined experience
    As would be expected the effect of combining all the available data for

Table 5. Permanent and temporary assurances combined, medical and non-medical combined, all durations combined, 1988 and 1989: actual deaths and ratios of actual deaths to those expected using the AM80 table for males and the AF80 table for females.

Age group (nearest ages)	Smokers Actual deaths	100A/E	Non-Smokers Actual deaths	100A/E	All policies* Actual deaths	100A/E	Excess Mortality Index** (per cent)
Males							
−30	22	116	55	83	114	87	40
31–45	116	116	121	59	1139	77	97
46–60	375	96	289	51	4117	69	88
61–75	188	90	157	52	2837	76	73
76–	76	97	35	62	1063	85	56
All ages	777	98	657	55	9270	74	78
Females							
−30	5	83	20	91	38	94	–
31–45	28	97	64	74	252	81	31
46–60	84	133	114	63	645	92	111
61–75	45	141	62	62	302	80	127
76–	15	125	17	44	138	83	184
All ages	177	125	277	65	1375	86	92

* Includes cases where smoking habits are not known
** 100x (100A/E Smokers ÷ 100A/E Non-Smokers − 1)

smokers and non-smokers (although still segregated by sex) is to mask some of the features revealed by the more detailed analysis. However, the main conclusions must remain the same; that whatever the level of analysis smokers suffer substantially heavier mortality than non-smokers.

It is well known that, age for age, the mortality of standard male lives is heavier than that of standard female lives. However, when the data are categorised by smoking habits some interesting features emerge, as can be seen in Table 6 where, for both males and females, the experience for each smoking category has been compared using the AM80 table. The rows in the table have been ranked, the category showing the highest level of mortality being at the top of the table and that showing the lightest mortality at the bottom. As would be expected these are male smokers and female non-smokers respectively. What is perhaps surprising is that the level of mortality of female smokers is considerably heavier than that of male non-smokers. In fact, the levels of mortality experienced by female smokers are not significantly different from those in

Table 6. Permanent and temporary assurances combined, medical and non-medical combined, 1988–1989: ratios of actual deaths to those expected using the AM80 table for both males and females for smokers, non-smokers and all smoking categories combined.

All ages	Duration 0 100A/E by AM80	Duration 1 100A/E by AM80	Duration 2+ 100A/E by AM80	All durations 100A/E by AM80
Males, Smokers	163	139	90	98
Males, Combined*	94	79	73	74
Females, Smokers	83	85	70	74
Males, Non-Smokers	66	64	51	55
Females, Combined*	43	54	52	51
Females, Non-Smokers	28	47	39	38

*Includes cases where smoking habits are not known.

the male combined experience. Similarly, but at a lower level, the mortality ratios for the male non-smoker group and the female combined groups, at durations 2+, are not significantly different.

Comparisons with other studies

The results so far from the CMI investigations support the conclusions of other studies in the same area. In particular the inter-company experience for 1983–85 compiled by the Committee on Individual Life Experience Studies of the Society of Actuaries, reviewed by James D Brock in 'The Actuary' of September 1988[1] mirrors very closely the results of the CMI investigations. Similarly, a study of the Canadian Institute of Actuaries Committee on Expected Experience[2], reporting on the experience for 1988 and 1989 showed, in general, very similar results. Their experience overall showed an even heavier mortality addition for smokers than the CMI experience, but the durational effect did not seem quite so marked. An earlier study by Rhodes and Savill[3] presented to the Institute of Actuaries Students' Society in December 1982, in a survey of evidence to that date, again reported very similar findings. The Bureau has yet to find any report on this topic, whatever the geographical location or status of its subjects, which does not tell the same story.

CONCLUSION

For the first time life offices in the UK have hard evidence, based directly on the experience of their own policyholders, of the differential in mortality between smokers and non-smokers. In the paper by Rhodes and Savill it was stated that the non-smoker discounts, where available in the term assurance

market at the time, ranged from 30% to 40%. Current discounts, although more widely available, appear to be more generally in the 20% to 30% range, with only a handful of offices offering more than 30%. However, the wide range of term assurance premium rates available from different offices indicates that factors other than the pure mortality risk alone have an influence on the rates offered by an individual office. It is possible for a non-smoking prospective policyholder, by 'shopping around', to obtain a lower standard rate premium through an aggressively priced policy from Office X than he or she could obtain on a discounted basis from Office Y which is pricing according to different criteria. That being said, the evidence is there that, *measured on risk alone*, larger non-smoker discounts than those currently available could be justified.

References

1. The Actuary (Society of Actuaries) Vol 22, No.8, September 1988.
2. Canadian Standard Ordinary Life Experience 1988 and 1989. Canadian Institute of Actuaries, April 1991.
3. 'Smoker and Non Smoker', presented to the Institute of Actuaries Students' Society, December 1982.

INTER-OFFICE COMPARISONS

F R O M time to time enquiries have been received in the Bureau as to whether there is any significant difference between the mortality experiences of the individual offices contributing data to the investigations. An office which submits data for a given year will have an analysis of its own experience prepared in the Bureau. It will also be sent a copy of the all offices experience for that year. An office can therefore tell how far its own experience differs from that of all offices combined. What it cannot tell is where its own experience falls in the spectrum. For example, an office which has very light experience does not know whether this light experience is balanced by several offices with experience just a bit heavier than the combined or whether there are perhaps several equally light offices being balanced by several correspondingly heavy offices; i.e. nothing is known about the dispersion of the individual experiences. It therefore seemed worthwhile to make some preliminary enquiries and the results are appended. It must be stressed that at all times in this exercise full confidentiality has been maintained as to the origin of any individual experience; all company names, together with the corresponding office numbers used for processing in the Bureau, have been suppressed in all material presented to the Executive Committee.

In the history of the Bureau there have been two previous investigations on this topic. The first, by Elderton, Oakley and Smither (*JIA*,**68**,54 and *TFA* **15**,315) studied the statistics underlying the A1924-29 Table, the first standard table for assured lives prepared by the Joint Mortality Committee. When the A1924-29 Table was published the Committee 'thought it would be helpful to let each of the contributing offices have a statement showing how the mortality of the particular office compared with that of the A1924-29 Table'. It was only when these calculations were completed that it was realised how wide were the variations in the experience of the individual offices. The authors considered whether, with such a heterogeneous group of potential users, one standard table was sufficient. They therefore devised supplementary tables from the experience of the seven lightest and five heaviest offices respectively, which were published in 1937.

The second investigation into the topic was made at the time of the publication of the A1949-52 Table. The individual calculations were carried out and 'it was again found that wide divergences existed among the mortality experiences of different offices'. Offices were allocated to a light or heavy group and the experience of the two groups published in *JIA* **85**,57 and *TFA* **26**,122. It was considered that very little use had in fact been made of the A1924-29 (Heavy) Table and that there was therefore little justification for deriving a new one. However, it was thought useful to derive a set of rates of mortality from the experience of the light offices. No monetary functions were produced for these

and it was recommended that, in practice, light offices use the standard A1949-52 Table with a rating down in age.

The present study covers the years 1987, 1988 and 1989. A more detailed set of calculations was carried out for the year 1988. Figures for 1987 and 1989 are also shown as it was thought it would be interesting to study not only the variation between offices in a given year, but also the variation for a particular office over a series of years.

The investigation looks at the experience of male permanent (whole life and endowment) assurance policyholders at durations 2 and over. The comparison basis is AM80. There are 34 offices in the study. They have been allocated to groups according to the number of expected deaths in 1988, as it was thought that the size of the office may be a factor in the variation. Group A contains offices with more than 700 expected deaths in 1988, Group B contains offices

Table 1. Permanent assurances, males, durations 2 and over. Ratios of actual deaths to those expected using the AM80 table for individual offices for the years 1987, 1988 and 1989. Also shown are ratios showing the individual office experience as a proportion of the all offices experience.

Office Ranking	100 A/E using AM80 Ult			100 A/E Office ÷ 100 A/E All Offices		
	1987	1988	1989	1987	1988	1989
Group A						
1	101	87^+	87	1·23	1·13	1·16
2	84	80	87	1·02	1·04	1·16
3	80	78	75	0·98	1·01	1·00
4	80	77	67	0·98	1·00	0·89
5	78	70^-	71	0·95	0·91	0·95
6	69	69^-	61	0·84	0·90	0·81
7	73	68^-	68	0·89	0·88	0·91
8	63	67^-	64	0·77	0·87	0·85
9	67	66^-	86	0·82	0·86	0·85
All Group A	79	74	74	0·96	0·96	0·99
Group B						
1	101	100^+	87	1·23	1·30	1·16
2	114	98^+	95	1·39	1·27	1·27
3	73	96^+	59	0·89	1·25	0·79
4	77	91^+	76	0·94	1·18	1·01
5	89	89^+	89	1·09	1·16	1·19
6	83	75	75	1·01	0·97	1·00
7	80	70	68	0·98	0·91	0·91
8	76	68^-	69	0·93	0·88	0·92
9	81	64^-	75	0·99	0·83	1·00
All Group B	88	84	77	1·07	1·09	1·03

Table 1. (continued)

Office Ranking	100 A/E using AM80 Ult			100 A/E Office ÷ 100 A/E All Offices		
	1987	1988	1989	1987	1988	1989
Group C						
1	100	106$^+$	80	1·22	1·38	1·07
2	81	96	95	0·99	1·25	1·27
3	103	91	79	1·26	1·18	1·05
4	73	89	89	0·89	1·16	1·19
5	105	88	80	1·28	1·14	1·07
6	74	86	58	0·90	1·12	0·77
7	84	80	80	1·02	1·04	1·07
8	100	77	89	1·22	1·00	1·19
9	68	77	67	0·83	1·00	0·89
10	87	70	73	1·06	0·91	0·97
11	84	67	82	1·02	0·87	1·09
12	69	64	80	0·84	0·83	1·07
13	68	62$^-$	81	0·83	0·81	1·08
14	69	56$^-$	54	0·84	0·73	0·72
15	80	55$^-$	71	0·98	0·73	0·72
16	46	53$^-$	54	0·56	0·69	0·72
All Group C	80	75	75	0·98	0·97	1·00
All Offices	82	77	75	1·00	1·00	1·00

Note: a (+) or (−) by the ratio for 1988 indicates that the difference between 100A/E individual office and 100A/E all offices is more than twice the standard deviation of the individual office value.

with between 400 and 700 expected deaths, and Group C contains offices with less than 400 expected deaths.

The results are shown in Tables 1 and 2. Table 1 shows the statistic 100A/E (all ages) for each office for each year of the study. Also shown for each office is the statistic (100A/E office ÷ 100A/E all offices combined). This shows at a glance whether an office is heavy or light compared to all offices combined. Within each group (A,B and C) offices are ranked in descending order of 100A/E in 1988; this is intended to obviate any possibility of identification of an office by reference to its position in the table. A plus (+) or minus (−) by the 100A/E for 1988 indicates that the difference (positive or negative) between the 100A/E office and 100A/E all offices combined is significant. The criterion is that the difference is more than twice the standard deviation (calculated as $100 \div \sqrt{\text{expected deaths}}$ of the observed individual office value.

Table 2 ranks the offices by the percentage variation of the experience of individual offices from that of all offices combined for the year 1988. Also shown are

Table 2. Permanent assurances, males durations 2 and over. Distribution of offices by percentage variation (positive or negative) from the experience of all offices combined, together with comparative figures for other experiences

Percentage variation from all offices experience d	CMI 1988	CMI 1924–1929	Canadian Standard Ordinary Life 1988 and 1989
$0 \leqslant d < 5$	7	22	2
$5 \leqslant d < 10$	3	17	3
$10 \leqslant d < 15$	9	13	5
$15 \leqslant d < 20$	7	2	0
$20 \leqslant d < 25$	0	–	⎫ 9
$d \geqslant 25$	8	–	⎭
Total	34	54	19

comparative figures for the CMI 1924-29 experience and of the Canadian Standard Ordinary Life Experience 1988 and 1989. When the CMI 1949-52 experience was being studied, although offices were grouped according to whether their experience was heavy or light, unfortunately no individual office comparisons were published.

The main conclusion to be drawn from the results shown in the two tables is that there is, indeed, a very wide variation between the mortality experiences of the contributing offices. From Table 2, it would appear that the variation in 1988 was wider than that in the 1924-29 experiences, the latter being more the kind of distribution one would expect. However, the 1988 CMI distribution is not out of line with that shown in the Canadian investigation.

From Table 1 it can be seen that in 1988 the mortality suffered in the experience of the heaviest office was exactly double that of the lightest office. What is perhaps surprising is that, using the 2 standard deviation test, in 1988 more than half the variations were significant. Taking the table as a whole, there is no evidence that the size of offices has any bearing on the variation in experience. It does, however, appear that there is a fair degree of consistency from year to year in individual offices.

The Bureau has no evidence which provides any useful explanation as to why the variations between the experiences of individual offices are so wide. The conventional explanation would be that they represent differing underwriting standards. This may well provide part of the explanation but is unlikely to be all of it. Perhaps, more than is realised, offices have their own particular niche in the market; an office may try to attract, or have an image that is attractive to, a

particular type of policyholder which results in its own specific, reasonably consistent, experience. Whatever the explanation, perhaps the main point to be drawn is that any standard table based on the experience of all offices combined should be regarded as a yardstick only; actuaries should adjust the aggregate experience as appropriate in the light of the experience of their own office.

CALCULATION OF CONTINUATION TABLES AND ALLOWANCE FOR NON-RECORDED CLAIMS BASED ON THE PHI EXPERIENCE 1975–78

IN the Report 'The Analysis of Permanent Health Insurance Data' (*C.M.I.R.* **12**, 1, 1991) (referred to below as 'the Report') the PHI Sub-Committee presented formulae for graduated claim recovery and mortality intensities based on the experience of individual male 'standard' insureds for the years 1975–78. It also explained how continuation tables could be calculated from the graduated intensities, in fact in a number of ways (Section 7.1 of Part B, Section 10.1 of Part E and Section 5.3 of Part F of that Report), but in each case by approximate methods which would be applicable to any graduation formula. It was also observed (Section 10.1 of Part E) that the actual graduation formulae that had been used were such that direct integration of the formula was possible. It is the purpose of this note to show how such direct integration can be done. It is also possible to show how a direct allowance for what were termed 'non-reported claims' for deferred periods 4 weeks, 13 weeks and 26 weeks can be allowed for directly.

The probability of remaining sick

The basic element in the calculation of a continuation table is the probability of survival while still sick. This is defined in Part A of the Report as $_t p_{x,z}^{\overline{SS}}$ which is the probability that a person who is sick at age x with duration of sickness z years remains sick for a further period of t years.

This probability can be calculated from the transition intensities for recovery, ρ, and death, ν, from the formula

$$_t p_{x,z}^{\overline{SS}} = \exp\left(-\int_0^t (\rho_{x+u,z+u} + \nu_{x+u,z+u})\,du\right) \qquad (1)$$

where $\rho_{x,z}$ is the recovery intensity at age x and duration z and $\nu_{x,z}$ is the mortality intensity at age x and duration z.

The definite integral in the expression on the right hand side of the above formula, and hence the whole expression, can be calculated explicitly if the functions used for ρ and ν can be integrated directly.

The formulae for ρ and ν are relatively complicated, and different formulae are used for different parts of the range of z, but they are nevertheless amenable to straightforward manipulation. They will be considered in turn. In each case the formula is expressed in terms of y, the age at commencement of sickness, rather than x, the attained age ($x = y + z$), but this is more convenient for these calculations anyway.

The formulae for ρ

The formulae for $\rho_{y+z,z}$ are shown in Section 4.4 of Part B of the Report. Separating out the formulae for different ranges of z they are:

For D1 (deferred period 1 week), for $0 \leq z < 4$ weeks:
(Note that a 'week' in these definitions is a natural week, assumed to be $1/52.18$ of a year.)

$$\rho_{y+z,z} = \{a + b(1 + q(4 - wz))\sqrt{z}(y - y_0)\}e^{-c\sqrt{z}} \tag{2.1}$$

For D4, D13 and D26 (deferred periods 4 weeks, 13 weeks and 26 weeks), for d weeks $\leq z < d + 4$ weeks (where d is the deferred period in weeks):

$$\rho_{y+z,z} = \left\{p + \left(\frac{wz - d}{4}\right)(1 - p)\right\}\{a + b\sqrt{z}(y - y_0)\}e^{-c\sqrt{z}} \tag{2.2}$$

For D1, for 4 weeks $\leq z \leq 1$ year, and for D4, D13 and D26 for $d + 4$ weeks $\leq z \leq 1$ year:

$$\rho_{y+z,z} = \{a + b\sqrt{z}(y - y_0)\}e^{-c\sqrt{z}} \tag{2.3}$$

For all deferred periods, for 1 year $< z \leq 5$ years:

$$\rho_{y+z,z} = \{a + b\sqrt{1 + s(z - 1)}(y - y_0)\}e^{-c\sqrt{1 + s(z-1)}} \tag{2.4}$$

For all deferred periods, for 5 years $< z \leq z_\omega$:

$$\rho_{y+z,z} = \{a + b\sqrt{1 + 4s}(y + z - 5 - y_0)\}e^{-c\sqrt{1 + 4s}} \tag{2.5}$$

For all deferred periods, $z_\omega < z$:

$$\rho_{y+z,z} = 0 \tag{2.6}$$

In the ranges for z in formulae (2.5) and (2.6) z_ω is the duration at which the value of ρ using formula (2.5) equals zero, which is in fact at a fixed attained age x_ω, calculated as

$$x_\omega = y_0 + 5 - \frac{a}{b\sqrt{1 + 4s}} \tag{3}$$

whence $z_\omega = x_\omega - y$.

In the above, w and y_0 are constants with values:

$$w = 52 \cdot 18 \qquad y_0 = 50,$$

and a, b, c, p, q and s are fitted parameters with values:

$$a = 51{\cdot}057202, \qquad p = 0{\cdot}205111,$$
$$b = -2{\cdot}687089, \qquad q = 1{\cdot}419428,$$
$$c = 4{\cdot}914441, \qquad s = 0{\cdot}362456.$$

whence x_ω can be calculated from formula (3) as 67.14.

In order to calculate the definite integral in formula (1) it is necessary to integrate each of the expressions for ρ in formulae (2.1) to (2.5) with respect to the duration z (formula (2.6) causes little trouble). For any one spell of sickness, the age at commencement of sickness, y, is constant. Each of formulae (2.1) to (2.5) can be re-expressed in more convenient terms as shown below.

Formula (2.1) becomes

$$\rho_{y+z,z} = A_1 e^{-c\sqrt{z}} + B_1 \sqrt{z}\, e^{-c\sqrt{z}} + C_1 z \sqrt{z}\, e^{-c\sqrt{z}} \tag{4.1}$$

where $A_1 = a$, $B_1 = b(1 + 4q)(y - y_0)$ and $C_1 = -bqw(y - y_0)$.

Formula (2.2) becomes

$$\rho_{y+z,z} = A_2 e^{-c\sqrt{z}} + B_2 \sqrt{z}\, e^{-c\sqrt{z}} + C_2 z\, e^{-c\sqrt{z}} + D_2 z \sqrt{z}\, e^{-c\sqrt{z}} \tag{4.2}$$

where

$$A_2 = \left(p - \frac{d}{4}(1 - p)\right)a, \quad B_2 = \left(p - \frac{d}{4}(1 - p)\right)b(y - y_0), \quad C_2 = \frac{w}{4}(1 - p)a$$

and

$$D_2 = \frac{w}{4}(1 - p)b(y - y_0)$$

Formula (2.3) becomes

$$\rho_{y+z,z} = A_3 e^{-c\sqrt{z}} + B_3 \sqrt{z}\, e^{-c\sqrt{z}} \tag{4.3}$$

where $A_3 = a$ and $B_3 = b(y - y_0)$.

Formula (2.4) becomes

$$\rho_{y+z,z} = A_3 e^{-c\sqrt{1+s(z-1)}} + B_3 \sqrt{1 + s(z - 1)}\; e^{-c\sqrt{1+s(z-1)}} \tag{4.4}$$

with A_3 and B_3 as above.

Formula (2.5) becomes

$$\rho_{y+z,z} = A_5 + B_5 z \tag{4.5}$$

where $A_5 = \{a + b\sqrt{1 + 4s}(y - 5 - y_0)\}e^{-c\sqrt{1+4s}}$ and $B_5 = b\sqrt{1 + 4s}\; e^{-c\sqrt{1+4s}}$.

It is necessary now to consider the integrals with respect to z of the functions

$$e^{-c\sqrt{z}}, \quad \sqrt{z}\,e^{-c\sqrt{z}}, \quad z\,e^{-c\sqrt{z}} \quad \text{and} \quad z\sqrt{z}\,e^{-c\sqrt{z}}$$

We put

$$I_1(z) = \int e^{-c\sqrt{z}}dz$$

Substituting $u = \sqrt{z}$, whence $z = u^2$ and $dz = 2u\,du$, we get

$$I_1(u) = \int 2u\,e^{-cu}du$$

Integrating by parts gives

$$I_1(u) = -\frac{2u\,e^{-cu}}{c} - \frac{2e^{-cu}}{c^2}$$

whence

$$I_1(z) = -2(c\sqrt{z}+1)\frac{e^{-c\sqrt{z}}}{c^2} \tag{5.1}$$

(Note that constants of integration are omitted here and elsewhere.)
Similar methods give

$$I_2(z) = \int \sqrt{z}\,e^{-c\sqrt{z}}dz$$

$$= -\frac{2z}{c}e^{-c\sqrt{z}} + \frac{2}{c}I_1(z)$$

$$= -2(c^2z + 2c\sqrt{z} + 2)\frac{e^{-c\sqrt{z}}}{c^3} \tag{5.2}$$

$$I_3(z) = \int z\,e^{-c\sqrt{z}}dz$$

$$= -\frac{2z\sqrt{z}}{c}e^{-c\sqrt{z}} + \frac{3}{c}I_2(z)$$

$$= -2(c^3z\sqrt{z} + 3c^2z + 6c\sqrt{z} + 6)\frac{e^{-c\sqrt{z}}}{c^4} \tag{5.3}$$

and

$$I_4(z) = \int z\sqrt{z}e^{-c\sqrt{z}}dz$$

$$= -\frac{2z^2}{c}e^{-c\sqrt{z}} + \frac{4}{c}I_3(z)$$

$$= -2(c^4z^2 + 4c^3z\sqrt{z} + 12c^2z + 24c\sqrt{z} + 24)\frac{e^{-c\sqrt{z}}}{c^5} \quad (5.4)$$

It is now a matter of substitution to get expressions for the integrals of ρ as shown below.

Formula (4.1) gives

$$\int \rho_{y+z,z}dz = A_1I_1(z) + B_1I_2(z) + C_1I_4(z) \quad (6.1)$$

Formula (4.2) gives

$$\int \rho_{y+z,z}dz = A_2I_1(z) + B_2I_2(z) + C_2I_3(z) + D_2I_4(z) \quad (6.2)$$

Formula (4.3) gives

$$\int \rho_{y+z,z}dz = A_3I_1(z) + B_3I_2(z) \quad (6.3)$$

Formula (4.4) requires separate consideration. Putting $u = 1 + s(z - 1)$, whence $du = s.dz$, we get

$$\int \rho_{y+z,z}dz = \frac{A_3I_1(u)}{s} + \frac{B_3I_2(u)}{s} \quad (6.4)$$

where I_1 and I_2 are calculated with u substituted for z.

Formula (4.5) gives

$$\int \rho_{y+z,z}dz = A_5z + B_5\frac{z^2}{2} \quad (6.5)$$

The formulae for ν

The formulae for $\nu_{y+z,z}$ are shown in Section 6.2 of Part B of the Report. Again they need to be separated out for different ranges of z, giving:

For all deferred periods, for $0 \le z \le 5$ years:

$$\nu_{y+z,z} = (a_0 + a_1y + a_2y^2)\frac{\exp\{-b/(z+c)^n\}}{(z+c)^{n+1}} + r\ e^{s(y+z)} \quad (7.1)$$

For all deferred periods, for 5 years $< z$:

$$\nu_{y+z,z} = [a_0 + a_1(y+z-5) + a_2(y+z-5)^2]\frac{\exp\{-b/(5+c)^n\}}{(5+c)^{n+1}} + r\,e^{s(y+z)}$$

$$(7.2)$$

where $a_0, a_1, a_2, b, c, n, r$ and s are fitted parameters with values:

$$a_0 = 0\cdot237884, \qquad c = 0\cdot357384,$$

$$a_1 = -0\cdot00481923, \qquad n = 1\cdot613917,$$

$$a_2 = 0\cdot0000958683, \qquad r = 0\cdot007221.$$

$$b = 0\cdot874735, \qquad s = 0\cdot024353.$$

Each of these formulae can be integrated without difficulty, giving, from formula (7.1)

$$\int \nu_{y+z,z}\,dz = (a_0 + a_1 y + a_2 y^2)\frac{\exp\{-b/(z+c)^n\}}{bn} + \frac{r\,e^{s(y+z)}}{s} \qquad (8.1)$$

and from formula (7.2)

$$\int \nu_{y+z,z}\,dz = \left(a_0 z + \frac{a_1(y+z-5)^2}{2} + \frac{a_2(y+z-5)^3}{3}\right)$$

$$\times \frac{\exp\{-b/(5+c)^n\}}{(5+c)^{n+1}} + \frac{r\,e^{s(y+z)}}{s} \qquad (8.2)$$

Calculation of the probabilities pSS

It is convenient now to define the function $pSS(y, z_1, z_2) = {}_{z_2-z_1}p_{y+z_1,z_1}^{\overline{SS}}$, that is, the probability that a life who became sick at age y and is still sick at duration z_1 remains sick until duration z_2. We also define

$$I_\rho(y, z_1, z_2) = \int_{z_1}^{z_2} \rho_{y+z,z}\,dz \qquad (9.1)$$

and

$$I_\nu(y, z_1, z_2) = \int_{z_1}^{z_2} \nu_{y+z,z}\,dz \qquad (9.2)$$

where in each case the integral is calculated over the appropriate sub-ranges of z_1 to z_2. Then

$$pSS(y, z_1, z_2) = \exp(-(I_\rho(y, z_1, z_2) + I_\nu(y, z_1, z_2)))$$

$$= \exp(-I_\rho(y, z_1, z_2))\cdot\exp(-I_\nu(y, z_1, z_2)) \qquad (10)$$

and from the above formulae all values of *pSS* within appropriate ranges can be calculated.

Calculations using this exact method confirm the values shown as $l(y,z)$ in Tables B6a to B6d of the Report (as corrected by the Errata on page 131 of this number of *C.M.I. Reports*). These Tables also show values of $r(y,z)$ and $d(y,z)$, the expected 'numbers' of recoveries and deaths occurring in the relevant duration interval, but these values cannot be calculated by calculus methods, and suitable approximations are necessary.

Non-reported claims

In the Report the PHI Sub-committee observed that the recovery intensities for deferred periods D4, D13 and D26 were substantially lower than those for D1 during the four weeks immediately following the end of the deferred period. The Sub-Committee attributed this to the possibility that some policyholders whose sickness lasts only a little beyond the end of the deferred period do not bother to claim benefit from the insurer. The shortfall of claims that would result if this assumption were true was described as 'non-reported claims'.

While the financial significance of non-reported claims is small (as shown by Waters, 1992), it is important to know what allowance to make for them when comparing actual claim inceptions with those expected according to the model described in the Report. In the calculations in part E of the Report no allowance was made for the non-reported claims, so the sickness intensities used for D4, D13 and D26 reflect the assumed total claims, and the recovery intensities used are those for D1. This is internally consistent, and the correct sickness rates were calculated and are shown for sickness periods beyond four weeks after the end of the deferred period, but the published inception rates are 'too high', in that they include the non-reported claims.

It is possible to calculate exactly what allowance should be made for the non-reported claims. First we define

$$pSS^1(y, z_1, z_2) = pSS(y, z_1, z_2) \text{ for deferred period 1}$$

and

$$pSS^d(y, z_1, z_2) = pSS(y, z_1, z_2) \text{ for deferred period } d \text{ (D4, D13 and D26).}$$

The limiting durations for the non-reported claims are $z_1 = d/w$ ie d weeks and $z_2 = (d+4)/w$, i.e. $d+4$ weeks. Then

$$r^d(y) = pSS^1(y, d/w, (d+4)/w)/pSS^d(y, d/w, (d+4)/w)$$

represents the proportion of claims that are reported, and the complement of this ratio represents the proportion of claims that are non-reported.

Calculated values of $100(1 - r^d(y))$, the percentage of claims that are non-reported, for selected ages (y) from 16 to 65, and for $d = 4$ weeks, 13 weeks and 26 weeks are shown in Table 1.

Table 1. Calculated values of percentage of 'non-reported' claims, $100(1 - r^d(y))$.

Age (y)	Deferred period (d)		
	4 weeks	13 weeks	26 weeks
16	40·1	20·6	9·7
20	38·8	19·5	9·1
25	37·1	18·2	8·3
30	35·4	16·8	7·5
35	33·6	15·5	6·7
40	31·8	14·1	6·0
45	29·9	12·7	5·2
50	28·0	11·2	4·4
55	26·0	9·8	3·5
60	24·0	8·3	2·7
65	21·9	6·8	1·9

It may be noted that $r^d(y)$ depends only on the difference between the recovery intensities for deferred period D1 and the other deferred periods in the 'run-in' period , ie the four weeks after the end of the deferred period, and not on the mortality intensities, which are assumed to be the same for all deferred periods. This can be seen by substituting formula (10) in the expression for $r^d(y)$, whence, with an obvious notation, we get

$$r^d(y) = \frac{pSS^1(y, d/w, (d+4)/w)}{pSS^d(y, d/w, (d+4)/w)}$$

$$= \frac{\exp(-I_\rho^1(y, d/w, (d+4)/w)) \cdot \exp(-I_\nu^1(y, d/w, (d+4)/w))}{\exp(-I_\rho^1(y, d/w, (d+4)/w)) \cdot \exp(-I_\nu^d(y, d/w, (d+4)/w))}$$

$$= \exp\{I_\rho^1(y, d/w, (d+4)/w) + I_\rho^d(y, d/w, (d+4)/w)\}$$

Thus $r^d(y)$ depends on the integral of the difference between the recovery rates for the relevant durations over the run-in period.

References

C.M.I. Committee (1991) 'The analysis of permanent health insurance data', *C.M.I.R.*, **12**, 1–263.

Waters H.R. (1992) 'Non-reported claims in long term sickness insurance' *Transactions of the 24th International Congress of Actuaries, Montreal*, **2**, 335–342.

CMIR 12 ERRATA

Part B

Page 31 §4.1, Formula (4)

$$\rho_{x+z,z} \text{ should read } \rho_{y+z,z}$$

Page 32 §4.2, Formula (5)

as above

Pages 46–50, tables B6

- In the headings "Age x exact . . ." should read "Age y exact . . .".
- In the headings for the second section of this table at the top of page 47

Sickness duration	should read	Sickness duration
Weeks		Years

Years

- Errors have also come to light in the figures given in these tables, the most substantial ones being at durations 5–10 years.

  A corrected set of tables B6 is appended.

Part C

Page 59, Table C3

The exposure at age 45 for deferred period 4 weeks should be 2,987 rather than 3,987

Part E

Page 123, Table E13a

- The sickness rates for periods 104/all on the CMIR12 basis should be 0.032, 0.095, 0.203, 0.403, 0.808 and 1.723 rather than 0.026, 0.091, 0.200, 0.401, 0.806 and 1.721.

Pages 136–221, Tables E20(a)–E36(b)

- Tables E24(a)–(e), E25, E29(a)–(e), E33(a)–(e) should have the leftmost column headed "Attained age x".
- The remainder of tables E20(a)–E36(b) should have the leftmost column headed "Attained age $x + t$".

Part F

Page 247, Formula (26)

- The term $\bar{a}_{x:\overline{n}|}^{\overline{HS}(d/all)}$ should read $\bar{a}_{x:\overline{n}|}^{HS(d/all)}$ and the term $\bar{a}_{x_0+t,d:\overline{n}|}^{1,2}$ should read $\bar{a}_{x_0+t,d:\overline{n-t}|}^{1,2}$

Page 247, Formula (27)

- The term $\bar{a}_{x:\overline{n}|}^{\overline{HS}(d/all)}$ should read $\bar{a}_{x:\overline{n}|}^{HS(d/all)}$ and the term $\bar{a}_{x_0+t,d:\overline{n}|}^{2,1}$ should read $\bar{a}_{x_0+t,d:\overline{n-t}|}^{2,1}$

Page 247, Formula (28)

- This formula should read

$$\bar{a}_{x:\overline{n}|}^{HS(d/all)} \doteq \sum_{t=0}^{n-1} v^{t+1/2} \frac{L_{x_0+t}}{l_{x_0}} \cdot ia(x_0 + t, d)\bar{a}_{x_0+t,d:\overline{n-t}|}^{1}$$

Page 251, Formula (30)

- The term $\bar{a}_{x_0+t,d:\overline{n}|}^{1,2}$ should read $\bar{a}_{x_0+t,d:\overline{n-t}|}^{1,2}$

Page 251, Formula (31)

- The term "v^{t+d}" should read "$v^{t+d+\frac{1}{2}}$" and the term $\bar{a}_{x_0+t,d:\overline{n}|}^{2,1}$ should read $\bar{a}_{x_0+t,d:\overline{n-t}|}^{2,1}$

Page 251, Formula (32)

- This formula should read

$$\bar{a}_{x:\overline{n}|}^{HS(d/all)} \doteq \sum_{t=0}^{n-1} v^{t+1/2} \frac{L_{[x_0]+t}}{l_{[x_0]}} \cdot ia_{[x_0]+t}^{d} \bar{a}_{x_0+t,d:\overline{n-t}|}^{1}$$

Tables B6. *Graduated double decrement tables of claim terminations*
Table B6(a). *Deferred period 1 week*

Age y exact at date of falling sick

Sickness duration	20			40			60		
Weeks	$l(y,z)$	$r(y,z)$	$d(y,z)$	$l(y,z)$	$r(y,z)$	$d(y,z)$	$l(y,z)$	$r(y,z)$	$d(y,z)$
1	100,000	61,015	59	100,000	45,085	85	100,000	22,643	154
2	38,926	19,500	29	54,830	20,037	57	77,203	14,909	138
3	19,396	7,230	18	34,737	9,973	42	62,156	11,797	124
4	12,148	3,488	14	24,721	5,793	35	50,236	8,923	110
5	8,647	2,242	11	18,894	3,918	29	41,203	6,253	99
6	6,393.7	1,507.5	8.8	14,946	2,768	25	34,850	4,571	91
7	4,877.3	1,050.9	7.3	12,154	2,023	22	30,188	3,454	84
8	3,819.1	755.2	6.0	10,108	1,522	19	26,649	2,680	79
9	3,057.9	557.0	5.1	8,567	1,172	17	23,891	2,125	74
10	2,495.8	420.0	4.3	7,378	921	15	21,693	1,715	70
11	2,071.4	323.0	3.7	6,442	736	14	19,908	1,406	66
12	1,744.8	252.6	3.2	5,692	598	13	18,436	1,168	62
13	1,488.9	200.7	2.8	5,081	492	11	17,205	982	59
14	1,285.4	161.6	2.5	4,578	409	10	16,164	833	56
15	1,121.4	131.7	2.2	4,158.6	344.2	9.6	15,274	714	54
16	987.5	108.5	1.9	3,804.9	292.2	8.8	14,506	616	51
17	877.1	90.3	1.7	3,503.9	250.2	8.1	13,839	535	49
18	785.0	75.9	1.5	3,245.6	215.8	7.5	13,255	468	47
19	707.6	64.3	1.4	3,022.2	187.5	7.0	12,739	412	45
20	641.9	54.9	1.3	2,827.7	163.9	6.5	12,283	364	43
21	585.8	47.2	1.1	2,657.2	144.2	6.1	11,875	323	41
22	537.5	40.8	1.0	2,507.0	127.5	5.7	11,511	288	40
23	495.6	35.5	0.9	2,373.8	113.3	5.3	11,183	258	38
24	459.1	31.1	0.9	2,255.2	101.1	5.0	10,886	232	37
25	427.1	27.4	0.8	2,149.1	90.6	4.7	10,618	209	35
26	399.0	24.2	0.7	2,053.8	81.5	4.4	10,373	189	34
27	374.0	21.5	0.7	1,967.8	73.6	4.2	10,150	171	33
28	351.8	19.2	0.6	1,890.0	66.7	4.0	9,945	156	32
29	332.0	17.2	0.6	1,819.4	60.6	3.8	9,758	142	31
30	314.3	15.4	0.5	1,754.9	55.3	3.6	9,585	130	30
31	298.3	13.9	0.5	1,696.1	50.5	3.4	9,425	119	29
32	283.9	12.6	0.5	1,642.2	46.3	3.2	9,278	109	28
33	270.8	11.4	0.4	1,592.6	42.6	3.1	9,141	100	27
34	258.9	10.4	0.4	1,547.0	39.2	2.9	9,014	92	26
35	248.1	9.5	0.4	1,504.8	36.2	2.8	8,896	85	25
36	238.2	8.7	0.4	1,465.8	33.5	2.7	8,786	79	24
37	229.1	8.0	0.3	1,429.7	31.0	2.6	8,683	73	24
38	220.8	7.3	0.3	1,396.1	28.8	2.5	8,587	67	23
39	213.1	6.8	0.3	1,364.8	26.8	2.4	8,496	62	22
40	206.0	6.2	0.3	1,335.7	24.9	2.3	8,412	58	22
41	199.5	5.8	0.3	1,308.5	23.3	2.2	8,332	54	21
42	193.4	5.4	0.3	1,283.0	21.7	2.1	8,257	50	21
43	187.8	5.0	0.3	1,259.2	20.3	2.0	8,187	47	20
44	182.6	4.6	0.2	1,236.8	19.1	1.9	8,120	43	19
45	177.7	4.3	0.2	1,215.8	17.9	1.9	8,057	41	19
46	173.2	4.0	0.2	1,196.0	16.8	1.8	7,997	38	18
47	168.9	3.8	0.2	1,177.4	15.8	1.8	7,941	35	18
48	164.9	3.5	0.2	1,159.9	14.9	1.7	7,887	33	18
49	161.2	3.3	0.2	1,143.3	14.0	1.6	7,837	31	17
50	157.7	3.1	0.2	1,127.6	13.2	1.6	7,788	29	17
51	154.4	3.4	0.2	1,112.8	14.7	1.8	7,743	32	19

Table B6a. (*Continued*)

Sickness duration	20			40			60		
	$l(y,z)$	$r(y,z)$	$d(y,z)$	$l(y,z)$	$r(y,z)$	$d(y,z)$	$l(y,z)$	$r(y,z)$	$d(y,z)$
Years									
1	150.8	73.2	4.3	1,096.3	350.2	44.4	7,691	772	542
2	73.3	21.1	1.4	701.7	121.1	19.8	6,377	250	303
3	50.8	8.6	0.8	560.9	53.5	13.8	5,824	93	237
4	41.4	4.2	0.6	493.6	26.9	11.5	5,494	36	210
5	36.6	2.8	0.5	455.2	18.3	10.7	5,248		
6	33.3	2.5	0.5	426.3	16.4	10.2			
7	30.3	2.2	0.5	399.7	14.6	9.8			
8	27.6	2.0	0.4	375.2	13.0	9.5			
9	25.2	1.7	0.4	352.8	11.6	9.1			
10	23.1			332.1					

Table B6(b). *Deferred period 4 weeks*

Age y exact at date of falling sick

Sickness duration	20			40			60		
Weeks	$l(y,z)$	$r(y,z)$	$d(y,z)$	$l(y,z)$	$r(y,z)$	$d(y,z)$	$l(y,z)$	$r(y,z)$	$d(y,z)$
4	100,000	9,727	128	100,000	7,748	154	100,000	5,725	236
5	90,145	12,595	123	92,098	10,123	151	94,039	7,436	237
6	77,427	13,287	112	81,823	10,925	142	86,366	8,089	231
7	64,028	12,550	97	70,756	10,682	129	78,046	8,070	220
8	51,382	10,161	81	59,945	9,025	114	69,756	7,014	206
9	41,140	7,493	69	50,806	6,950	102	62,536	5,561	193
10	33,578	5,651	58	43,754	5,462	91	56,782	4,490	182
11	27,869	4,345	50	38,201	4,367	82	52,109	3,681	172
12	23,473	3,399	43	33,753	3,545	74	48,256	3,059	163
13	20,031	2,700	38	30,134	2,916	68	45,034	2,570	155
14	17,294	2,174	33	27,150	2,427	62	42,309	2,182	148
15	15,087	1,772	29	24,662	2,041	57	39,980	1,868	141
16	13,286	1,460	26	22,564	1,733	52	37,971	1,612	134
17	11,800	1,215	23	20,779	1,484	48	36,224	1,401	128
18	10,561	1,021	21	19,247	1,280	45	34,694	1,225	123
19	9,520	865	19	17,922	1,112	41	33,346	1,078	118
20	8,636	738	17	16,769	972	39	32,150	953	113
21	7,881	635	15	15,758	855	36	31,085	846	108
22	7,231	549	14	14,867	756	34	30,130	755	104
23	6,668	478	13	14,077	672	32	29,271	676	100
24	6,177	419	12	13,374	599	30	28,495	607	96
25	5,747	368	11	12,745	537	28	27,792	547	93
26	5,367.6	325.7	9.8	12,180	483	26	27,152	495	89
27	5,032.0	289.3	9.1	11,670	437	25	26,567	449	86
28	4,733.6	258.1	8.4	11,208	396	24	26,032	408	83
29	4,467.1	231.1	7.8	10,789	360	22	25,541	372	80
30	4,228.1	207.8	7.3	10,407	328	21	25,089	340	78
31	4,013.1	187.4	6.8	10,058	300	20	24,671	311	75
32	3,818.9	169.6	6.3	9,738	275	19	24,285	285	73
33	3,643.0	153.9	5.9	9,445	252	18	23,928	262	70
34	3,483.1	140.1	5.6	9,174	233	17	23,595	241	68
35	3,337.4	127.9	5.2	8,924	215	17	23,286	223	66
36	3,204.3	117.1	4.9	8,693	198	16	22,997	205	64
37	3,082.3	107.4	4.7	8,478	184	15	22,728	190	62
38	2,970.2	98.8	4.4	8,279	171	15	22,476	176	60
39	2,867.0	91.0	4.2	8,094	159	14	22,240	163	58

Table B6b. (*Continued*)

Sickness duration	20			40			60		
Weeks	$l(y,z)$	$r(y,z)$	$d(y,z)$	$l(y,z)$	$r(y,z)$	$d(y,z)$	$l(y,z)$	$r(y,z)$	$d(y,z)$
40	2,771.8	84.1	3.9	7,921	148	13	22,018	152	57
41	2,683.8	77.8	3.7	7,760	138	13	21,810	141	55
42	2,602.3	72.1	3.6	7,609	129	12	21,613	131	54
43	2,526.6	67.0	3.4	7,467	121	12	21,429	122	52
44	2,456.3	62.3	3.2	7,335	113	12	21,254	114	51
45	2,390.7	58.1	3.1	7,210	106	11	21,089	106	50
46	2,329.6	54.2	2.9	7,093	100	11	20,933	99	48
47	2,272.4	50.7	2.8	6,982	94	10	20,786	93	47
48	2,219.0	47.4	2.7	6,878	88	10	20,646	87	46
49	2,168.9	44.4	2.6	6,780.1	83.1	9.7	20,513	81	45
50	2,121.9	41.7	2.5	6,687.2	78.4	9.4	20,387	76	44
51	2,077.7	46.0	2.8	6,599.3	87.0	10.8	20,266	84	50
Years									
1	2,028.9	985.1	57.8	6,501.6	2,076.7	263.4	20,132	2,022	1,417
2	986.0	284.0	18.6	4,161.5	718.2	117.2	16,693	656	793
3	683.3	115.4	10.9	3,326.1	317.1	81.6	15,244	243	620
4	557.1	56.0	8.3	2,927.5	159.5	68.4	14,382	94	551
5	492.9	37.6	7.3	2,699.6	108.6	63.3	13,737		
6	448.0	33.4	6.8	2,527.8	97.0	60.7			
7	407.9	29.6	6.3	2,370.1	86.6	58.3			
8	371.9	26.4	5.9	2,225.2	77.2	56.1			
9	339.6	23.5	5.5	2,091.9	68.8	54.0			
10	310.7			1,969.2					

Table B6(c). *Deferred period 13 weeks*

Age y exact at date of falling sick

Sickness duration	20			40			60		
Weeks	$l(y,z)$	$r(y,z)$	$d(y,z)$	$l(y,z)$	$r(y,z)$	$d(y,z)$	$l(y,z)$	$r(y,z)$	$d(y,z)$
13	100,000	4,294	199	100,000	3,037	233	100,000	1,763	352
14	95,507	6,227	190	96,730	4,440	226	97,885	2,564	346
15	89,090	7,466	177	92,065	5,407	215	94,974	3,130	337
16	81,447	8,097	161	86,443	5,994	201	91,508	3,501	325
17	73,190	7,538	144	80,248	5,730	186	87,682	3,392	311
18	65,508	6,333	129	74,333	4,943	172	83,979	2,966	298
19	59,046	5,365	116	69,217	4,295	160	80,715	2,609	285
20	53,566	4,579	105	64,762	3,755	149	77,821	2,306	273
21	48,882	3,937	95	60,858	3,302	139	75,242	2,048	262
22	44,850	3,407	86	57,416	2,919	130	72,931	1,827	252
23	41,357	2,966	79	54,367	2,594	122	70,852	1,636	242
24	38,312	2,596	72	51,651	2,315	115	68,974	1,470	233
25	35,643	2,285	66	49,221	2,075	108	67,272	1,325	224
26	33,292	2,020	61	47,038	1,867	102	65,722	1,198	216
27	31,211	1,795	56	45,069	1,686	96	64,308	1,087	209
28	29,360	1,601	52	43,287	1,528	91	63,012	988	201
29	27,707	1,434	48	41,668	1,389	86	61,823	900	194
30	26,225	1,289	45	40,193	1,266	82	60,729	822	188
31	24,891	1,162	42	38,845	1,158	78	59,718	753	182
32	23,687	1,052	39	37,610	1,061	74	58,784	691	176
33	22,596	955	37	36,475	975	70	57,918	635	170
34	21,604	869	35	35,430	898	67	57,113	584	165
35	20,700	793	32	34,464	829	64	56,365	539	160
36	19,875	726	31	33,571	767	61	55,666	497	155
37	19,118	666	29	32,744	710	59	55,014	460	150
38	18,423	613	27	31,974	659	56	54,404	426	146
39	17,783	565	26	31,259	613	54	53,832	395	142
40	17,192	521	24	30,591	571	52	53,296	367	138
41	16,647	483	23	29,968	533	50	52,791	341	134
42	16,141	447	22	29,385	498	48	52,317	317	130
43	15,671	415	21	28,839	466	46	51,869	296	127
44	15,235	387	20	28,327	437	45	51,447	276	123
45	14,828	360	19	27,845	410	43	51,048	257	120
46	14,449	336	18	27,393	385	42	50,671	240	117
47	14,095	314	17	26,966	362	40	50,313	225	114
48	13,763	294	17	26,564	341	39	49,974	210	111
49	13,452	276	16	26,185	321	38	49,652	197	109
50	13,161	259	15	25,826	303	36	49,347	185	106
51	12,887	285	17	25,487	336	42	49,056	203	122
Years									
1	12,584	6,110	358	25,109	8,020	1,017	48,731	4,894	3,431
2	6,116	1,762	115	16,072	2,774	452	40,405	1,587	1,919
3	4,238	716	67	12,845	1,225	315	36,899	587	1,500
4	3,456	347	51	11,306	616	264	34,812	228	1,334
5	3,057	233	45	10,426	419	244	33,251		
6	2,779	207	42	9,762	375	234			
7	2,530	184	39	9,153	335	225			
8	2,307	164	36	8,594	298	217			
9	2,107	146	34	8,079	266	209			
10	1,927			7,605					

Table B6(d). *Deferred period 26 weeks*

Age y exact at date of falling sick

Sickness duration	20			40			60		
Weeks	$l(y,z)$	$r(y,z)$	$d(y,z)$	$l(y,z)$	$r(y,z)$	$d(y,z)$	$l(y,z)$	$r(y,z)$	$d(y,z)$
26	100,000	1,882	188	100,000	1,221	220	100,000	556	331
27	97,930	2,870	180	98,559	1,869	212	99,112	844	323
28	94,881	3,657	170	96,477	2,400	204	97,946	1,078	314
29	91,053	4,250	160	93,874	2,820	195	96,553	1,266	304
30	86,644	4,257	149	90,860	2,862	185	94,984	1,286	294
31	82,237	3,840	139	87,813	2,617	176	93,404	1,178	284
32	78,258	3,475	130	85,020	2,399	167	91,943	1,080	275
33	74,653	3,154	122	82,454	2,204	159	90,588	992	266
34	71,377	2,872	114	80,091	2,030	152	89,330	914	258
35	68,391	2,621	107	77,909	1,874	145	88,158	842	250
36	65,663	2,399	101	75,891	1,733	139	87,066	778	242
37	63,163	2,201	95	74,019	1,606	133	86,046	719	235
38	60,866	2,024	90	72,280	1,491	127	85,092	666	228
39	58,752	1,865	85	70,662	1,386	122	84,198	618	221
40	56,801	1,723	81	69,154	1,291	117	83,358	574	215
41	54,998	1,594	77	67,745	1,205	113	82,570	533	209
42	53,327	1,478	73	66,427	1,126	109	81,827	496	204
43	51,776	1,373	69	65,193	1,053	105	81,127	462	198
44	50,334	1,277	66	64,035	987	101	80,467	431	193
45	48,991	1,190	63	62,947	926	97	79,843	402	188
46	47,738	1,111	60	61,923	870	94	79,253	376	183
47	46,567	1,038	58	60,960	818	91	78,694	351	179
48	45,472	972	55	60,051	770	88	78,163	329	174
49	44,445	911	53	59,193	726	85	77,660	308	170
50	43,482	855	51	58,382	685	82	77,182	289	166
51	42,576	942	57	57,615	759	94	76,727	318	191
Years									
1	41,577	20,188	1,184	56,761	18,131	2,299	76,218	7,655	5,366
2	20,205	5,821	381	36,331	6,270	1,023	63,197	2,482	3,002
3	14,003	2,364	223	29,038	2,768	712	57,713	918	2,346
4	11,417	1,147	170	25,558	1,392	597	54,449	356	2,086
5	10,100	770	150	23,569	948	552	52,007		
6	9,181	684	139	22,069	847	530			
7	8,358	608	129	20,692	756	509			
8	7,621	540	120	19,427	674	489			
9	6,960	481	112	18,263	600	471			
10	6,367			17,192					

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* See also 'On Graduation by Mathematical Formula', D. O. Forfar, J. J. McCutcheon and A. D. Wilkie *JIA* **115**, 1 and *TFA* **41**, 97.

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